Operational and Scientific Monitoring Plan

Environmental Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

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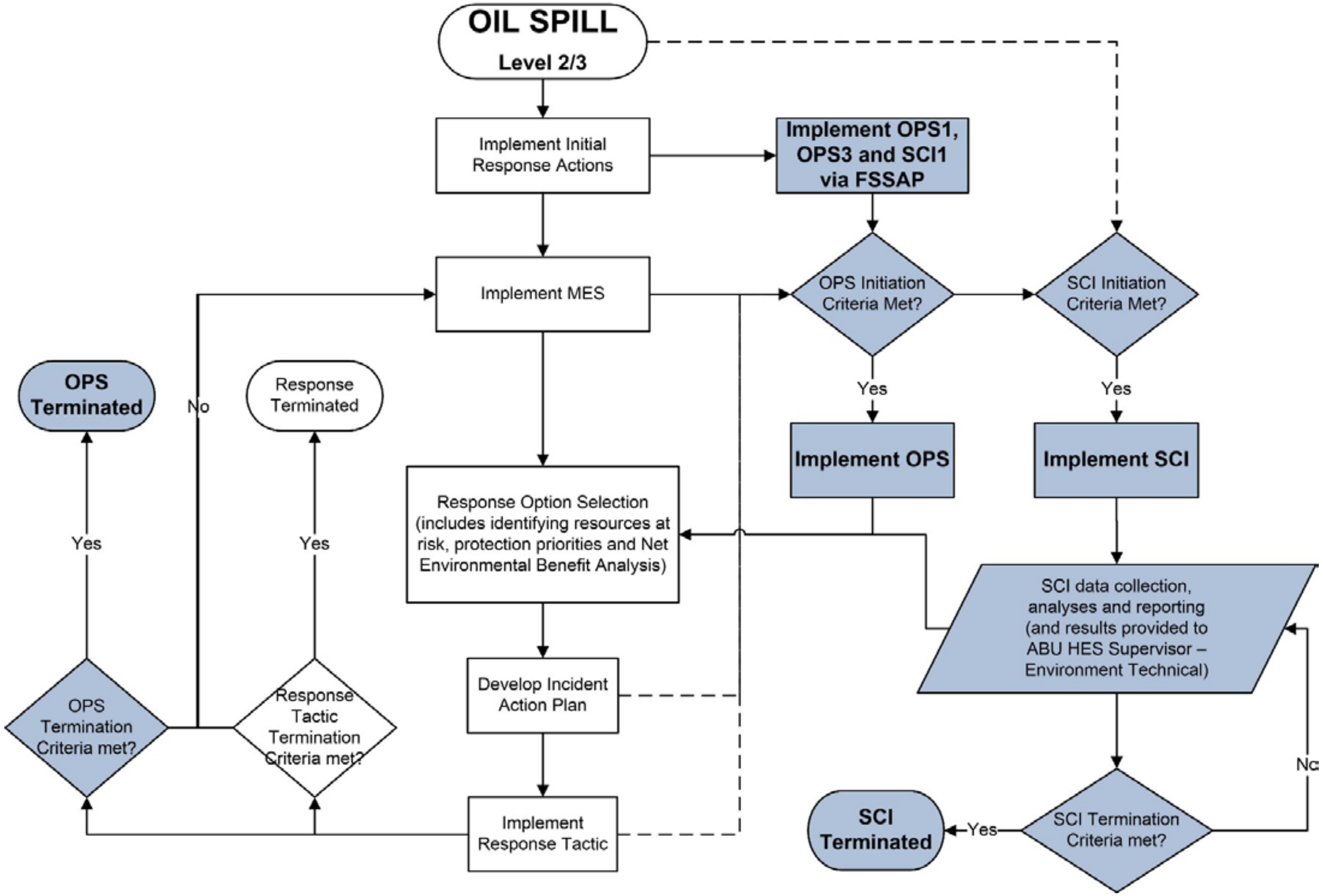
QUICK REFERENCE GUIDE

Operational and Scientific Monitoring within the Oil Spill Response Planning Process



Note: Shaded cells refer to steps related to this Plan. For details relating to other steps, refer to the relevant OPEP.

Overview of Monitoring Components

Code	Operational Component	Aim of Monitoring
OPS1	Oil Characterisation	Identify physical/chemical properties of the oil via laboratory analysis to assist response option(s) selection
OPS2	Chemical Dispersant Efficacy	Rapid information on the efficacy of dispersants as a response option
OPS3	Oil in Water	Collect data on the effects of the spill and response options (including dispersants) on water quality
OPS4	Oil in Sediment	Collect data on the exposure of sediments to oil and any effect of response activities on sediment quality
OPS5	Rapid (Oiled) Shoreline	Assess the state of shoreline habitats, presence and extent of oil, assess impacts of response activities
OPS6	Rapid Seabird and Shorebird	Rapidly quantify the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted or already impacted, assess the impacts of response activities
OPS7	Rapid Marine Megafauna	Rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted or already impacted
OPS8	Fish Tainting	Collect data on the effects of the spill and response options on pelagic and benthic fish species
Code	**Scientific Component**	**Aim of Monitoring**
SCI1	Water Quality	Assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI2	Sediment Quality	Assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation
SCI3	Coastal and Intertidal Habitat	Assess impacts to coastal and intertidal habitats and associated biological communities
SCI4	Seabird and Shorebirds	Identify and quantify the post-impact status and recovery of seabirds and shorebirds
SCI5	Marine Megafauna	Identify and quantify the post-impact status and recovery of marine reptiles, pinnipeds and other marine megafauna
SCI6	Benthic Habitat	Assess impacts to subtidal benthic habitat and biological communities
SCI7	Fisheries, Aquaculture, Fish	Monitor lethal and sublethal effects on fish and aquaculture species, and changes in fish population and abundance
SCI8	Heritage	Monitor changes in shipwrecks

Initiation Criteria and Implementation Times

Criteria	What is Initiated	Implement When	By Who	Comments
Level 2 or above spill to marine waters	This Plan, and OPS1,3 and SCI1 & SCI3 via the FSSAP	72hrs of the EMT declaring a Level 2/3 spill	OSMP Team, or field crew. Refer to FSSAP	The First-strike Sampling and Analysis Plan (FSSAP) is a template for rapid implementation of OPS1, 3 and 4.
Dispersant application is selected and is applied	OPS2 – Dispersant Efficacy Testing	Refer to relevant OPEP. Implement when dispersant is applied	Oil spill responder	
Oil predicted to reach coastal areas or shorelines	OPS4 is initiated for sediments	5 days from first prediction of coastal/shoreline exposure	OSMP Team, or field crew. Refer to FSSAP	Refer to First-strike Sampling and Analysis Plan for template
	OPS5 is initiated for rapid shoreline assessment	Refer to applicable OPEP / EP	Oil spill responder – shoreline specialist	
	OPS6 is initiated if those shores support seabirds/shorebird populations or their habitats	48 hrs from predicted/confirmed exposure to birds or shoreline habitats	Initially: Oil spill responder – shoreline specialist Later: OSMP Team	
Predicted exposure of oil to offshore sediments	OPS4 is initiated	5 days from first prediction of exposure to offshore sediments	OSMP Team	Refer to First-strike Sampling and Analysis Plan for template
Predicted exposure to sensitive marine megafauna habitat or migration pathways or fisheries	OPS7 for megafauna	48 hrs from first prediction of exposure to sensitive marine megafauna habitat	Initially: Aerial surveillance specialist Later: OSMP Team	
	OPS8 for fish tainting	5 days from first prediction of exposure of oil to known fisheries	OSMP Team	
OPEP response options implemented	Refer to Table on following page for activation of OPS components due to response options	Refer to each OPS component.	Refer to each OPS component.	Some response options and support functions trigger OPS components, e.g.: dispersant application, shoreline protection, shoreline clean-up, oiled wildlife, and waste management

Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Monitoring, Evaluation, and Surveillance
(Oil Pollution Emergency Plan (OPEP))

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X	X				X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X

OPS1: Oil Characterisation

OPS2: Chemical Dispersant Efficacy Assessment

OPS3: Oil in Water Assessment

OPS4: Oil in Sediment Assessment

OPS5: Rapid (Oiled) Shoreline Assessment

OPS6: Rapid Seabird and Shorebird Assessment

OPS7: Rapid Marine Megafauna Assessment

OPS8: Fish Tainting Assessment

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5.

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1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP) (this Plan) describes the types of environmental monitoring that may be implemented in the event of an emergency condition[1] resulting in a Level 2 or above oil spill to marine or coastal waters where Chevron Australia Pty Ltd (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State). This Plan and associated documents is the principal tool for determining the extent, severity, and persistence of environmental impacts from an oil spill.

This Plan was also developed to meet monitoring requirements under these Commonwealth and State regulations:

- Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations
- Petroleum and Geothermal Energy Resources (Environment) Regulations
- Petroleum Pipelines (Environment) Regulations
- Petroleum (Submerged Lands) (Environment) Regulations.

Broadly, this Plan comprises two types of monitoring: operational and scientific. Operational monitoring collects information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations. Operational monitoring typically finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Scientific monitoring focuses on the short-and long-term environmental impact assessment. It may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Scientific monitoring determines the potential ongoing environmental impact attributable to the spill or the associated response activities, and informs the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a particular assessment or study, and has tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. Despite the individual initiation/termination criteria, components are inextricably linked, both across and within the two types of monitoring.

Aside from the initiation and termination criteria, the information in this Plan (and supporting documents, refer to Section 1.2) is not prescriptive; it provides a flexible framework for environmental monitoring that can be adapted based on the characteristics of a specific oil spill event. The Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred so that the monitoring implemented is appropriate to the nature and scale of the event.

[1] Emergency conditions are defined in each activity-specific Environmental Plan (EP) and relevant Oil Pollution Emergency Plan (OPEP).

1.2 Scope

This Plan focuses on operational and scientific monitoring of a Level 2 or above[2] oil spill event only, where CAPL is the Nominated Titleholder or Operator. Oil spill risks, prevention, and response activities are described in the activity-specific Environment Plan (EP) and Oil Pollution Emergency Plan (OPEP). Monitoring, Evaluation, and Surveillance (MES) activities of an oil spill are excluded from operational monitoring in this Plan; these are included in the relevant[3] OPEP.

This Plan is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 1). The relationship between the various emergency management and oil spill documentation is outlined in Figure 1-1. An emergency condition would result in the activation of the Emergency Management Team (EMT), and the relevant OPEP and this Plan would be enacted (Figure 1-1).

In the event of an oil spill, activity-specific plans (which may include Oil Spill Tactical Response Guides and Incident Management Guides) will be enacted by the On-site Response Team (ORT) who will control the source of the spill and initiate any immediate actions required to ensure personnel safety and reduce the volume of oil released to the environment.

For spill events where CAPL is not the Control Agency, the scientific monitoring components are activated as per the initiation triggers listed in Section 5; the Control Agency is responsible for implementing operational monitoring.

[2] Although Level 1 oil spills may have environmental impacts that require investigation (at an appropriate scale), Level 1 spills are typically small in size and of short duration; the spill response may be complete before the OSMP could be implemented.

[3] CAPL is currently transitioning to a consolidated OPEP that will eventually address multiple activity-specific EPs and replace activity-specific OPEPs. This document will use the term ‘relevant OPEP’ until such time as all activity-specific EPs are addressed by the consolidated OPEP. Emergency Management Teams should check with the ABU Oil Spill Coordinator or the OSMP Monitoring Coordinator to understand which OPEP is applicable at the time.

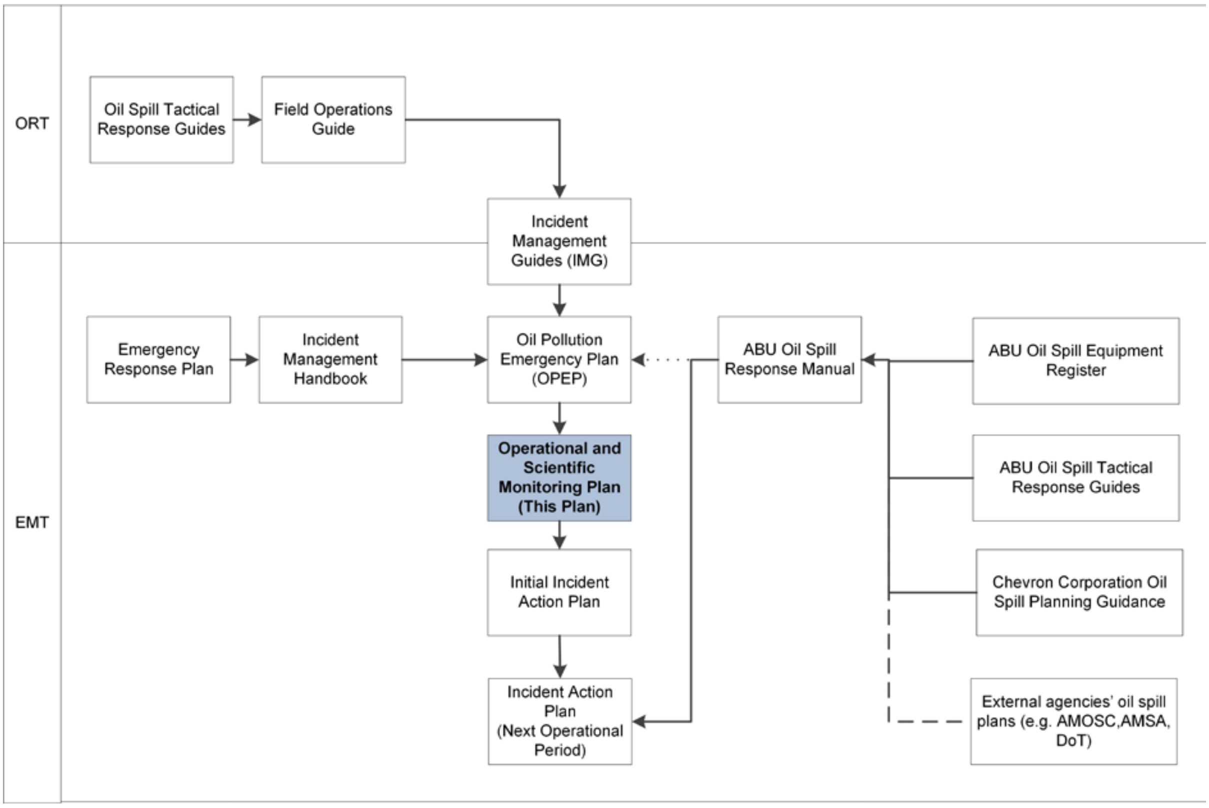

Figure 1-1: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Plan.

This Plan is supported by a number of other documents, tools and processes, as indicated in Figure 1-2.

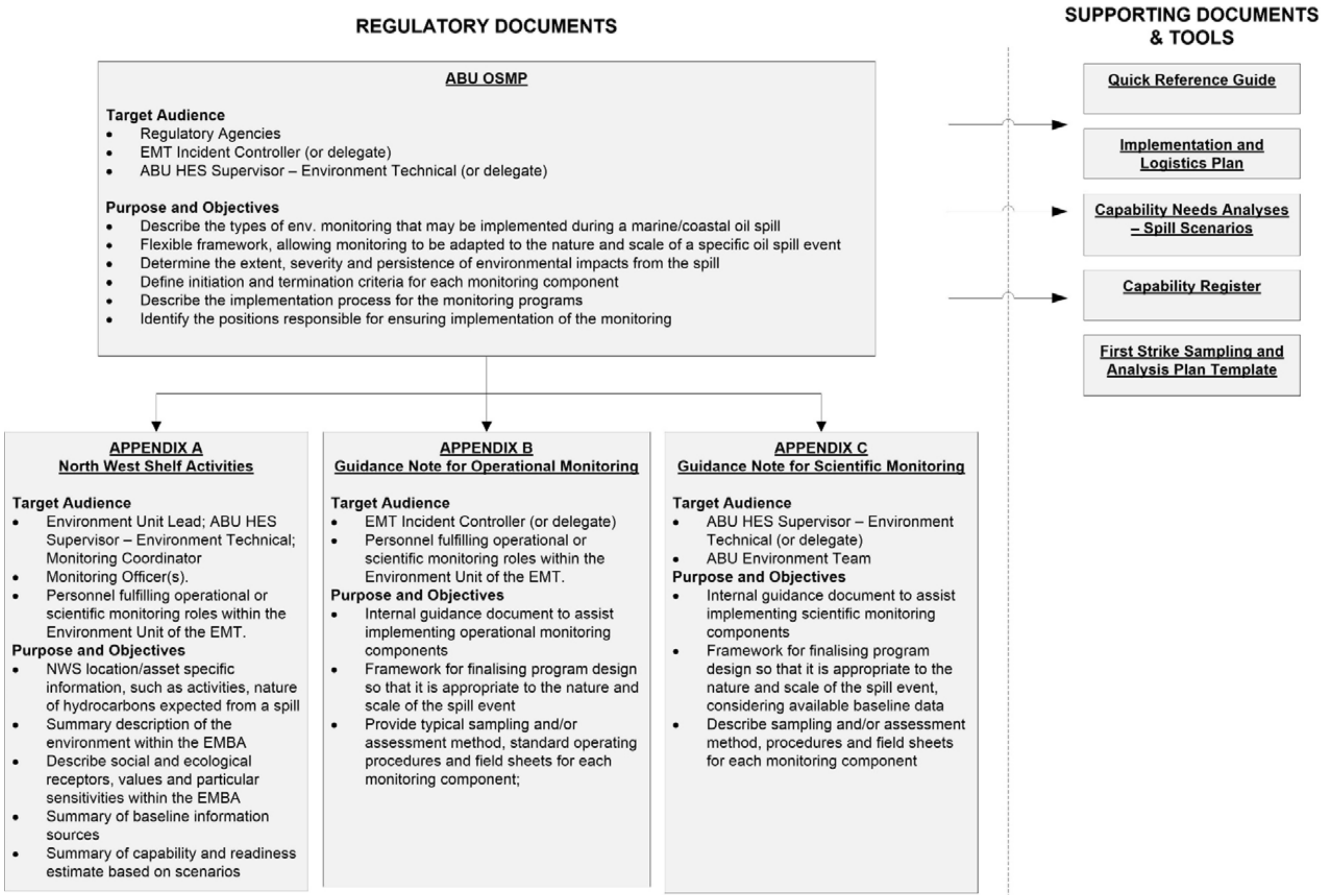

Figure 1-2: ABU OSMP Document Hierarchy and Supporting Tools

1.3 Objectives

The objectives of this document are to:

- describe the components of the operational and scientific monitoring that may be implemented in the event of an oil spill to marine or coastal waters
- define initiation and termination criteria for each monitoring component
- outline the environmental monitoring framework and process for designing and implementing the monitoring components
- identify the positions responsible for ensuring implementation of the monitoring
- outline the process for identifying, developing, and maintaining scalable capability to implement this Plan in a timely manner that is appropriate to the nature and scale of the event
- summarise the Environment that May be Affected (EMBA) by oil spills resulting from CAPL's activities on the North West Shelf; including sensitive environmental receptors within those areas
- outline estimates of capability and readiness required to implement this Plan in those areas
- provide guidance on designing monitoring programs and standard operating procedures for typical monitoring methods.

1.4 Target Audience

This document is intended for use by:

- EMT Incident Commander
- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s).

2 Implementation Strategy

The OSMP (this Plan) is one of the key processes under the Emergency Management (Ref. 2) element of the Operational Excellence Management System (OEMS). The OEMS is a comprehensive management framework that supports Chevron Corporation's commitment to protect the safety and health of people and the environment. The OEMS framework ensures a systematic approach to environmental management, with the environmental aspects of each project addressed from project conception, throughout project planning, and as an integral component of implementation.

This Section outlines:

- Activation of this Plan, initiation of individual components, and implementation of those components
- positions, roles and responsibilities for personnel involved in implementing operational and scientific monitoring, specifically the key positions responsible for meeting the commitments outlined in this Plan
- the systems and processes to ensure that the Plan is fit for purpose and CAPL is ready to implement it
- the mechanism for consulting with stakeholders while implementing the Plan
- the schedule for reviewing this Plan to maintain currency of information and pursue continual improvement.

Specific information related to implementing this Plan on the North West Shelf geographic area is provided in the Appendix A.

2.1 Activation, Initiation, and Implementation

This Plan is activated when the EMT declares a Level 2 (or above) spill to marine or coastal waters[4], where CAPL is the Nominated Titleholder or Operator. For this Plan, activation means the requirements of the Plan are now applicable.

Individual monitoring components are initiated and terminated according to prescriptive initiation and termination criteria, respectively. For the Plan, initiation means starting preparation for implementation.

Upon initiation, some monitoring components have specific timeframes for implementation. For this Plan, the implementation time refers to being ready, at the point of staging or departure, to mobilise for monitoring. For example, for vessel-based monitoring components it could mean being field-ready with equipment, personnel and other resources at the nominated staging area or vessel departure point.

2.2 Roles and Responsibilities

The roles and responsibilities outlined in Table 2-1 apply to monitoring during the incident response while the EMT is active; a subset of these positions may be maintained beyond the response phase. For positions not specific to this Plan, the roles and responsibilities listed in Table 2-1 are in addition to those identified in other Emergency Management documents.

The EMT Incident Commander (or delegate) is ultimately accountable for managing the response operation, which includes this Plan. The OSMP

[4] Marine or coastal waters includes waters within Australian Marine Parks

Monitoring Coordinator is the key coordination role for implementing OPS and SCI components in accordance with this Plan and reporting to the Environment Unit Lead. However, the ABU HES Supervisor – Environment Technical (an everyday non-EMT position) has a key role in advising implementation of scientific monitoring components during the response phase, liaising directly with the EMT Incident Commander or indirectly via the OSMP Monitoring Coordinator. Beyond the response phase the ABU HES Supervisor – Environment Technical assumes responsibility for ongoing scientific monitoring.

Several OSMP-specific roles (see shaded cells in Figure 2-1) are designated through this Plan. Depending on the scale of the event, individual people may perform multiple roles; similarly, multiple people may share the same role.

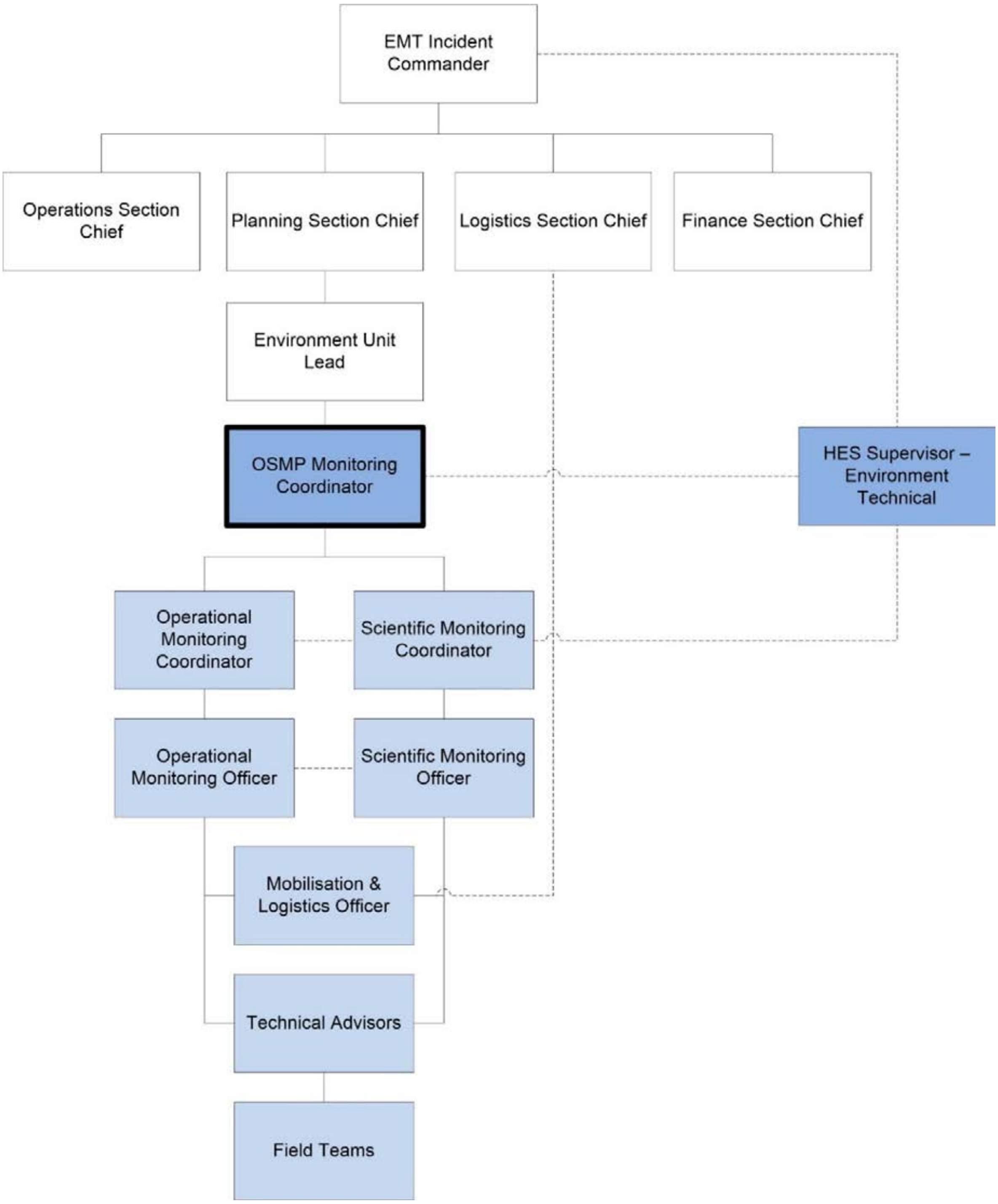

Figure 2-1: Organisational Structure Associated with Implementing Operational and Scientific Monitoring

Note: Shaded cells refer to roles specific to this Plan.

Table 2-1: Roles and Responsibilities

Role	Responsibility Summary
EMT Incident Commander (or delegate)	Ultimately accountable for implementing this Plan. Specific responsibilities: • ensure that the ABU HES Supervisor – Environment Technical (or delegate) and the Environment Unit Lead is sufficiently resourced to oversee and guide implementation of this Plan
Environment Unit Lead	The Environment Unit Lead has a broad range of duties in an emergency response. For this Plan, the Environment Unit Lead is the key position for relaying information between the EMT and the Monitoring Coordinator. Specific responsibilities: • ensure OSMP-specific roles (Figure 2-1) are established • integrate operational and scientific monitoring with the emergency response
OSMP Monitoring Coordinator	Responsible for coordinating the implementation of OPS and SCI components in accordance with this Plan, specifically: • identify the monitoring components that may be triggered based on the information collected during MES, OPS and via implementation of response options • ensure that monitoring components are implemented according to their specific initiation criteria, within nominated response times, and aligned with descriptions provided in Sections 4 and 5 and the relevant guidance notes (Appendix B and Appendix C) • contact point with the EMT via the Environment Unit Lead • facilitate activation of external support, if necessary.
ABU HES Supervisor – Environment Technical (or delegate)	• Oversee implementation of scientific monitoring components • Focal point for liaising with relevant stakeholders on monitoring design, monitoring priorities, and results (as required).
Scientific Monitoring Coordinator and Operational Monitoring Coordinator	The Operational and Scientific Monitoring Coordinators are the key program management roles for each type of monitoring. Responsibilities include: • provide overarching technical advice • advise on environmental impact from implementing monitoring and response options • approve final sampling and analysis plans for monitoring components
Operational Monitoring Officer and Scientific Monitoring Officer	The Operational and Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • ensure sampling and analysis plans align with monitoring objectives • understand the data metrics collected in the event of a spill • advise the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, logistics) are encountered • oversee data analyses and interpretation • manage data, including spatial data • present data in an appropriate and informative format to allow for timely decisions.
Technical Advisors	Technical Advisors are assigned to individual monitoring components as required. Key responsibilities include: • advise on sampling design, methods and analysis. Assist in developing sampling and analysis plans • ensure quality assurance/quality control (QA/QC) of data, and its interpretation • prepare reports.

Role	Responsibility Summary
Mobilisation and Logistics Officer	Responsible for: • ensuring all field teams are mobilised to site as soon as practicable and in accordance with CAPL processes. • liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of monitoring field teams. • Identify and help facilitate procurement of any necessary resources.
Field Teams	A Field Team includes one Field Team Lead, who is the key contact point to the Technical Advisor or Monitoring Officer during a field deployment. The responsibilities of all Field Team members include: • understand the details of monitoring methods • ensure that they are supplied with adequate equipment and field data collection sheets to undertake the monitoring component • ensure awareness and understanding of QA/QC procedures • help with report preparation if required.
Other roles	Other support roles may include: • scribe(s) to document decisions • Document / data manager • External consultant coordinator • Laboratory services coordinator

2.3 Capability and Readiness

Development and maintenance of capability and readiness to implement the OSMP is categorised into three key resource groups:

- personnel
- logistics
- equipment, infrastructure, and support services.

Implementation of system-level measures such as internal reviews, readiness assessments (exercises and drills), and schedules ensure that resources within these interconnected groups are fit for purpose, capable, and ready for deployment to meet the required outcomes of the OSMP. CAPL's compliance assurance process manages compliance by verifying conformance against OSMP commitments (Section 2.4.1).

2.3.1 Personnel

Those capable of implementing this OSMP come from internal (CAPL and corporate global structure) and external (contractor) personnel.

Suggested minimum capability requirements (qualification, training, awareness, and experience) for individuals to fulfil OSMP-specific roles, from HES – Supervisor Environment Technical through to Field Team member, are identified in the ABU OSMP Capability Register (Ref. 3). The estimated number of personnel needed to fulfil roles for any given event depends on the event's circumstances. These estimates are determined internally and guided via internal workshops or exercises for responding to a range of credible scenarios, with a credible worst-case scenario defining the upper limit of the estimate. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

The expected capability of individual personnel to perform OSMP roles is assessed by comparing their skills against the requirements. Personnel are graded into one of three competency levels for each role according to these guidelines:

- SME (Subject Matter Expert level): knowledgeable and qualified. Examples of knowledge include peer reviewed publications, expert panel positions, and extensive experience (15+ years). Examples of qualification include relevant degrees: PhD or MS or BSc Hons with extensive experience. Such a person should be able to direct research and have in-depth knowledge of principles and practices of the role.
- P (Practitioner level): knowledgeable in the specific area. Examples of knowledge include experience (5+ years), and/or publications. Such a person should have a relevant degree (BSc or above) and experience, and be able to implement research and understand the principles of the role.
- A (Awareness level): a level of competency. Examples of competency include some level of practical experience to implement the role. Such a person should have relevant qualifications and/or experience, and be able to assist in implementing the role, but may not thoroughly understand principles or practices.

For specific key OSMP roles, people may be strategically pre-nominated based on their suitability to specific positions; with redundancy in personnel able to fill the key role. When this Plan is enacted, individual personnel will be assigned to key OSMP roles using this process:

- Identify roles that must be filled according to Figure 2-1 and the specific OPS and SCI Plans that have, or are likely to be, initiated. Note: EMT Incident Commander and Environmental Unit Leader roles are filled under Emergency Management.
- Confirm that individuals within CAPL who have been pre-nominated on the ABU OSMP Capability Register (Ref. 3) are still suitable for their roles and are available.
- Assign identified individuals to roles and communicate these assignments to the EMT.

Internal personnel capability is documented every six months in the ABU OSMP Capability Register. External contractors self-assess their capability against the requirements and provide a Statement of Personnel Capability and Readiness every six months.

2.3.1.1 Internal

Internal capability within CAPL includes those based in Western Australia (Perth, Onslow, and Barrow Island). If required, Chevron Corporation’s international offices (e.g. San Ramon [California]; Houston) have personnel skilled in oil spill monitoring if the scale and duration of the response is beyond local personnel.

Internal personnel are assigned to these OSMP-specific roles:

- HES Supervisor – Environmental Technical
- Monitoring Coordinator
- Operational Monitoring Officer/Scientific Monitoring Officer

- Mobilisation and Logistics Officer

Internal staff may perform Field Team roles and responsibilities, particularly first-response OPS monitoring; however, it is expected that Field Team personnel would be sourced externally.

2.3.1.2 External

External personnel, primarily for the roles of Field Team or Technical Advisors, are likely to be filled by contractors to CAPL and/or service providers. Current external capability relevant to specific OPS and SCI Plans and available to CAPL is summarised in Table 2-2.

Further scalability of external personnel is achievable through corporate-level contracts with service providers. For example, Chevron Corporation maintains a contract with Cardno for general environmental services, including responding to emergency situations.

Table 2-2: Capability and Arrangements for External Contractors

Contractor Type	Capability	Activation
Environmental Contractors	All operational and scientific monitoring components	Master contracts exist between CAPL and several specialist environmental consultancies, allowing them to undertake the types of monitoring required under this Plan. Additionally, environmental consultants contracted to Chevron corporation are also available.
Environmental Research Agencies	All operational and scientific monitoring components	Master contracts exist between CAPL, the Cooperative Research Council (CRC), the WA Energy Research Alliance (WA ERA) and Murdoch University, which allow several research agencies and universities to undertake the types of monitoring required under this Plan.
AMOSC	Aerial surveillance and dispersant efficacy testing - field (OPS2), rapid shoreline assessment (OPS5)	CAPL is an AMOSC member company and is represented on the AMOSC board. Activation is via 24hr, 7 days a week emergency hotline.
OSRL	Aerial surveillance and dispersant efficacy testing (OPS2)	CAPL is a member of OSRL. Activation is via 24hr, 7 days a week emergency hotline.
ChemCentre WA	Dispersant efficacy testing – laboratory (OPS2)	CAPL has a direct contract with ChemCentre.

2.3.1.3 Development of Personnel Capability

As described in Section 2.3.1, the ABU OSMP Capability Register (Ref. 3) defines the upper estimate of personnel requirements to implement this Plan for a credible worst-case scenario.

CAPL has a process to develop and record personnel capability (training, awareness, and experience) towards meeting the requirements. This process includes:

- an ABU OSMP Training Plan (included as part of the ABU OSMP Capability Register (Ref. 3)), which is used to identify and schedule capability development activities

- recording the completion of capability development, either through the Learning Management System (for computer-based learning components), or manually via the ABU OSMP Capability Register (Ref. 3)
- collating additional competency data within the ABU OSMP Capability Register (Ref. 3). Data collated include, but are not limited to, qualifications (tertiary education), years of experience, training (e.g. oil spill training, oiled wildlife response, offshore survival), and emergency exercise involvement.

The ABU Environmental Team Lead (or delegate) is responsible for ensuring that the above process and associated procedure(s) are implemented correctly, via six-monthly verification of the ABU OSMP Capability Register (Ref. 3) and six-monthly verification of external contractors' Statements of Personnel Capability and Readiness.

2.3.2 Logistics

Capability and readiness to implement this Plan depends on a functioning logistics system. Although the Mobilisation and Logistics Officer nominated through this Plan is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, the capability and readiness to execute the required work is held within, and delegated to, the CAPL Supply Chain Management Team via the EMT.

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) defines the minimum logistics capability required to implement this Plan within the required time frames. The requirements for any given event depends on the event's circumstances, but the upper estimate of logistics support is determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities.

Resources and logistics required to resource this Plan are just a subset of those required to resource a spill response. ABU Supply Chain Management, along with a large pool of contractors, is equipped with personnel to service ABU's complex and diverse asset portfolio (including two large LNG plants, an onshore oilfield, and offshore platform and offshore wells). During a spill, logistics resources would be re-directed to the response.

2.3.2.1 Access

For areas not under CAPL's operational control, access will be planned in conjunction with relevant State and Commonwealth statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), WA Department of Biodiversity, Conservation and Attractions (or equivalents) for marine parks, and relevant agencies for access to restricted heritage protection areas.

2.3.3 Equipment, Infrastructure, and Support Services

The ABU OSMP Capability Register – Resource Requirements Analysis (Ref. 4) estimates the equipment and infrastructure required to implement this Plan within the required time frames. The requirements for any given event depend on event's circumstances; the upper estimate of logistics support was determined internally, guided via internal workshops or exercises simulating a response to credible worst-case scenarios. These scenarios cover the geographic range of CAPL's petroleum activities; refer to Appendix A for scenarios related to North West Shelf activities. Critical equipment is identified and stores/inventories maintained according to need.

The capability and readiness to procure equipment, infrastructure, and support services is held within, and delegated to, the CAPL Supply Chain Management Team. Internal capability and/or external contractual arrangements for many of the support services are already in place; examples are presented in Table 2-3.

Table 2-3: Capability and Arrangements for Equipment, Infrastructure, and Support Services

Support Service	Capability	Activation
Analytical Laboratories	All laboratory analyses	Master contracts exist between CAPL and selected analytical laboratories, allowing them to undertake the types of analysis required under this Plan. Laboratories associated with university or research institutions can also be accessed via the CRC and WA ERA arrangements.
Vessels	Vessels of a range of size classes, specifications and capabilities, from small landing craft and tender vessels up to Platform Support Vessels	Master contracts exist between CAPL and selected vessel providers, with ability to provide all types of survey vessel that may be required under this Plan. Vessel providers are managed by internal CAPL marine logistics experts.
Aircraft	Helicopters and fixed-wing aircraft in a range of size classes and capabilities	Master contracts exist between CAPL and aircraft providers (e.g. Bond helicopters and Cobham aviation). Aircraft providers are managed by internal CAPL aviation experts.
Transport networks	Road and air freight networks	External contractors provide warehousing, line-haul and marine freight services to ABU supply bases and assets, with the ability to scale up services as required.
Travel services	Domestic travel and related services for personnel and small equipment	CAPL has a contract with a corporate travel services business that provides 24-hour support for all personnel travel. Contact with the provider is through CAPL administrators.
Communications	Establishment of communications systems and networks	CAPL telecoms maintain internal capability to procure and deploy communications networks.
Quarantine	Quarantine advice, inspection, detection, response and monitoring	A comprehensive quarantine management system was developed for all freight and personnel movements to/from Barrow Island. This process is administered via the CAPL Supply Chain Management team and, to varying degrees, can be applied to any freight/personnel movements, regardless of the destination. The quarantine management system is managed by internal CAPL experts, with inspection services undertaken by contractors.

2.4 Testing and Verifying Capability

System-level measures (e.g. internal audits, exercises, workshops) test and verify capability and readiness; exercising the OSMP is included in the ABU multi-year exercise schedule. Outcomes from these measures is used for continual improvement.

2.4.1 Compliance Assurance

Compliance Assurance (Ref. 5) is an element of the CAPL OEMS. This process manages compliance by verifying conformance with Operational Excellence requirements in applicable company policy, government laws, and regulations. This process has two key supporting procedures, as detailed below.

2.4.1.1 Compliance Assurance Audit Program

This procedure (Ref. 6) establishes internal audit programs to verify the effectiveness of controls and the extent to which requirements are met by CAPL. Audits may focus on in-field activities or administrative processes depending on the activities being undertaken around the time of audit. A record of audits and the audit outcomes is maintained, and actions arising from internal audits are tracked until closure, in accordance with Section 2.4.1.2.

2.4.1.2 Compliance Assurance Management of Instances of Potential Non-compliance

This procedure (Ref. 7) addresses instances where the requirements may not have been fully met. If findings are identified during internal audits, corrective actions are identified, assigned, and recorded in Essential Suite, which is a Chevron-wide database that sends notifications and follow-up emails to the responsible person for timely closure of audit actions.

2.5 Providing Information and Consulting with Stakeholders

External notification and reporting to regulators, Hazard Management Authorities, and key stakeholders is outlined in the relevant OPEP. The EMT coordinates ongoing communications with stakeholders, via embedding a Policy, Government and Public Affairs (PGPA) representative in the EMT to provide ongoing advice to, and coordination of, stakeholders (e.g. DoT, DBCA, Australian Maritime Safety Authority [AMSA]) or via regular verbal or written communications. The PGPA Officer also coordinates generic communications (e.g. key messaging) with relevant non-regulatory stakeholders through the ABU Communications Response Team.

The ABU HES Supervisor – Environment Technical (or delegate) is the focal point for communication and consultation of a technical scientific nature. This position consults with relevant government stakeholders on monitoring design and priorities, specifically with respect to state marine parks. Claims or objections raised by government stakeholders will be responded to, including communication of changes made to monitoring programs as a result of consultations. Similarly, this role is also responsible for communicating results of monitoring programs. The form, frequency, and content of communications will be appropriate to the nature and scale of the incident.

2.6 Reviewing this Plan

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years or more often as required (e.g. in response to new information). Internal processes linked to implementation of this Plan may be reviewed more frequently.

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, opportunities for improvement identified from inspections, audits, exercises, and any relevant emerging environmental issues.

3 Environmental Monitoring Framework

3.1 Overview

This Plan provides a flexible framework for implementing operational and scientific monitoring, thus allowing adaption to the nature and scale of a specific oil spill event. This Plan lists possible types of sampling and analyses that may be undertaken, allowing for the detailed final design (including selection of sample sites, monitoring priorities, methods, analytes etc.) to be confirmed once an event has occurred. This Plan is linked to the MES component of a spill response, as described in the relevant OPEP and the ABU Oil Spill Response Manual (Ref. 1).

The Plan comprises two types of monitoring:

- Operational – to collect information about the oil spill and associated response options to aid planning and decision making in executing spill response or clean-up operations
- Scientific – to determine the short- and long-term environmental impact of the oil spill and associated responses, and inform the requirements for remediation.

Both types of monitoring comprise several components. Each component represents a discrete assessment or study, with tailored initiation and termination triggers to determine if, and when, that monitoring component will be implemented. In some cases the criteria are fixed; others are linked to the relevant OPEP. Despite the individual initiation/termination criteria, the components are inextricably linked, both across and within the two types of monitoring.

Typically, operational monitoring is initiated by the spill event itself, through MES information collected during the response, or by implementation of a response option. Operational monitoring usually finishes when the spill response is terminated, usually because response objectives were met and/or scientific monitoring was initiated.

Specific components of scientific monitoring are triggered by the spill itself, while others are triggered by data generated by MES and operational monitoring. Scientific monitoring may occur in parallel to operational monitoring and can continue for some time after the oil spill event. Either type of monitoring may occur in areas impacted by the spill, areas not yet impacted by the spill (to gather pre-impact data), and areas not likely to be impacted by the spill (to act as reference or control data).

Figure 3-1 summarises how operational and scientific monitoring relates to oil spill response. The Quick Reference Guide at the front of the document summarises the initiation criteria, termination criteria, and time frames for implementation, while Sections 4 and 5, and Appendix B and Appendix C provide further details for each monitoring component.

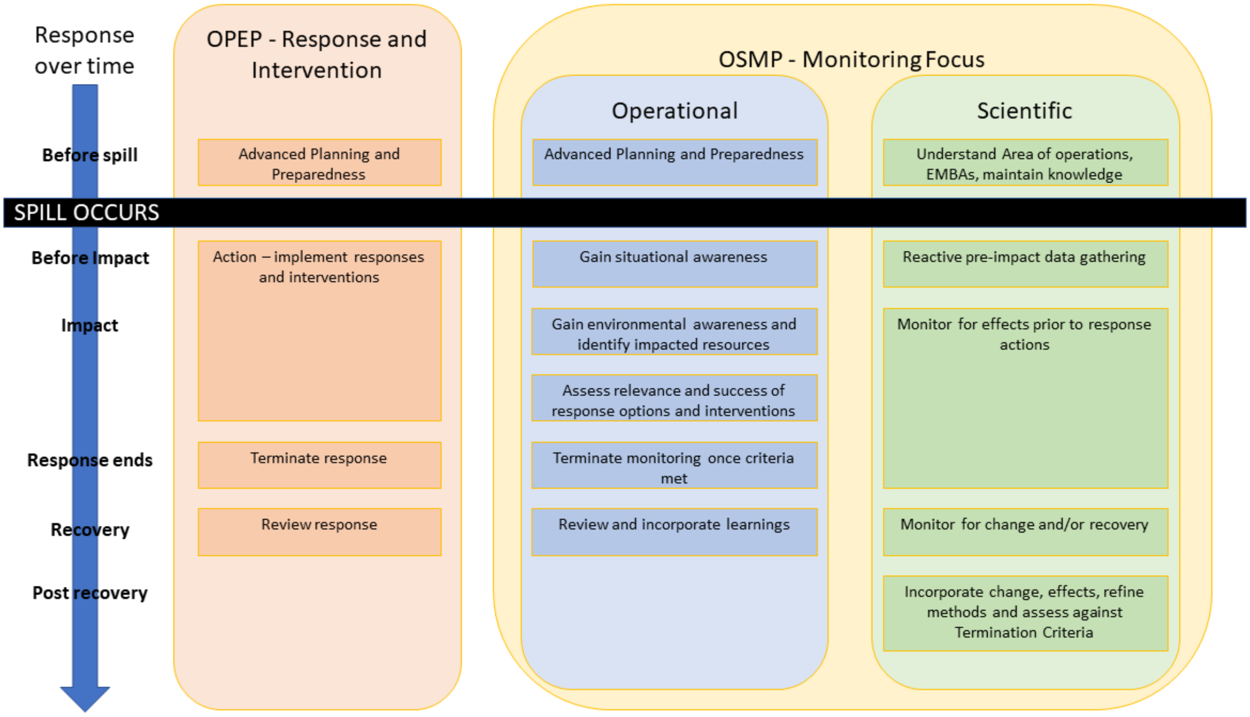

Figure 3-1: Oil Spill Response and Role of Operational and Scientific Monitoring

3.2 Design and Implementation

In the event of a spill to marine or coastal waters, advance planning and pre-mobilisation activities commence in anticipation of initiating monitoring components; these activities include consultation with stakeholders on monitoring design and priorities, as appropriate to the nature and scale of the spill (see Section 2.5).

Once a component of operational or scientific monitoring is triggered, a series of steps, beginning with preparing the final program design, is implemented (Figure 3-2). Each spill event is unique, and therefore the receptors at risk, selection of sites, and implemented monitoring programs will vary between each event.

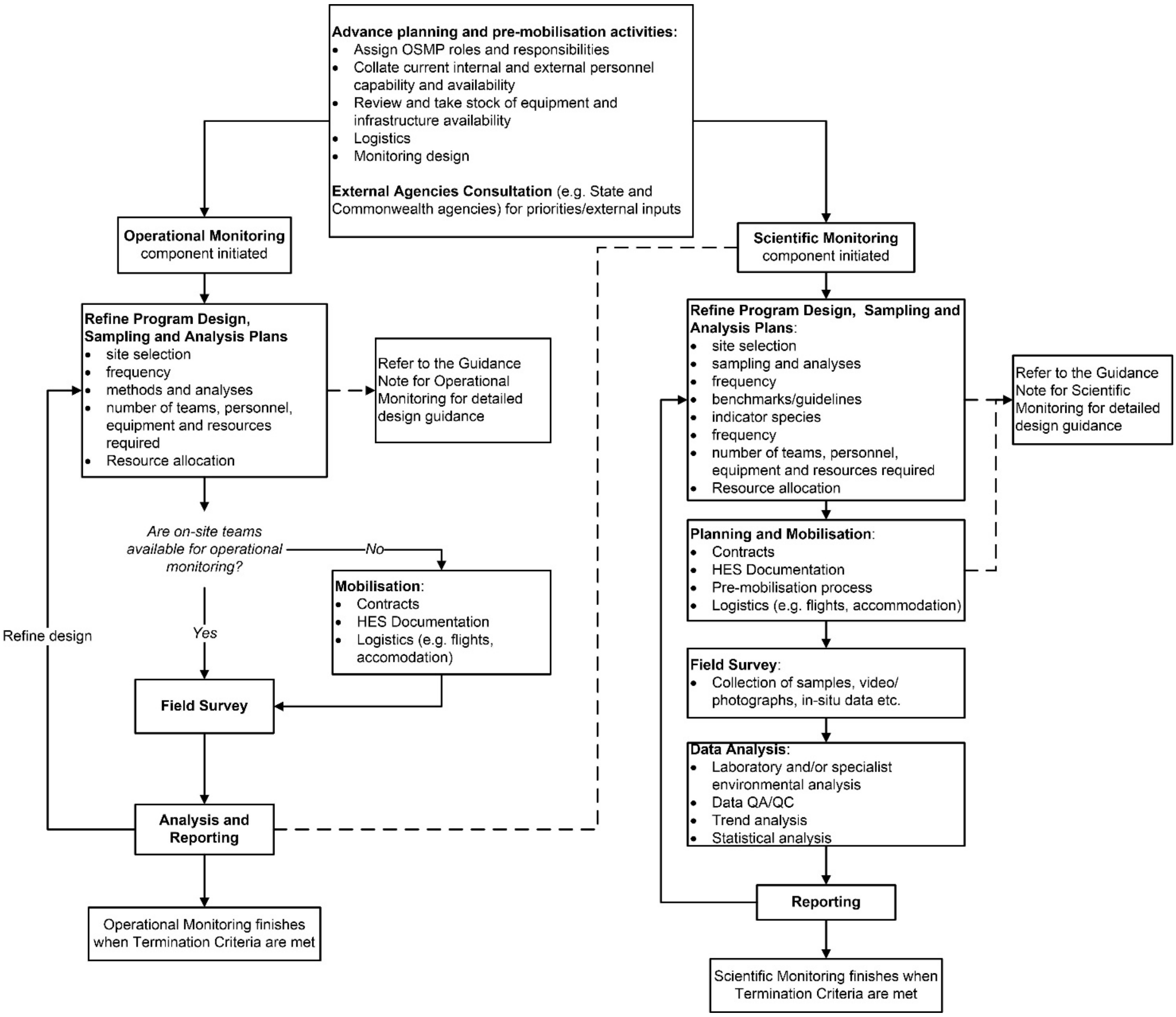

Figure 3-2: Implementation Process for Operational and Scientific Monitoring

Monitoring design is different for the two types of monitoring; however, the methods to obtain the data may be common between monitoring types. Operational monitoring focuses on informing planning and decision making in executing spill response; therefore, the objectives of this monitoring are closely linked to the MES tactics and response options used. Scientific monitoring focuses on determining the short- and long-term impacts; therefore, the main objective of this monitoring is to establish cause and to quantify effects.

Regardless of the monitoring type, common elements of designing a monitoring program include:

- clarify how the monitoring information will be used
- set the objectives of the study – what does the program seek to measure (e.g. descriptive; measurement of change; determination of cause and effect)
- define the parameters to include in monitoring
- define the spatial boundaries of the study

- identify monitoring priorities
- determine the most effective allocation of available resources.

3.2.1 Operational Monitoring

The Guidance Note and Standard Operating Procedures for Operational Monitoring (Appendix B) provides fine-level detail aimed at environmental personnel who implement operational monitoring components, including:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Where practicable, operational monitoring standard operating procedures are aligned with existing processes, including:

- DoT oiled shoreline assessment
- Special Monitoring of Applied Resource Technologies (SMART) protocol (Ref. 8) and the American Petroleum Institute (API) Subsea Dispersant Monitoring method (Ref. 9) for dispersants
- AMSA sampling guides (Ref. 10).

3.2.2 Scientific Monitoring

The Guidance Note and Standard Operating Procedures for Scientific Monitoring (Appendix C) is aimed at environmental personnel implementing scientific monitoring components. The guidance note includes:

- implementation considerations
- a framework for finalising program design so that it is appropriate to the nature and scale of the event
- resources required to implement the monitoring
- descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors (e.g. Before-After-Control-Impact, impact vs control, gradient of impacts, lines of evidence, control charts), taking into consideration existing baseline data and current monitoring techniques
- guidance on effects size and power to detect change
- descriptions of standard operating procedures to undertake the sampling required, including field sheets and checklists.

Selection of the survey design(s) will depend on these criteria:

- the scale and pattern of potential effects of the spill
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of OPS data

- availability of appropriate reference sites
- statistical approach proposed to analyse the data
- the range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

To ensure the application of robust designs and sampling approaches that have the highest likelihood of detecting an environmental impact while allowing suitable flexibility, these guiding principles have been adopted:

- align with existing baseline sampling design and methods wherever possible to maximise data comparability
- allow for appropriate spatial and temporal replication to account for natural dynamics in the system
- use exposure gradients where appropriate
- use indicator taxa where appropriate
- use benchmarks where appropriate (see further information below)
- assess statistical power (if relevant).

If benchmarks[5] are relevant in the scientific studies, they will be selected taking into consideration trigger values that have already been established (e.g. Ref. 11, Ref. 12, Ref. 13, Ref. 14) or if appropriate, follow the process as outlined in Ref. 11 to develop a relevant benchmark value. If several levels of protection are available (e.g. Ref. 11), the 95% species protection level will be adopted, except in areas where a higher (99%) protection level is appropriate (e.g. marine parks, undisturbed ecosystems) or, conversely, a lower (80% or 90%) protection level is appropriate (e.g. highly disturbed ecosystems, defined low ecological protection areas).

3.3 Identifying Monitoring Priorities

Priorities for monitoring will be specific to the nature and scale of the event and will change throughout the duration of the monitoring effort. Factors to be considered when setting monitoring priorities include:

- presence of sensitive ecological and social receptors within the EMBA and protection prioritisation of those receptors
- predicted time until sensitive receptors are exposed to hydrocarbons
- availability of baseline data and/or ability and time frame to rapidly obtain pre-spill data
- availability of appropriate reference sites

[5] Benchmarks are used to describe concentrations above which there is the possibility of risk to the environmental receptor.

- statistical approach proposed to analyse the data
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

3.3.1 Sensitive Receptors

CAPL has a process for identifying and ranking ecological and social receptors that are sensitive to oil spills, including: shoreline types; marine habitats; marine, coastal and terrestrial species. This process is described in the ABU Oil Spill Protection Prioritisation Process (Ref. 15), and is generally aligned with the Western Australian (WA) Department of Transport (DoT) Protection Prioritisation Process (Ref. 16).

CAPL's Protection Prioritisation Process for the North West Shelf consists of seven broad steps. In summary, the steps are:

1. Determine the Environment that May Be Affected (EMBA) by an oil spill using modelling
2. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
3. Use literature and research data to determine the sensitivity of the various receptors to the effects of oil
4. Rank each receptor according to its sensitivity to oil and display the rankings geospatially
5. Review deterministic oil modelling runs used for response planning assessment.
6. Overlay the results on PP geospatial data
7. List the highest value PPs

Steps 1 to 4 are done during the planning stage, while steps 5 to 7 are undertaken following an oil spill.

The ecological and socioeconomic values and sensitivities known to occur with the EMBA of each activity are defined in the activity-specific EPs. A Description of the Environment, which includes a summary of the values and sensitivities relevant to CAPL's North West Shelf Activities, is provided in Appendix A.

These values and sensitivities identified within the EMBA are used to assist CAPL in identifying the appropriate response strategies to implement through the application of a Net Environmental Benefit Analysis (NEBA). NEBA is way to compare the net environmental benefits associated with multiple management alternatives. Used both prior to a spill occurring (Strategic NEBA) and after a spill (Operational NEBA), NEBA is the process of considering advantages and disadvantages of different spill response options (including no response) to arrive at a spill response decision that results in the lowest overall environmental and social impacts. Operational Monitoring data will contribute to on-going Operational NEBAs by providing information relevant to understanding the feasibility and effectiveness of the response options being carried out.

3.3.1.1 Ecological

The alignment of sensitive environmental receptors, relevant to CAPL's North West Shelf Activities, and the operational and scientific monitoring components is provided in Appendix A.

3.3.1.2 Socioeconomic

The Commonwealth and State regulations (outlined in Section 1.1) define the 'environment' to mean ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places, and the socioeconomic and cultural features of those matters.

For this Plan, a direct cause-effect pathway needs to be identified to allow for the successful monitoring of any potential significant impact. Direct monitoring of shipwrecks is addressed by SCI8; however, CAPL considers that the ecological impacts of an oil spill are suitable as a substitute measure of any potential significant impact on the remainder of socioeconomic and heritage features, including heritage features protected by the EPBC Act. CAPL has identified seven categories of socioeconomic and heritage features; the justification for the inclusion/exclusion of additional monitoring for these features is provided in Appendix A.

If the monitoring of ecological receptors indicates that a potential significant impact to socioeconomic and/or heritage features may occur, then CAPL will liaise with suitably qualified archaeologists, including relevant CAPL Aboriginal engagement representatives, to document accurate records, including map references, photographs, and descriptions of the material from in situ evaluations. Similarly, CAPL will liaise with relevant statutory bodies (i.e. government heritage and tourism agencies, Aboriginal affairs agency, fisheries and maritime agencies) to incorporate aspects of monitoring into operational and scientific monitoring programs, or if impacts have occurred, to determine an appropriate management action (e.g. in regards to temporary closures) and termination criteria. Refer to Section 2.5 for further details.

3.4 Resource Allocation

Responding to the spill itself often involves scaling of resources to effectively manage the spill. This is also the case with operational and scientific monitoring. Whilst a predicted worst-case scenario is planned for, each spill will be unique in terms of trajectory, required logistics (e.g. access, communications) and presence of sensitive receptors.

In the initial hours and days after a spill has been reported, the Environment Unit Lead (EUL) ensures the relevant operational monitoring components are commenced within the timeframes specified in the relevant OPEP and/or OSMP. The EUL works with the Operations Section Chief and OSMP Monitoring Coordinator to determine the most appropriate location and distribution of the available monitoring teams using the common operating picture (COP) and operational net environmental benefit analysis (NEBA) results.

The location and distribution of the monitoring teams in the initial stages of the spill will be influenced by the ecosystem components most at risk of impact from the spill. For example, if the spill is a considerable distance offshore and COP data indicates no shoreline contact is expected for a number of days, then the EUL may determine that the most appropriate resourcing strategy would be to direct the monitoring teams to focus on OPS1: oil characterisation and OPS3: oil in water assessment close to the spill source. However, once dispersant is applied, it may be necessary to divert some resources to conduct OPS2: chemical dispersant efficacy assessment, OPS3: oil in sediment assessment and SCI6: Benthic Habitat Impact Study, as the oil becomes more entrained into the water column.

The ABU OSMP Capability Register (Ref. 3) documents the skills and competency of personnel who may be called upon for monitoring activities. Many personnel are capable of performing a number of different roles, so that the OSMP structure is flexible enough to suit the nature and scale of the incident. The flexibility of monitoring teams is important to ensure resources can be directed towards the most relevant monitoring component.

Once the location and distribution of monitoring teams has been agreed, it is stated in the monitoring section of the EMTs Incident Action Plan (IAP). The Operational and Scientific Monitoring Coordinators appoint Technical Advisors for each monitoring component and work with them to finalise sampling and analysis plans. Data generated during the current operational period should be communicated directly back to the EMT via the EUL. This information is important to ensure the EMT make informed decisions around the allocation of resources for response activities and monitoring activities for the next operating period.

If the spill response is ongoing, additional resources to conduct operational and scientific monitoring will be scaled in. It is also possible that some OPS components will be replaced by SCI components, depending upon whether termination and initiation triggers have been met.

4 Operational Monitoring

4.1 Overview

Operational monitoring provides information for use in EMT response planning and decision making by measuring the impacts and effectiveness of response options. As such, operational monitoring needs to be able to provide data within a time frame relevant to the Incident Action Plan cycle. Operational monitoring can also provide information that can initiate components of the scientific monitoring program, where applicable (see Section 5).

The components of the operational monitoring program are:

- OPS1: Oil Characterisation
- OPS2: Chemical Dispersant Efficacy Assessment
- OPS3: Oil in Water Assessment
- OPS4: Oil in Sediment Assessment
- OPS5: Rapid (Oiled) Shoreline Assessment
- OPS6: Rapid Seabird and Shorebird Assessment
- OPS7: Rapid Marine Megafauna Assessment
- OPS8: Fish Tainting Assessment.

Appendix B contains the full suite of operational monitoring components listed above. Each plan provides fine detail aimed at personnel who implement operational monitoring components, including:

- Monitoring rationale;
- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

Where practicable, the standard operating procedures are aligned with existing standards and processes, including:

- Department of Transport (Western Australia) oiled shoreline assessment (Ref. 17)
- Special Monitoring of Applied Resource Technologies (SMART) protocol for dispersants (Ref. 18).
- CSIRO Oil Spill Monitoring Handbook (Ref. 19)
- AMSA sampling guides (Ref. 20)
- ANZECC Guidelines (Ref. 11)
- Revised ANZECC/ARMCANZ Sediment Quality Guidelines (Ref. 21).

OPS components may be implemented concurrently with each other, and/or in conjunction with response activities such as Monitoring, Evaluation and Surveillance (MES) tactics described in the relevant OPEP. Examples of such synergies include:

- Complete aspects of OPS6 and OPS7 during aerial observation (MES)
- Complete OPS1, OPS2, OPS3, OPS4, OPS6 and OPS7 during vessel observation (MES)
- Deploy a tracking buoy, complete shoreline assessment and visual observations (MES) whilst implementing OPS1, OPS3, OPS4 and OPS5

Depending on the size and nature of the spill, OPS components may need to be implemented multiple times, or continuously, during the spill response; the frequency will be based on the data needs of the EMT.

Further to the initiation criteria specified for each operational monitoring component, Table 4-1 identifies operational monitoring components that may be triggered for the different response options and support functions.

Table 4-1: Operational Monitoring Components Used to Monitor and Inform Response Options and Activities

Response Option	Operational Monitoring Component							
	OPS1	OPS2	OPS3	OPS4	OPS5	OPS6	OPS7	OPS8
Source Control – Well Capping	X		X	X				
Source Control – Diverter/Shut-off Valves	X		X					
Natural Recovery and Assisted Natural Dispersion	X		X					X
Dispersant Application	X	X	X					X
Containment and Recovery	X							
Shoreline Protection	X		X	X	X			
Shoreline Clean-up	X		X	X	X			
Oiled Wildlife (Support Function)	X					X	X	
Waste Management (Support Function)	X		X	X	X	X	X	X

OPS1: Oil Characterisation	*OPS5: Rapid (Oiled) Shoreline Assessment*
OPS2: Chemical Dispersant Efficacy Assessment	*OPS6: Rapid Seabird & Shorebird Assessment*
OPS3: Oil in Water Assessment	*OPS7: Rapid Marine Megafauna Assessment*
OPS4: Oil in Sediment Assessment	*OPS8: Fish Tainting Assessment*

Note: This table displays the response options and the corresponding operational monitoring component that will be used to monitor and inform that option during the response. For example, the 'shoreline clean-up' response option is monitored through OPS1, OPS3, OPS4, and OPS5

4.2 OPS1: Oil Characterisation

Overview	OPS1 provides the EMT with the chemical properties of the released oil.
Initiation Criteria	Activation of this Plan
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 72 hours of initiation
Aim	Provide quantitative information on the chemical properties of the oil to assist the EMT in selecting the most effective response option(s).
Monitoring Approach	**Sampling**: • Collect spilt oil sample **Analysis**: • Chemical characterisation • Toxicological (if required) analysis **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • OPS1 is no longer contributing to or influencing spill response decision making, and • All data required by the EMT Incident Commander (or delegate) are received.

4.3 OPS2: Chemical Dispersant Efficacy Assessment

Overview	OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil.
Initiation Criteria	The EMT has decided to apply dispersant as a response option.
Implementation Time	Within 24 hours of initiation
Aim	To provide rapid information on the efficacy of dispersant as a response option.
Monitoring Approach	**Sampling**: • Surface chemical dispersant: SMART Protocol • Subsurface chemical dispersant: API method **Analysis**: • On-site and/or laboratory analysis of hydrocarbon and dispersant presence and state (e.g. concentration, oil droplet size) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS2 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS2 monitoring is likely to increase overall environmental impact.

4.4 OPS3: Oil in Water Assessment

Overview	OPS3 provides the EMT with ongoing information on the water quality, particularly the oil content, within the response areas.
Initiation Criteria	Activation of this Plan
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 72 hours of initiation
Aim	The key component of this monitoring program is collecting data on the effects of the spill and response options on water quality.
Monitoring Approach	**Sampling**: • In situ water quality monitoring • Surface and subsurface sampling (if required). **Analysis**: • Data analysis to look for oil signatures from in situ data • Chemical characterisation of samples • Compare hydrocarbon characteristics to results of released oil from OPS1 • Assess bioavailability of oil **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS3 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS3 monitoring is likely to increase overall environmental impact; and – OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.5 OPS4: Oil in Sediment Assessment

Overview	OPS4 provides the EMT with ongoing information on the sediment quality, particularly the oil content, within the response areas.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to marine and/or coastal sediment.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation
Aim	The key component of this monitoring program is collecting data on the exposure of sediments to oil and any effect of response activities on sediment quality.
Monitoring Approach	**Sampling**: • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical characterisation of samples • Compare hydrocarbon characteristics to results of released oil from OPS1 • Assess bioavailability of oil **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS4 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS4 monitoring is likely to increase overall environmental impact; and – OPS4 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.6 OPS5: Rapid (Oiled) Shoreline Assessment

Overview	OPS5 provides the EMT with ongoing information on: • the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed • any observed impacts to shorelines and associated habitats from response activities • the effectiveness of clean-up activities. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to shoreline habitat
Implementation Time	Within the response times for oiled shoreline assessment, as described in the relevant OPEP.
Aim	To assess the state of shoreline habitats, to identify the presence and extent of oil, and to assess impacts of response activities through shoreline assessments.
Monitoring Approach	**Sampling**: • Oiled Shoreline Assessment **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS5 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS5 monitoring is likely to increase overall environmental impact; and – OPS5 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.7 OPS6: Rapid Seabird and Shorebird Assessment

Overview	OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts/confirms an exposure of oil to seabirds, shorebirds or shorelines known to support seabird and shorebird populations and/or habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS6 monitoring may be implemented during MES activities.
Aim	To provide rapid quantification of the presence and state of seabirds and shorebirds, their use (e.g. breeding, nesting, foraging) of areas predicted to be impacted or have been impacted by the oil spill, and to assess the impacts of response activities on seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (ground, aerial, and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) determines that continuing OPS6 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) determines that continuing OPS6 monitoring is likely to increase overall environmental impact; and – OPS6 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.8 OPS7: Rapid Marine Megafauna Assessment

Overview	OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna within the predicted trajectory of the oil spill.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known sensitive marine megafauna habitat.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 48 hours of initiation. Initially, OPS7 monitoring may be implemented during MES activities.
Aim	To rapidly quantify the presence, state, and type of marine megafauna and their use (e.g. migrating, foraging) of areas predicted to be impacted or that have been impacted by the oil spill.
Monitoring Approach	**Sampling**: • Rapid surveillance surveys (aerial and/or vessel) **Analysis**: • Not applicable **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	OPS7 should be implemented until these termination triggers are met: • The EMT Incident Commander (or delegate) considers that continuing OPS7 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS7 monitoring is likely to increase overall environmental impact; and – OPS3 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

4.9 OPS8: Fish Tainting Assessment

Overview	Monitoring undertaken to better manage fisheries, public, or media concerns relating to potential effects of the spill or response activities.
Initiation Criteria	Modelling and/or analysis of data from MES predicts an exposure of oil to known fisheries.
Implementation Time	• Preparation to deploy field personnel and equipment will commence upon initiation • Implementation will be achieved within 5 days of initiation.
Aim	The key component of this monitoring program is collecting data on the effects of the spill and response options on pelagic and benthic fish species.
Monitoring Approach	**Sampling**: • Collect samples of target fish species • Benthic and pelagic species **Analysis**: • Determine if oil tainting is present • Determine if dispersed/entrained oil has tainted fish (only applicable if dispersant used as a response option) **Reporting and/or data**: • To be provided to the EMT Incident Commander (or delegate) once available.
Termination Criteria	• The EMT Incident Commander (or delegate) considers that continuing OPS8 monitoring will not result in a change to the scale or location of active response options; or • The EMT Incident Commander (or delegate) has advised that agreement has been reached with the Jurisdictional Authority relevant to the spill to terminate the response; or • The Monitoring Coordinator (or delegate) considers that continuing OPS8 monitoring is likely to increase overall environmental impact; and – OPS8 monitoring has provided sufficient data to assess initiation of scientific monitoring components.

5 Scientific Monitoring

5.1 Overview

Scientific monitoring focuses on short-and long-term environmental impact assessments. The scientific monitoring implemented will be appropriate to the scale, location, and duration of the oil spill and only the relevant components (determined by the receptors exposed) will be implemented. CAPL will engage experts (internal or external) specific to each study scope as required.

The components of the scientific monitoring program are:

- SCI1: Water Quality Impact Study
- SCI2: Sediment Quality Impact Study
- SCI3: Coastal and Intertidal Habitat Impact Study
- SCI4: Seabird and Shorebird Impact Study
- SCI5: Marine Megafauna Impact Study:
  - SCI5a: Marine Reptiles
  - SCI5b: Pinnipeds
  - SCI5b: Other Marine Megafauna.
- SCI6: Benthic Habitat Impact Study
- SCI7: Fish Effects Impact Study:
  - SCI7a: Fishery and Aquaculture Impact Study
  - SCI7b: Fish Impact Study.
- SCI8: Heritage (including Shipwrecks)

Appendix C contains the full suite of scientific monitoring plans listed above. Each plan provides fine detail aimed at environmental personnel who will implement the scientific monitoring components, including:

- A framework for finalising program design so that it is appropriate to the nature and scale of the event;
- Resources required to implement the monitoring;
- Descriptions and guidance on various experimental monitoring approaches that can be applied to monitor various receptors taking into consideration existing baseline data and current monitoring techniques; and
- Descriptions of standard operating procedures to undertake the sampling required, including checklists.

These components are presented separately below; however, in practice they may be carried out simultaneously, and monitoring may commence while response activities are still occurring.

5.2 SCI1: Water Quality Impact Study

Overview	The behaviour of the oil once released will vary depending on several factors, including sea temperature and weather conditions. Sampling of the oil in the water will provide quantitative data on the fate, weathering, and distribution of the oil. The geographic scope of SCI1 is the region offshore from the LAT.
Initiation Criteria	Activation of this Plan.
Implementation Time	Implementation will be achieved within 7 days of initiation
Aim	To assess water quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • In situ water samples • Collect surface and subsurface samples **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by a National Association of Testing Authorities (NATA) accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There is no demonstrable impact on water quality from hydrocarbons/dispersants; or • Hydrocarbon and dispersed hydrocarbon concentrations in water are below relevant benchmarks or guideline values, or have returned to within the expected natural dynamics of baseline state and/or reference sites; or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring. Note: SCI1 may still be required by other SCI studies even after the termination criteria are reached.

5.3 SCI2: Sediment Quality Impact Study

Overview	Sampling of the oil in sediments will provide quantitative data on the fate, weathering, and distribution of the oil in sediments. The geographic scope of SCI2 is the region offshore from the LAT. The main concerns are the persistence of poly-aromatic hydrocarbons and total petroleum hydrocarbons.
Initiation Criteria	Operational monitoring (OPS4) has confirmed hydrocarbon concentrations are above: • relevant benchmarks or guideline values at the termination of the response option, or • baseline values at the termination of the response option.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess sediment quality for oil and/or dispersant content against environmental benchmarks or natural variation.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • Collect push cores and/or grab samples • Surface and subsurface sampling (if required) **Analysis**: • Chemical analysis (hydrocarbon, dispersants [if used in the response] etc.) • Samples analysed by NATA-accredited (where possible) laboratory **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• All hydrocarbon concentrations in sediments are below relevant benchmarks or guideline values or below baseline or reference site values, whichever is greater; or • No ongoing impacts to biological receptors can be linked to sediment quality, or • Agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring Note: SCI2 may still be required by other SCIs even after the termination criteria are reached.

5.4 SCI3: Coastal and Intertidal Habitat Impact Study

Overview	SCI3 determines the extent, severity, and persistence of impacts on coastal and intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequence response activities.
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of coastal or intertidal habitats or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess impacts to coastal and intertidal habitats and associated biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Conduct pre-impact surveys where possible • State of habitats and associated biological communities (transects, quadrats) • Aerial imagery **Analysis**: • Percent cover, community composition, health/condition **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to coastal and intertidal habitats and associated biological communities (confirmation that habitats and species were not exposed to hydrocarbons); or • Measures of coastal and intertidal habitats and associated biological communities have returned to within the expected natural dynamics of baseline state and/or reference sites, at areas that were impacted by hydrocarbons spills, or • The extent of damage and rate of recovery of key coastal and intertidal parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

1.1 SCI4: Seabird and Shorebird Impact Study

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on seabirds and shorebirds from an oil spill.
Initiation Criteria	Operational monitoring (OPS6) has: • predicted or confirmed shoreline contact of hydrocarbons at important bird habitat location or known bird colonies, and/or • recorded dead, oiled, or injured bird species during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of seabirds and shorebirds.
Monitoring Approach	**Sampling**: • Surveillance surveys (ground and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Community composition, abundance, health/condition • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on seabirds and/or shorebirds; or • Measured parameters of seabird and/or shorebird communities have returned to within the expected natural dynamics of baseline state or reference sites, within seabird or shorebird communities that have been impacted by hydrocarbon spills, or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5 SCI5: Marine Megafauna Impact Study

5.5.1 SCI5a: Marine Reptiles

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine reptiles (turtles and sea snakes) from an oil spill. Monitoring will primarily focus on marine turtles, given sea snakes have a highly dispersed distribution that results in limited opportunities for monitoring.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed shoreline or habitat contact of hydrocarbons at important habitat locations for turtles (foraging and rookery) and sea snakes, or • recorded dead, oiled, or injured turtles or sea snakes during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine reptiles.
Monitoring Approach	**Sampling**: • Surveillance surveys (aerial or vessel, i.e. field), including nesting sites • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance (counts), species identification • Nest characteristics • Necropsy and chemical analysis. **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on turtles or sea snakes; or • Measured parameters of turtles (and sea snake communities if determined appropriate) have returned to within the expected natural dynamics of baseline state or reference sites, within turtle and sea snake communities that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.2 SCI5b: Pinnipeds

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on pinniped populations (Australian Sea Lion *Neophoca cinerea*, New Zealand Fur Seal *Arctocephalus forsteri*, and the Australian Fur Seal *A. pusillus*, and other pinnipeds present) from an oil spill. Monitoring will focus on onshore populations (e.g. breeding colonies and haul-out sites). This is based on the priority of the life cycle stage (e.g. breeding), and that population estimates are generally based on onshore counts.
Initiation Criteria	Operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for pinnipeds (foraging, breeding colonies, and haul-out sites), or • recorded dead, oiled or injured pinnipeds during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of pinnipeds.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Health/condition • Observed behaviour, counts of abundance, population structure • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on pinnipeds; or • Measured parameters of pinniped populations have returned to within the expected natural dynamics of baseline state or reference sites, within pinnipeds that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.5.3 SCI5c: Other Marine Megafauna

Overview	This scientific monitoring study is intended to determine the extent, severity, and persistence of impacts on marine megafauna from an oil spill. Note: The understanding of abundance and distribution of many marine mammals (e.g. cetaceans and dugongs) and large cartilaginous fish (e.g. Whale Sharks) is often poor, making it difficult to assess potential impacts from oil spill incidents. The low density and mobility of these animals also makes it difficult to assess and quantify effects.
Initiation Criteria	SCI5c is triggered when operational monitoring (OPS7 or MES) has: • predicted or confirmed contact of hydrocarbons at important habitat locations for marine megafauna, or • recorded dead, oiled or injured megafauna during the response phase.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To identify and quantify the post-impact status and recovery of marine megafauna.
Monitoring Approach	**Sampling**: • Surveillance surveys (vessel and/or aerial) • Fauna (e.g. tissue sampling, dead fauna collection) **Analysis**: • Presence of oil • Health/condition • Observed behaviour, abundance, community composition, population structure, track census counts • Necropsy and chemical analysis **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on marine megafauna; or • Measured parameters of marine megafauna have returned to within the expected natural dynamics of baseline state or reference sites, within marine megafauna that have been impacted by hydrocarbon spills; • The extent of damage and rate of recovery of key parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.6 SCI6: Benthic Habitat Impact Study

Overview	This scientific monitoring program is designed to: • determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities • collect information to determine short-and long-term (including direct and indirect) impacts of hydrocarbons (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following termination of the response
Initiation Criteria	Operational monitoring (OPS3, OPS4), MES, or scientific monitoring (SCI1, SCI2) has predicted or confirmed exposure of subtidal benthic habitat or communities to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To assess the impact on subtidal benthic habitat and biological communities as a consequence of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Benthic habitat survey (e.g. photographed/video transects) • Fauna and flora (e.g. tissue sampling) **Analysis**: • Percent cover, community composition, health/condition, benthic grabs **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact to benthic habitat and communities (confirmation that benthic habitats were not exposed to hydrocarbons); or • Measures of benthic habitat and communities have returned to within the expected natural dynamics of baseline state or reference sites, at benthic areas that were impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key benthic habitat parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

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5.7 SCI7: Fisheries and Fish Impact Study

5.7.1 SCI7a: Fisheries and Aquaculture Impact Study

Overview	This scientific monitoring study focuses on the direct effects of an oil spill on fish and aquaculture resources. Monitoring for the impact of the oil spill on fish health will be carried out using fish tissue sampling and analysis to ascertain direct contamination.
Initiation Criteria	Operational monitoring (OPS3, OPS4, OPS8), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to hydrocarbons of fishing areas, habitat for commercial fisheries, or active aquaculture leases.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor lethal and sublethal effects of oil spills on fish and aquaculture species.
Monitoring Approach	**Sampling**: • Fish physiological indicators and biochemical markers, fish tissue sample, including muscle, biopsy and gut contents, blood, bile, gonads, and dead fish counts **Analysis**: • Chemical analysis (e.g. hydrocarbon, dispersants [if used in the response] etc.), tainting **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impacts on fish and aquaculture; or • Measured parameters of fish and aquaculture have returned to within the expected natural dynamics of baseline state or reference sites, within marine fisheries and aquaculture locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key fisheries and aquaculture parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.7.2 SCI7b: Fish Impact Study

Overview	This scientific monitoring study focuses on the effects of an oil spill on fish population and abundance if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.
Initiation Criteria	Operational monitoring (OPS3), MES, or scientific monitoring (SCI1) has predicted or confirmed exposure to fish areas or fish habitat to hydrocarbons.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in fish population and abundance as a result of an oil spill and associated response.
Monitoring Approach	**Sampling**: • Population surveys (e.g. baited underwater video surveys, remotely operated vehicles [ROVs], towed camera) **Analysis**: • Community composition, abundance **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	• There has been no demonstrable impact on fish and fish population structure, or • Measured parameters of fish and fish habitat have returned to within the expected natural dynamics of baseline state or reference sites, within locations that have been impacted by hydrocarbon spills; or • The extent of damage and rate of recovery of key seabird and/or shorebird parameters has been quantified and agreement has been reached with the relevant stakeholders and Jurisdictional Authorities to cease monitoring.

5.8 SCI8: Heritage (including Shipwrecks)

Overview	This scientific monitoring study focuses on the effects of an oil spill on shipwrecks in areas considered to have heritage.
Initiation Criteria	MES, operational or scientific monitoring has predicted or confirmed exposure of shipwrecks to hydrocarbon or associated response activities.
Implementation Time	Implementation will be achieved within 7 days of initiation.
Aim	To monitor changes in shipwrecks as a result of an oil spill and associated response activities (e.g. anchoring and ROV disturbance).
Monitoring Approach	**Sampling**: • Surveys (e.g. ROV) **Analysis**: • Heritage attributes **Reporting and/or data**: • To be provided to the OSMP Monitoring Coordinator and/or ABU HES Supervisor – Environment Technical (or delegate).
Termination Criteria	SCI8 will be terminated when: • There has been no demonstrable impact on shipwrecks, or • Measured parameters of shipwrecks have been documented and no further change as a result of hydrocarbons or response activities is anticipated.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
ABU	Australian Business Unit
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
API	American Petroleum Institute
BSc Hons	Bachelor of Science, with Honours
CAPL	Chevron Australia Pty Ltd
CRC	Cooperative Research Council
DoT	Western Australian Department of Transport
EMBA	Environment that May be Affected
Emergency Condition	As defined in each activity-specific EP and relevant OPEP
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
HES	Health, Environment, and Safety
ICS	Incident Command System
IMG	Incident Management Guide
Implementation	Being ready, at the point of staging or departure, to mobilise for monitoring
Initiation/Termination	'Or' means only one of the possible options, 'and' means both need to occur before initiation/termination
LAT	Lowest Astronomical Tide
MES	Monitoring, Evaluation, and Surveillance
MS	Master of Science
NATA	National Association of Testing Authorities, Australia
NEBA	Net Environmental Benefit Analysis
OEMS	Operational Excellence Management System
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OPS1	Oil Characterisation
OPS2	Chemical Dispersant Efficacy Assessment
OPS3	Oil in Water Assessment
OPS4	Oil in Sediment Assessment
OPS5	Rapid (Oiled) Shoreline Habitat Assessment
OPS6	Rapid Seabird and Shorebird Habitat Assessment
OPS7	Rapid Marine Megafauna Assessment

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Acronym / Abbreviation	Definition
OPS8	Fish Tainting Assessment
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
PGPA	Policy, Government and Public Affairs
PhD	Doctor of Philosophy
QA/QC	Quality Assurance/Quality Control
ROV	Remotely Operated Vehicle
SCI	Scientific monitoring
SCI1	Water Quality Impact Study
SCI2	Sediment Quality Impact Study
SCI3	Coastal and Intertidal Habitat Impact Study
SCI4	Seabird and Shorebird Habitat Impact Study
SCI5	Marine Megafauna Impact Study
SCI6	Benthic Habitat Impact Study
SCI7	Fish Effects Impact Study
SCI8	Heritage (including shipwrecks)
Significant Impact	Defined as a moderate or higher consequence rating as per the Chevron Integrated Risk Prioritization Matrix. This aligns with 'moderate to significant environmental damage' as described in the Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2009; and to 'moderate, or more serious than moderate environmental impact' as described in the Western Australian Petroleum and Geothermal Energy Resources (Environment) Regulations 2012, Petroleum Pipelines (Environment) Regulations 2012, and the Petroleum (Submerged Lands) (Environment) Regulations 2012; as applicable.
SMART	Special Monitoring of Applied Resources Technologies
WA	Western Australia
WA ERA	WA Energy Research Alliance

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	ABU Oil Spill Response Manual (Chevron Australia, 2014)	OE-11.01.101
2.	Emergency Management Process – ABU Standardised OE Process (Chevron Australia, 2012)	OE-11.01.01
3.	ABU OSMP Capability Register (Chevron Australia)	ABU181001264
4.	ABU OSMP Capability Register – Resource Requirements Analysis (Chevron Australia)	
5.	ABU OE Compliance Assurance Process – ABU Standardised OE Process (Chevron Australia, 2014)	OE-12.01.01
6.	Compliance Assurance Audit Program – ABU Standardised OE Procedure (Chevron Australia, 2015)	OE-12.01.19
7.	Compliance Assurance Management of Instances of Potential Noncompliance – ABU Standardised OE Procedure	OE-12.01.18
8.	Special Monitoring of Applied Resource Technologies (SMART) protocol	
9.	Industry Recommended Subsea Dispersant Monitoring Plan, API Technical Report 1152 (American Petroleum Institute, 2013)	
10.	Oil Spill Monitoring Handbook (Commonwealth Scientific and Industrial Research Organisation, 2016)	
11.	Australian and New Zealand Guidelines for Fresh and Marine Water Quality (Australian and New Zealand Environment and Conservation Council/Agriculture and Resource Management Council of Australia and New Zealand, 2000).	
12.	Aquatic Life Benchmarks (United States Environmental Protection Authority, 2012). Available from: http://www.epa.gov/bpspill/water-benchmarks.html	
13.	National Assessment Guidelines for Dredging (Department of the Environment, Water, Heritage and the Arts, 2009).	
14.	Australia New Zealand Food Standards Code.	
15.	Chevron Australia. 2018. ABU Oil Spill Protection Prioritisation. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
16.	DoT 2017. DOT307215 Provision of Western Australian Marine Oil Pollution Risk Assessment – Protection Priorities. Protection Priority Assessment for Zone 2: Pilbara – Final Report. Report for the WA Department of Transport, Perth.	
17.	Department of Transport – Shoreline Assessment Form. Available at www.transport.wa.gov.au/	
18.	USCG *et al.* (2006). *Special Monitoring of Applied Response Technologies* (SMART). U.S. Coast Guard (USCG), National Oceanic and Atmospheric Administration (NOAA), U.S. Environmental Protection Agency (U.S. EPA), Centers for Disease Control and Prevention (CDC), Minerals Management Service (MMS).	

Ref. No.	Description	Document ID
19.	Hook, S., Batley, G., Holloway, M., Irving, P., and Ross, A. (2016). Oil Spill Monitoring Handbook. CSIRO, Clayton South. Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra.	
20.	AMSA (2003) Oil Spill Monitoring Handbook. Prepared by Wardrop Consulting and the Cawthron Institute for the Australian Maritime Safety Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra	
21.	Simpson SL, Batley GB and Chariton AA (2013). Revision of the ANZECC/ARMCANZ Sediment Quality Guidelines. CSIRO Land and Water Science Report 08/07. CSIRO Land and Water	

Appendix A North West Shelf Activities

Operational and Scientific Monitoring Plan
North West Shelf Activities

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Operational and Scientific Monitoring Plan
North West Shelf Activities

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Approvals

	Name	Signature	Date
Author:	Kris Holmes HES Specialist – Environment		
Checked:	Erin Hinds ABU Oil Spill Coordinator		
Approved:	Andrew Smith ABU Team Lead - Environment and Quarantine Systems		

Contents

Tables

Figures

1 General Introduction

1.1 Purpose

The Australian Business Unit (ABU) OSMP (Figure 1-1; Ref. 3) sits above this OSMP NWS Activities document and is an overarching document that covers all CAPL assets in State and Commonwealth waters. The ABU OSMP includes information, relevant to all assets, on implementing the OSMP (including capability and readiness), the environmental monitoring framework (including operational and scientific monitoring) and monitoring components (initiation criteria, termination criteria, and implementation timeframes).

This Operational and Scientific Monitoring Plan North West Shelf Activities (OSMP NWS; this document) provides location- and asset-specific information related to Chevron Australia Pty Ltd (CAPL) activities on the North West Shelf of Western Australia (WA) that would be used if an unplanned hydrocarbon discharge from a CAPL asset occurred in the region. The document covers upstream and downstream marine assets of the Gorgon Gas Development, Wheatstone Project, and Barrow Island Joint Venture – including platforms, pipelines, and processing and export facilities.

This document summarises or refers to information in other CAPL documents such as Environment Plans (EPs), Oil Pollution Emergency Plans (OPEPs), and CAPL's Description of the Environment document (Ref. 2). The aim of the asset-specific information is not to repeat such information but to direct the reader to the relevant sections in those documents and therefore expedite the response process.

1.2 Scope

This document is a component of the OSMP framework described in the ABU OSMP (Ref. 3), where the overall scope is presented. It guides CAPL personnel in responding to a hydrocarbon spill in the NWS. Service providers are expected to read and understand this document before providing hydrocarbon spill standby services to CAPL.

1.3 Objectives

The overarching objective of this document is to direct responders to existing information and baseline data that may assist monitoring during an oil spill; more specifically, this document's objectives are to:

- briefly describe the environment that may be affected (EMBA) by a hydrocarbon spill, with reference to relevant EPs, the Description of the Environment document (Ref. 2), and other relevant documents (Section 3).
- collate baseline information sources (Section 4.3).
- provide a summary of estimates of capability and readiness for the NWS region including scenarios, scalability, sustainability, and response times (Section 5).

1.4 Target Audience

This document is intended for use by:

- Emergency Management Team (EMT) Incident Commander
- Environment Unit Lead

- ABU Health Environment Safety (HES) Supervisor – Environment Technical
- OSMP Monitoring Coordinator
- Operational and Scientific Monitoring Officer(s)
- personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a basic understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Related Documentation

This document is specific to NWS activities and is a component of the OSMP framework described in the ABU OSMP (Figure 1-1).

Table 1-1 summarises and provides links to CAPL documents that are relevant to NWS activities. Refer to Section 4.3 for information and documents relating to the baseline state of environment.

CAPL uses GeoHouse to reference environmental aspects relative to oil spill modelling outputs. GeoHouse is mapping software that can store literature with georeferenced tags that allow users to identify where studies have been undertaken. This expedites access to key literature that is needed during the early phases of implementation of operational (OPS) and scientific (SCI) monitoring.

Table 1-1: Chevron Australia Key Documents Relevant to NWS Activities

Document Title	Summary of Interface with this Appendix
EP and OPEP Register (Ref. 6; ABU180500351)	The EP and OPEP Register lists all current ABU EPs and OPEPs that have been accepted and are in force. This Appendix, along with the ABU OSMP and other supporting documents describe the environmental monitoring that may be implemented in the event of an emergency condition described in the activity specific EPs listed within this register. Operational monitoring outcomes support OPEP implementation and termination by collecting information about the oil spill and associated response options to aid planning and decision making for executing spill response or clean-up operations.
Description of the Environment (Ref. 2)	This document describes the environment within CAPLs planning area (the outer area in which CAPL's activities may interact with the environment).
ABU Protection Prioritisation Process (Ref. 4)	This process outlines and ranks the receptors (i.e. values or resources) at risk and helps CAPL understand which receptors should take priority in terms of protection from a spill.

ABU OSMP

Target Audience

- Regulatory Agencies
- EMT Incident Controller (or delegate)
- ABU HES Supervisor – Environment Technical (or delegate)

Purpose and Objectives

- Describe the types of env. monitoring that may be implemented during a marine/coastal oil spill
- Flexible framework, allowing monitoring to be adapted to the nature and scale of a specific oil spill event
- Determine the extent, severity and persistence of environmental impacts from the spill
- Define initiation and termination criteria for each monitoring component
- Describe the implementation process for the monitoring programs
- Identify the positions responsible for ensuring implementation of the monitoring

APPENDIX A
North West Shelf Activities

Target Audience

- Environment Unit Lead; ABU HES Supervisor – Environment Technical; Monitoring Coordinator
- Monitoring Officer(s).
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives

- NWS location/asset specific information, such as activities, nature of hydrocarbons expected from a spill
- Summary description of the environment within the EMBA
- Describe social and ecological receptors, values and particular sensitivities within the EMBA
- Summary of baseline information sources
- Summary of capability and readiness estimate based on scenarios

APPENDIX B
Guidance Note for Operational Monitoring

Target Audience

- EMT Incident Controller (or delegate)
- Personnel fulfilling operational or scientific monitoring roles within the Environment Unit of the EMT.

Purpose and Objectives

- Internal guidance document to assist implementing operational monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event
- Provide typical sampling and/or assessment method, standard operating procedures and field sheets for each monitoring component;

APPENDIX C
Guidance Note for Scientific Monitoring

Target Audience

- ABU HES Supervisor – Environment Technical (or delegate)
- ABU Environment Team

Purpose and Objectives

- Internal guidance document to assist implementing scientific monitoring components
- Framework for finalising program design so that it is appropriate to the nature and scale of the spill event, considering available baseline data
- Describe sampling and/or assessment method, procedures and field sheets for each monitoring component

Operational Specific Documents
Supporting the OSMP

ABU OSMP Quick Reference Guide

Initiation summary; checklists for the first 48hrs; OSMP framework and hotlinks to important documents

Implementation and Logistics Plan

Detailed steps required to implement the various monitoring components, and links, contact details and information related to logistics. Includes:
- Step by step ‘playbooks’ for each component
- Logistics arrangements for mobilising vessels, personnel, equipment and other resources, both internal and 3rd party

ABU Capability Needs Analyses – LOWC scenario and HFO scenario

A tool used to determine the resourcing requirements for operational and scientific monitoring under particular (pre-nominated) spill scenarios, for up to 4 phases of the response. Includes:
-number of teams required per component, number of personnel per team, and the skill/role makeup of those teams
- equipment and resources required per team
- summation of resourcing per phase
- sources and suppliers of those resources
- gap analysis of what equipment might be available in the short-term and what items are long-lead or unlikely to be available
- explanatory document on using the tool

ABU OSMP Capability Register

A register of personnel and equipment (CAPL, Chevron corporate and 3rd party) that is likely to be available in the event of a spill. Includes:
- personal information contact details
- qualifications and training relevant to OSMP
- self assessment of capability to fill OSMP roles (SME, Practitioner or Assistant)
- pre-nomination of internal people into specific OSMP roles

First Strike Sampling and Analysis Plan Template

Provide a well developed framework, methods and QAQC procedures for rapid implementation of first-strike sampling required under OPS 1, OPS3 and OPS4, within 48 hours of a spill. Includes:
- outline of the sampling program design, number, type and location of sampling required
- sampling equipment required
- methods for sampling, preservation, transportation and storage,
- QA/QC procedures

Figure 1-1: OSMP Document Structure

2 Region-specific Introduction

2.1 Description of the Assets

Assets and activities on the NWS, which are under the operational control of CAPL and outlined in Table 2-1. Further information on the individual assets or activities can be found in the activity specific EPs (Table 1-1; Ref . 6).

Table 2-1: Summary of Operating Assets, Infrastructure and Spill Scenarios covered in related EP and/or OPEPs

Asset	Infrastructure Location	Spill Scenarios in Related EP and/or OPEP
Wheatstone	Producing and infill wells, all located within Commonwealth Waters; Commonwealth and State Waters components of the trunkline; Marine Terminal area at Ashburton North	Spill scenarios include: • the release of marine diesel oil (MDO), intermediate fuel oil (IFO), or Heavy Fuel Oil (HFO) at all asset locations, including CAPL's operations within the Port of Ashburton and in adjacent waters including the Port of Onslow • the loss of condensate and produced fluids from the hydrocarbon system, including wells and trunkline
Gorgon	Producing wells, future production wells, and a future exploration well in Commonwealth Waters; Commonwealth and State Waters component of the feed gas pipeline; liquefied natural gas (LNG) jetty on Barrow Island; Gorgon domestic gas (DomGas) pipeline including pipeline and subsea installation and pre-commissioning	Spill scenarios include: • an MDO spill arising from a vessel collision or failure of the mobile offshore drilling units (MODUs) in Commonwealth Waters • the release of MDO or HFO from vessels operating within the Port of Barrow Island or adjacent State Waters • a Gorgon or Jansz condensate leak arising from a major defect in the production pipeline (in scope for both State and Commonwealth Waters) • a Gorgon or Jansz condensate release arising from a loss of well control (LOWC) during well intervention, abandonment, or infill drilling (Commonwealth Waters only)
Barrow Island Joint Venture (BWIJV)	Exploration and production operations on Barrow Island and surrounding areas; tanker loading line for Barrow Island crude offtake	Spill scenarios include: • failure of the tanker loading line

2.2 Hydrocarbon Properties

Credible spill scenarios relevant to CAPLs activities are outlined in the activity specific EPs. Depending on the activity, the hydrocarbon released to the environment may be one of several hydrocarbon types. The composition and physical properties of the hydrocarbons will evolve over time through weathering processes that change its composition and properties, such as the viscosity, density, water content and pour point. The rate of change of the hydrocarbon properties will affect the likely time-window of monitoring opportunities for OSMP components and the associated logistical requirements of these programs. As such it is important that OSMP teams are aware of the characteristics of the hydrocarbon types they will encounter.

Hydrocarbons represented in the worst credible spill scenarios within activity specific EPs can be grouped into oil types as defined by the International Tanker Owners Pollution Federation Ltd (ITOPF) classification system:

- Group 1 – Including Iago, Wheatstone, and Jansz condensate; Wheatstone trunkline fluids; and Wheatstone flowline fluids
- Group 2 – Including MDO, Gorgon condensate, Barrow Island crude and Gorgon/Jansz mixed trunkline fluids
- Group 3/4 – Including HFO and IFO (depending on blend).

Chevron ABU: Oil Properties and Dispersion Application Applicability (Ref. 5) outlines the basic hydrocarbon characteristics of the hydrocarbons that may be spilt to the environment. A summary of this information is presented in Table 2-2.

Table 2-2: Oil Types that may be Spilt to the Environment from CAPL NWS Activities

Product and Asset	Oil Type and ITOPF Group	API
Jansz Condensate (Gorgon Project)	Condensate – Group 1 AMSA Classification: Group I, light, non-persistent oil	51.4
Gorgon Condensate (Gorgon Gas Development)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.3
Gorgon/Jansz Condensate Blend (Gorgon Gas Development)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	45.3
Wheatstone Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	55.4
Iago Condensate (Wheatstone Project)	Condensate Blend – Group 1 AMSA Classification: Group I, very light, non-persistent oil	49.1
Wheatstone Trunkline (Processed trunkline fluids from Wheatstone, Iago and JDP wells.)	Condensate Blend – Group 1 AMSA Classification: Group I, light, non-persistent oil	52.3
Barrow Island Crude (WA Oil)	Light Crude Oil – Group 2 AMSA Classification: Group II, persistent, light crude oil	35.9
MDO (General vessel use)	Diesel – Group 2 AMSA Classification: Group III Medium, persistent oil	35.9
HFO/IFO (General cargo vessel use)	IFO – HFO – Group 3 / Group 4 AMSA Classification: Group III and IV heavy, persistent oils	15.1

3 Description of the Environment

Within each individual EP, the environment that may be affected (EMBA) by planned operations is described. The EMBA for a particular activity or asset is determined by modelling the potential worst-case spills from the petroleum activities; the EMBA represents a combination of multiple model outputs based on many plausible spill scenarios. Importantly, the EMBA does not represent the area that would be affected during a single spill event. A single spill would affect only a small proportion of the EMBA.

The Description of the Environment (Ref. 2) defines an Planning Area for CAPLs activities and assets (and associated spill scenarios) on the NWS, as described in Section 2.1. The Planning Area was derived using impact thresholds from conservative stochastic spill modelling undertaken for the range of emergency conditions described within the relevant activity specific EPs and is based on low level hydrocarbon presence, representative of a socio-economic impact.

Comprehensive descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2). Further descriptive information for the EMBA specific to certain ABU activities is detailed in the activity specific EPs.

4 Monitoring Ecological and Social Receptors in the EMBA

Descriptions of the NWS environment, values and sensitivities are presented in the Description of the Environment (Ref. 2) and activity specific EPs. The process for identifying and ranking ecological and social receptors that are present within the EMBA and sensitive to oil spills is described in the ABU Oil Spill Protection Prioritisation Process[1] (Ref. 4). The process involves these steps:

1. Identify ecological and socio-economic receptors present in the EMBA by gathering available geospatial data and information from industry, government bodies and monitoring/research projects
2. Use the latest available literature and research data to determine the sensitivity of the various receptors to the effects of oil
3. Rank each receptor according to its sensitivity to oil and display the rankings geospatially

The ranking of ecological and socio-economic receptors allows the emergency management team to make timely and defensible decisions around response and monitoring priorities. A key mechanism for this is through the completion of strategic and operational Net Environmental Benefit Analysis (NEBA), which are completed both pre-spill (strategic) and at regular intervals during the response operation (operational). Further, the ranking values will be considered when designing and implementing operational and scientific monitoring and prioritising resources.

4.1.1 Ecological Receptors

The alignment of sensitive ecological receptors to OPS and SCI monitoring plans is detailed in Table 4-1 and in Section 3.3.1.1. of the ABU OSMP (Ref. 3).

Table 4-1: Sensitive Ecological Receptors within the NWS EMBA and Corresponding Monitoring Components

Receptor	Summary Description
Marine Fauna	
Turtles	Presence of oiled turtles and any impact on potential nesting areas from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS7: Rapid Marine Megafauna Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI5: Marine Megafauna Impact Study
Seabirds and shorebirds	Presence of oiled seabirds and shorebirds and any potential impact to coastal habitat from the oil spill or associated spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • OPS6 Rapid Seabird and Shorebird Assessment • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study

[1] The EMBA represented in the ABU Oil Spill Protection Prioritisation Process relates to an uncontrolled loss of condensate from the Wheatstone or Gorgon production platforms. These scenarios have the greatest geographical coverage of any spill scenarios.

Receptor	Summary Description
Cetaceans, pinnipeds, and large cartilaginous fish	Presence of oiled marine megafauna including whales, dolphins, Dugong, pinnipeds, Whale Sharks, sharks, manta rays, sawfish, and other marine megafauna can be monitored via: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study
Fish	Monitoring of any potential impact on fish populations and fisheries, including aquaculture can be monitored via: • OPS8: Fish Tainting • SCI7: Fish Effects Impact Study
Sea snakes	Monitoring of any potential impact on sea snake populations is considered infeasible due to difficulties in finding and tracking a suitable population to enable scientific rigour. Opportunistic observations can be made through appropriate monitoring scopes, including: • OPS7: Rapid Marine Megafauna Assessment • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study
Shoreline Habitats	
Mangroves, intertidal mudflats and sandflats, intertidal shoals and sandbars, sandy beaches, intertidal rock pavement, and rocky shores	Extent of oil presence, persistence, associated change in percent (live) cover of these habitats, and impacts from spill response activities can be monitored via: • OPS5: Rapid (Oiled) Shoreline Assessment • SCI3: Coastal and Intertidal Habitat Impact Study
Marine Habitats	
Pelagic	Monitoring of any potential impact on micro flora and fauna (e.g. plankton) inhabiting the pelagic zone can be inferred by water and sediment quality studies: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study
Benthic habitats	Extent of oil presence, persistence, associated change in percent (live) cover of these benthic habitats such as coral reefs, seagrass, macroalgal communities, filter-feeding communities, and soft sediment communities can be monitored via: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study

4.1.2 Socioeconomic Receptors

The alignment of sensitive socioeconomic and heritage receptors to OPS and SCI monitoring plans is detailed in Table 4-2.

Table 4-2: Socioeconomic and Heritage Features and Corresponding Monitoring Components

Category	Justification
Infrastructure	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within areas of infrastructure are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study
Commercial shipping	Oil spills are not considered to have a long-term significant impact on the use of existing commercial shipping channels and regional ports
Commercial fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Recreational fishing	Potential impacts of an oil spill and associated response activities on fish are considered in: • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Aquaculture	Potential impacts of an oil spill and associated response activities on aquaculture are considered in: • OPS3: Oil in Water Assessment • SCI1: Water Quality Impact Study • SCI7 Fish Effects Impact Study
Tourism and recreation	Potential impacts of an oil spill and associated response activities on water, sediment, benthic habitat, or marine fauna within tourism and recreation areas are considered in: • OPS3: Oil in Water Assessment • OPS5: Rapid (Oiled) Shoreline Assessment • OPS8: Fish Tainting Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI3: Coastal and Intertidal Habitat Impact Study • SCI4: Seabird and Shorebird Impact Study • SCI5: Marine Megafauna Impact Study • SCI6: Benthic Habitat Impact Study • SCI7: Fish Effects Impact Study
Heritage (including shipwrecks)	Potential impacts of an oil spill and associated response activities on water, sediment, or benthic habitat within heritage areas are considered in: • OPS3: Oil in Water Assessment • OPS4: Oil in Sediment Assessment • SCI1: Water Quality Impact Study • SCI2: Sediment Quality Impact Study • SCI6: Benthic Habitat Impact Study • SCI8: Heritage (including Shipwrecks)

4.2 Stakeholder Consultation

The process for consultation with key stakeholders is presented in the ABU OSMP (Ref. 3). Table 4-3 shows a matrix of key values and sensitivities, and the core stakeholders that may need to be consulted. The stakeholder list not exhaustive; consult the stakeholder management plan within the relevant EP for a full list of stakeholders consulted when preparing that EP.

Table 4-3: EP Values and Sensitivities and Associated Core Stakeholders for Consultation

Particular EP Values and Sensitivities	Core Stakeholders										
	DAWE	AFMA	AMSA	NOPSEMA	DBCA	DoT	DPIRD	WAFIC	DWER	Port Authorities	Local Gov' t
National Heritage Areas	X			X	X				X		X
World Heritage Areas	X		X	X	X				X		X
Ramsar Wetlands	X			X	X				X		X
Australian Marine Parks	X	X	X	X	X				X		
State Marine Areas/Reserves	X			X	X	X	X	X	X		X
Commonwealth Marine Areas – KEFs identified through Marine Bioregional Plans	X	X	X	X							
Commonwealth and State Fisheries and Aquaculture			X					X	X		
Recreation and Tourism			X		x	X		X		X	X

Note:

DAWE = Department of Agriculture, Water and the Environment

AFMA = Australian Fisheries Management Authority

AMSA = Australian Maritime Safety Authority

NOPSEMA = National Offshore Petroleum Safety and Environmental Management Authority

DBCA = Department of Biodiversity, Conservation and Attractions

DoT = WA Department of Transport

DPIRD = Department of Primary Industries and Regional Development

WAFIC = Western Australian Fisheries Industry Council

DWER = Department of Water and Environment Regulation

4.3 State of the Environment (Baseline) – Information Sources

Baseline monitoring provides information on the condition of ecological receptors prior to, or spatially independent (e.g. if used in control chart analyses) of, a spill event and is used for comparison with the post-impact scientific monitoring where required. This is particularly important for scientific monitoring where the ability to detect changes between pre-impact and post-impact conditions is necessary.

CAPL has completed several studies around project and asset sites that would provide suitable quantitative data for comparison with post-spill conditions. Additionally, CAPL also completes ongoing monitoring programs that would also inform baseline state; these studies and the type of data available are summarised in Section 4.3.1.

CAPL also has access to information from industry partners through direct or collaborative agreements (Section 4.3.1.2). Public information sources (Section 4.3.3) complement CAPL and industry partner data.

Some operational and scientific monitoring components are suited to pre-impact baseline monitoring. If an oil spill to marine or coastal waters occurs, reactive pre-impact monitoring will, where practicable, be implemented to gather additional data on the current state of the environment. Where timing, logistics, and safety considerations allow for the implementation of reactive baseline monitoring, methods will follow the relevant operational or scientific monitoring components.

Baseline information on the ecological receptors of the NWS will be reviewed and updated annually. The process for obtaining and maintaining baseline data is outlined below:

1. Assess existing CAPL studies (much of the baseline information will come from the comprehensive Description of the Environment (Ref. 2), which provide a baseline description of the physical, ecological, cultural, and socioeconomic marine environment of north-west WA relevant to CAPL's petroleum activities and potential oil spill scenarios.
2. Systematically assess scientific and grey literature searched through Web of Science, Web of Knowledge, Google Scholar, and any other relevant sources.
3. Assess industry–government environmental metadata (I-GEM), or other industry portals, to understand design and collection methods (which would strongly influence data collection and project design post-spill).
4. Document in logical sequence the existing baseline data gathered from steps 1 to 3 above. Collect, manage, and cite research sources to create a database of abstracts/summary, keywords, and links to literature locations that can be easily searched and rapidly produce a reference list.
5. Identify gaps in the knowledge and consider what further information is required (i.e. undertake a data gap analysis).
6. Undertake a risk assessment of the gaps.
7. Identify how data would be collected to fill gaps (if required).

4.3.1 Data Collected by Chevron Australia

Baseline environmental data resources held by, or on behalf of CAPL are described in the following sections and summarised in Table 4-4.

4.3.1.1 Data Stored Internally

CAPL stores environmental data across a range of accessible platforms and repositories, the mixture of which changes over time depending on the age, type, originator, and IS facilities/platforms available at the time.

Table 4-4 provides an indication of the data storage location at the time of writing this revision.

Table 4-4: Available Baseline Data Relevant to Monitoring the Effects of Oil Spills in the Marine Environment

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Gorgon Gas Development						
• Coastal and Marine Baseline State and Environmental Impact Report • Materials Offloading Facility (MOF), Liquefied Natural Gas (LNG) Jetty, Dredge Spoil Disposal Ground	2008–2011 • East coast of Barrow Island	• Benthic habitat mapping (broadscale mapping, finer detail at selected coral monitoring sites) • Coral (composition, % cover, size class frequency, growth and survival, recruitment) • Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health) • Fish – intertidal and subtidal (composition,	SCI1 SCI2 SCI3 SCI6 SCI7	**CAPL website** Report # **G1-NT-REPX0001838** Appendices # **G1-NT-REPX0001838**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • Document Management System (DMS)	I-GEM – Chevron – Coral (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Macroalgae (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Seagrass (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Mangrove (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Demersal Fish (Gorgon Marine Baseline Program) 2008–2010 I-GEM – Chevron – Demersal Fish (Gorgon Post-
• Coastal and Marine Baseline State and Environmental Impact Report • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing	2008–2011 • West coast of Barrow Island			**CAPL website** Report # **G1-NT-REPX0002749**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Coastal and Marine Baseline State and Environmental Impact Report • Domestic Gas Pipeline	2008–2011 • DomGas Pipeline Route, DomGas Mainland Shore Crossing			**CAPL website** Report # **G1-NT-REPX0002750**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		abundance, fork length) • Sediments (particle size distribution, total organic/inorganic carbon) • Water quality (light, turbidity, profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity])				Development Surveys) 2011–2014 I-GEM – Chevron – Water Quality (Gorgon) 2009 I-GEM – Chevron – Sediment Quality (Gorgon) 2009–2010
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 1: 2011–2012 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 2: 2012–2013 • MOF, LNG Jetty, Dredge Spoil Disposal Ground, Year 3: 2013–2014	2011–2014 East coast of Barrow Island	• Coral (composition, % cover, size class frequency, growth and survival, recruitment) • Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Mangroves (composition, canopy density, pneumatophore density, leaf pathology, qualitative health)	SCI2 SCI3 SCI6 SCI7	**CAPL website** Year 2, Report #G1-NT-REPX0005152	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	I-GEM – Chevron – Coral (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Benthic Macro-invertebrates (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Macroalgae (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Seagrass (Gorgon Post-Development Surveys) 2011–2014 I-GEM – Chevron – Mangrove (Gorgon Post-Development Surveys) 2011–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish – intertidal and subtidal (composition, abundance, fork length) • Sediments (particle size distribution)				
• Post-Development Coastal and Marine State and Environmental Impact Survey Reports • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 1: 2013 • Offshore Feed Gas Pipeline System and Marine Component of the Shore Crossing , Year 2: 2014	2013–2015 West coast of Barrow Island	• Non-coral benthic macroinvertebrates (composition, abundance) • Macroalgae (composition, % cover, biomass) • Seagrass (composition, % cover, biomass) • Fish – intertidal and subtidal (composition, abundance, fork length)	SCI3 SCI6 SCI7	**CAPL website** Year 2, Report # **G1-NT-REPX0007241**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Baseline Marine and Coastal Sediment Sampling and Analysis (unpublished)	• East coast of Barrow Island • West coast of Barrow Island • DomGas Pipeline Route, DomGas	2009–2011 • Sediments (particle size distribution, total inorganic/organic carbon, moisture content, nitrogen [NH_3, NO_X, Total Kjeldahl Nitrogen (TKN)], phosphorus, metals/ metalloids,	SCI2 SCI3		• Network drive (O drive)	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
	Mainland Shore Crossing	organotins, PAHs, TPHs, BTEX, organochlorine/ organophosphate pesticides, oil/grease)				
• Baseline Study of the Composition and Quality of Nearshore Waters	East coast of Barrow Island	2008 • Water quality (profiles [salinity, temperature, depth, dissolved oxygen, pH, turbidity], nutrients [NH_3, NO_X, orthophosphate], total organic carbon, metals, carbonates, Total Dissolved Solids [TDS], turbidity)	SCI1		• Network drive (O drive)	
• Marine Environmental Quality Management Plan	East coast of Barrow Island	• 2016–ongoing • Water quality (metals) • Sediment quality (metals and hydrocarbons) • Biota quality (metals)	SC1 SC12 SCI7		• Network drive (O drive) • SharePoint 3PC site	
• Baseline Hydrocarbon Content of Bivalves on Barrow Island (unpublished)	East coast of Barrow Island	• 2014 • PAH, TPH, BTEX, and metals	SCI3 SCI7		• Network drive (O drive). Report# G1-VE-H-CE00-H23C8325700019	I-GEM – Chevron – Oysters (Gorgon) 2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
• Monitoring programs required under the Long-term Marine Turtle Management Plan	• East coast of Barrow Island • Mainland coast (Mundabullangana)	• 2005–ongoing (annual survey) • Flatback Turtles (nest success, track counts and satellite tracking, hatchling survival and dispersal)	SCI5	**CAPL website** Gorgon Gas Development and Jansz Feed Gas Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Marine Turtle Nesting (Gorgon) 2005–2014
• Terrestrial and Subterranean Baseline State and Environmental Impact Report	• East coast of Barrow Island • West coast of Barrow Island • DomGas Mainland Shore Crossing	• 2003–2006 • Avifauna (assemblage, total counts) • Physical landforms (coastal foredunes, cliffs, and gorges)	SCI4	**CAPL website** Terrestrial and Subterranean Baseline State Environmental Impact Report. Report # G1-TE-H-0000-REPX027	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • DMS	
• Barrow Island Seabird Monitoring Program (as required under Terrestrial and Subterranean Environmental	• East coast of Barrow Island • West coast of Barrow Island	• 2008–ongoing (annual survey) • Abundance, nest density, presence/absence of egg or chick/fledgling	SCI4	**CAPL website** Gorgon Gas Development and Jansz Feed Gas	• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site	I-GEM – Chevron – Seabirds (Gorgon) 2008–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Monitoring Program)	• Middle Island, Boodie Island, Parakeelya Island, Double Island North, Double Island South	in burrows, predation and mortality records		Pipeline: Five-year Environmental Performance Report (August 2010–August 2015) Report # **G1-NT-REPX0007517**	• DMS	
• Introduced Marine Pest Monitoring for the Gorgon Gas Development	East coast of Barrow Island	• 2010–ongoing • Intertidal species composition • Subtidal species composition	SCI3		• Environmental Data Management System (EDMS) • Environment raw data archiving project register • Network drive (O drive) • SharePoint 3PC site • DMS	
• Coastal Monitoring	East coast of Barrow Island	• 2008–ongoing • Coastal landforms, stability, and habitat	SCI2 SCI3 SCI4 SCI5		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Project						
Wheatstone Baseline State of the Marine Environment Report	• Onslow area • Thevenard Island area	• 2012–2013	SCI1 SCI2 SCI6		• Network drive (O drive) • SharePoint 3PC site • DMS Report	I-GEM – Chevron – Coral (Wheatstone Baseline State of the Marine Environment) 2009–2013 I-GEM – Chevron – Macroalgae (Wheatstone Baseline

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
						State of the Marine Environment) 2012 I-GEM – Chevron – Seagrass (Wheatstone Baseline State of the Marine Environment) 2012 I-GEM – Chevron – Filter Feeders (Wheatstone Baseline State of the Marine Environment) 2012
Wheatstone Marine Fauna Monitoring Program	• Onslow Area • Thevenard Island Area • Montebello Island Area	• 2009–2010 • Whales (acoustic loggers)	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Exmouth Gulf to Barrow Island	• 2009–2010 • Whales (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2012–2014 • Dugong (aerial observations) • Other marine fauna also recorded	SCI5		• Network drive (O drive) • DMS	I-GEM – Chevron – Dugong (Wheatstone) 2012–2014
Wheatstone Marine Fauna Monitoring Program	• Onslow Area	• 2010–2011	SCI7		• Network drive (O drive) • DMS	

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
		• Fish (community composition, abundance)				
Deepwater Benthic Habitats	• Onslow Area	• 2008–2009 • Benthic habitat (composition)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Baseline Benthic Habitat Monitoring	• Onslow Area	• 2009–2013 • Benthic habitat (composition, percent cover)	SCI6		• Network drive (O drive) • DMS	
Wheatstone Mangrove Monitoring Program	• Onslow Area	• 2009–ongoing • Mangroves (composition, canopy density, qualitative health) • Algal mat coverage	SCI3		• Network drive (O drive) • SharePoint 3PC site • DMS	
Wheatstone Coastal Habitat Survey	• Onslow Area	• 2008–2009 • Intertidal habitat, coastal type • Physical shoreline features	SCI3			
Wheatstone Turtle Impact Monitoring Program	• Onslow Area	2013–ongoing • Flatback Turtles (nest success, track counts, hatchling survival and dispersal)	SCI5	**CAPL website** EIS/ERMP APPENDIX O11 – TECHNICAL APPENDIX MARINE TURTLES	• Network drive (O drive) • SharePoint 3PC site • DMS	I-GEM – Chevron – Turtles (Wheatstone) 2012–2014

Data Source	Collection Time and Location	Summary of Data	Relevant SCI Component	External Report Reference	Data Location	Metadata Record Description
Baseline Hydrocarbon Content of Bivalves and Sediments (unpublished)	• Onslow Area • Offshore Islands • Thevenard Island Area	2013 PAH, TPH, BTEX, and Metals	SCI2 SCI3		• Network drive (O drive) • DMS	
Thevenard Island (TVI) Marine Environmental Monitoring Program	• Thevenard Island Area	• 1991–ongoing • Coral (composition, abundance) • Sediment (hydrocarbons, metals) • Bivalve (hydrocarbons, metals)	SCI2 SCI3 SCI6		• Network drive (O drive) • DMS	
TVI Marine Environmental Monitoring Program	• Thevenard Island Area	• 2009–2010 • Benthic Habitat	SCI6		• Network drive (O drive) • DMS	
Sea Serpent Project	Various	• Deep-sea benthic surveys • Deep-sea marine fauna surveys • Sediment sampling	SCI2 SCI5 SCI6 SCI7		• Network drive (O drive) • DMS	
Deep-sea sediment sampling	2013 HERA-1 and Delphin-1	• Sediment sampling (hydrocarbons)	SCI2		• Network drive (O drive) • DMS	

4.3.1.2 Data Stored Externally

Additional baseline datasets are available to CAPL, but are held by external consultants and described in reports held by CAPL. These data can be accessed when required from the consultants.

4.3.2 Industry Agreements (including I-GEM)

Vermillion Oil and Gas (Australia) Pty Ltd have confirmed that, in the event of an oil spill, they would release data collected at the Montebello Islands on sediment and water quality, mangrove condition, marine turtle nesting activity, and bird presence (roosting; nesting and foraging) for CAPL's use in environmental assessment.

I-GEM is an industry and government collaboration to collate and present spatial metadata on marine environmental baseline and monitoring studies collected in the last decade. The objective of this program is to ensure industry and government have the same marine studies knowledge.

The intention of I-GEM is to capture spatially referenced metadata on marine environmental studies from the Abrolhos Islands to the Timor Sea and from the nearshore waters of the coast to the edge of Australia's continental shelf. This metadata database will allow organisations to understand what environmental baseline studies exist and where, and identify the custodian. The database provides a valuable shared resource to support impact assessment in the unlikely event of a major oil spill in the region.

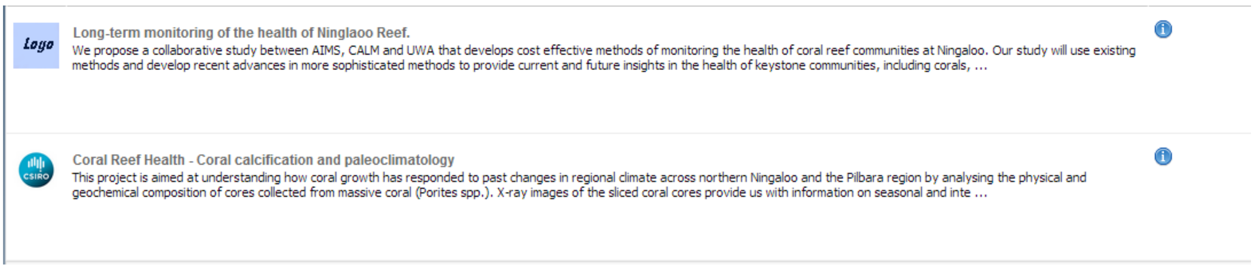
I-GEM metadata are publicly accessible from the AODN metadata catalogue, with accessibility to the WAODN metadata catalogue. It is not necessary to apply for a user name and password to search publicly available metadata records and public data; however, a user name and password is required to create metadata records or download and view restricted data.

Login details for CAPL are included in Environment Unit Lead guidance documents and a user guide is available via this link.

An example of an I-GEM metadata search is provided below.

Search: *coral health Ningaloo*

Results as viewed online:



Extract of titles relevant to example search:

- Long-term monitoring of the health of Ningaloo Reef
- CSIRO Coral Reef Health – Coral calcification and paleoclimatology

- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- WAMSI Node 3.2.2c – Spatial variation in algal-herbivore interactions on the Ningaloo Reef, Western Australia: Regional differences in the piscine drivers of macroalgal herbivory in a coral-reef marine park (Honours thesis)
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Environmental Drivers: Coastal Reef Monitoring (Ningaloo) 2014–2015
- Methods for monitoring the health of benthic communities, Ningaloo Reef, Western Australia (WAMSI Node 3 Project 3.1.2)
- AIMS Long-Term Monitoring of Ningaloo Marine Park: Status of Drupella and shallow water benthic reef communities
- Data on the long-term monitoring of Ningaloo Marine Park
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Fish Short Transect Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Reef Fish Survey – Reef Target Fish Survey 2013-2015
- CSIRO Coral Reef Health Broadscale Survey – Reef Benthic Survey 2013–2015
- CSIRO Coral Reef Health Sediment Survey 2013–2015
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Stable isotope ratios of selected flora and fauna from Ningaloo and the Pilbara 2014–2016
- CSIRO Coral Reef Broadscale Invertebrate Survey – 2013–2015
- CSIRO Macroalgae and seagrass biomass and diversity across the Pilbara Region in November 2013 and May 2014
- CSIRO Pilbara Marine Conservation Partnership (PMCP) – Fish and Sharks – Raw Stereo-BRUV Imagery – 2015_08_Ningaloo.deep.sanctuaries_stereoBRUVs

Example of metadata record linked to each title:

Link: http://catalogue.aodn.org.au:80/geonetwork?uuid=506cd950-371b-4c99-a43e-584557972348

Abstract: This project is aimed at understanding how coral growth has responded to past changes in regional climate across northern Ningaloo and the Pilbara region by analysing the physical and geochemical composition of cores collected from massive coral (*Porites* spp.). X-ray images of the sliced coral cores provide us with information on seasonal and inter-annual changes in the density and rate of vertical extension from which we can calculate annual rates of coral growth, or more precisely, calcification. Coral cores from massive *Porites* spp. were collected from sites across northern Ningaloo (Tantabiddi and Coral Bay in July 2013) and the western Pilbara (Onslow to the Dampier peninsula in April 2014).

4.3.3 Public Information Sources

A bibliography of research and data relevant to CAPL's Resources at Risk project was created in 2014. This document listed published and unpublished material relevant to the marine and intertidal environments within the EMBA in the event of a worst-case scenario hydrocarbon release associated with the Wheatstone or Gorgon Gas Developments. The output was a comprehensive bibliography of the physical, ecological, and biological components of the marine and intertidal environments within the EMBA. An overview of this output is stored as a list in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe83127eae/chronicleId/09024afe83127e9f/versionLabel/CURRENT or on SharePoint at this link Resources at Risk

Chevron holds a Zotero user licence to enable access to the details of the bibliography. The relevant text file to be opened with Zotero is stored in DMS at this link http://webtop-sg.dm.chevron.net/webtop/drl/objectId/09024afe8312927d/chronicleId/09024afe8312927d/versionLabel/CURRENT.

5 Capability and Readiness Estimate

5.1 Process for Determining Required Capability

The ABU OSMP (Ref. 3) outlines the high-level process for determining capability requirements and maintaining an appropriate level of capability, internally and externally. This Section summarises the process for estimating the personnel, logistics, and equipment required to implement operational and scientific monitoring for two representative modelled spill scenarios on the NWS:

- Offshore loss of well control event
- Heavy Fuel Oil spill (1040 m^3 over three days) at the Wheatstone Product Loading Facility (Ashburton North)

The requirements for one field team to implement each individual monitoring component were determined via internal workshops that considered:

- number of personnel per team
- team composition (e.g. field leader, subject matter experts [SMEs], field workers)
- sampling equipment per team (generic equipment [e.g. laptop] and that specific to the monitoring component [e.g. water column profiler])
- work platform (e.g. 4WD vehicle, fixed-wing aircraft, inshore vessel, offshore vessel).

For each scenario, the number of teams required to implement the monitoring components was determined for up to four phases of the event:

- Phase 1: Initial (0–30 days)
- Phase 2: 30 days to end of release and dispersion; ~240 days
- Phase 3: Initial Recovery (3 years)
- Phase 4: Ongoing (time defined for each receptor).

The number of teams accounted for the following factors:

- co-mobilisation of common scopes (i.e. the ability of one team to implement multiple monitoring components)
- shift hours (12-hour or 24-hour operations) and rotation of field teams (e.g. 14 days on/off).

Up to four equipment suppliers were identified for each equipment type, with their name, number of items available, lead time for equipment to be ready to mobilise from the location, location, and contact number.

5.2 Existing Capability Compared to Estimate

CAPL’s capability to implement the ABU OSMP (Ref. 3) for an incident on the NWS draws on internal (CAPL and corporate structure) and external (contractor) resources. Capability is maintained in a central register; internal personnel capability is updated quarterly, while external capability is updated every 6 months.

The combined internal and external capability is compared to Phase 1 estimated requirements to ensure sufficient resources are available to support the initial response, while allowing time for scaling up for prolonged events.

6 Acronyms and Abbreviations

Table 6-1 defines the acronyms and abbreviations used in this document.

Table 6-1: Acronyms and Abbreviations

Acronym/ Abbreviation	Meaning
~	Approximately
°C	Degrees Celsius
4WD	Four-wheel drive (vehicle)
ABU	Australian Business Unit
AFMA	Australian Fisheries Management Authority
AMSA	Australian Maritime Safety Authority
ANZECC	Australian and New Zealand Environment and Conservation Council
AODN	Australian Ocean Data Network
APPEA	Australian Petroleum Production and Exploration Association
ArcGIS	An integrated collection of GIS software products developed by ESRI that provides a standards-based platform for spatial analysis, data management, and mapping
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
Avifauna	Birds of a particular region
BIA	Biologically Important Area
Biogenic	Produced or brought about by living organisms
Bombora	Raised, dome-shaped, limestone feature, >1 m high, often formed by coral of the genus Porites.
Bonn Convention	Convention on the Conservation of Migratory Species of Wild Animals 1979
BTEX	Benzene, toluene, ethylbenzene, and xylene compounds
CAMBA	China–Australia Migratory Bird Agreement
CAPL	Chevron Australia Pty Ltd
Cetacean	Various aquatic (mainly marine) mammals of the order Cetacea, (including whales, dolphins and porpoises) characterised by a nearly hairless body, front limbs modified into broad flippers and a flat notched tail
Commonwealth Waters	Waters stretching from three to 200 nautical miles from the Australian coast.
CSIRO	Commonwealth Scientific and industrial Research Organisation
DAWE	Commonwealth Department of Agriculture, Water and the Environment
DBCA	Western Australian Department of Biodiversity, Conservation and Attractions
Demersal	Living on the seabed or just above it
DMP	Former Western Australian Department of Mines and Petroleum (2009–2017); now Department of Mines, Industry Regulation and Safety
DMS	Document Management System
DomGas	Domestic Gas
DoT	Western Australian Department of Transport
DPIRD	Western Australian Department of Primary Industries and Regional Development

Acronym/ Abbreviation	Meaning
DWER	Western Australian Department of Water and Environment Regulation
EDMS	Environmental Data Management System
EMBA	Environment that May be Affected
EMT	Emergency Management Team
EP	Environment Plan
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Finfish	A term used to distinguish fish with fins and gills, from shellfish, crayfish, jellyfish, etc.
Foraminifera	Microscopic, single-celled organisms with shells
FSSMP	First Strike Sampling and Analysis Plan
GIS	Geographic Information System
HES	Health, Environment, and Safety
HMAS	His Majesty's Australian Ship (during World War II)
HSK	Ship of the German Navy (during World War II)
IAA	Impact Assessment Area
I-GEM	Industry–Government Environmental Metadata
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IPIECA	International Petroleum Industry Environmental Conservation Association
IS	Information Systems
IUCN	International Union for Conservation of Nature
JAMBA	Japan–Australia Migratory Bird Agreement
KEF	Key Ecological Feature
km	Kilometre
km^2	Square kilometre
LNG	Liquefied Natural Gas
m	Metre
m/s	Metres per second
m^3	Cubic metre
MEQMP	Marine Environmental Quality Management Plan
MNES	Matters of National Environmental Significance, as defined in Part 3, Division 1 of the EPBC Act
MOF	Materials Offloading Facility
N/A	Not applicable
Nekton	The aggregate of actively swimming organisms at the sea's surface
NH_3	Ammonia
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NO_x	Oxides of nitrogen (NO and NO_2)
NWMR	North-West Marine Region
NWS	North West Shelf

Acronym/ Abbreviation	Meaning
NWSJEMS	North West Shelf Joint Environmental Management Study
OPEP	Oil Pollution Emergency Plan
OPS	Operational monitoring
OSMP	Operational and Scientific Monitoring Plan
PAH	Polycyclic Aromatic Hydrocarbon
Pelagic	Living in the open sea rather than in coastal or inland waters
pH	Acidity or basicity of a solution
Photic Zone	The depth of the water in a lake or ocean that is exposed to sufficient sunlight for photosynthesis to occur. The depth of the photic zone can be greatly affected by turbidity.
PSU	Practical Salinity Units, equivalent to parts per thousand
QA/QC	Quality Assurance / Quality Control
Ramsar Wetland	A wetland of international importance, recognised globally under the Ramsar Convention. The Ramsar Convention is an international treaty for the conservation and sustainable use of wetlands; it recognises the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value.
ROKAMBA	Republic of Korea–Australia Migratory Bird Agreement
SCI	Scientific monitoring
SME	Subject Matter Expert
SQL	Structured Query Language (Microsoft)
State Waters	The marine environment within three nautical miles of the mainland of Western Australia or its islands
TDS	Total Dissolved Solids
TKN	Total Kjeldahl Nitrogen
TPH	Total petroleum hydrocarbon
Trophic	Pertaining to food or nutrition
TVI	Thevenard Island
WA	Western Australia
WAFIC	Western Australian Fisheries Industry Council
WAMSI	Western Australian Marine Science Institution
WAODN	Western Australian Ocean Data Network

7 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 7-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2023 *Description of the Environment*. Chevron Australia, Perth, Western Australia.	ABU-COP-02890
2.	Chevron Australia. 2017. *Operational and Scientific Monitoring Plan: Environmental Monitoring in the Event of an Oil Spill to Marine Coastal Waters*. Rev. 6.0. Chevron Australia, Perth, Western Australia	ABU130700448
3.	Chevron Australia. 2018. *ABU Oil Spill Protection Prioritisation*. Revision 1.0 Chevron Australia, Perth, Western Australia.	ABU180500232
4.	Chevron Australia. 2018. *Chevron ABU – Oil Properties and Dispersion Application Applicability*	ABU180501458
5.	Chevron Australia. 2020. *ABU Operations: Environment Plan Changes Tracking Register*	ABU180500351

Appendix B Guidance Note and Standard Operating Procedures – Operational Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Operational Monitoring

Document ID:	ABU150300650
Revision ID:	4.0
Revision Date:	25 May 2020
Next Revision Due	25 May 2025
Information Sensitivity:	Company Confidential

Contents

Tables

Figures

1 Introduction

1.1 Purpose

The Operational and Scientific Monitoring Plan (OSMP): Operational Monitoring Guidance Note (this Guidance Note) describes the implementation for operational monitoring if an emergency condition results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on operational monitoring only, as set out in the OSMP (ABU130700448; Ref. 1).

The OSMP splits operational monitoring into individual components (Figure 1-1); each represents a particular assessment or study, with tailored initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for operational monitoring purposes, not scientific monitoring. Therefore, some of the design and methodology cannot be prescriptive and must focus on rapid data collection for response decision-making rather than long-term studies to determine impact.

1.2 Scope

This Guidance Note focuses on the implementation of operational monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs (OPS) is part of the OPEP processes and is not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at Chevron Australia, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

The geographic scope of the implementation of the OSMP, including this document, is described in Section 2.3.1 and shown in Figure 2-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for operational monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures (SOPs) for required sampling, including providing standard field sheets and checklists.

1.4 Target Audience

Personnel fulfilling operational monitoring roles within the Environment Unit (Figure 2-1) of the Emergency Management Team (EMT) will use this Guidance Note.

Note: Although this document gives guidance for operational monitoring, it is assumed that the teams implementing the monitoring outlined in this document have a baseline understanding of operational monitoring, and are familiar with environmental sampling methods, equipment, and procedures.

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft), and/or events beyond CAPL's control can be accommodated. The potential survey areas occur in a remote region with limited logistical capability, and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity) may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more OMPs as described in this document. If this occurs, CAPL will take measures and/or reprioritise its monitoring programs to ensure the objectives of this document are met.

This document provides a framework for finalising program design so that it is appropriate to the nature and scale of the event. This document provides more details for OPS that must be implemented immediately by CAPL. External environmental specialists, engaged to support other OPS, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required by the EMT.

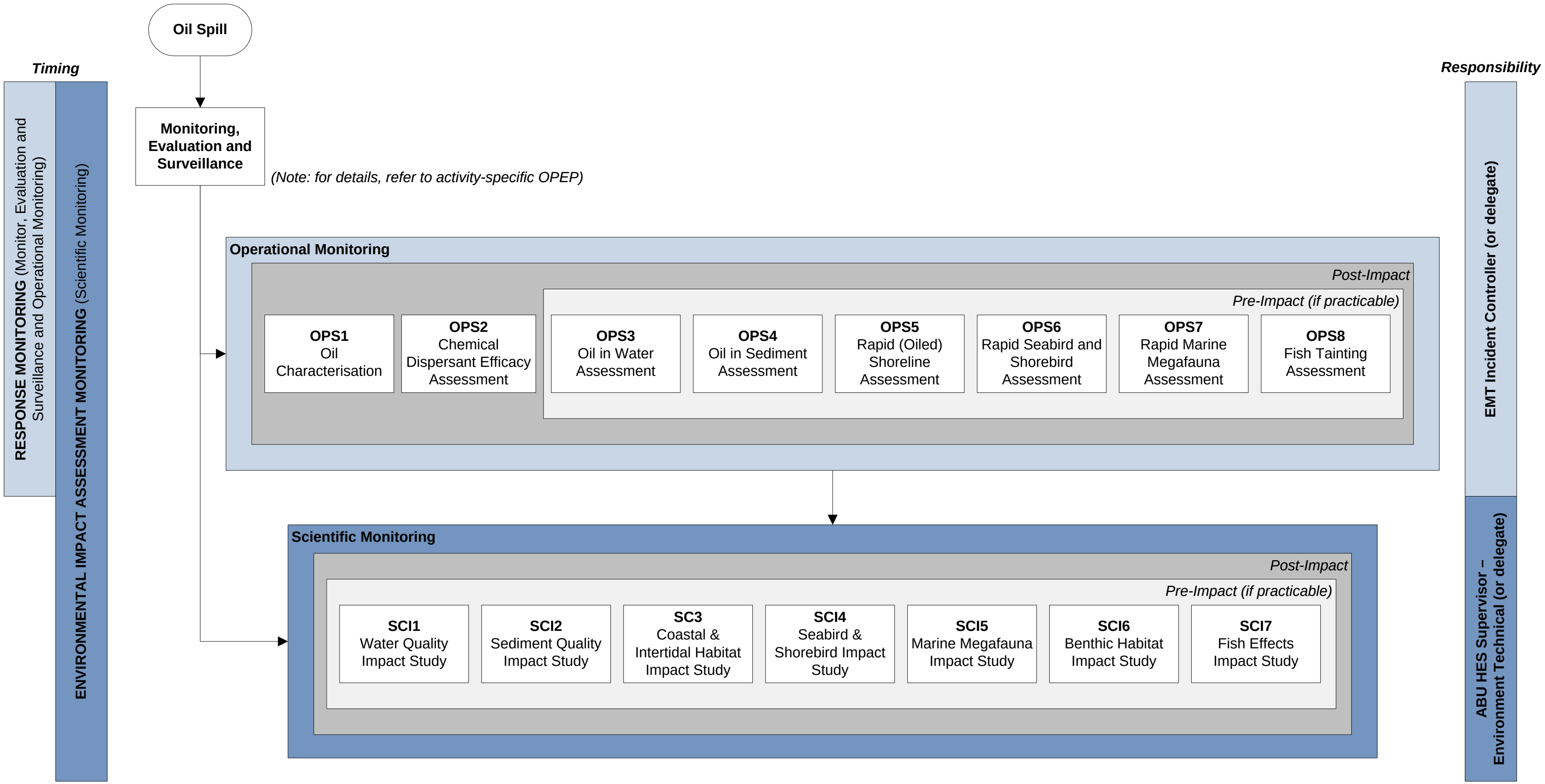


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

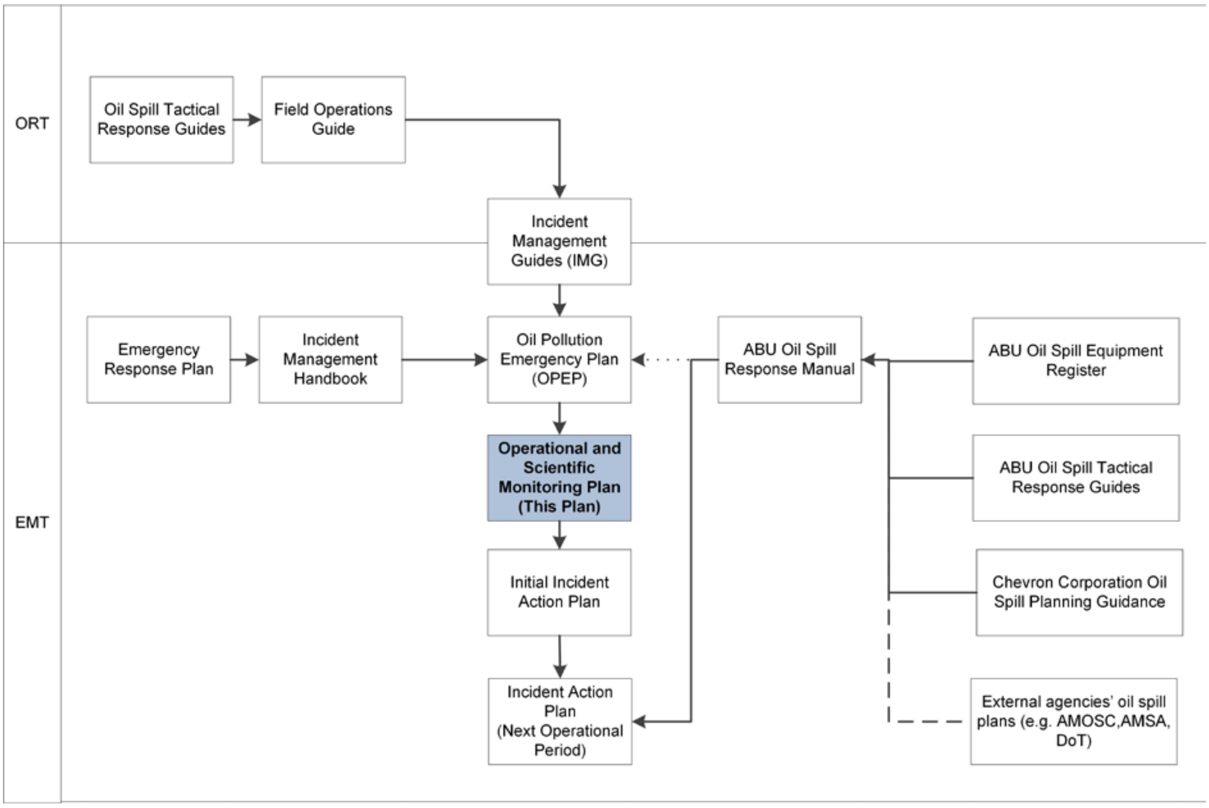


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review this Plan every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions, and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 12 defines the acronyms and abbreviations used in this Guidance Note.

2 Implementation Strategy

Operational and Scientific Monitoring is a key element in effectively responding to oil spill incidents and CAPL's process for this activity is described in the ABU OSMP (Ref. 1). This Guidance Note is one of the key supporting procedure documents that support the OSMP.

2.1 Roles and Responsibilities

The roles and responsibilities outlined in Figure 2-1 apply to all phases of the monitoring process. The EMT Incident Commander (or delegate) will be responsible for ensuring the implementation of the operational monitoring components. Several specific monitoring roles (see shaded cells in Figure 2-1) will also be required.

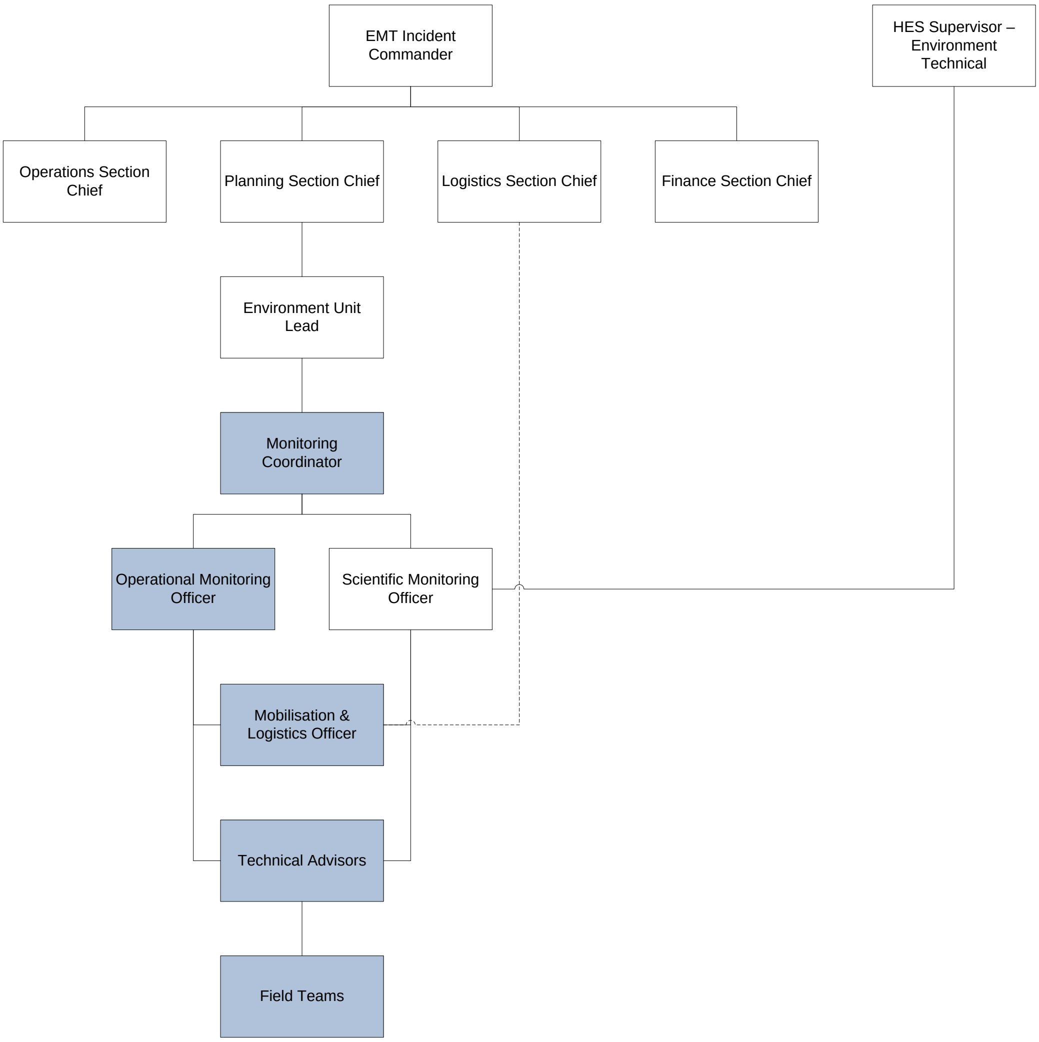


Figure 2-1: Roles Associated with Operational Monitoring

Note: Shaded cells refer to roles associated with this Guidance Note.

Table 2-1: Operational Monitoring Roles, Responsibilities, and Rationale for using this document

Role	Responsibilities	Reason for using this document
EMT Incident Commander (or delegate)	Ultimately responsible for ensuring that operational monitoring is implemented in accordance with the OSMP (Ref. 1).	Is aware of this document but does not directly implement each OPS
Environment Unit Lead (EUL)	Key position for relaying information between the EMT and the Monitoring Coordinator.	Refers the Monitoring Coordinator to this document for use by the monitoring team
Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • contact point with the EMT (through EUL) • providing overarching technical advice • financial tracking and management (in consultation with Finance Section in EMT) • logistics tracking (in consultation with Logistics Section in EMT) • engaging with required third-party contractors including consultants and laboratories • supporting the EUL in ensuring that: – relevant OPS components are implemented in line with the descriptions in the OSMP (Ref. 1) – necessary monitoring roles are defined as appropriate to the nature and scale of the event • ensuring operational monitoring components are implemented within the times defined in Section 2.2.	• Communicating monitoring activities to the EMT • Acquiring personnel to fulfil roles and ensure responsibilities are met
Operational Monitoring Officer	Operational Monitoring Officers are the technical leads for each of the monitoring types. Responsibilities include: • understanding the data metrics that would be collected in the event of a spill • advising the Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time or logistics) are encountered • facilitating activation of contractors if necessary • overseeing data analyses and interpretation • managing data including spatial data • presenting data in an appropriate and informative format to allow for timely decisions.	• Design of OPS programs • Ensuring SOPs are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted and reported back to the EUL

Role	Responsibilities	Reason for using this document
Mobilisation and Logistics Officer	The Mobilisation and Logistics Officer is responsible for ensuring that field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable and in accordance with CAPL processes. This position also liaises with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams. If required, this position is also responsible for facilitating procurement of any necessary vessels or sampling equipment.	• Understanding resources required (resource lists for each OPS) • Understanding requirements to mobilise people and equipment for monitoring tasks
Technical Advisors	Technical Advisors will be assigned to monitoring scope(s) as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include: • overseeing and advising on the collection of data • advising the Operational and Scientific Monitoring Officers on data collection methods • ensuring sampling and analysis plans (where required) are completed before mobilisation • ensuring quality assurance/quality control (QA/QC) and interpreting data • preparing reports.	• Design of OPS • Verifying SOPs • Ensuring QA/QC in data collection and reporting
Field Teams	A Field Team will include a Field Team Lead, who will be the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for: • understanding the details of monitoring methods • having adequate field data collection sheets and survey-specific equipment readily available • ensuring awareness and understanding of QA/QC procedures • assisting with report preparation if required • implementing relevant health, environment, and safety (HES) protocols.	• SOPs for each OSMP • Resource lists

2.2 Timing Commitments

Implementation times were committed to and are provided in the OSMP (Ref. 1).Implementation times for the Operational Monitoring Components are directly linked to the initiation criteria which are found in Section 4 of the OSMP. Implementation times must be adhered to.

2.3 Mobilisation Times

2.3.1 Operational Areas

The operational areas of CAPL are shown in Figure 2-2; these areas also represent the geographic scope of the implementation of the OSMP (Ref. 1), including this document. Indicative mobilisation times for these areas is provided in Appendix A.

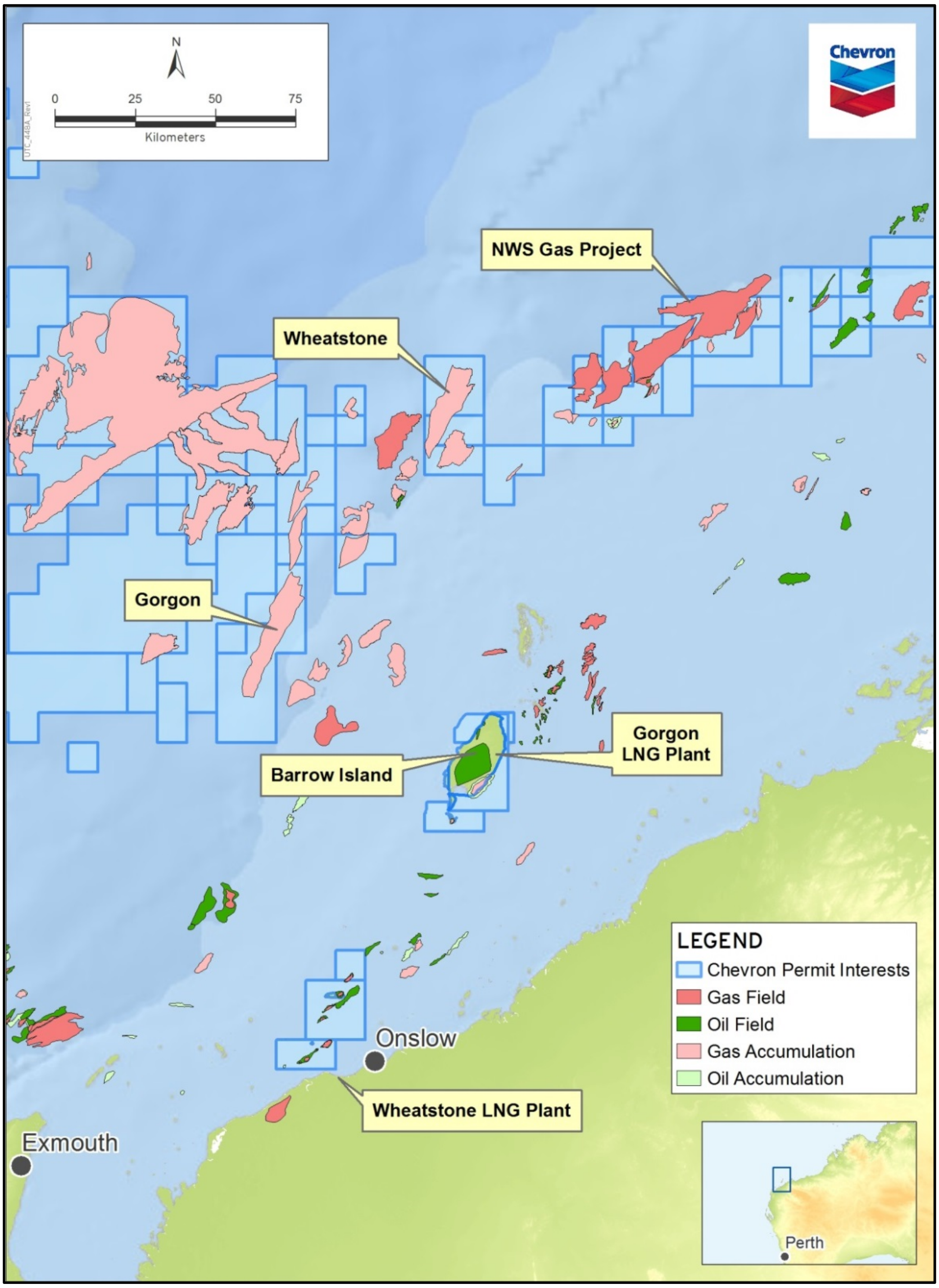


Figure 2-2: CAPL Operational Areas

2.3.2 Non-operational Areas

For areas not under CAPL operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and WA Department of Parks and Wildlife (Parks and Wildlife) for locations managed by the Marine Parks and Reserves Authority (MPRA).

2.3.3 Permits

Individual operational monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required where biological samples are collected from the water column or seabed, or where an exemption is required to use a specific type of sampling gear. For operational monitoring, this applies to OPS8: Fish Tainting Assessment, under which live and dead fish specimens will be collected. Several different permits or exemptions will be required from different government departments, depending on where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 2-2 outlines the permits required and issuing authority. outlines the likely permits required for each monitoring component. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 2-2: Permits Potentially Required to Support Operational Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required For	Legislative Requirement
Parks and Wildlife	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles	Conducting scientific research (including filming and photography) in a State Marine Protected Area (MPA) in State Waters out to three nautical miles	*Wildlife Conservation Act 1950* (WA) and Regulations – Regulation 17
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nautical miles. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and associated Regulations

2.4 Safety and Health

Safety and health is paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with operational monitoring are listed in Table 2-3. This information may be used to develop a Job Safety Analysis (JSA) before undertaking operational monitoring activities. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 2-3 are not exhaustive.

Table 2-3: Potential Hazards Associated with Operational Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas • Appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Manual handling training • Weights clearly marked on labels • Lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Appropriate footwear • Non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. volatile organic compounds [VOCs]), H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Air monitoring • Site entry • Respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration, inability to undertake assigned duties	• Premedication as needed
Aerial Operations		
Motion Injury from aircraft on airfield taxiing or starting engines	• Impact injuries • Possible fatalities	• Flight crew safety instructions and pre-flight briefings • Designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• HUET and/or BOSIET training for all aerial observers • PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Communications plan • Flight crew briefing regarding simultaneous operations (SIMOPS)

Hazards	Impacts	Mitigation Measures
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck • Rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Vessel crew training • Navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Transfer procedures • Follow Vessel Master's instructions • Awareness of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Alarm systems • Firefighting equipment on board • Emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Regular work breaks to cool down or warm up • Appropriate clothing and PPE • Hydration • Sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Vessel engines stopped or in neutral during deployment • On-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms)	• Health impacts: severe pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) • Appropriate clothing and PPE • Over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Regular work breaks • Appropriate clothing and PPE • Hydration • Sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Awareness of sea state and conditions • Use PFDs

2.4.1 Personal Protective Equipment (PPE)

The work described in this document must be performed in compliance with minimum PPE requirements as defined in the ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 24). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23). For operational monitoring activities, conduct a risk assessment to determine the PPE required and consider items listed below as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater, worn under overalls or high-visibility clothing)
- over-ankle reef booties (not dive booties; should have grip on the sole)
- protective gloves suitable for entering water during intertidal work. Consider long lycra gloves, latex gloves, dishwashing gloves or a combination (without causing cross-contamination of samples)
- consider duct-taping PPE to wrists and ankles when contacting sea water.

2.4.2 Washdown for Marine Stinger Safety

Following exposure to marine stingers, particularly Irukandjis (i.e. exposure to salt water), clothing and equipment is to be washed down before disrobing. Vinegar washdown provides the greatest measure of protection. Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until these surfaces have been treated with fresh water for at least ten minutes. See Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 23) for the Vinegar Washdown procedure.

3 Operational Monitoring

Operational monitoring is undertaken to:

- collect information about the oil spill and enhance situational awareness
- aid planning and decision-making in executing spill response or clean-up operations
- assess the impact on sensitive resources
- assess the effectiveness of response options.

Operational monitoring typically finishes when the spill response is terminated, usually because response objectives have been met and/or scientific monitoring has been initiated.

The primary objective of operational monitoring is to provide information that can be used in planning or carrying out a current spill response operation. The characteristics of operational monitoring are:

- results are generally required quickly
- lower requirement for statistical strength (e.g. smaller requirement for replicates at sampling locations and fewer locations)
- lower requirement for identifying control sites or demonstrating baseline conditions
- includes monitoring required before response activities will be approved by regulatory agencies (e.g. use of chemical agents, such as dispersants, or bioremediation agents)
- includes monitoring to help predict environmental effects or define the sensitivity of resources to guide spill response activities.

3.1 Designing the Monitoring Program

The text in this Section is from the Australian Maritime Safety Authority's (AMSA) Oil Spill Monitoring Handbook (Ref. 4); refer to that Handbook for more information. Appendix C contains an extract of the Oil Spill Monitoring Handbook that describes program design.

3.1.1 Setting the Objectives of the Study

Setting objectives is the first step in defining what a monitoring program needs to deliver. In its simplest form it is a statement of what the monitoring program seeks to measure (e.g. descriptive; measurement of change; determination of cause and effect), and defines the parameters to include in monitoring. When setting objectives it is important to understand how monitoring information will be used in the decision-making process. Some key aspects to consider when setting objectives are:

- What specific question(s) needs to be answered?
- Have knowledge gaps been identified and addressed?
- Have the limitations of not having information been evaluated?
- Will the information gathered address major stakeholders' needs?
- How will the information be managed and communicated?

- Do specific objectives:
  - Clearly and concisely communicate the purpose of monitoring?
  - Specify what the monitoring will achieve?
  - Indicate when the monitoring is complete?

3.1.2 Responsibility for Setting Objectives

For OPSs, primary objectives will generally be determined by the CAPL EMT Incident Commander or other nominated person within the EMT. Responsibility for designing or developing a monitoring program is assigned to the EUL who manages the monitoring team. The monitoring team(s) will collect the information needed to meet the set objectives.

3.1.3 Determining the Scale of the Program

It is important that the monitoring program reflects the scale and potential effects of the spill, and addresses key environmental issues relevant to the spill. The appropriate scale for a program will be determined largely by the specific objectives of the program. If variability is high, the time and resources required to reliably detect an impact may require a large monitoring effort. The need for such effort must then consider whether the objective of the study is of sufficient importance to justify the monitoring needed, i.e. the time and resources required may be considered ‘unreasonable’ unless the objective of the study is of high importance.

3.1.4 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study will depend primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives; usually set by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up options.

The boundaries should also be sufficient to cover representative areas of each:

- type of substrate
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

Compromise and constant review of priorities may be necessary as OPSs are usually designed and executed during an emergency situation where time and resources are likely to be limited.

3.2 Data Management

Sampling data, and assessments of that data, need to be conveyed to the appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that information is presented appropriately and on time. Field data collected can be obtained in various forms:

- results from field sampling and observations
- forms
- photographs
- videos
- maps
- notebooks and logs
- portable global positioning system (GPS)/geographic information system (GIS) units
- verbal transmission
- Chain of Custody forms
- laboratory reports
- samples (biological, sediment, or oil).

Photographic and video evidence ranging from coastlines to detailed quadrats are a useful operational monitoring tool. Photo documentation has the advantage that skilled interpretation of data can be done later, remotely, and be centralised; such documentation is a fast and relatively inexpensive data collection process.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any OPS will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive, well organised, and appropriately analysed.

Appendix D is an extract from the AMSA Oil Spill Monitoring Handbook (Ref. 4) that provides a guide to data management.

3.3 Laboratory Analysis

Hydrocarbon analysis will be undertaken by an appropriate laboratory, with (where possible) National Association of Testing Authorities (NATA) accreditation for the analytes of interest or a robust QA/QC program. It is the responsibility of the Operational Monitoring Officer to ensure correct laboratory requests, deliveries, and reports are obtained.

3.4 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 25; see also Appendix F).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in Chain of Custody Form.
4. The Chain of Custody Form (Appendix F) should stipulate that the report is sent to the Monitoring Coordinator and EUL.

Services can be directly engaged by CAPL personnel or by selected Environmental Contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 26).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies, as outlined in Table 3-1. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

Table 3-1: Surcharge Rates for Expedited Turnaround Times for CAPL Contracted Laboratories

Turnaround Time Surcharge	ALS	ChemCentre
Same day	100% sample cost	Not available
1 day	40% sample cost	100% sample cost

Turnaround Time Surcharge	ALS	ChemCentre
2 day	25% sample cost	50% sample cost
3 day	none	none

3.5 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for operational monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by these consultants in relation to OPS1–OPS8 are:

- skills and expertise available within the organisation to execute the plan
- resources available, including the number of personnel with skills within the organisation for field deployment and office/laboratory support
- access to the required equipment for quick activation
- ability to mobilise teams on short notice.

4 OPS1: Oil Characterisation

4.1 Rationale

OPS1 provides quantitative information on the chemical properties of the oil, which helps the EMT select the most effective response option(s). It requires samples of the oil to be collected and analysed.

Operational monitoring for the nature and behaviour of oil during a response is essential to:

- allow ongoing assessment of the effectiveness of, and any negative side-effects of, specific treatments that are applied, such as chemical dispersion or shoreline cleaning techniques
- provide in-field information on the oil properties, behaviour, and weathering of the spilt oil to assist in spill response operations.

Oil characterisation helps quantify the physical and chemical properties of the oil, which determine how the oil will behave in, and interact with, its receiving environment. This information helps the EMT select the most suitable response options.

Depending on the nature of the spill, ongoing oil characterisation sampling may be required throughout the spill. For this Guidance Note, standard processes will focus on the first-response sampling. Further oil spill characterisation sampling may be required (e.g. vertical water column profiling), which will be supported by external environmental consultants.

This monitoring component will be co-mobilised with OPS3: Oil in Water Assessment in most instances and will be the first operational monitoring component implemented when the OSMP is initiated.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Monitoring Design

This monitoring activity requires a sample of the spilt oil to be collected, and in-field observations made. The appropriate design of this activity will vary between situations depending on:

- Size of the spill
- Knowledge of the source of the spill
- Location and access to the spill
- Weathering rate of the oil
- Potential environmental and economic consequences of the spill
- Requirements to test specific response methods that may affect oil or be sensitive to the oil properties (e.g. Testing chemical dispersants)
- Requirements to inform the public or other stakeholders
- The availability of human resources, suitable vessels, and other logistics

- Capacity for transporting samples from the site (e.g. By helicopter or vessel)
- Safety considerations.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Move sampling locations, as required. Because the primary objective of this monitoring program is to assess changes in the properties of the oil over time, move sampling locations with the slick and/or plume based on the MES activities of aerial surveillance, visual observations, and oil satellite tracking buoys.
- Plan the number of locations and samples to be collected, taking into account level of effort, potential logistical limitations, weather conditions, etc. that may compromise sample integrity.
- Contact the laboratories that will receive the oil samples for analysis to ensure they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- Adjust the sampling strategy, as required. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- When sampling in remote areas with limited shipping capabilities, plan to make sure that the integrity of samples is not compromised by ensuring that the processing laboratory receives the samples within their recommended holding time. It may take several days for shipments from remote areas to reach a laboratory facility. This last stage is the most important and requires due diligence until the samples are safely delivered. (Ref. 20).
- Collect floating oil using an oleophilic sampling device that selectively collects oil, or carefully skim with a narrow-neck flask to minimise mixing with the water immediately below the slick, which may contain soluble hydrocarbons or other components that would contaminate the floating oil sample.
- Take multiple samples, as required. The sample taken should be representative of the oil. If the slick varies in appearance, or if more than one oil may be present, then multiple samples need to be taken.
- Consider the size of the slick, source of spill (number of potential oils present), and distribution (number of locations) of slick.
- Determine the type of containers and the amount of the sample needed (see Appendix E). The total volume of sample and the containers required should be determined before field activities commence. It is better to divide a single

sample than to take multiple samples from a slick, particularly if more than one oil could be involved or the oil is highly variable.

- Decide the platform to sample from (response/other vessel, shoreline).
- Consider the potential for contamination from response vessels (e.g. bilge outlets, exhausts), logistics, weather, and other safety considerations (staff training and experience) (Ref. 4).
- Measure the physical parameters of the water in the vicinity of the oil slick; this will provide important information on the behaviour of the oil in water. See OPS3 for measuring the physical water parameters.
- Sampling at depth may be required for subsurface oil slicks. This can be achieved using a Niskin bottle or similar device that allows remote opening and closing. Alternatively, samples can be pumped from defined depths using a hose suspended vertically.
- Collect at least three replicates (three complete samples) to allow assessment of local variability in oil properties and to allow for QA/QC.
- Prepare and transport discrete samples within holding times (there is potential to increase time frames if solvent extracts are prepared) to a suitable NATA-accredited laboratory for analysis.

Visual indicators of the floating oil properties should also be taken and recorded on Form 4 (in Appendix F), and should include:

- The colour and optical effects generated by surface films—indicating the local concentration of oil that is present—judged using the standardised Bonn Agreement Oil Appearance Code
- The general flow properties at ambient temperatures indicated by the tendency to spread and flow freely (pour point > ambient sea temperature) or to clump and solidify (pour point < ambient sea temperature)
- The formation of water-in-oil emulsions (referred to as mousse) revealed by a characteristic change in colour (typically to a brown/orange colour), sometimes with a foamy appearance
- The formation of solid sheets or balls indicating that the more volatile components have evaporated from the slick, leaving a waxy residue
- Evidence of submergence indicating that the oil film is at a similar or greater density to the ambient sea water.

4.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

4.5 Standard Operating Procedure – Field Sampling

Sampling techniques will vary depending on the type and location of the oil to be collected. Some considerations are consistent across all techniques:

- All sampling and storage equipment should be stainless steel, Teflon, glass or other non-plastic material.
- Avoid plastics as plasticisers may mimic the anolytes in analysis and give false results.
- Use clean equipment at each sample site to avoid cross-contamination. If equipment requires cleaning, wash with a detergent and triple rinse with distilled water.
- Unless prescribed differently by the laboratory for specific analyses, each oil sample should contain 10 mL to 200 mL of oil, and jars are not be filled more than ¾ full to allow room for liquids to expand with temperature changes. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss (see Ref. 5)

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
1	Confirm all required resources are available and ready to use.	☐
2	Familiarise team members with sampling design and allocate tasks required to be completed, such as sample collection, data recording, photography.	☐
3	Conduct safety assessment of task and JSA	☐
4	Commence data entry into the Oil Sampling Form (Form 4 in Appendix F)	☐
5	Using the sample jar or other sampling device, take samples from the thickest part of the slick or film. This is usually the 'leading edge' of the slick.	☐
6	If sampling from a vessel, use a grab pole or similar to take a sample from the bow, or at least to the forward, of the vessel and avoid contamination from vessel engines.	☐
7	Collect three replicate samples from each site (i.e. Site 1; samples A, B, and C), record the location with a GPS and mark the collection site on the sampling form (Section 4.7)	☐
8	For films/sheens, use a piece of sorbent material to soak up the oil film. This can be passed through the film several times. Place a piece of unoiled sorbent in a sample jar as the control and label accordingly (this is additional to the three replicates). For thin slicks and sheens, collect water samples (at least 1 L) and samples using oleophilic materials. Depending on the thickness of the slick, it may be more appropriate to use sorbents and Teflon swabs to sample the slick. Both materials will repel water and adsorb hydrocarbons when moved through the water. The material should then be placed in the sample jars with an unused piece of the material in a separate jar to be sent as a control to analysis. Chemically treated sorbent pads should not be used to sample slicks (Ref. 5).	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
	 **Figure 4-1: Example of a Sheen** *Source: Ref. 5*	
9	Shoreline sampling of stranded oil is relatively simple; however, it is important to try to limit the amount of non-oiled material in a sample. Do not fill sample jars more than ¾ full. Methods include directly scooping oiled sand into the jar using the jar itself or by scraping oil off sediment and debris using a wooden scraper or metal ruler. Use a clean scraping tool for each sample to avoid cross-contamination. Place oiled debris such as small stones and some vegetation directly into the jars. Sampling field team members are not to handle dead or live oiled animals. Immediately contact the EUL to arrange for oiled wildlife responders to address the issue. (Ref. 5)	☐
10	Place samples into laboratory-provided jars/bottles and seal. Fill the sample to approximately ¾ full if the oil is heavy or weathered. Expansion of the sample should not be a problem if samples are chilled properly. Sorbent films or light, volatile oil samples should fill the jar to reduce evaporative loss.	☐
11	Label jars/bottles immediately with: • sample number or code • sample description (oil, debris, thick slick, film etc.) • time and date (24-hour clock and DD/MM/YYYY) • location (GPS coordinates; place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sample is for legal purposes)	☐
12	Record the above information on a sample log (Form 4 in Appendix F). Reference any photographs taken or other observations on the log. Take photographs throughout the sampling process of: • the sampling area • the sampling site • the sampling jar before the sample is collected • the sampling process • the sample jar with contents and being sealed • the sealed and secured sampling jars in the case • the completed paperwork • the sealed and secured case on completion of the sampling. If samples have been given to a Vessel Master, a photograph should be taken of the samples in the Master's possession. Keep a log of what photographs were taken to assist with compiling the documentation at a later time. (Ref. 5)	☐

Step	Standard Operating Procedure – Field Sampling for Oil Characterisation	Completed
13	Place samples in a small esky with frozen ice pack. Transfer to refrigerator if possible for storage at 4 °C.	☐
14	Complete Chain of Custody forms (Appendix F)	☐
15	Send samples to the laboratory as soon as possible (within 24 to 48 hours if possible). Preservation techniques and sample holding times are listed in Appendix E.	☐

4.6 Reporting

- All data collected is to be analysed within the Planning Unit to achieve the OPS1 objectives.
- All data collected is to be collated for the Planning Officer for integration into the Incident Action Plan (IAP).
- All data collected is to be made available to the Monitoring Coordinator for initiation of the Scientific Monitoring (if applicable).

4.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS1:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 3 – OPS1: Oil Characterisation – Oil Sampling Form.

5 OPS2: Chemical Dispersant Efficacy Assessment

5.1 Rationale

OPS2 provides the EMT with information on the efficacy of the chemical dispersant applied to the spilt oil. Note: This OPS is only for the full-scale efficacy assessment of dispersant and does not cover any laboratory or shipboard (e.g. 'shake jar test') field-testing. CAPL personnel would be likely to conduct Tier 1 Special Monitoring of Applied Response Technologies (SMART) Monitoring Protocol in the first instance. Tier 2 and 3 monitoring will be conducted by external agencies, and will be implemented based on the size and nature of the spill, the effectiveness of Tier 1 monitoring, and the need for more accurate analysis of dispersant efficacy

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Design

5.3.1 Surface Dispersant Application

The SMART protocol is a field tool for monitoring the effectiveness of dispersants. The SMART protocol suggests three tiers of monitoring (Note: the SMART tiers are NOT related to the tiered concept of oil spill response) (Ref. 6) and are described in Table 5-1.

Table 5-1: SMART Protocol for Dispersant Efficacy

Tier	Description
Tier I	This monitoring is usually performed after the 'shake jar test'. If the shake jar test is effective, then a 'test spray' is done before full-scale deployment of dispersant spraying. Tier 1 involves visual monitoring (refer to the Visual Observation Dispersant Monitoring Handbook [Ref. 6]), which gives rapid results until additional resources and equipment are deployed to conduct Tier II and III monitoring.
Tier II	Combines visual monitoring with on-water teams conducting real-time water column monitoring (using the fluorometer) at a single depth and collecting water samples for later analysis.
Tier III	Expands on the Tier 2 water monitoring to meet the information needs of the incident. This may include monitoring at multiple depths (using the fluorometer) and also taking water quality measurements or more extensive water samples.

(Source: Ref. 6)

Note: CAPL personnel would only be required to undertake Tier 1 Monitoring, which includes visual observations only. Tiers 2 and 3 Monitoring will be undertaken by trained and experienced third parties because specialised equipment is required.

The SMART tiers may merge during a response. For example, personnel may monitor at multiple depths without taking samples if no laboratories are available to analyse samples.

The Tier 1 SMART Monitoring Protocol involves visual observation from an aerial or vessel platform (whichever is available) to determine whether applying dispersant to the spill appears effective. Table 5-2 lists some of the advantages and disadvantages for each platform.

Table 5-2: Suitable Platforms for Tier 1 Visual Monitoring: Advantages and Disadvantages

Platform	Advantages	Disadvantages
Fixed installation or vessel	• Assets are relatively readily available	• Using a vessel or installation to survey from provides a very limited field of view
Fixed-wing aircraft	• Faster transit times than a helicopter • Longer endurance than a helicopter • Less expensive than a helicopter • More seats available than on a helicopter (per unit cost) • More readily available	• Depending on position in aircraft, view could be obstructed
Helicopter	• More manoeuvrable than fixed-wing aircraft • Fly slower and able to loiter, unlike fixed-wing aircraft • Ability to land ‘off airport’ • Unobstructed visibility	• Short endurance

(Source: Ref. 6)

5.3.2 Subsea Dispersant Monitoring

Subsea dispersant injection is an effective and efficient response option; however, some of the oil may still rise to the surface and therefore the SMART Monitoring Protocol will continue to be used in conjunction with subsea dispersant monitoring methods.

Subsea dispersant application and monitoring will be undertaken by third-party support agencies with expertise in this response method. Development of the subsea dispersants monitoring plan will be undertaken in consultation with Chevron Corporation Worldwide Emergency Response Resources. The subsea dispersants monitoring program must align with the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7).

Subsea dispersant monitoring will include these monitoring ‘phases’:

- Phase 1: Assessment of subsea dispersant effectiveness and reduction in surface VOCs
- Phase 2: Characterisation of dispersed oil concentrations in the water column
- Phase 3: Assessment of potential for ecological effects.

Phases 2 and 3 will follow the methods outlined in the Industry Recommended Subsea Dispersant Monitoring Plan (Ref. 7). Phase 3 will rely on data obtained in OPS1 and OPS3. The ecological effects will be assessed by comparing water quality data obtained in these operational monitoring components (including, but not limited to, total petroleum hydrocarbons [TPH] and dissolved oxygen [DO]) to toxicity benchmarks, which, when combined with the distribution of sensitive of receptors and forecast oil movement, will be used to determine the extent of any adverse environmental effects of using subsea dispersants versus leaving oil to disperse naturally. This information will be fed into an operational NEBA assessment used for decision-making regarding the continuation or termination of subsea dispersant use.

Initially, the hydrocarbon plus dispersant ecotoxicity benchmark will be based on:

- Lethal concentration for 50% of the test species (LC50) = 10 ppm TPH
- No Observed Effect Concentration (NOEC) = 1 ppm TPH.

Threshold data sourced from the United States Environmental Protection Agency (Ref. 27).

The benchmarks are based on best-available literature and may be updated if new information becomes available. Note: These benchmarks will only inform the area/receptors likely to be impacted under different response scenarios (and inform NEBA) and will not trigger a termination of subsea dispersant injection.

During an uncontrolled release, toxicity testing of hydrocarbons and/or hydrocarbons plus dispersants will be used to validate assumptions made when determining literature-based toxicity benchmarks, or to refine these benchmarks where appropriate.

Measurements of DO will be assessed against an ecotoxicity benchmark of:

- 4.6 mg/L, which corresponds to a 90% species protection
- median lethal oxygen concentrations for 50% of species (LC50) = 2mg/L.

Data sourced from Vaquer-Sunyer and Duarte (Ref. 28).

Note: DO concentrations naturally vary with depth and may occur below 4.6 mg/L, typically in mid-water (mesopelagic zone) environments (e.g. at depths ~300–500 m [Ref. 29]). Therefore, in an Operational NEBA assessment, DO concentrations measured at a potential impact zone would need to be considered against natural DO concentrations (e.g. using controls or available literature) when determining adverse environmental effects.

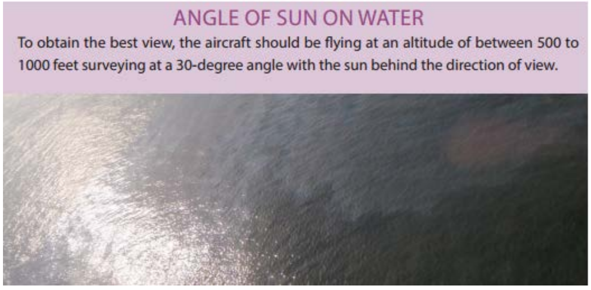
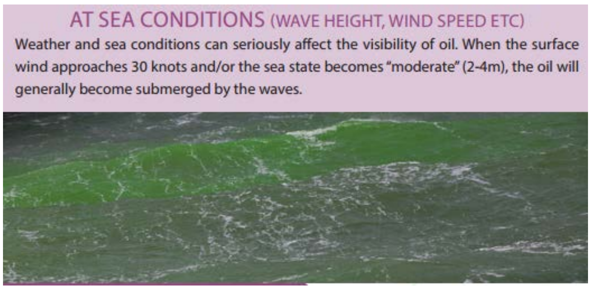
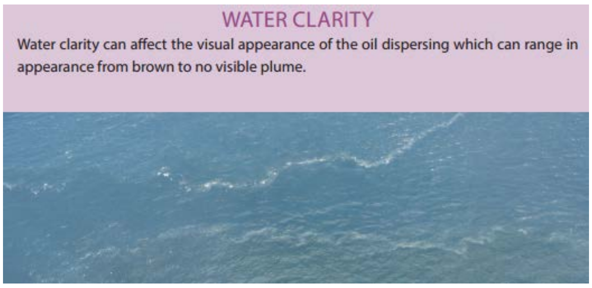
5.4 Resources

5.4.1 Tier 1 Surface Dispersant Efficacy Monitoring

Item (per team)	Check
Sampling platform (vessels must be in survey for commercial use)	☐
Specialist sampling team (2 to 3 people) – if using CAPL personnel, one or more Oil Spill Offshore Specialists should be included in this team	☐
Digital camera and/or video recorder	☐
Handheld GPS	☐
Compass (may be useful to orientate when in flight)	☐
Spare batteries	☐
A method of communication with the crew (vessel/aircraft, including spray vessels/aircraft)	☐
Stopwatch	☐
High-visibility jacket/vest may be required on the airfield (once in flight, remove to minimise glare; it is also advisable to wear clothes that are dark or neutral in colour)	☐
Form 5 (Surface Dispersant Monitoring Form) and Form 6 (Visual Dispersant Monitoring Form) in Appendix F	☐

(Source: Ref. 6)

5.5 Standard Operating Procedures – Tier 1 Surface Dispersant Efficacy Monitoring

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Receive tasking information. This information may be provided verbally or on a form, and include the purpose of the mission (e.g. to determine through visual observation whether dispersant application appears to be effective or not). Although this seems like a relatively straightforward task, several factors or natural phenomena may confuse the pictures at monitoring sites such as: • Angle of the sun on water  • Weather  • Sea state  • Water clarity  • Dispersant dosage rates • Time between application and monitoring
2.	Conduct a pre-mission briefing to provide operational details, such as: • location of the area of operation

<table>
<tr><th>No.</th><th>SOP – Field Sampling for Oil in Subtidal Water Assessment</th></tr>
<tr><td></td><td>

- objective of the flight
- roles and responsibilities of each of the survey crew
- radio frequencies used in the area and on the response
- call signs of other aircraft that are operating in the vicinity
- locations of any temporary or permanent exclusion zones
- health and safety points of note for the vessel or aircraft being used

</td></tr>
<tr><td colspan="2">

NOTE: Wherever possible, and as soon as it can be made available, fluorometry and/or particle analysis should be used in support of the Tier 1 observation. This equipment can help quantify the effectiveness of the spray operation by determining whether the ratio or amount of suspended oil particles in the water column has increased significantly following dispersant application. Expert external personnel will undertake this monitoring as per the Tier II and III SMART Monitoring Protocol.

</td></tr>
<tr><td colspan="2">Conduct Visual Dispersant Effectiveness Monitoring</td></tr>
<tr><td>3.</td><td>

Record all observations on the Visual Dispersant Observers Log Form (Form 6 of Appendix F)

OIL APPEARANCE POST DISPERSANT APPLICATION

Described as '3' on the Visual Dispersant Observers Log Form.

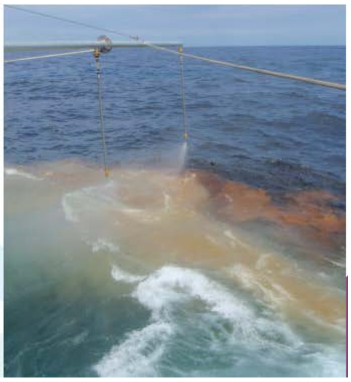
Indications of effective dispersant operations

Visual indicators that show the dispersant is effective:

- yellow/coffee/grey colour plume present in the water (the exact colour will vary with original colour of the oil)
- oil spill surface area reduced
- oil rapidly disappearing from the surface
- oil in some areas being dispersed to leave only sheen on the surface.

NOTE: Colour changes may not been seen immediately; allow time (e.g. 10 to 40 minutes) for dispersion to occur, particularly for more viscous oils.





Indications of ineffective dispersant operations

OIL APPEARANCE POST DISPERSANT APPLICATION

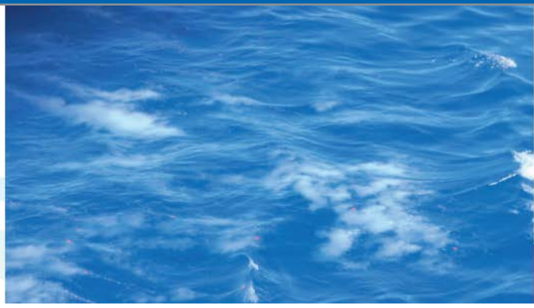
Described as '1' on the Visual Dispersant Observers Log Form.

A milky white plume will be present if:

- too much dispersant is applied (overdosing)
- there is poor targeting of the spill area
- if the spilt oil is heavy or emulsified, the dispersant may not penetrate the oil running off into the unoiled water
- dispersant is washed off the black oil as a white, watery solution leaving oil on the surface
- quantity of oil on the sea surface is not altered by dispersant

</td></tr>
</table>

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment



Applying too little dispersant (underdosing) will make the spray run ineffective and there will be no visible effect on the oil other than possibly temporary herding.

Underdosing is recognisable through:

- some surface activity (oil appearance altered)
- droplets of oil seen rapidly rising back to the sea surface, but overall quantity appears to be similar to that before dispersant spraying.

OIL APPEARANCE POST DISPERSANT APPLICATION

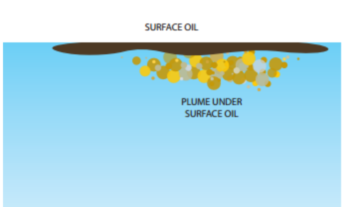
Described as '2' on the Visual Dispersant Observers Log Form.

Oil will remain on the sea surface in its normal state. Careful observations must be made as the effect from a bow wave and herding of the dispersant may be misleading and give false impressions (negative or positive) of effective application.

False Negatives: Where it is wrongly concluded that little or no dispersion is occurring.

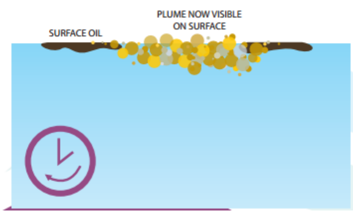
DISPERSED PLUME UNDER REMAINING SLICK

The dispersed oil plume may be hidden by the remaining surface oil giving the impression that the dispersant application has no effect. This is unlikely to persist for any prolonged period.



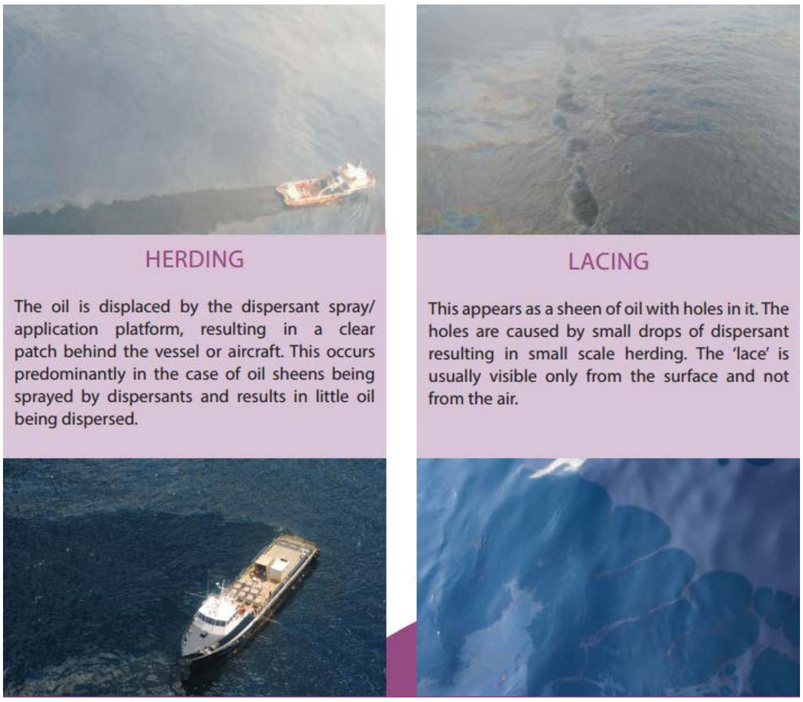
DISPERSED PLUME REQUIRES TIME TO FULLY DEVELOP

It may be several hours after the application of dispersant before it begins to be visibly effective. If emulsification occurs a visible plume may not be present, although the emulsion may be seen to "break" (turn from a thick chocolate mousse consistency to visually darker and less viscous substance).



POOR VISIBILITY CONDITIONS

The dispersed plume is not highly visible and can be obscured by haze or fog.

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
	False Positives: Where it is wrongly concluded that dispersion is occurring. OIL APPEARANCE POST DISPERSANT APPLICATION Described as ‘4’ on the Visual Dispersant Observers Log Form. 

(Source: Ref. 6)

Key points

- Ideally aerial support is needed to help locate areas near the spill that will be targeted for chemical dispersant and areas that are clear of surface oil.
- Ensure that the oil thickness, oil condition etc. are recorded by the Aerial Surveillance Specialists as per the Bonn Agreement Oil Appearance Code.
- The dispersant may take 10 to 40 minutes to affect the oil and may continue working for up to an hour afterwards.
- Communication with the dispersant application platform is essential to ensure that the monitoring vessel is positioned in the correct location.
- Record data using:
- GPS with waypoints (to mark positions of dispersant application)
- photographs (ideally georeferenced) for all stages of monitoring
- Visual Dispersant Monitoring Observer Log (Form 6 of Appendix F)

(Source: Ref. 6)

5.6 Reporting

Report (to incident command):

- unit/individual log

- location of the dispersant application (use a GPS to record the latitude and longitude)
- degree of weathering and thickness of the oil before dispersant application
- weather and sea state (dispersants require a degree of turbulence to promote mixing with the oil, although this can be created using the wake of a vessel)
- method of dispersant application
- time when dispersant was applied and time when any notable chemical dispersion was observed
- anything that has been or may be impacted by the oil or dispersant application such as marine mammals, fish coral reefs, etc.

5.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS2:

- Form 5: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
- Form 6: Visual Dispersant Monitoring Observer Log.

6 OPS3: Oil in Water Assessment

6.1 Rationale

OPS3 provides the EMT with ongoing information on the water quality, in particular the distribution of oil in the water column, within the response areas. This information will help verify MES predictions and data.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be confirmed before field sampling starts, as per the OSMP (Ref. 1). Ongoing sampling during operational monitoring will also use these sample collection methods.

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, the following points should be considered:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations; this is determined by the Operational Monitoring Officer in the design of the monitoring program.
- For intertidal monitoring, sediment (OPS4) and water quality samples (OPS3) should be taken concurrently.
- Water quality monitoring will involve taking water samples for laboratory analysis, and recording in situ physical water quality parameters using a water quality probe. The physical water quality parameters will also feed into OPS1 to allow determination of oil behaviour in ambient water conditions. A defined sampling strategy must be in place before conducting fieldwork. The objective of water quality monitoring will be determined based on the nature of the spill and may include sampling reference sites, delineating the extent of hydrocarbons in water, determining the maximum concentration of

hydrocarbons in water, or determining the change in hydrocarbon concentrations over time.

- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics.
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.
- Plan the number of areas and samples to be collected at each area, taking into account level of effort, potential logistical limitations, weather conditions, and other issues that may compromise sample integrity.
- The number of sampling locations and number of sites per location needed will be determined based on the sampling objectives.
- For water samples, sampling 'areas' can be defined as:
  - waterbodies with defined boundaries (such as lagoons, bays, or river mouths)
  - distances downcurrent from the release site (such as 0–5 km, 5–10 km)
  - waterbodies expected to have similar oil exposure based on observations or models (particularly plume models).
- Depending on the water depth, water samples may need to be collected at different depths. Generally, near-surface samples should be prioritised if the sampling effort is limited by logistics or other factors. In shallower water (<5 m), samples should be collected at just one near-surface depth. (Note: Do not exceed the depth rating of the instrumentation).
- Contact the laboratories that will be receiving field samples for analysis and confirm they have the capacity to receive and analyse samples from the study. Follow relevant guidelines from the laboratory and consult with them about necessary modifications.
- The sample volume required, along with the container type and required analysis, is listed in Appendix E
- Shoreline visualisation tools (e.g. GIS maps, satellite images, Oil Spill Response Atlas [OSRA; Ref. 30]) should be used to develop a sampling strategy and estimate distances, number of sampling sites, intertidal zone width, etc. before going into the field. The sampling strategy should have flexibility to be adjusted based on conditions in the field.
- Consult appropriate OPS guidelines (such as OPS4: Oil in Sediment or OPS1: Oil Characterisation) for the concurrent collection of other environmental media and biota when water sampling. If observed during water sampling, tar balls, sheens, or other oil residues can be collected opportunistically for chemical analysis and fingerprinting.
- The number of sampling locations and sites should be determined based on the nature of the spill. As a minimum, three sampling sites per location should

be used. In addition, at least one triplicate sample (three complete samples) should be taken at a minimum of one site per location.

(Source: Ref. 20)

Table 6-1 summarises the monitoring to be undertaken for each location. Water quality physical parameters only need to be recorded once per location, while hydrocarbon analysis should be undertaken at each site within a location. For a complete list of analysis, including sample volume, containers, and holding times, refer to Appendix E.

Table 6-1: Summary of Oil in Water Assessment Monitoring to be Undertaken in the Event of an Offshore Hydrocarbon Spill

Monitoring Component	Parameter	Location	Survey Method
Water Quality	Physical parameters: • salinity • temperature • DO • pH • total dissolved solids (TDS)	Subtidal	Probe
	Hydrocarbons: • Total recoverable hydrocarbons (TRH) • suites of VOCs and semi-volatile organic compounds (SVOCs)—SVOCs include polycyclic aromatic hydrocarbons (PAHs), phenols, phthalates, and chlorinated hydrocarbons • benzene, toluene, ethyl benzene and, xylenes (BTEX)	Subtidal and offshore	Niskin bottles
		Intertidal	Manual bucket or grab pole

6.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect water samples and physicochemical profiles for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36).

Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

6.5 Standard Operating Procedures – Field Sampling for Oil in Water Assessment

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an 'actual' GPS location to mark the sampled location
Survey physicochemical parameters	
4.	Prepare the water quality probe (e.g. YSI 6600 v2) for use, including battery check and calibration
5.	Holding the display, lower the probe into the water

No.	SOP – Field Sampling for Oil in Subtidal Water Assessment
6.	Position the probe end near the bottom (0.5 m above sediment) for the first reading
7.	Wait for the reading on the display to stop changing rapidly (1 minute) and record a reading for each of these parameters: salinity, temperature, DO, pH, and turbidity
8.	Raise the probe to 0.5 m below the surface level for another reading
9.	Wait for display to equalise (1 minute) and record a reading for each of these parameters: salinity, temperature, pH, and turbidity
10.	Sample at only one site per location unless the water seems highly variable
11.	At each subsequent location, triple-rinse all equipment submersed in water with site water before sampling
Collect water samples for laboratory analysis	
12.	Place vessel in neutral to avoid contaminating samples with hydrocarbons from the vessel's exhaust
13.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • depth of sample • time of collection • collector's name
14.	For sampling at depth, thread a Niskin bottle onto a hydrographic line following the instruction manual for the device
15.	Ensure that stoppers on both ends of the bottle are held open and that the release mechanism works before deploying overboard. Ensure the weight used to trigger the stoppers to close on the bottle is manually held on board around the tether
16.	Using measurements on the line to guide the depth of the bottle, lower the bottle using the tether until the bottle is at the desired depth
17.	When the bottle is at the correct depth, straighten the line and then drop the weight straight down the line to trigger the stoppers of the bottle to close
18.	Retrieve the bottle using the line and neatly coiling the tether as it comes on board
19.	Once the bottle is on board, rinse the glass laboratory bottle to ensure all surfaces are washed. Empty bottle. Rinse three times.
20.	Once rinsed, fill the laboratory bottle with sample water
21.	Complete the sample collection data sheet/Chain of Custody forms (see Appendix F)
22.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
23.	At one site per location, collect at least one triplicate (three complete samples)
24.	Sample at least three sites per location
25.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C)
26.	Once finished at the site, store the equipment safely and move to next site
27.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
28.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

No.	SOP – Field Sampling for Oil in Intertidal Water Assessment
Pre-work	
1.	Ensure the required sampling containers are available for use on site, with sufficient spares for ad hoc sampling
2.	Use GPS to navigate the team as close to the proposed site as possible
3.	Take an 'actual' GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)
Collect water samples for laboratory analysis	
4.	Fill out the label on the laboratory bottle (use permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. water) • date • analyses to be conducted (e.g. TPH) • location of sampling • time of collection • collector's name
5.	Using a decontaminated bucket, wade in and carefully collect water from a depth of about 0.5 m (within the zone between low and high tides), then transfer the bucket to the beach
6.	Rinse the glass laboratory bottle/s to ensure all surfaces are washed. Empty bottle. Rinse three times.
7.	Once rinsed, fill the laboratory bottle with sample water and ensure there is no debris stopping the thread from sealing tightly
8.	Complete the sample collection data sheet / Chain of Custody forms (see Appendix F)
9.	Place sample in a small esky with frozen ice bricks to maintain a temperature of 4 °C
10.	Collect at least one triplicate (three complete samples) from one site at each location (i.e. Site 1; samples A, B, and C).
11.	Once finished at the site, store equipment safely and move to next site
12.	At each subsequent site, triple-rinse all equipment submersed in water with site water before sampling
13.	Sample at least three sites at each location.
14.	Send samples to the laboratory as soon as possible. Maximum holding times for analysis are listed in Appendix E

6.6 Reporting

- Record and report the results to the Monitoring Coordinator for integration into IAP development.
- Record results and handover to the Monitoring Coordinator for initiation of the SMPs (if applicable).

6.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS3:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form

- Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form.

7 OPS4: Oil in Sediment Assessment

7.1 Rationale

OPS4 provides the EMT with ongoing information on the sediment quality, in particular the oil content, within the response areas. This monitoring is undertaken to better design shoreline clean-up methods, determine adverse effects from clean-up (e.g. shoreline washing/mechanical clean-up on shorelines), formulate priorities, and/or measure the effectiveness of clean-up activities.

Key considerations for oil in sediment assessment:

- oil may enter intertidal/subtidal sediment
- oiled sediment may release oil over time
- sediment often contains sensitivities of high value (biological, human uses, cultural, commercial)
- sediment is susceptible to oil impacts
- sediment may be directly impacted by response actions (e.g. shoreline washing operations including sediment reworking, high- and/or low-pressure washing).

CAPL personnel are likely to conduct surface and intertidal sediment sampling; however, offshore sediment monitoring will be performed by external agencies. This Section provides guidance for internal and external monitoring teams.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Monitoring Design

In the event of a hydrocarbon spill, pre-emptive monitoring will, where practicable, be implemented to gather additional environmental data on the current condition of ecological receptors within the potentially affected area. The selection of sites and the extent and intensity of reactive monitoring will be influenced by the nature and scale of the spill and will be confirmed before field sampling starts, as per the OSMP (Ref. 1).

A defined, incident-specific sampling and analysis plan should be in place before conducting fieldwork. A First Strike Sampling and Analysis Plan Template (ABU180500476; Ref. 36) has been developed to provide guidance and instructions for implementing first-strike sampling and analysis, under the requirements of this operational monitoring component and within the initiation times listed in the OSMP. This plan provides a template to be completed by those implementing the OSMP. Once relevant details on the spill become available from the Emergency Management Team (EMT) the template can be completed and will become a sampling and analysis plan that can be issued to the sampling team for use.

The Operational Monitoring Officer along with Technical Advisors (as required) will be required to finalise this template.

When finalising the template, consider these points:

- Sampling at intertidal locations must coincide with tidal states that allow sampling to be undertaken on foot, in water less than waist deep.
- Sampling in offshore environments will occur from an appropriate vessel using diverless operations.
- Sediment (OPS4) and water quality (OPS3) samples should be taken concurrently.
- The analytical parameters for sediment, along with the sample volume, container types, and holding times are listed in Appendix E.
- The terminology used to define general to specific sampling geographies is:
  - Location = a place that represents the area; it may include a visible hydrocarbon plume, or a bay or beach that generally comprises similar physical characteristics
  - Site = a specific point within a location where samples are collected or observations are made.
- At least three sites should be sampled within each location.
- At least one triplicate sample (three complete samples at one site – e.g. Site 1 A, B, and C) should be taken at each location.

Determining the survey method depends on the purpose of the survey. The AMSA Oil Spill Monitoring Handbook (Ref. 4) is used to provide guidance on the selection of survey methods. Figure 7-1 shows the decision tree for four onshore sediment sampling methods and Figure 7-2 is a copy of Methods S.8.1 to S.8.4, as outlined in the AMSA Oil Spill Monitoring Handbook (Ref. 4). Figure 7-3 lists subsurface sediment sampling guidelines from the Handbook (Ref. 4).

These guidelines can be used by the Operational Monitoring Officer when designing an appropriate operational monitoring program for subsurface and intertidal sediment sampling.

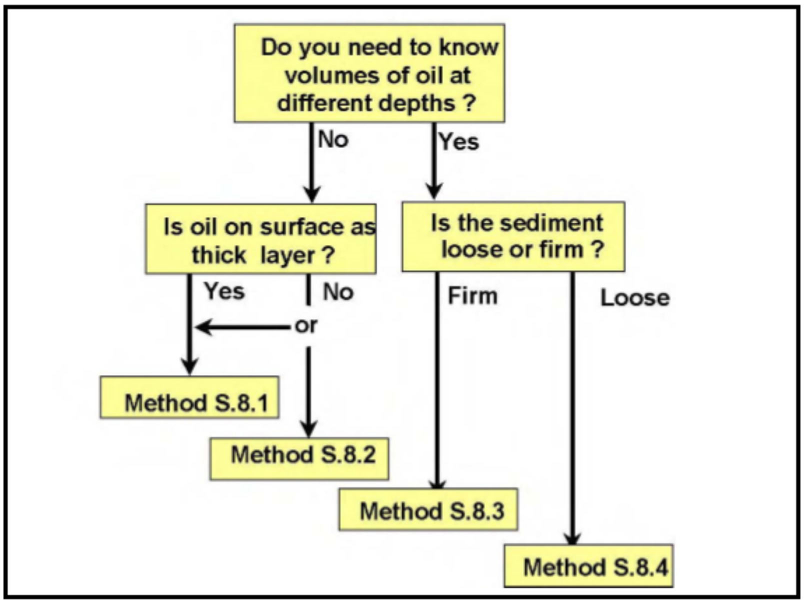


Figure 7-1: Selection of Sediment Sampling Methods

(Source: Ref. 4)

GUIDELINE FOR OBTAINING SEDIMENT SAMPLES	S.8

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for obtaining sediment samples.

Methodology

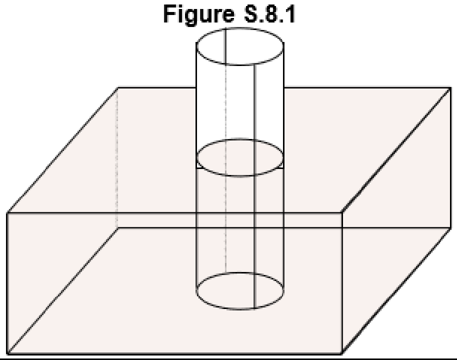
S.8.1 Push Core Sampling A

This method of sampling involves pushing a clean plastic tube down into the substrate and extracting a column, or "core" of sediment. It is suitable for most sediment conditions, but particularly when:

- *Oil is present on the surface as a thin layer (coat, stain, film).*
- *Oil penetrated to a fairly shallow depth (e.g. < 10 cm).*
- *Accurate measures of the amount of oil at various depths are not needed*

1	Push plastic tube into sediment. Generally the depth of sampling should not be more than two thirds of the length of the tube.
2	Seal the top of the tube and extract. A gentle gyration may be applied to facilitate this but avoid bending the tube.
3	If the sediment is wet or loose, or does not stick to the inside of the tube when extracted, it may be necessary to dig down beside the tube and block the bottom opening before removing the tube from the sediment. Alternately sealing the top of the tube with a bung can facilitate extraction of the core.
4	The core of sediment should be transferred immediately to a clean glass container.

Figure S.8.1



Equipment

The sampling tube can be constructed from a piece of PVC tubing. This should be split along its length so that it can be pulled apart and the core easily removed. The tube diameter should be about 5 cm (2"), giving a surface area of about 20 cm^2 and a core volume of 200 cm^3 for a 10 cm deep sample. Tubes should be cut to at least 30 cm lengths.

S.8.2 Push Core Sampling B

This method is essentially the same as Method 1, but is used when it is necessary to differentiate between surface oil and subsurface oil. This may be needed if attempting to determine, for example:

- *The amount of oil that could be removed by tidal action (i.e. surface oil) in low energy shores and oil likely to persist (i.e. subsurface oil).*
- *The rate of degradation of the oil. In this case the presence of relatively large amounts of surface oil could mask any observation of changes in subsurface oil (or visa versa).*

1	Scrape surface oil from a given area prior to pushing in the sampling tube.
2	Transfer this “surface sample” to a clean storage jar and record the area cleaned (square centimetres) and approximate depth of sediment removed (if possible).
3	Proceed as per S.8.1.

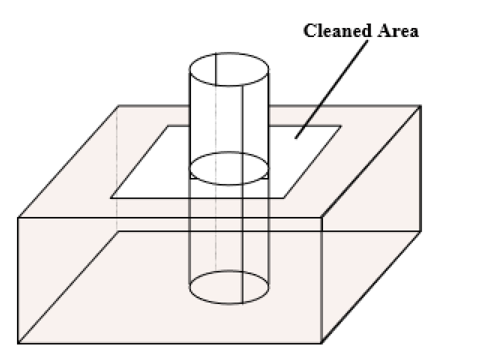


Figure S.8.2

Equipment

	A clean wooden or stainless steel scraper will be required.

S.8.3 Sediment Block Extraction

This method of sampling is used when an accurate measure of the amount of oil at various depths is needed. It is useful only for firm, and preferably dry, sediments. The method can be modified for wet consolidated sediments but some hydrocarbons will be lost with water draining from the samples.

1	If fluid oil is present on the surface it should be removed by scraping the oil from a measured area of sediment. This area should be slightly more than a 30 cm x 30 cm square.
2	With a flat spade, make a “U” shaped cut into the mud. The depth should be no more than 30cm (spade blade depth).
3	Place the spade in the bottom cut (base of the "U" shape) and lever up the block of sediment. Note a wedge may need to be cut below the base of the "U" and a pivot object used to facilitate the leverage.
4	The open edge of the "U" should break free. This is the uncontaminated edge of the core. Because this side has not been cut, no oil has been pushed along it from the surface, i.e. it is uncontaminated.

5	Samples from various depths can be taken by slicing into the back from this open edge. Care should be taken not to sample close to the three cut (contaminated) sides
6	Note: If water percolates down the core, the core can be laid on its side so that water, and associated oil, drains along the core gradient not down the gradient.
7	Place sediment samples into labelled clean jars.

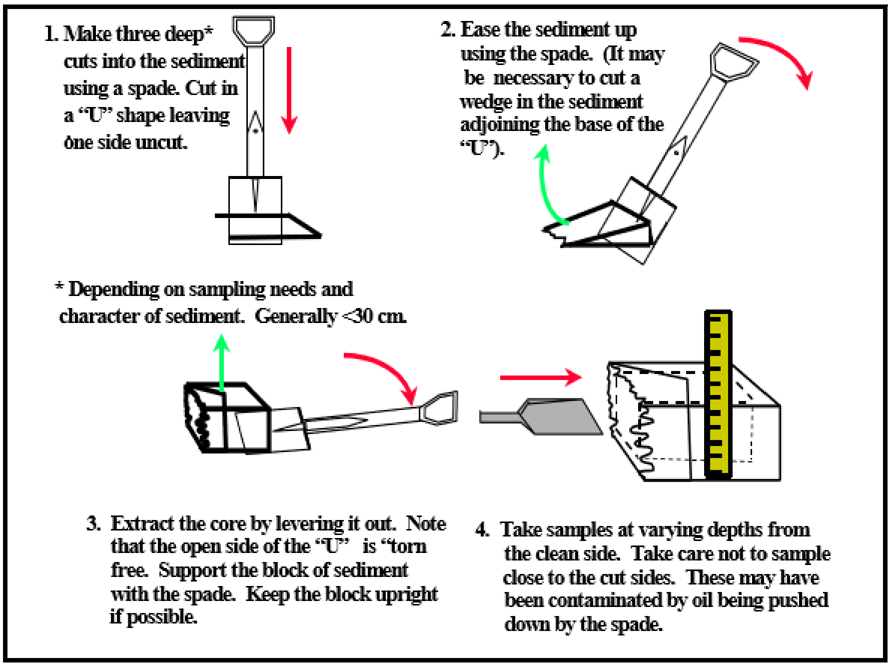


Figure S.8.3

S.8.4 Loose Sediment Extraction	
This method can be used in loose sediments such as gravel, pebbles or wet muds, where, if Method 2 is used, the core of sediment would likely collapse. It can also be used when or where the sediment particle size is too large for Method S7.1, S7.2 or S7.3.	
1	A metal perimeter is pushed into the sediment (surface oil can be left or removed as per earlier methods).
2	Sediment is then removed from inside the perimeter. This can be done as a composite sample, or layer by layer, depending on whether data from different depths are required.
3	The perimeter prevents the sides of the excavated pit from collapsing and contaminating lower sediment layers with upper sediments, and also limits the seepage of oily water or liquid oil from the upper layers of sediment.
4	The size of the perimeter should be large enough to allow an adequate working area, but not require the removal of too much sediment. A 30 cm x 30 cm square should Suffice.

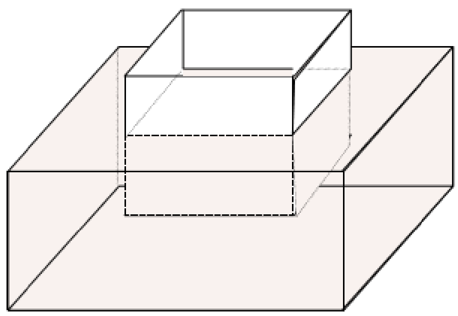


Figure S.8.4

Figure 7-2: Onshore Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR SAMPLING OF SEABED SEDIMENTS	M.9

Rationale

Oil can become incorporated into offshore sediments through natural processes or due to shoreline cleanup methods. If this accumulates to a significant extent then alternative cleanup strategies may be required. This monitoring method is usually only required in shallow waters. Grab Samplers or Drop Corers can be used. The former are suitable for the wider set of sediments and sea conditions. Sample handling is also easier. Sample volume should be consistent between sites and surveys to allow cross comparison.

Methodology

1	Determine the number of samples required. Consider:		
	1.1	Area of possible contamination.	
	1.2	Currents.	
2	Decide platform to sample from (response/other vessel, shoreline). Vessels should:		
	2.1	Be suited to expected weather and other safety considerations (staff training and experience).	
	2.2	Be stable and suitable for expected water depths and sea states.	
	2.3	Provide adequate deck space (vessel should be > 5m).	
	2.4	Have shelter (e.g closed cabin).	
	2.5	Be equipped with communications, GPS and life preservation equipment.	
	2.6	Comply with state boating regulations re safety equipment.	
3	Obtain sampling kits or supplies:		
	3.1	Sample jars (250 ml or other larger size if biological samples are to be taken). Pre cleaned, teflon or aluminium cap or alfoil barrier.	As Required
	3.2	Tape (for sealing jars). 2cm wide.	2
	3.3	Plastic sheeting	>1/sample
	3.4	Sampling equipment (grab or corer: see 5) Note: if biological samples are to be taken samples should be at least 10 cm depth and have a minimum surface area of at least 125 square centimetres	
	3.5	Disposable gloves	
	3.6	Sample identification labels.	
	3.7	Sorbent padding for storage cooler.	
	3.8	Sample Log Sheets.	
	3.9	Sample storage coolers with pre-frozen freezer blocks.	
	3.10	Chain of Custody Forms.	
	3.11	Waterproof plastic envelopes (for forms).	
	3.12	Decontamination equipment (Guideline G.2).	
4	Samplers should be deployed in clean water, not through surface oil. A perimeter may be used to keep the surface clean (see Guideline 7).		

<table>
<tr><td colspan="5">M.9 Methodology Continued</td></tr>
<tr><td>5</td><td colspan="4">Obtain samples:</td></tr>
<tr><td></td><td>5.1</td><td colspan="3">Grab Sampler: Spring loaded (see Figure M.9.1):</td></tr>
<tr><td></td><td></td><td>5.1.1</td><td colspan="2">Lower the grab at a slow, constant speed (about 0.3m/second) to avoid prematurely triggering the grab.</td></tr>
<tr><td></td><td></td><td>5.1.2</td><td colspan="2">Once the seafloor is hit and the grab is triggered, recover the grab slowly.</td></tr>
<tr><td></td><td></td><td>5.1.3</td><td>If sediments are muddy, the grab may be cleaned in surface waters prior to bringing it on deck (Note: This should <u>not</u> be done if surface waters that may be oily).</td><td rowspan="5">
Figure M.9.1 Example of Spring-loaded Grab Sampler
(Photo: Cawthron Inst.)</td></tr>
<tr><td></td><td></td><td>5.1.4</td><td>The Grab Sampler should be opened over a sheet of plastic (but <u>not</u> emptied onto it).</td></tr>
<tr><td></td><td></td><td>5.1.5</td><td>Debris such as seagrass or algae should be separated from the sediment. The presence of this should be logged.</td></tr>
<tr><td></td><td></td><td>5.1.6</td><td>Note: This seagrass and algal material may be required for analysis, e.g. for the presence of entrained oil.</td></tr>
<tr><td></td><td></td><td>5.1.7</td><td>Sediment samples should be removed from the centre of the grab sample (i.e. away from the sides) using clean spatulas or scoop, and placed in clean jars.</td></tr>
<tr><td></td><td></td><td>5.1.8</td><td colspan="2">Label jars with location, water depth, time and date, description.</td></tr>
<tr><td></td><td></td><td>5.1.9</td><td colspan="2">Place unused sediment in bin.</td></tr>
<tr><td></td><td></td><td>5.9.10</td><td colspan="2">Wash Grab Sampler in the sea, then distilled water. (see Guideline G.2).</td></tr>
</table>

M.9 Methodology Continued				
5	5.2	Drop Core Sampler:		
		5.2.1	Lower Corer, avoiding twisting of lines. Allow Corer to "free fall" the last 5-6m or so to the seafloor.	
		5.2.2	Recover Corer at a very slow, regular rate (<0.3 m/second).	
		5.2.3	Make sure that the Corer does not strike the side of the vessel.	
		5.2.4	Always hold the Corer in a vertical position and seal the ends (with. supplied caps) as soon	
			as possible Note: The top cap should be clearly marked "TOP" and attached to the correct end of the Corer.	**Figure M.9.1 Deployment of Spring-loaded Grab Sampler** (Photo: Sakhalin Energy Investment Company)
		5.2.5	Attach waterproof labels (Tags are easier). Labels should note location, water depth, time and date, description including length of sediment core (samples may settle during transportation).	
		5.2.6	Store cores upright.	
6	A Sample Log should be maintained (see Guideline G.1).			

Figure 7-3: Subsurface Sediment Sampling Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

7.4 Resources

This monitoring component requires specific technical and general equipment to adequately collect sediment samples for chemical screening. All equipment required is listed in the First Strike Sampling and Analysis Plan Template (Ref. 36). Where possible, equipment should be wet-tested in an uncontaminated area before mobilising to site.

7.5 Standard Operating Procedures – Field Sampling for Oil in Sediment Assessment

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Pre-work	
1.	Ensure that sufficient sample containers for the analysis being undertaken (as listed in Appendix E), including spare sample containers for ad hoc sampling, are available
2.	Use detergent to wash all equipment that will be used to collect samples and rinse completely with distilled water before use. Equipment to be cleaned includes spatulas, mixing bowls, grabs, etc.
3.	Navigate to site
4.	Use GPS to navigate the team as close to the proposed site as possible
5.	Take an 'actual' GPS location to mark the sampled location (see GPS manual for instructions on calibrating the GPS device and recording a location)

No.	SOP – Field Sampling for Oil in Intertidal Sediment Assessment
Collect sediment samples **(This SOP may be amended [using guidelines from Figure 7-2 and Figure 7-3] by the Operational Monitoring Officer depending on the site to be sampled and the nature and scale of the spill)**	
6.	Fill out the label on the laboratory bottle (use a permanent marker) with this information: • sample number (each sample container must have discrete number) • sample type (e.g. sediment) • date and time of collection • analyses to be conducted (e.g. TPH) • location of samplingcollector's name
7.	Place a quadrat on the ground on the sampling site so that all samples are taken within an area of 1 m^2
8.	Prepare the corer by unclipping the top cap of the cylinder
9.	Push the corer into the sediment until the corer is slightly buried, then replace the cap of the cylinder; remove the core from the ground in a vertical motion
10.	Empty the contents of the corer into a Pyrex bowl using Teflon-coated spoons
11.	Repeat the sediment sample collection five times within the quadrat using the corer to retrieve sediments and place into the Pyrex bowl
12.	Homogenise the sediments from the five cores using Teflon-coated spoons until the colour and texture is uniform; however, limit mixing to avoid oxygenation
13.	Fill the labelled jar completely with soil/sediment, then replace the cap making sure the cap cover is tightly sealed
14.	Complete the sample collection data sheet / Chain of Custody forms (Appendix F)
15.	Place the sample in a small esky with ice bricks to maintain a temperature of 4 °C
16.	Return excess sediment to the sea immediately after completing the process
17	Use a field sheet to record activities (see Form 8 in Appendix F)
18.	Once finished at the site, store the equipment safely and move to next site
19.	In each location, sample a minimum of three sites, including one triplicate
20.	At each subsequent site, triple-rinse all equipment submersed in water with distilled water before sampling
21.	Send samples to the laboratory as soon as practicable and within the applicable holding times (see Appendix E for holding times)

7.6 Reporting

- Provide results to the EUL for analysis and integration into IAP development.
- Collate results for use by the Monitoring Coordinator for initiation of the SMPs (if applicable) and overall response impact tracking by the Planning Section Chief.

7.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS4.

- Form 1 – Chain of Custody Form
- Form 3 – Freight Consignment Form
- Form 7 – OPS4: Oil in Sediment Assessment Form.

8 OPS5: Rapid (Oiled) Shoreline Assessment

8.1 Rationale

OPS5 provides the EMT with ongoing information as to the state (e.g. habitat type, extent of oiling) of shorelines within the predicted trajectory of the oil spill or that have been exposed to the spill. The geographic scope of OPS5 is the region above lowest astronomical tide (LAT) to the supratidal zone. CAPL personnel trained in oiled shoreline assessment will likely undertake OPS5.

The priority for rapidly gathering oiled shoreline data is to enable the operational response. However, consideration should be given to the scientific data requirements, to inform subsequent scientific monitoring plans.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Design

The design of OPS5 requires judgements to be made about scope, methods, data inputs, and outputs that are specific to the incident response. These judgements must balance the operational needs of the response with the logistical and time constraints of gathering and processing information, and the level of certainty needed. Usually there is a need for information to be collected and processed rapidly to suit response needs, with a lower level of sampling and accuracy needed than for scientific purposes.

OPS5 involves two proposed methods for field surveys:

- Reconnaissance surveys: designed as an initial phase (or further as required) to characterise the distribution, extent, and condition of shoreline habitats before exposure
- Continual monitoring surveys: monitors hydrocarbon spill extent at the shoreline to assess the potential impact, extent of actual impact, and the effectiveness of clean-up.

Reconnaissance surveys, combined with physical monitoring, will monitor shoreline biological communities, concentrating on key habitats or species that are indicators of biological community health. The level of detail required for operational monitoring only needs to be sufficient to describe the distribution and extent of habitats, rather than rigorous and comprehensive data on the condition of biological communities. Appropriate community biological indicators for the shoreline habitats at risk for each individual spill will need to be determined during pre-survey planning (see Section 8.3.1). The OPS5 monitoring design will need to consider:

- Monitoring usually needs to cover a large area and results are required quickly, thus the methods need to be efficient, cost-effective, and relayed back to the EMT as quickly as possible to assist in decision-making.
- The number of sampling sites and replication within sampling sites needs to be sufficient to characterise habitats and validate existing data, but the level of data is not required to provide robust data with statistical power for hypothesis testing.

- The focus is on collecting relevant information for spill response decisions on shoreline habitats at risk and identifying response activities to be approved by relevant regulatory agencies (see the relevant OPEP), rather than identifying reference sites or demonstrating baseline conditions.
- Monitoring needs to help predict environmental effects or define resource sensitivity to guide spill response activities.
- Monitoring should define the resource and logistical constraints to sampling.
- Wherever possible, the monitoring methods used will complement information required for subsequent scientific monitoring.

The reconnaissance survey may use various remote sensing (including aerial surveys) and ground survey methods, which can be used independently or collectively. It aims to gather information on the condition and distribution of shoreline habitats so as to inform the assessment of the potential impact and the development of effective spill responses. The reconnaissance survey may also provide preliminary information, data, and guidance for the subsequent scientific monitoring program.

Reconnaissance surveys will be conducted to:

- characterise pre-impact/post-spill distribution, extent, and condition of habitats within the predicted spill area
- validate that the effects of oil from the spill have reached the shoreline; or
- confirm that the spatial area predicted to be impacted in MES trajectory modelling is relevant.

Detailed statistical analysis of the physical, biological, and chemical data is not required. The locations of all sampling sites will be recorded by GPS and linked to electronic and hardcopy monitoring proforma. The georeferenced data from reconnaissance surveys will be used to update ocean current maps of the study area to further identify the current distribution, extent, and condition of shoreline habitats to help predict environmental effects or to define the sensitivity of resources to guide spill response actions.

Remote sensing includes aerial surveillance and a wide range of airborne and satellite technologies (e.g. infrared thermal imaging, side-looking airborne radar, satellite images). Aerial surveillance is a reliable and rapid method for characterising the distribution and extent of habitats within the spill area, and validating oiled shorelines and habitats at risk from the spill. Photos, videos, maps, and verbal feedback all provide basic information that can be used to define information needs and response priorities. Helicopters can be useful in combining aerial surveillance with ground surveys.

Ground surveys allow more detailed observations of shoreline conditions including the physical structure, ecological character, and human use of shorelines. This monitoring approach can provide comprehensive detail on the resources and activities likely to be affected by a spill, the potential extent of oiling and level of impact, likely recovery, and logistical considerations for different response methods. Rapid shoreline survey methods will be determined by the EMT to ensure the priorities relating to the spill response activities are the primary objective of the ground survey.

Physical monitoring will determine how oil will behave over time, the likelihood that the shoreline can be damaged by oil and clean-up activities, and how the shoreline can most effectively be cleaned. The physical character of the shoreline segment will be described in terms of:

- extent of shoreline habitat and segment boundaries
- substrate type and size
- length and width of shoreline
- form: geomorphological type, processes, dimensions, profile, or gradient
- energy: winds, waves (Table 8-1)
- degree of anthropogenic influence
- photographic evidence and observation of access restrictions.

Table 8-1: General Indicators of Shoreline Energy

Energy	Low →						
Substrate	Mud	Sand	Grit	Pebble	Cobble	Boulder	Bedrock
Form	Swamp	Flats	Beach	Reef	Cliff		
Gradient/Slope	Flat	Gentle Slope	Steep Slope	Vertical			

Oiled Wildlife and Dead Fauna

Dead fauna provide essential information for an impact assessment and wider ecological interest. Marine invertebrates, including bivalves, crabs, sea urchins, and starfish that are washed up dead or moribund and discovered ad hoc during surveys should be recorded in terms of the numbers and species, with photographs and at least some representative specimens taken for later analysis. As far as practicable, individual samples will be labelled (including location and date found). If possible, collected individuals will be received and logged on arrival at a central location then deep frozen. Dead specimens will kept for later reference, evidence, or scientific research and natural history collections.

Continual monitoring relies on rapid and frequently repeated surveys to regularly update the EMT on the level of oiling on shorelines during the operational phase and provides information to determine the effectiveness of response operations. Survey The frequency will vary depending on the characteristics of the spill, habitats/species affected, weather and sea state, and rate of clean-up, and is likely to be iterative.

8.3.1 Pre-survey Planning

A rapid review of the hydrocarbon spill response resource tools will be conducted on shoreline habitats that are impacted or at risk of being impacted as determined by MES. Shoreline habitats will be assessed with regards to their sensitivity to impacts from the Tier 3 hydrocarbon spill and accessibility for clean-up operations. Pre-survey planning includes:

- identifying the shoreline segments
- determining the survey requirements.

8.3.1.1 Identifying Shoreline Segments

The area predicted to be impacted will be divided into discrete management areas by the EMT to plan and implement proposed sampling designs, defined as 'segments'. Shoreline segment identification will be undertaken once the spatial scale of the spill and the area required for survey has been identified. Shoreline segments will be defined using these considerations:

- likelihood of hydrocarbon contact on shorelines, as determined in OPS1
- homogeneity of habitats, physical features, and sediment type to assign location identifiers
- length of segment considering the resolution required to detail the distribution of hydrocarbon; as a guide, segments should be between 0.2 km and 2 km long
- practical aspects that can be used by the EMT for deployment of response (i.e. access and staging locations).

The OSRA (Ref. 30) may be useful for reviewing the distribution of sensitive habitats, species, and protected areas. These information sources will be reviewed to help select impact shoreline segments (in high-risk areas where sensitive receptors are found or are of protection or conservation priority) and reference shoreline segments (where potential impacts can be compared against natural conditions). If delineating appropriate segments is difficult because of insufficient information on habitat type and extent, then the information collected during the reconnaissance survey(s) may be used to refine the segments.

8.3.1.2 Determining Survey Requirements

The scale of the spill and the likelihood/consequence of impact with sensitive habitats/species will determine the level of effort required for OPS5. Survey method planning should consider these questions to specify if the proposed survey is 'reasonable' and 'appropriate' in scope, design, and subsequent cost:

- Will the results be sufficient to guide response action (wherever possible), help quantify the specific impacts, and assess the effectiveness of response actions?
- Is the scope of the program, and speed of obtaining results, the minimum necessary to fulfil the stated objectives?

For the operational phase assessment of most shoreline habitats, broad-scale transects (at the segment level) with recording of observations is recommended, combined with digital photograph quadrats captured at fixed intervals along the transect. The photographs will be reviewed as part of a pilot study for the scientific monitoring program SCI3: Coastal and Intertidal Habitat Impact Study, if required. For more densely populated habitats (e.g. mangroves), selective sampling may be more appropriate. The number of replicate sites needed to provide a representation of the area at risk depends on the scale of the individual spill conditions.

8.4 Resources

Item	Check
Oil Spill Assessment team (3 to 4 people per team, including one trained Oil Spill Assessment Specialist)	☐
Transect tape measure	☐
Flags or stake (to mark location of buried oil)	☐
Trowel and/or shovel	☐
Plastic sediment corer	☐
Dumpy level and staff	☐
Tide table(s)	☐
Clipboards (large enough to fix A4 assessment sheets)	☐
Assessment sheets printed on waterproof paper	☐
DoT Field Guide	☐
Species ID sheet	☐
Several pencils	☐
Radio	☐
First aid equipment	☐
GPS (it is essential to note the system the GPS uses [e.g. WGS 84])	☐
Camera (with polarised filter if available)	☐
Aircraft for reconnaissance (if available)	☐
Vessel/vehicle (depending on location)	☐

8.5 Standard Operating Procedures – Field Surveys

No.	SOP – Field Sampling for Aerial Surveys
Pre-work	
1.	Select and commission aircraft. Aircraft should have downward visibility (helicopter/ fixed-wing aircraft with over-fuselage wing), GPS, slow speed, and be suitable for low altitudes (preferably a helicopter)
2.	Assemble equipment
3.	Obtain information on the predicted shoreline impact area
4.	Time the flight to correspond with the low tide (if possible)
5.	Discuss and confirm the flight pan with the pilot
Aerial survey	
6.	Undertake a high-altitude (up to 500 m) rapid flyover of the shoreline to gain an overall perspective of the extent of oiling. Use this to determine: • length of shoreline to be surveyed during the flight • frequency timing of photographs
7.	Conduct a low-altitude, slow-speed survey of the target shoreline
8.	Record data:

No.	SOP – Field Sampling for Aerial Surveys
	• Take video of still photos at a downward angle of 30° to 45°. Note: Unlike aerial surveillance over water it is not always possible to avoid photographing into the sun. A polarising filter may be used to reduce glare, but use of this filter should be recorded on the photographer log • Mark oil distribution on map (shoreline assessment form). Estimate and mark: – tidal position (upper, mid, or lower intertidal) – band width – percentage cover – shoreline substrate • Mark photo locations and direction on the coastal map using an arrow (direction) and number (sequence) • Backup then clear camera memory after each survey
9.	Note: Separate surveys should overlap shoreline lengths by a few hundred metres or should include an obvious feature (e.g. building, headland, rock outcrop) at the start of the next survey
10.	At the end of each survey: • review and copy photos • label and catalogue photos

No.	SOP – Field Sampling for Ground Surveys
Pre-work	
1.	Identify shoreline segments
2.	Conduct JSA
3.	Develop survey objective in conjunction with the EMT and collect resources to undertake the survey
Ground survey	
4.	Complete shoreline assessment form (see AMSA Oil Spill Monitoring Handbook, Guideline S.5 Figure 8-1 and S.2 Figure 8-2 [Ref. 4])
5.	Record presence/absence of any oiled wildlife
6.	Conduct shoreline geomorphology assessment, including beach profiling if required (see AMSA Handbook, Guideline S.3 Figure 8-3 [Ref. 4])
7.	Collate assessment forms and any other supporting information (such as logbooks of notes), then submit to supervisor for data management

GUIDELINE FOR ASSESSMENT OF OILED SHORELINES: SURFACE OIL — S.5

Rationale

Monitoring the extent and distribution of oil on shorelines is needed for planning shoreline response strategies, methods and cleanup. This procedure sets out the method for describing oil on shoreline Segments (Guideline S.1). The general distribution of oil over large lengths of shoreline is monitored by using modified aerial surveillance procedures (Guideline S.3).

Methodology

1	Divide shoreline into Sectors and Segments (see Guideline S.1)			
2	Record the following shoreline descriptors:			
	2.1	Length	In metres	
	2.2	Width	In metres, from high tide to low tide.	
	2.3	Gradient	In degrees; approximate or as per Guideline S.3	
	2.4	Energy	High, medium or low as suggested by form	
	2.5	Substrate	Mud, sand, pebble etc. as per Guideline S.2	
	2.6	Form (or type)	Cliff, platform cobble beach etc.	
3	For each Segment, draw a sketch map showing the approximate location of the oil.			
4	Record the following parameters for the oily band:			
	4.1	Length	In km for Sectors or total, in m, for Segments. The distance the oily band extends along the shoreline.	
	4.2	Width	In metres. Average width of the oily band within a Segment or Sector. Measured across a beach from high to low elevations.	
	4.3	% Cover	Visual estimate of the percentage of the band (or average of bands). As per Figure below;	

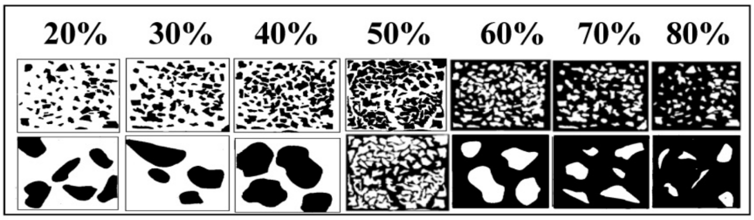


Figure S.5.1

	4.4	Oil Thickness	Po	Pooled oil. Can be estimated or measured in mm or cm.
			Cv	Cover. In mm, this is measurable (> 1mm thick)
			Ct	Coat. Can be scratched off rock with fingernail. Ct will mask the colour and texture of underlying substrate.
			St	Stain. Cannot be scratched off rock. Texture of substrate is visible through the oil
			Fi/ Sh	Film (Fi) or Sheen (Sh). Transparent. The colour and texture of substrate is visible through the oil
5	If necessary, or requested, classify surface oiling as per Tables overpage.			

S.5 Methodology Continued

Surface Oil Coverage

	Width of Oiled Band			
% Oil Cover	>6m	3-6m	0.5-3m	<0.5m
51-100	**High**	**High**	**Medium**	**Low**
11-50	**Medium**	**Medium**	**Low**	**Very Low**
1-10	**Low**	**Low**	**Very Low**	**Very Low**
<1	**Very Low**	**Very Low**	**Very Low**	**Very Low**

Surface Oil Classification

	Surface Oil Coverage			
Ave. Thickness	High	Medium	Low	Very Low
Pooled/Thick	**Heavy**	**Heavy**	**Light**	**Light**
Cover (>1mm)	**Heavy**	**Heavy**	**Moderate**	**Light**
Coat	**Moderate**	**Moderate**	**Light**	**Very Light**
Stain/Film	**Light**	**Light**	**Very Light**	**Very Light**

Figure S.5.2

(Source Wardrop 2000 as adapted from Owens & Sergy, 1994)

Note: Use Band Width (W) and % Coverage (%) to determine the surface oil cover, and then use oil Thickness (T) to classify the degree of oiling; the Surface Oil Classification.

Figure 8-1: Surface Oil Monitoring Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR CHARACTERISING SHORELINE SUBSTRATE	S.2

Rationale

Substrate type (particle size) determines the size of the spaces between particles and this in turn influences the depth to which oil will penetrate, and the ease with which wave action will remove the oil. These considerations are important in determining the need for, and type of, shoreline cleanup.

Methodology

Type	Abbr.	Descriptive Terms	Explanation
Bedrock or Rock	**R**	• Porous/non-porous • Broken/not broken (crevices/no crevices).	Porosity and crevices increase the likely persistence of the oil.
Boulder	**B**	• As above.	>256mm diameter: Larger than a head.
Cobble	**C**	• Porous (e.g. coral, pumice)/non-porous.	64 – 256mm: Fist or brick to head-sized
Pebble	**P**	• Or use "shingle" if flattened.	4 – 64mm: Pen diameter to fist sized.
Granules/ Gravel	**G**	• Rounded/flat. • Compacted/loose.	2 – 4mm diameter.
Sand	**S**	• Fine to coarse.	0.06 – 2mm diameter.
Mud/Silt/ Clay	**M**	• Note organic matter (debris/ fauna/ flora). • Consolidated/loose. • Dry (e.g. mud cliffs).	<0.06mm diameter. Field Test: Mix with water: If it "clouds up" it is silt/mud. If it sinks/clears it is sand.
Earth/ Soil	**E**	• Generally only applicable to cliffs and seawalls.	
Ice	**I**	• Likely only in the Antarctic territories.	
Shellgrit	**Sh**	• Wet/dry.	Usually with sand (Sh/S).
Coral(1)	**Co**	• Rubble/Boulder/ Cobble (e.g. Co-C).	Use to describe dead coral areas, e.g. coral cobble.
Concrete(2)	**Cc**	• Rubble; rip-rap.(2)	Artificial substrates/forms should be described and marked on segment maps.
Wood	**W**	• Debris/logs; pilings.	Debris can overlay other substrates.
Metal	**Mt**	• Pilings, sheeting.	Usually artificial structures.

1. *If corals are live, the shoreline should be described as coral noting its biological character and substrate type.*
2. *The abbreviation "A" can be used to designate artificial structures when they are not otherwise easily described, e.g. A-B would describe artificial boulder shoreline (i.e. rip-rap).*

Figure 8-2: Shoreline Assessment Guidelines from the AMSA Oil Spill Monitoring Handbook

(Source: Ref. 4)

GUIDELINE FOR DETERMINING BEACH PROFILE (GRADIENT)	S.3

Rationale

Physical cleanup methods can alter the elevation or profile of sand, pebble or cobble beaches. This may lead to erosion of beach or back beach areas. Shoreline profile may need to be monitored during cleanup, particularly if heavy machinery is used.

Methodology

S.3A Use of Marker Stakes

This is the simplest method and is suitable for low energy shores where manual rather than mechanical cleanup is used. It detects changes in sediment distribution but does not allow an accurate profile of the beach to be determined.

1	Hammer wooden or steel stakes into the beach at a number of locations and at various tidal elevations.
2	Measure the distance between the top of each stake and the sediment surface (H in Figure S.3.1).

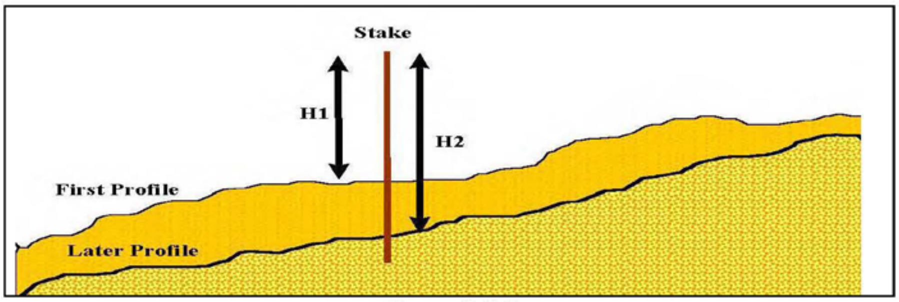


Figure S.3.1

S.3B Pole and Horizon Method 1

This method is suitable for all "soft" sediment shoreline types, i.e. those that allow a stake to be pushed or hammered into the surface.

1	Fix stakes (the "back stakes") along the beach above the high tide mark (i.e. in the Supratidal Zone).
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the top of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The back stake is used to measure changes in sediment height; i.e. changes in the distance between the tape level and the top of the stake (H in Figure S.3.2).
5	This procedure can be repeated at regular intervals along the transect.

Oil Spill Monitoring Handbook

S.3B Pole and Horizon Method 1 Continued

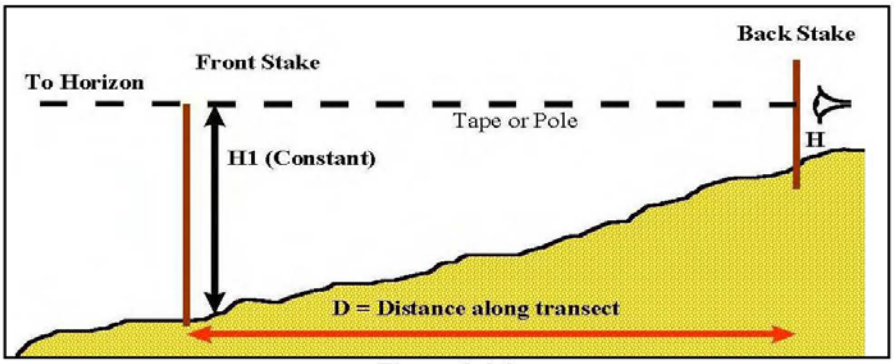


Figure S.3.2

S.3C Pole and Horizon Method 2	
This is similar to Method 2.3B except that it does not require the front stake to be pushed into the surface.	
1	Fix stakes (the "back stakes") along the beach above the high tide mark.
2	A linear transect is established across the beach (from supratidal zone to lower intertidal zone). The orientation of this is identified using a compass bearing from each "back stake" position.
3	To measure beach profile, a second stake (the "front" stake) is placed 2-4 m along the transect, and a tape or pole is used to align the top of the back stake to the horizon, and the eye of an observer on the back stake. Alternatively a spirit level can be used to ensure that the pole is horizontal.
4	The height between the sediment and the tape/pole at the front stake is measured (H1). The drop from the back stake to the front stake is H1-H0 (H0 is the height of the back stake, see Figure S.3.3)
5	This procedure is repeated at various intervals along the transect. Note if the "front stake" is left in place, measurements down-beach can be referenced from this point. This is an advantage if a pole (2-4 metres) is used to align stakes.

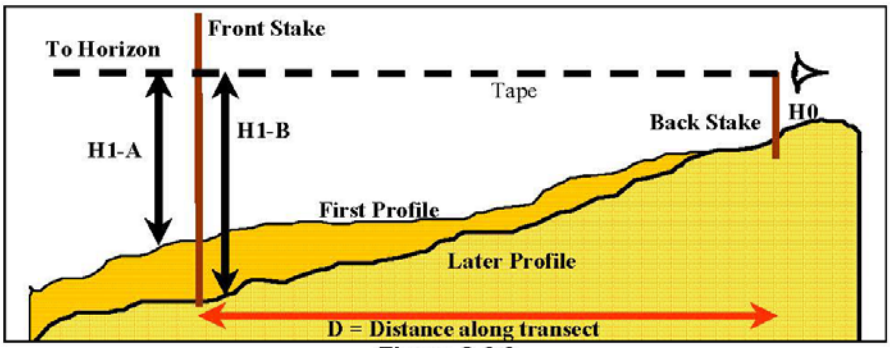


Figure S.3.3

	Page 2 of 3	**S.3**

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Figure 8-3: Guidelines for Determining Beach Profiles from the AMSA Oil Spill Monitoring Handbook Guideline

(Source: Ref. 4)

8.6 Reporting

- All data on shoreline habitats and spill impacts are to be sent to the EMT each day.

- Results are to be provided to the EUL for analysis and integration into the IAP development.
- Results are to be collated for use by the Monitoring Coordinator to initiate scientific monitoring programs (SCIs) (if applicable) and overall response impact tracking by the Planning Chief.
- All raw data collected should be disseminated into geospatial format for subsequent use in the Emergency Response GeoHouse tool and/or OSRA WMA.
- A final report will be prepared at the completion of the spill response activities, which will include all data collected and its interpretation.

8.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS5:

- Form 9 – OPS5: Rapid (Oiled) Shoreline Assessment Form.

9 OPS6: Rapid Seabird and Shorebird Assessment

9.1 Rationale

OPS6 provides the EMT with initial and ongoing information as to the presence and condition of seabirds and shorebirds within the predicted trajectory of the oil spill. CAPL personnel trained in oiled shoreline assessment will likely undertake the shorebird component of OPS6, at the same time as OPS5 (Rapid Shoreline Assessment).

The objectives of OPS6 are to:

- identify shorebird and seabird populations and habitats at risk from the spill
- undertake a rapid assessment of known shorebird and seabird populations to help determine appropriate management and response actions during the oil spill event so as to manage the potential impacts to, and inform long-term scientific monitoring of, shorebirds and seabirds
- identify appropriate response strategies to minimise threats to shorebirds and seabirds, based on spill characteristics, modelling outcomes, habitats, and quantified shorebirds and seabirds at risk.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Design

Occasionally, the study area may be small enough to comprehensively search the entire area within a reasonable time. However, selective searches may be required if the study area is too large to search it completely within a reasonable time. In such cases, rapid shoreline assessments will use key baseline data on the distinct habitat types and common alongshore distributions of ecologically significant species known to inhabit the area to concentrate the search effort within favoured habitat and known distributions. Priority will be given to areas of known occurrence or favoured habitats of breeding seabirds and shorebirds. However, other areas or habitats will not be completely excluded from survey designs in case relevant information is identified outside areas of known occurrence or favoured habitats.

The operational field study will cover rapid assessments of known breeding colonies for seabirds and important foraging areas for shorebirds to provide single measures of diversity and abundance of birds. The rapid assessments provide important information that will be communicated by the Field Teams to the EMT to mitigate, as far as practicable, impacts from hydrocarbon on the identified locations and bird species. The information from these rapid assessments will inform:

- the shoreline protection efforts
- the oiled wildlife response team
- the scientific monitoring program for seabirds and shorebirds (SCI4 – Shorebird and Seabird Impact Study).

These methods detail how this seabird and migratory shorebird assessment will be implemented for hydrocarbon spills for the Project, as adapted from the Survey Guidelines for Australia's Threatened Birds (Ref. 31):

- aerial and/or vessel-based surveys to verify the presence and abundance of seabirds at identified significant breeding colonies of seabirds within the known and predicted trajectory of the hydrocarbon spill
- aerial, vessel, and/or ground surveys to verify the presence and abundance of shorebirds at identified important foraging areas within the known and predicted trajectory of the hydrocarbon spill
- records of observed oiled or dead seabirds and shorebirds.

The timing and frequency of implementation of the survey activities will be confirmed by the EMT, or delegate. Priority will be given to aerial shoreline assessments because they can capture the most data within the shortest time. Vessel-based and/or aerial surveys may also be used to detect and count pelagic seabirds offshore; however, these surveys will have a lower priority due to their low efficiency in detecting birds.

On-ground shoreline assessments may also be conducted opportunistically with OPS5 – Shoreline Habitat Rapid Assessment. Before implementing the on-ground survey activities, the EMT (or delegate) must ensure that field personnel have the appropriate qualifications (e.g. Fauna Handling), or work under the guidance of those with appropriate qualifications, to capture and respond to oiled birds in the field.

Operational activities and surveys on shorelines may disrupt the breeding cycles of birds if not conducted with adequate care. However, the option to disrupt and shift the colony will be considered during operational planning as a potential strategy to minimise threats of hydrocarbon impacts on migratory shorebirds and seabirds.

9.4 Resources

The specific skills required to complete this OPS are:

- shorebird and seabird observers with appropriate experience in:
  - shorebird and seabird identification
  - familiarity with shorebird and seabird behaviour
  - familiarity with shorebird and seabird associated habitats
- oiled wildlife responders with appropriate experience in:
  - oiled wildlife response
  - fauna handling
  - fauna euthanasia.

Item	Check
Assessment team (3 to 4 people), including one trained Fauna Handler and/or one trained Oiled Wildlife Responder	☐
Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration	☐

Item	Check
Field guides to help identify shorebirds	☐
Notepad and pen	☐
Handheld GPS	☐
Binoculars, ideally 8x30 to 10x50 i(smaller or larger binoculars are inappropriate for bird watching)	☐
Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification	☐
Logbook/observation sheets	☐
Measurement tools	☐
Gloves	☐
Refrigerator or eskies with ice	☐
Sample bags	☐
Camera	☐
Aircraft for reconnaissance	☐
Vessel/vehicle (depending on location)	☐

9.5 Standard Operating Procedure – Shorebird and Seabird Rapid Assessment Surveys

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
Vessel-based survey techniques *		**Aerial survey techniques**
Pre-work		
1.	Use MES to establish the boundaries of the study area. Once priority areas for monitoring are determined, gather background information on the study area (including habitat type and ecologically significant birds known to occur there).	
	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification.	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Selected to maximise ease of detecting and identifying birds detection and minimise the risk of colliding with ground structure of airborne birds (Ref. 8)
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Bird observations:	Bird observations:

No.	SOP – Shorebird and Seabird Rapid Assessment Surveys	
	Vessel-based survey techniques *	**Aerial survey techniques**
	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species	• record observations of each individual bird or group of birds in real time to a dedicated handheld logger • conduct complete counts of dense flocks • count all birds observed and record their identity to the lowest taxonomic group possible, preferably species
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables, as far as practicable, including location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)	Record other variables, as far as practicable, including location, whether transect is in oil-affected water, and weather conditions: • temperature • precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas
10.	Record the presence of other vessels within the survey area, as these vessels may affect the behaviour of the birds	Record the presence of vessels or other aircraft within the survey area, as they may affect the behaviour of the birds
11.	Count individuals following the vessel only once	

** Note: Access to a dedicated vessel for seabird surveys may not be possible in the event of a spill. However, data on seabirds may be gathered opportunistically on board a response vessel working in the spill area.*

9.5.1 Shoreline Surveys

Shoreline surveys are effective for detecting the presence and abundance of many breeding shorebird and seabird species. The rapid surveys undertaken for this program will examine shoreline plots of predetermined sizes based on information obtained from MES. The rapid surveys will include known seabird breeding colonies and shorebird foraging sites to confirm the presence of bird aggregations, and will be undertaken at islands identified and prioritised to be at risk of impact from the hydrocarbon spill, as far as practicable. Note: The ability to detect birds that are present varies with the time of day, season, and between years. For example, the areas of coastal habitat occupied by many shorebird species may vary over the course of the day in relation to tidal cycles (Ref. 8; Ref. 9; Ref. 10). Further, many birds present are migratory and may use only part of their range at any particular time of the year (Ref. 11; Ref. 12; Ref. 13; Ref. 14). Changes in abundance and highly irregular movement patterns may also occur in relation to variable environmental conditions such as cyclonic events (Ref. 15, Ref. 16). For tidal areas, these guidelines will apply, as far as practicable:

- Spatial coverage should be conducted of the entire habitat thought to be used by the same population of shorebirds, and the entire area of contiguous habitat where shorebirds may occur. This may include multiple discrete roosts and feeding areas.

- Surveys for roosting shorebirds should be conducted as close to high tide as practicable and no more than two hours either side of high tide (unless local knowledge indicates a more suitable time).
- Surveys for foraging shorebirds should be conducted as close to low tide as practicable and no more than two hours either side of low tide (unless local knowledge indicates a more suitable time).
- Surveys should not be undertaken during periods of high rainfall or strong winds.
- Surveys should not be undertaken when activities that disturb the birds, such as shoreline clean-up, are taking place.
- For large sites or for sites where large numbers of birds are expected, it is recommended that at least two people undertake the counts and agree on the number of birds and the number of species present.

Counting shorebirds may be done by directly counting individuals of each species present or by estimating if numbers are large. It is recommended to estimate the total number of birds first. If the birds being counted take flight, this ensures knowledge of the total number, and possibly some idea of the proportions of each species, has been obtained. Estimating proportions of species is a secondary priority.

9.5.2 Aerial Shoreline Surveys

Aerial surveys allow rapid coverage of large areas of land and/or water and can cover areas that are difficult to access on the ground. Aerial shoreline surveys provide information on taxon presence and their quantity, and also reveal the location of particular habitat types or nest sites for follow-up ground surveys. Aerial shoreline surveys are performed for shorebirds and seabirds using either helicopters or fixed-wing aircraft. Aerial surveys usually involve flying along systematically or randomly-placed straight-line routes (similar to ground-based transect surveys) along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details on procedures for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.3 Vessel-based Shoreline Surveys

Vessel-based shoreline surveys for shorebirds and seabirds usually involve systematically or randomly-placed line transects along shorelines where birds or bird colonies may occur. The best coverage and accuracy is achieved with two observers recording from each side of the vessel (Ref. 17). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable.

9.5.4 Pelagic Surveys

Both vessel-based and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel-based surveys have the advantage of providing more time to identify the taxa and record other details such as age, sex, and behaviour. This improves the chances of recording rare, inconspicuous, and diving taxa.

9.5.5 Vessel-based Surveys

Vessel-based surveys include observations and recordings of birds at sea from a moving vessel. Vessel-based surveys may be conducted opportunistically and therefore observers may not be able to specify the vessel's course. The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Pelagic surveys and colony censuses may be useful because the study area supports several species that breed elsewhere and visit Australian waters outside their breeding season; they do not come to land and so would not be detected by colony surveys.

9.5.6 Aerial Pelagic Surveys

Aerial surveys of seabirds are typically performed using either helicopters or fixed-wing aircraft. Aerial surveys involve flying along systematically or randomly-placed, straight-line routes (similar to ground-based transect surveys) at sea where birds may occur. The best coverage and accuracy is achieved with two observers recording from each side of the aircraft (Ref. 17). About 600–1000 km of transects can be flown in a six-hour period (Ref. 10). The survey guidelines presented in Section 9.5.1 will apply, as far as practicable. Further details for conducting aerial surveys can be found in Braithwaite *et al.* (Ref. 18) and Resources Inventory Committee (Ref. 10).

9.5.7 Recording Oiled and Dead Seabirds and Shorebirds

This rapid survey includes collecting, recording, and scientifically examining a representative sample of live oiled and dead seabirds and migratory shorebirds. The sample size will depend on the resources available to undertake the assessment. As far as practicable, the initial assessment of live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel will collect information on:

- date and location of finding
- identification to species
- details of rings or other markers (e.g. satellite transmitters)
- oiling status of the bird (% oiled)
- external ageing and sexing
- external biometrics (to determine age and breeding population of origin) including:
  - bill length
  - bill shape
  - body mass
  - wing length
  - tarsus length
- internal examination to determine sex and age.

Live oiled and dead seabirds and shorebirds collected by Emergency Response personnel (e.g. shoreline clean-up teams or vessel crews engaged in response) who do not have the appropriate level of experience to conduct the initial assessment, will capture and store the individual birds as soon as possible and mark each bird with information on:

- date and location of finding
- degree of oiling (% oiled)
- species (if known).

The dead seabirds and shorebirds will be stored in appropriate facilities (preferably freezing facilities). Identified live, oiled birds found onshore and at sea will be captured, as far as practicable, using equipment such as nooses, hoop nets, and throw nets and then transported to the staging facility. The number and status of oiled seabirds and shorebirds may also be collected during other operational surveys (e.g. OPS5 – Shoreline Rapid Assessment). Methods for collecting and/or capturing oiled shorebirds are provided in Appendix B of the western Australian Oiled Wildlife Response Plan (Ref. 22).

9.6 Reporting

- All data on shorebird and seabird presence/absence and spill impacts will be sent to the EMT each day.
- A final report will be prepared at the completion of the monitoring plan (as determined by the termination triggers) and will include all the data collected and its interpretation.

9.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS6:

- Form 10 – OPS6: Rapid Seabird and Shorebird Assessment.

10 OPS7: Rapid Marine Megafauna Assessment

10.1 Rationale

OPS7 provides the EMT with initial and ongoing information as to the presence of marine megafauna (including marine turtles, sea snakes, pinnipeds, cetaceans, sharks, and rays) within the predicted trajectory of the oil spill.

The objectives of OPS7 are to:

- assess, and if possible confirm, the presence of marine megafauna in the environment that may be affected to predict the potential exposure to oil
- assess, and if possible confirm, where marine megafauna are in relation to the spill incident and the predicted spill trajectory to assess the level of risk
- observe, and where possible quantify, actual exposure of receptors to oil or exposure to the incident response measures
- record mortality of marine megafauna in the environment that may be affected.

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Design

OPS7 records and collates observations of marine mammals, reptiles, and large cartilaginous fish within the study area using reconnaissance aerial and/or vessel-based surveys. Rapid and systematic identification (using standardised survey protocols) is required . Given the low precision of data/knowledge on the distribution and abundances of most marine mammals, reptiles, and large cartilaginous fish, and the time available in the event of a spill, quantification of abundance is unlikely. However, qualitative assessment of animal numbers present and any observable impacts to individuals is possible. Methods are principally designed to collect information on presence/absence, mortality, and, if possible, the status of those individuals encountered (e.g. behaviour, oiling etc.).

Flexibility is required when implementing OPS7 so that methods/procedures best suited for collating information to inform the response strategy can be selected. The design outlines several potential approaches, with the decision made at the time of the spill on which aspects will be implemented.

10.3.1 Pre-survey Planning

It is anticipated that the surveys conducted as part of OPS7 will supplement already established distribution information. Data on relevant species, their seasonality, and potential breeding stage will be tabled to determine the scope of surveillance surveys and to establish priorities for data collection.

Information from MES will be overlaid with resource maps for the relevant species, including location of critical habitats. This information will be used to identify the priority species and any specific survey locations that will be considered when determining the geographic area for reconnaissance and scientific monitoring studies (if required). Given the impracticalities of monitoring all potential receptors under the marine mammal, reptile, and large cartilaginous fish groupings, indicator species will be used to provide a method to track the potential impact. Depending on location of the spill and its predicted extent, several potential indicator species for assessing risk to marine megafauna during the operational response have been identified.

The selection of indicators species was based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* [EPBC Act] listed species).

Based on these considerations, indicator species recommended for operational monitoring are outlined in Table 10-1.

Table 10-1: Potential Indicator Species for Surveillance Surveys

Baleen Whales	Toothed Whales or Dolphins	Other Marine Mammals	Large Cartilaginous Fish	Reptiles
• Blue Whale • Humpback Whale	• Bottlenose Dolphin • Indo-Pacific Humpback Dolphin • Spinner Dolphin • Australian Snubfin Dolphin	• Dugong • New Zealand Fur Seal	• Whale Shark	• Green Turtle • Flatback Turtle

10.3.2 Monitoring Design

The scale of likely impact will determine the scale of both spatial and temporal monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be adaptable on the day to changes in the predicted zone of impact of an oil spill incident. The priority of resources, receptors, and sites are likely to be different under different spill or weather conditions, the seasonal presence of species, and/or the life stage of the species present. A judgement will need to be made at the time of the spill about the relative value of different sites and resources that are the focus of operational monitoring.

10.3.3 Field Survey Assessment

The study will include rapid surveillance surveys to determine what marine mammals and large cartilaginous fish are present in the predicted spill trajectory pathway and the wider environment that may be affected by the spill. The size of the wider environment that may be affected will be determined based on several factors including: season, life stages of species likely to be observed, geographic range, species residency, and timing in relation to migration. A qualitative visual assessment over and extending beyond the area of the hydrocarbon spill (but within the area of impact) to identify the presence and/or behaviour/activity of the selected marine wildlife is recommended. The standard survey platforms used for assessing marine wildlife at sea and along coastlines are aerial (manned) or marine vessels. Aircraft can survey large and inaccessible areas in a short space of time and reduce the risk of double counting that can potentially occur from vessel-based surveys. Aerial surveillance works well for large marine mammals (principally whales) and where waters have good light penetration and visibility. However, aerial survey methods do not provide robust counts for inshore dolphin populations where shallow waters are turbid. Visual assessments using aerial surveillance may under-report substantially, and species identification can be problematic. In situations where the study area includes shallow coastal waters, vessel-based surveys are more suitable (taking into account safety considerations). The environmental conditions at the time of survey will influence what survey platform is most appropriate. For operational monitoring, aerial surveys are preferred, with vessel-based surveys completed opportunistically.

10.3.4 Vessel-based Surveys

Vessel-based surveys for presence of marine mammals and large cartilaginous fish will occur opportunistically and will depend on vessel access. Observational data will be gathered on species and location of any marine mammals and large cartilaginous fish close to the surface slicks, as well as any unusual behaviour or ill health.

As far as practicable, the observer(s) will be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals.

Double-platform data collection will be implemented, when possible. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location
- species
- group size
- group composition (adults and calves)
- angle to sighting (declination)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.5 Aerial Survey

Aerial surveillance for marine mammals and large cartilaginous fish will, as far as practicable, be undertaken daily in conjunction with MES aerial surveys. The survey will detect presence of visible animals without confidence of estimates of abundance. Visual and photographic/video data should be collected and information on sea state and flight path recorded, as outlined below. Where possible, double-platform line-transect and cue counting will be implemented to limit bias. Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collated should include:

- location (GPS)
- species
- group size
- group composition (adults and calves)
- behaviour (directional/non-directional swimming, feeding, resting)
- cue (underwater, body at surface, splash, blow)
- swimming direction
- reaction to the survey craft.

10.3.6 Shoreline Survey (Marine Turtles)

Track data for marine turtles will be collected using aerial photographic surveillance; however, in poor weather conditions it may be necessary to conduct ground-based track census surveys. Aerial overnight track counts are constrained by tides and sun elevation—overnight tides clear the beach of new tracks below the high-tide line, while tracks cannot be seen past ~10:00 am due to the sun's elevation making them impossible to see clearly. The tracks and other evidence left on the beach after a marine turtle has emerged (crawls) can be used to identify the species. The aerial survey results will be verified by ground surveys, which will also confirm the level of oil contamination at key nesting beaches (which is not always possible from the air). Shoreline surveillance will be conducted in conjunction with OPS5 – Rapid Shoreline Assessment.

10.3.7 Live Stranding and Carcass Recording (Marine Mammals)

Strandings of marine megafauna create an important opportunity for gathering information on the species' biology, pathology, toxicology, population genetics, and natural and human-induced population mortality.

If a fauna stranding is recorded, at least 10 carcasses will be sampled for tissue analysis (providing the criteria for necropsy are met). If fewer than 10 carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

In Western Australia, Wildcare (08 9474 9055; part of DBCA) is the lead stranding organisation. Standardised protocols are available for carcass handling and necropsy procedures; these will be adopted:

- Standardised protocols for the collection of biological samples from stranded cetaceans (Ref. 32)
- Marine Mammals Ashore: A Field Guide for Strandings (Ref. 33)
- Eros *et al.* outlines details on salvage and necropsy procedures for dugong (Ref. 34).

Trained professionals will be involved in handling any strandings encountered. Where carcasses are observed, physical details (species, length, sex, condition, etc.) will be recorded and photographs taken. Basic biological information and tissue samples for laboratory analysis (where appropriate) also need to be collected.

A necropsy should be undertaken by a pathologist to determine cause of death. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of death can be attributed to the oil spill event. The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis, with analysis unlikely on severely decomposed carcasses. Tissue samples are required for hydrocarbon analysis and, where possible, these must be assessed against background reference points for the interpretation to be meaningful.

Immediate necropsy, or appropriate freezer storage of carcasses, is required for the physiological and pathological state to be correlated to any concentration of petroleum products found in tissue samples. For any marine megafauna tissue collected, a basic set of analytical tests will be undertaken as part of the scientific monitoring conducted as part of SCI5.

10.3.8 Oiled, Injured, Diseased, and Dead Fauna Recording

Oiled, injured, diseased, and dead reptiles will be handled by trained personnel. All records will be entered into an Oiled Wildlife Database and include details on species, size, sex, condition, damage, etc. with photographic records made of the body. All dead and oiled/injured animals will be collected—live animals for clean-up and tissue sampling; dead animals for tissue sampling and freezer storage.

Any sea snakes collected will be sent to the WA Museum for identification. Live sea snake observations will be photographed for identification.

10.4 Resources

CAPL has access to a number of environmental professionals based on Barrow Island, at Onslow, and in Perth. The specific skills required to complete this OPS are:

- experience in marine spill response operations
- marine mammal knowledge and field skills to correctly identify marine mammals (Marine Mammal Observer [MMO] certification [essential]; experience in marine mammal surveys from aerial surveys [desirable])
- veterinary and pathology expertise on call for diagnosis of cause of death with experience in record keeping (chain of command procedures) and advising on diagnosis of death

To prevent injury to animals and the people handling them, it is preferable that only experienced people handle wildlife. Any on-site training should include written descriptions of handling and cleaning techniques, and demonstrated compliance with these. Each person should also be provided with a written brief that covers safety, legal requirements, and the importance of recording all data.

Item	Check
Survey platform: Access to rotary or fixed-wing aircraft (recommended AMSA Dornier 318 or CASA 212-400 fixed-wing aircraft; i.e. high-wing aircraft with downward visual capability) or marine vessels	☐
Trained MMO on aircraft	☐
Handheld video camera with date stamp and GPS capability	☐
Digital camera (with GPS) and telephoto lens	☐
GPS device	☐

Item	Check
Binoculars, preferably 8x30 to 10x50	☐
Clinometers	☐
Nautical charts	☐
Logbook/observation sheets	☐
Species field identification guide(s)	☐
Audio recorder	☐

Aircraft are available on Barrow Island and Karratha through Bristow's. The activation time (under ideal metocean conditions) for the helicopter on Barrow Island is two hours (three hours from Karratha or Exmouth). Vessel providers are available from regional port/harbour facilities in Exmouth, Onslow, Dampier, and Port Hedland.

10.5 Standard Operating Procedure – Field Sampling

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
Pre-work		
1.	Calibrate distance estimation for each observer	Calibrate transect estimation for each observer
2.	Establish transects to be surveyed	Establish transects to be surveyed
3.	Establish strip width for transects (e.g. 400 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, scan the entire area around the vessel out to a maximum distance that still permits accurate identification	Establish strip width for transects each side of the aircraft: • 400 m for whales and dugong • 750 m for Whale Sharks
During survey		
4.	Vessel speed: 10 knots (range 5–15 knots)	Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot Altitude: approximately 500 ft Beaufort state: <3
5.	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger	Record latitude and longitude continuously (e.g. 30-second intervals) using handheld data logger
6.	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)	Marine mammal observations: • record observations of each individual or group in real time to a dedicated handheld data logger • count all observed individuals, record their identity (preferably species), and determine their age class (if possible)
7.	Obtain photographs and/or video to help identify and count species	Obtain photographs and/or video to help identify and count species
8.	Record other variables including, as far as practicable, location, vessel speed and direction, whether transect is in oil-affected water, and weather conditions:	Record other variables including, as far as practicable, location, whether transect is in oil-affected water, and weather conditions: • temperature

No.	SOP – Standard Marine Megafauna Survey Methods	
	Vessel-based survey techniques	**Aerial survey techniques**
	• temperature • precipitation • wind strength and direction • visibility (including glare)	• precipitation • wind strength and direction • visibility (including glare)
9.	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas	Confine observations to daylight hours, and suspend in heavy rain, heavy winds, fog, or rough seas

10.6 Reporting

- All data will be sent to the EMT each day.
- A final report will be prepared at the completion of the spill response activities and will include all the data collected and its interpretation.

10.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS7:

- Form 11 – OPS7: Aerial Survey Log Form
- Form 12 – OPS7: Marine Vessel Survey Log Form.

11 OPS8: Fish Tainting Assessment

11.1 Rationale

OPS8 relates to monitoring undertaken to better manage concerns expressed by fisheries, the public, or the media about the potential effects of the spill or response activities.

Fish tainting assessment (OPS8) will be performed by external agencies possessing this specialised skill set. This Section provides general guidance and expectations for external monitoring teams.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this OPS are provided in Section 4 of the OSMP. Implementation times for this OPS are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Design

The key component of OPS8 is collecting data on the effects of the spill and response strategies on pelagic and benthic fish species. The assessment will include:

- an adequate and reasonable sample size for both pelagic and benthic species (where applicable to response strategies) for rapid response sampling
- those areas of known importance for commercial fisheries
- requirements to inform recreational and commercial fisheries
- availability of human resources, suitable vessels, and other logistics
- capacity for transporting samples from the site (e.g. by helicopter or vessel)
- safety considerations.

As per wildlife impact monitoring during the Montara oil spill (Ref. 19), samples can be collected from commercial fishers who have landed fish in areas known to have been impacted by oil (refer to MES results to determine). If no commercial fishers have landed catch for areas within the zone of (potential/actual) impact, other operational monitoring vessels and teams can be used for this task. However, if the response depends on the results of this program for decision-making for the next operational period/IAP, then a vessel and team dedicated to the task will be engaged as they become available.

Implementation of OPS8 will focus on rapidly determining fish taint, given the specifics of the spill and the zone of actual impact, thus allowing for appropriate response strategies to continue. The results of OPS8 could also reduce the time that commercial and recreational fisheries are impacted.

Whole fish samples for chemical analysis and examination of fish health will be obtained through field sampling, with the analysis being undertaken at specialist fish health laboratories.

Study design guidance:

- Plastics can contaminate samples, therefore sampling methods and storage containers should avoid plastics.

- As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics relevant to the spilt hydrocarbons (such as various ratios) will be screened to confirm the contaminant's source.
- If fish kill is observed, whole, dead fish must be collected and preserved (frozen) for necropsy. If a large number dead fish are evident, the total number will be estimated, with a reduced number (~20 fish per species) of representative specimens retained for necropsy. The standard procedure for reporting fish kills to the WA DoF will be adhered to (Ref. 35).

11.4 Resources

OPS8 depends on field sampling, thus all vessel-related requirements and logistical considerations are relevant. Chemical analysis of tissue samples will require an extensive list of equipment for extracting tissue samples and examining fish health; a complete list should be developed in consultation with appropriate experts in this field and the ecotoxicologist (biopsy collection and handling), but may include:

- disposable nitrile gloves
- glass vials with PTFE lids
- aluminium foil
- ziplock bags.

11.5 Standard Operating Procedure – Field Sampling

No.	SOP – Field Sampling for Fish Tainting
1.	Contact the Fish Health Laboratories for advice on the preferred options for sampling and shipping. Phone: 08 9368 3286 or 08 9368 3357 Email: jo.bannister@agric.wa.gov.au; phillier@agric.wa.gov.au The three main options are: • Live sick specimens placed in plastic bags filled one-third with water and two-thirds with air (or oxygen if possible), to be delivered within 12 hours. (Use this option, where possible.) • Frozen whole fish and/or very fresh dead or recently killed fish placed in separate, clean, amber glass vials with PTFE lids or wrapped in aluminium foil stored in a ziplock bag, kept at -20 °C, to be delivered within 24 hours. • Small dead fish, with their abdomen slit open, should be placed in 10% formalin (or in methylated spirits in an emergency). If possible, chilled or frozen specimens (as above) should also be supplied. Supply: • a one-litre sample of water from where the fish were collected • an accurate history of the fish, their environment, and any water quality data.
2.	Send samples for diagnosis to: **Fish Health Laboratories** c/o Animal Health Laboratory Department of Agriculture and Food 3 Baron-Hay Court SOUTH PERTH WA 6151

11.6 Reporting

- Record and report results to the EUL for integration into IAP development.
- Record and report results to the EUL for referral to the Public Information Section for dissemination to recreational and commercial fisheries.

- Record results and handover to the Monitoring Coordinator for initiation of the SCIs (if applicable).

11.7 Forms and Tools

Refer to Appendix F for the forms required to undertake OPS8:

- Form 1 – Chain of Custody Form
- Form 2 – Freight Consignment Form
- Form 12 – Fish Tainting Assessment Form.

12 Acronyms and Abbreviations

Table 12-1 defines the acronyms and abbreviations used in this document.

Table 12-1: Acronyms and Abbreviations

Acronym/Abbreviation	Definition
°C	Degrees Celsius
µg/L	Micrograms per litre
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
BOSIET	Basic Offshore Safety Induction and Emergency Training
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Hydrocarbon chain length
cm	Centimetre
cm^3	Cubic centimetre
dB(A)	A-weighted decibels
DO	Dissolved Oxygen
DoF	Western Australia Department of Fisheries
DoT	Western Australian Department of Transport
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
EUL	Environment Unit Lead
FID	Flame Ionization Detector
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HES	Health, Environment, and Safety
HUET	Helicopter underwater Escape Training
IAP	Incident Action Plan
IMG	Incident Management Guide
JSA	Job Safety Analysis
kg	Kilogram

Acronym/Abbreviation	Definition
km	Kilometre
kn	Knot
L	Litre
LAT	Lowest Astronomical Tide
LC50	Lethal concentration for 50% of the test species
LNG	Liquefied Natural Gas
m	Metre
MES	Monitoring, Evaluation, and Surveillance
mg	Milligram
mL	Millilitre
mm	Millimetre
MMO	Marine Mammal Observer
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NOEC	No Observed Effect Concentration
NWS	North West Shelf
Oleophilic	Oil attracting
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
Parks and Wildlife	Western Australian Department of Parks and Wildlife
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
QA/QC	Quality Assurance/Quality Control
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.

Acronym/Abbreviation	Definition
SCI	Scientific Monitoring Program
SIMOPS	Simultaneous Operations
SMART	Special Monitoring of Applied Response Technologies
SOP	Standard Operating Procedure
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia.
SVOC	Semi-volatile Organic Compound
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TPH	Total Petroleum Hydrocarbons
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere.
WA	Western Australia

13 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 13-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2015. Operational and Scientific Monitoring Plan, Environmental Monitoring in the Event of an Oil Spill to Marine or Coastal Waters. Perth, Western Australia.	ABU130700448
2.	Chevron Australia. 2014. ABU Oil Spill Response Manual. Perth, Western Australia.	OE-11.01.101
3.	Chevron Australia. 2012. Emergency Management Process – ABU Standardised OE Process. Perth, Western Australia.	OE-11.01.01
4.	Australian Maritime Safety Authority, 2003. Oil Spill Monitoring Handbook. Available from: https://www.amsa.gov.au/environment/marine-pollution-response/scientific-info/dispersants/Documents/Oil_Spill_Monitoring_Handbook.pdf. [Accessed 13 Jul 2017.	
5.	Department of Transport. 2012. Oil Sampling Handbook.	
6.	Oil Spill Response Limited. 2011. Dispersant Application Monitoring Field Guide Tier I Visual Observation.	
7.	American Petroleum Institute. 2013. Industry Recommended Subsea Dispersant Monitoring Plan.	
8.	Howes, J. and Bakewell, D. 1989. Shorebird Studies Manual. Asian Wetland Bureau Publication No 55 University of Malaya. Kuala Lumpur, Malaysia.	
9.	Bibby, C., Burgess, N., Hill, D. and Mustoe, S. 1992. Bird Census Techniques. (referenced within Commonwealth of Australia, 2010).	
10.	Ministry of Environment, Lands and Parks Resource Inventory Branch Terrestrial Ecosystem Task Force. 1997. Standardised Inventory Methodologies for Components of British Columbia's Biodiversity: Shorebirds. Prepared for the Resources Inventory Committee. Victoria, British Columbia.	
11.	Marchant, S and Higgins, PJ, eds. 1993. Handbook of Australian, New Zealand and Antarctic Birds.	
12.	Baker-Gabb, D. 1998. BOP Watch Update No. 5. Royal Australasian Ornithologists Union Newsletter.	
13.	Griffioen, PA and Clarke, MF. 2002. Large-scale bird movement patterns evident in eastern Australian atlas data. *Emu - Aust Ornithology*. Vol 102: 2002.	
14.	Barret, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. 2003. The New Atlas of Australian Birds. East Hawthorn, Victoria.	
15.	Recher, HF. 1988. Counting terrestrial birds: Use and applications of census procedures in Australia. *Australian Zoological Reviews*, 1. pp. 25–45.	
16.	Garnett, S. and Crowley, G. 2000. The Action Plan for Australian Birds 2000. Available from http://www.environment.gov.au/node/34417 [Accessed 13 Jul 2017]	
17.	Komdeur, J., Bertelse,n J. and Cracknell, G. 1992. Manual for Aeroplane and ship surveys of waterfowl and seabirds. Wetlands International Publication Vol. 19.	

Ref. No.	Description	Document ID
18.	Braithwaite, LW, Maher, M, Briggs, SV, Parker, BS. 1986. An aerial survey of three game species of waterfowl (family Anatidae) populations in eastern Australia. *Australian Wildlife Research*. 1986. Vol. 13(2) pp.213–23.	
19.	Gagnon, MM. 2009. Report on biopsy collections from specimens collected from the surrounds of the West Atlas Oil Leak. Curtin University of Technology. Perth, Western Australia. Available from: https://www.environment.gov.au/system/files/pages/1a63b46f-0a2a-4b4a-818c-319ea8d7cd23/files/montara-fish-report.pdf [Accessed 13 Jul 2017]	
20.	Bejarano, AC, Michel, J, and Allan, SE. 2014. Guidelines for Collecting High Priority Ephemeral Data for Oil Spills in the Arctic in Support of Natural Resource Damage Assessments. Prepared for NOAA. Available from: http://response.restoration.noaa.gov/sites/default/files/NOAA-guidelines-ephemeral-data-collection_Arctic_December2014.pdf. [Accessed 13 Jul 2017]	
21.	ITOPF. 2012. Sampling and Monitoring of Marine Oil Spills Technical Information Paper 14. London, United Kingdom. Available from: http://www.itopf.com/fileadmin/data/Documents/TIPS%20TAPS/TIP14SamplingandMonitoringofMarineOilSpills.pdf [Accessed 13 Jul 2017]	
22.	Australian Marine Oil Spill Company / Department of Parks and Wildlife. 2014. Western Australian Oiled Wildlife Response Plan. Available from: https://www.dpaw.wa.gov.au/images/documents/conservation-management/marine/wildlife/West_Australian_Oiled_Wildlife_Response_Plan_V1.1.pdf [Accessed 13 Jul 2017]	
23.	Chevron Australia. 2012. Marine Stinger Protective Clothing Best Practice Guidelines. Perth, Western Australia.	G1-NT-GDLX0000374
24.	Chevron Australia. 2015. ABU – Personalised Protective Equipment (PPE) Standard. Perth, Western Australia.	OE-03.06.112
25.	Chevron Australia. Template Request for Chevron Lab Services. Perth, Western Australia.	ABU140601604
26.	Chevron Australia. ABU Contracts for the Provision of External Laboratory Services – Contractor Information. Perth, Western Australia.	ABU-COP-02478
27.	Proposed Rule for Revisions to the National Oil and Hazardous Substances Pollution Contingency Plan; Subpart J Product Schedule Listing Requirements’. Federal Register; Vol. 80, No. 14, Thursday, January 22, 2015 / Proposed Rules – p. 3425 (USEPA, 2015).	
28.	Vaquer-Sunyer, R., and Duarte, C. 2008. Thresholds of hypoxia for marine biodiversity. Proc Natl Acad Sci U S A. 2008 Oct 7;105(40) pp.15452–7.	
29.	Puyate, Y.T. and Rim-Rukeh, A. 2008. Some physico-chemical and biological characteristics of soil and water samples of part of the Niger Delta Area, Nigeria. *J App Sci Env.* Vol 12(2): pp.135–141.	
30.	Western Australian Department of Transport. Oil Spill Response Atlas.	
31.	Department of the Environment, Water, Heritage and the Arts. 2010. Survey Guidelines for Australia’s Threatened Birds: Guidelines for detecting birds listed as threatened under the EPBC Act. Available from: http://www.environment.gov.au/epbc/publications/survey-guidelines-australias-threatened-birds-guidelines-detecting-birds-listed-threatened [Accessed 13 Jul 2017]	
32.	Department of the Environment and Heritage. 2006. Standardised protocols for the collection of biological samples from stranded cetaceans. Available from: http://www.environment.gov.au/resource/standardised-protocols-collection-biological-samples-stranded-cetacean [Accessed 13 Jul 2017]	
33.	Geraci, JR and Lounsbury, VJ, 1993. Marine Mammals Ashore: A Field Guide for Strandings. Texas A&M Sea Grant.	

Ref. No.	Description	Document ID
34.	Eros, C., Marsh, H., Bonde, R., O'Shea, T., Beck, C., Recchia, C., Dobbs, K., Turnter, M., Lemm, S., Pears, R. and Bowater, R. 2007. Procedures for the salvage and necropsy of the dugong (Dugong Dugong). Research publication / Great Barrier Reef Marine Park Authority ; no. 85.	
35.	Department of Fisheries. 2017. Aquatic Animal Health. Available from http://www.fish.wa.gov.au/Sustainability-and-Environment/Fisheries-Science/Aquatic-Animal-Health/Pages/default.aspx [Accessed 13 Jul 2017]	
36.	Chevron Australia. 2019. First Strike Sampling and Analysis Plan Template	ABU180500476

Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required via					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
58	47	7.3	5.3	3.4	2.3	20	-		
67	51	8.4	6.1	3.9	2.7	22	-		
75	73	9.4	6.8	4.4	3.0	31	-		
114	95	14.3	10.4	6.7	4.6	41	-		
-	110	-	-	-	-	47	-		
57	57	7.1	5.2	3.4	2.3	24	-		
187	168	23.4	17.0	11.0	7.5	72	9.3 hours		
-	173	-	-	-	-	74	-		
116	107	14.5	10.5	6.8	4.6	46	-		
113	108	14.1	10.3	6.6	4.5	46	9 hours		
87	87	10.9	7.9	5.1	3.5	37	-		
13	13	1.6	1.2	0.8	0.5	6	-		
65	57	8.1	5.9	3.8	2.6	24	6.7 hours		
-	65	-	-	-	-	28	-		
108	108	13.5	9.8	6.4	4.3	46	-		
57	57	7.1	5.2	3.4	2.3	24	-		
-	70	-	-	-	-	30	-		

1. *Allow ~3 hours to travel from the east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time is based on site information and knowledge and Geohouse*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations*, hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (......)..

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix
Seal
Here

Director :	....	....
(signature)	(print name)	(date)
Director/Secretary:	....	....
(signature)	(print name)	(date)

Declaration where sole director/secretary (if applicable):

I .... declare that I am the sole director and sole company secretary of
(print name)

....	....	....
(print company name)	(signature)	(date)

Attorney

Attorney under Power:	....	....
(signature)	(print name)	(date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee

The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant** - state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought** - give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents -**

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

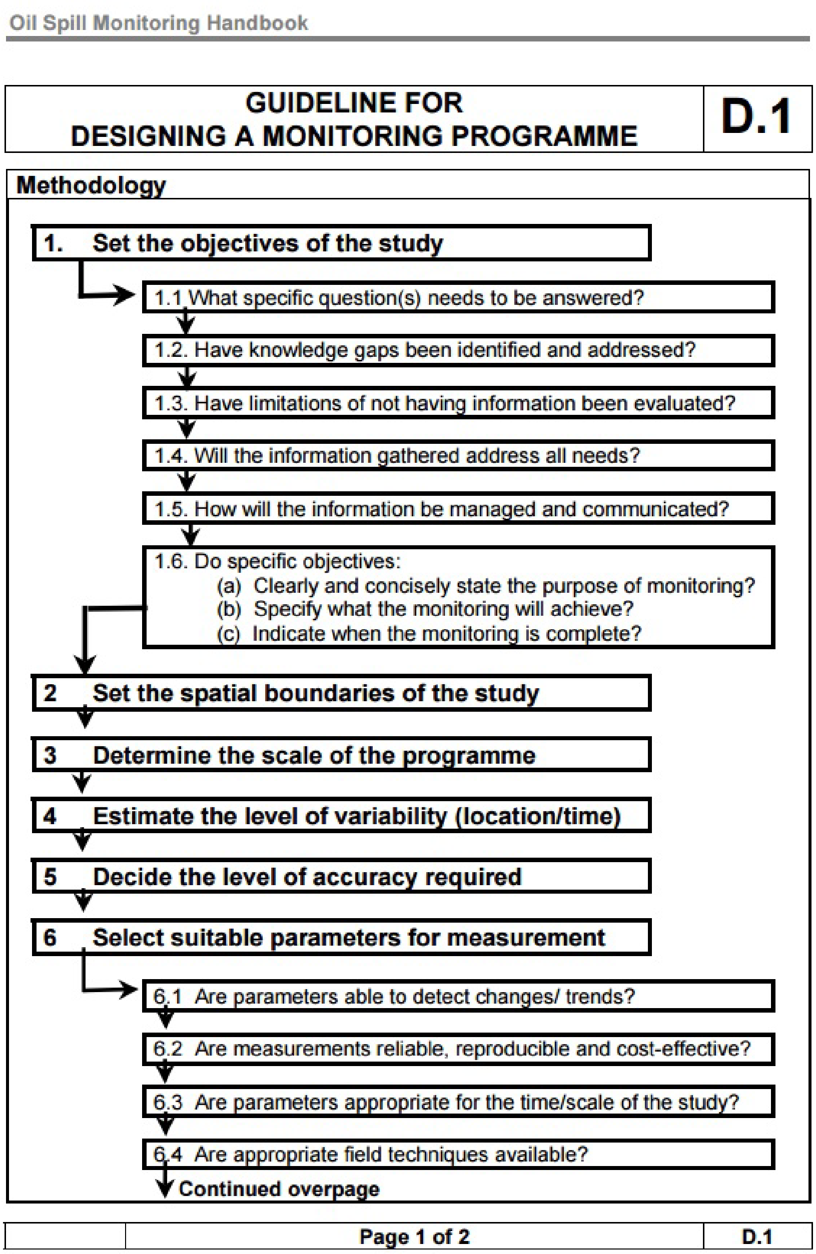
   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.

Appendix C Operational Monitoring Program Design

Extract from AMSA's Oil Spill Monitoring Handbook (Ref. 4)


Oil Spill Monitoring Handbook

GUIDELINE FOR DESIGNING A MONITORING PROGRAMME — **D.1**

Methodology

1. Set the objectives of the study

1.1 What specific question(s) needs to be answered?

1.2. Have knowledge gaps been identified and addressed?

1.3. Have limitations of not having information been evaluated?

1.4. Will the information gathered address all needs?

1.5. How will the information be managed and communicated?

1.6. Do specific objectives:
- (a) Clearly and concisely state the purpose of monitoring?
- (b) Specify what the monitoring will achieve?
- (c) Indicate when the monitoring is complete?

2 Set the spatial boundaries of the study

3 Determine the scale of the programme

4 Estimate the level of variability (location/time)

5 Decide the level of accuracy required

6 Select suitable parameters for measurement

6.1 Are parameters able to detect changes/ trends?

6.2 Are measurements reliable, reproducible and cost-effective?

6.3 Are parameters appropriate for the time/scale of the study?

6.4 Are appropriate field techniques available?

Continued overpage

Page 1 of 2 — **D.1**

Oil Spill Monitoring Handbook

7 Determine method for obtaining data

- 7.1 Can data collection be undertaken safely?
- 7.2 Can data be obtained by field measurements?
- 7.3 Does the design account for spatial and temporal variability?
- 7.4 Will the study provide information in a relevant timeframe?
- 7.5 Will samples need to be collected?
- 7.6 Will sampling devices collect representative samples?
- 7.7 Will sampling devices contaminate or affect the sample?
- 7.8 Will samples contaminate or affect the sampling devices?
- 7.9 What size sample containers are required?
- 7.10 Will samples need to be preserved before analysis?
- 7.11 Are procedures in place to track samples and field data?
- 7.12 Can potential sampling error be minimised?
- 7.13 Can potential sampling error be assessed?
- 7.14 Can data be analysed and accessed in a timely manner?

8 Determine sample numbers and schedule

- 8.1 Are replicates needed?
- 8.2 How frequently is sampling required?

9 Determine the likely duration of the study?

10 Obtain materials, plan deployment (logistics)

11 Determine data management requirements

	Page 2 of 2	**D.1**

Appendix D Guideline for Data Management

Oil Spill Monitoring Handbook

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

	Page 1 of 2	Q.1

Oil Spill Monitoring Handbook

Q.1 Methodology Continued				
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

Appendix E Oil Characterisation – Analytical Parameters

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Total petroleum hydrocarbons (TPH) **C4-C12**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight	**Oily Sample:** 2 x 250 mL glass jar or 100 mL amber bottle (no or limited water content) **Water Sample:** Each analysis needs a 100 mL amber bottle i.e. 10 x 100 mL (or 1 x 1 L amber glass bottle). **Sediment Sample**: 4 x 250 mL glass jar NOTE: Should the oily sample or the sediment sample contain little oily material, larger quantities should be collected (more equivalent to the water sample quantities).	All containers use Teflon lined plastic screw caps/lids. All containers must be completely full with no airspace. All containers kept at or below 4 °C following collection until the time it arrives at laboratory. Holding time for analysis or extraction by lab is 7 days following sample collection. This means that following collection the sample must be received by the laboratory within allowable time for the sample to be analysed or extracted to	
Total recoverable hydrocarbons (TRH) **C6-C40**	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH C6-C40 with silica gel clean-up	USEPA3510/8015 GC/FID. Includes EPA Method 3546/ ASTM D-5765 for sediments.	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
TRH Speciation Aliphatic/Aromatic fractions	CWG 1998	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			
Hydrocarbon product identification – GC-FID chromatograms	USEPA3510/8015 GC/FID, chromatogram review (non-NATA). Includes EPA Method 3546/ ASTM D-5765 for sediments.						Written statement by chemist, plus provision of chromatogram

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Full VOC Target Scan, with Select Ion Mode (SIM) reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes: • **Monocyclic Aromatic Hydrocarbon speciation (MAH)** • **Naphthalene** • **Oxygenated Compounds**	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight		make the 7 day holding time (i.e. less than 7 days).	**MAH:** Benzene, toluene, ethyl benzene and, xylenes (BTEX), styrene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, sec-butylbenzene, 1,3,4-trimethylbenzene, tert-butylbenzene, p-isopropyltoluene, n-butylbenzene **Naphthalene** **Oxygenated Compounds:** 2-propanone (acetone), vinyl acetate, 2-butanone (MEK), 4-methyl-2-pentanone (MIBK), 2-hexanone (MBK)
Fuel oxygenates	USEPA 5030/8260 P&T/GC/MS or HS/GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Tert-amyl ethyl ether (TAEE), Tert-amyl methyl ether (TAME), tert-butyl alcohol (TBA), diisopropyl ether (DIPE), ethyl tert-butyl ether (ETBE), methyl tert-butyl ether (MTBE)
Solvents	HS-GCMS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			Butyl acetate, ethyl acetate, 1-heptane, cyclopentene, cyclohexene, pentane, hexane, heptane, octane, nonane, decane
Full **SVOC Target Scan, with SIM reporting. Includes use of ultra-trace analysis where available and Scan for Unknowns. Includes:** • **Phenols** • **PAHs** • **Phthalate esters** • **Nitrosamines** • **Nitroaromatics and ketones**	USEPA 3510/8270 GC/MS	mg/L or µg/L	mg/L or µg/L	mg/kg as a dry weight			**Phenols:** phenol, 2-chlorophenol, 2-methylphenol, 3 & 4-methylphenol, 2-nitrophenol, 4-nitrophenol,2,4-dimethylphenol, .4-dinitrophenol, 2,4-dichlorophenol, 2,6-dichlorophenol, 4-chloro-3-methylphenol, 2,4,6-trichlorophenol, 2,4,5-trichlorophenol, pentachlorophenol, hexachlorophene, m, o and p-cresol, 2-methyl-4.6-dinitrophenol, dinoseb, 2-cyclohexyl-4.6-dinitrophenol, 2,3,4,6-tetrachlorophenol **PAH:** naphthalene, 2-methylnaphthalene, 2-chloronaphthalene, acenaphthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, N-2-fluorenylacetamide, benz(a)anthracene, chrysene, benzo(b)&(k)fluoranthene, 7,12-dimethylbenz(a)anthracene, benzo(a)pyrene, 3-methylcholanthrene, indeno(1,2,3-cd)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, benzo(e)pyrene, coronene, perylene

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
• **Anilines and benzidenes**							**Phthalate esters:** Dimethyl phthalate, Diethyl phthalate, Di-n-butyl phthalate, Butyl benzyl phthalate, Bis(2-ethylhexyl) phthalate, Di-n-octyl phthalate **Nitrosamines:** N-Nitrosomethylethylamine, N-Nitrosodiethylamine, N-Nitrosopyrrolidine, N-Nitrosomorpholine, N-Nitrosodi-n-propylamine, N-Nitrosopiperidine **Nitroaromatics and ketones:** 2-Picoline, Acetophenone, Nitrobenzene, Isophorone, 2,6-Dinitrotoluene, 2,4-Dinitrotoluene, 1-Naphthylamine, 4-Nitroquinoline-N-oxide, 5-Nitro-o-toluidine, Azobenzene, 1,3,5-Trinitrobenzene, Phenacetin, 4-Aminobiphenyl, Pentachloronitrobenzene, Pronamide, Dimethylaminoazobenzene, Chlorobenzilate **Anilines and benzidenes:** aniline, 4-chloroaniline, 2-nitroaniline, 3-nitroaniline, dibenzofuran, 4-nitroaniline, carbazole, 3,3-dichlorobenzidine
Paraffins, Isoparaffins, Aromatics, Napthenes, and Olefins (PIANO)	USEPA 8260 M	mg/L or µg/L					All volatile organic paraffins, isoparaffins, aromatics, naphthenes, olefins. Can be performed by ALS Newcastle.
Asphaltene Content	MA-1221/D3279	as a % of the whole oil					Can be done through labs subcontracting to Intertek Geotech (Petroleum Geochemistry Division).
Metals content (vanadium, Zinc, nickel, cadmium, lead, mercury)	USEPA 6020 ICP/MS (nickel, vanadium, cadmium, lead), ASTM 3112 Hd-B CV/FIMS (mercury)	mg/L or µg/L			**Oily Sample:** Additional 2 x 250 mL glass jar (no or limited water content)		
Sulfur content by XRF	ASTM D4294	%					
Density or Specific Gravity (at 15 °C)	ASTM D1298/D5002/D4052	mg/L					
Viscosity (at 20 °C and 30 °C)	ASTM D445	centistokes (cSt)					
Pour Point	ASTM D97	°C					

Analytical parameter	Suggested lab analytical method or field method	Type of spill material sample, including analysis units			Volume of sample/ Bottle requirements	Preservation and Holding time	Comment
		Oily/slick materials (limited water), separate phase oily product present or Oily potential source material	Water with sheen or water from underneath slick/spill	Oily sediment			
Water Content	ASTM 2709	% of sample					
Particle Size Distribution (PSD)	AS1289.3.6.1 – 2009			g/cm³	**Sediment Sample:** Additional 2 x 250 mL glass jar		Method by sieving – can be done on wet and dry sediments.
Total Organic Carbon (TOC)	ASTM D7573 – 09			%			Method by high temperature catalytic combustion and IR detection.
Water quality physical parameters: • **temperature** • **dissolved oxygen (DO)** • **salinity/EC** • **pH** • **redox potential (Eh)** • **turbidity** • **colour**	Suitable calibrated field probe or sample sent to laboratory.				**Water Sample to Laboratory**: 250 mL plastic bottle	If sent to lab then it is likely that the holding time for many of these analyses will be exceeded • 6 hours for DO, pH, Eh • 2 days for salinity/EC, turbidity and colour All containers use Teflon-lined plastic screw caps/lids. All containers must be completely full with no airspace. All containers kept at or below 4 °C following collection until the time it arrives at laboratory.	

Appendix F Forms

Form number	Description	Document ID
1.	Chain of Custody forms	
2.	Freight consignment form	
3.	OPS1: Oil Sampling Form	
4.	OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring	
5.	OPS2: Visual Dispersant Monitoring Observer Log	
6.	OPS3: Oil in Water Assessment – Oil Sampling Form	
7.	OPS4: Oil in Sediment Assessment Form	
8.	OPS5: Rapid (Oiled) Shoreline Assessment Form	
9.	OPS6: Rapid Seabird and Shorebird Assessment	
10.	OPS7: Aerial Survey Log Form	
11.	OPS7: Marine Vessel Survey Log Form	
12.	OPS8: Fish Tainting Assessment Form	

Form 1 – Chain of Custody

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

1.0 General Information			
Samples sent to: (contract laboratory)			
Attention:			
Chevron Charge Caption:		or Service Order No.:	

2.0 Sample Information			
Samples From:		Sampled by:	
Sample Type:		Date Sampled:	

	Description of sample	Analysis required
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		

☐ **Additional samples overleaf** ☐ **Preserved at 4°C**

3.0 Tracking

☐ **Copy 1** To Contract Lab with Sample
- Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative.
- Lab to mail this **original** copy to EH&S representative with completed results.

☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.

☐ **MEJ number must be included prior to analysis of samples.**

Acknowledge receipt signature:		Date:	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Document ID: OE-11.01.34 *Revision ID: 3.0. Revision Date: 16 November 2011.* *Information Sensitivity: Company Confidential* *Printed 21 December 2015.*		*Page 2 of 3*

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre, Building 500 Resources and Chemistry Precinct,
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

Off Conlon Street, BENTLEY WA 6102

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:	NOTES	ANALYSIS REQUIRED	**ChemCentre Job No:**
CLIENT (Billing): ADDRESS: CLIENT P/O No: .... SAMPLED BY: .... RESULTS TO:			**Please indicate if QC results are required:** **☐ Method QC** **☐ Batch QC** **☐ Special LOD (use comments section)** *Method QC data refers to results from a lab blank and a lab verification standard. *Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.

LAB ID	SAMPLE ID / DESCRIPTION	Sample Type	Depth	DATE COLLECTED	TIME COLLECTED							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ Normal Turnaround	**☐ Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

CVX Advanced Shipping Notification (ASN)

Order Ref No:	
Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
Sl No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Oil Sampling Form

Sample Sheet _____ of _____

Sampling Location Sketch

(State location and site references)

Sample Sheet _____ of _____

OIL SAMPLING FORM FOR OPS1					
Incident Name:			Ref No.		
Sampling Team					
Sample Number Unique number (as shown on sampling location sketch)					
Date (dd/mm/yyyy)					
Time 24 hrs					
Location/Reference Site reference and GPS coordinates					
Tide, current and weather					
Colour and optical effect (Bonn Agreement)					
Flow properties at ambient temp					
Water-in-oil emulsion (mousse)?					
Formation of solid sheets or balls?					
Evidence of submerged oil?					
Container Type	Glass jar				
	Bottle				
	Other				
Comments General observations, sampling method, variation on collection procedure etc.					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C	Held By:				

(Based on DoT Oil Sampling Form)

Form 4 – OPS2: Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring

<table>
<tr><th colspan="2">Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring</th></tr>
<tr><th colspan="2">Incident</th></tr>
<tr><td>Incident name:</td><td>Ref No.:</td></tr>
<tr><th colspan="2">Reporting Details</th></tr>
<tr><td>Assessment team leader:</td><td>Position/Organisation:</td></tr>
<tr><td colspan="2">Team members (Name/Organisation):</td></tr>
<tr><td>Date completed:</td><td>Time completed (24 hrs):</td></tr>
<tr><td>Reporting to:</td><td>Position/Organisation:</td></tr>
<tr><td>Date received:</td><td>Time received (24 hrs):</td></tr>
<tr><th colspan="2">Location Details</th></tr>
<tr><td colspan="2">Wind:</td></tr>
<tr><td colspan="2">Sea state:</td></tr>
<tr><td colspan="2">Water temp:</td></tr>
<tr><td colspan="2">Visibility/cloud cover:</td></tr>
<tr><td colspan="2">Dispersant used:</td></tr>
<tr><td colspan="2">Application method:</td></tr>
<tr><td colspan="2">Oil condition and type:</td></tr>
<tr><th colspan="2">Activity Log</th></tr>
<tr><td colspan="2">Comments should include:
1. Where and when dispersant was applied
2. Perceived effectiveness:
a. No obvious dispersion – Dispersant being washed off the black oil as white watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.
b. Slow or partial dispersion – Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.
c. Rapid dispersion – Oil rapidly disappearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on water.
Ensure photos are taken to demonstrate the observations – include the photo number that you are referring to and if possible the direction the photo was taken in.
3. Operations – was the dispersant applied appropriately in the correct dosage?
4. Sensitivities – note potential ecological impacts, the presence of marine mammals, coral reefs etc.</td></tr>
<tr><th>Time</th><th>Actions/Events</th></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Surface Dispersant Monitoring Summary Form – Tier 1 SMART Monitoring
Evidence collected e.g. photos
 Observation of oil prior to dispersant application
 Observation of oil post dispersant application
 Observation of oil post dispersant application
Recommendations: (e.g. the dispersant appears to be effective on fresh oil)

(Source Ref. 6)

Form 5 – Visual Dispersant Monitoring Observer Log

VISUAL DISPERSANT MONITORING OBSERVER LOG

Incident		Date		Observers	
Aircraft Type		Call Sign		Area Of Survey	
Survey Start Time		Survey End Time		Average Altitude	
Wind Speed (knots)		Wind Direction		Notes	
Cloud Base (feet)		Visability (nm)			
Time High Water		Time Low Water			
Current Speed (nm)		Current Direction			

SLICK	TIME UTG	OIL POSITION (CENTRE)		SLICK ORIENT Degrees	OIL SLICK LENGTH			OIL SLICK WIDTH			AREA km^2	AREA COVERAGE %	OILED AREA km^2
		LATITUDE NORTH	LATITUDE EAST/WEST		G/SPEED	TIME Seconds	DISTANCE km	G/SPEED	TIME Seconds	DISTANCE km			
A													
B													
C													
D													
E													

SLICK	OIL APPEARANCE Post Dispersant Application%				Log Photo Reference Number (and direction photo taken)	OIL APPEARANCE - Post Dispersant Application	
	1	2	3	4			
A						1	No obvious dispersion - Dispersant being washed off the black oil as white, watery solution leaving oil on surface. Quantity of oil on sea surface not altered by dispersant.
B						2	Slow or partial dispersion - Some surface activity (oil appearance altered). Spreading out of oil. Droplets of oil seen rapidly rising back to sea surface, but overall quantity appear to be similar to that before dispersant spraying.
C						3	Rapid dispersion - Oil rapidly disapearing from surface. Light brown plume of dispersed oil visible in water under the oil and drifting away from it. Oil in some areas being dispersed to leave only sheen on.
D						4	Other observations - Such as herding or lacing.

(Source Ref. 6)

Form 6 – OPS3: Oil in Water Assessment – Oil Sampling Form

Sample Sheet _____ of _____

OIL IN WATER SAMPLING FORM FOR OPS3					
Incident Name:			Ref No.		
Sampling Team					
Location Name					
Date (dd/mm/yyyy) / Time					
Tides, currents and weather					
Coordinates for physical water quality sample.					
Probe readings:		Bottom	Surface	Bottom	Surface
• Salinity					
• Temperature					
• Dissolved Oxygen					
• pH					
• Turbidity					
Site Number					
Site Coordinates					
Sample Depth					
Replicate/Triplicate Samples					
Container Type	Glass bottle				
	Glass Jar				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., evidence of hydrocarbons (e.g. odour, sheen)					
Photos Taken	Held By:				
Replicate A	Held By:				
Replicate B	Held By:				
Replicate C (if required)	Held By:				

(Based on the DoT Oil Sampling Form)

Form 7 – OPS4: Oil in Sediment Assessment Form

Sample Sheet _____ of _____

Sampling location sketch

Sample Sheet _____ of _____

OIL IN SEDIMENT SAMPLING FORM FOR OPS4					
Incident Name			**Ref No**		
Location Name					
Personnel Sampling					
Date / Time					
Weather conditions Wind speed/direction, sea state, cloud cover, rainfall					
Site Coordinates					
Site Number					
Container Type	**Glass jar**				
	Other				
Comments General observations, sampling method, variation on collection procedure etc., sediment characteristics (colour, odour, grain size)					
Photos taken	**Held By:**				
Replicate A	**Held By/Ref no.:**				
Replicate B	**Held By/Ref no.:**				
Replicate C	**Held By/Ref no.:**				

(Source: DoT Oil Sampling Form)

Form 8 – OPS5: Rapid (Oiled) Shoreline Assessment Form

Shoreline Assessment Form					
Incident					
Incident name:				Ref No.:	
Reporting Details					
Assessment team leader:			Position/Organisation:		
Team members (Name/Organisation):					
Date completed:			Time completed (24 hrs):		
Reporting to:			Position/Organisation:		
Date received:			Time received (24 hrs):		
Location Details					
Sector:			Segment:		
Name of beach or location:					
Description (e.g. slope):					
Topography/other map (No.):				Map reference:	
Access via:	☐ Foot	☐ Road	☐ 4WD	☐ Boat	☐ Helicopter
Hazards:					
Timing					
First assessment:	☐ Yes	☐ No	Last assessment:	☐ Yes	☐ No
Timing:	☐ Pre-Impact	☐ Post-Impact Before Clean-up		☐ Post-Impact After Clean-up	
Time since:	Impact (days/hrs):		Last clean-up (days/hrs):		

Assessment				
Parameter	**LITZ**	**MITZ**	**UITZ**	**Supratidal**
Shoreline Description				
Shoreline type*				
Substrate type				
Length of shoreline				
Width of shoreline				
Biological character				
Oil Distribution and Character				
Oil Band Length				
Oil band width				
% cover in oil band				
Surface oil thickness				
Oil appearance/character				

Shoreline Assessment Form				
Depth of buried oil (from surface)				
Buried oil bands (min-max m/cm)				
Description of buried oil				
Other				
Un-oiled debris				
Oiled debris				

Sketch Map (Include North point and a scale)

Notes:

Photo Numbers:

(Based on DoT Oiled Shoreline Assessment Form)

Form 9 – OPS6: Rapid Seabird and Shorebird Assessment

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General site description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife description:	(type/species present, abundance, behaviour)	
Oiled wildlife description:	(type/species present, abundance, behaviour)	

Photographs:	Looking along transect from start: ☐ Looking along transect from end: ☐ Note any additional photos taken at site (e.g. vegetation, fauna, access etc.):

Form 10 – OPS7: Aerial Survey Log Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Length:	(Approx. length of transect)	
Weather conditions:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description:	(include notes on exposure [wave energy etc.], drainage, gradient)	
Wildlife observations:	(type/species present, abundance, behaviour)	
Video and Photographic record:	Looking along transect from start: ☐ Looking along transect from end: ☐	

Form 11 – OPS7: Marine Vessel Survey Log Form

BLUE PLANET MARINE

Gorgon LNG Project
Marine Fauna Observations

Chevron

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page _____ of _____

Form 12 – OPS8: Fish Tainting Assessment Form

Site code:		
GPS coordinates:	Start:	End:
Personnel:		
Date:		
Time:		
Location description:		
Site condition of tainted fish:	e.g. wind speed/direction, sea state, cloud cover, rainfall	
General description of fish:		
Fish observations:	(type/species present, tainting observations/records)	
Other records:	Notes as necessary	

Appendix C Guidance Note and Standard Operating Procedures – Scientific Monitoring

Operational and Scientific Monitoring Plan

Guidance Note for Scientific Monitoring

Document ID:	**ABU151200658**
Revision ID:	**4.0**
Revision Date:	**25 May 2020**
Next Revision Due	**25 May 2025**
Information Sensitivity:	**Company Confidential**

Contents

Tables

Figures

1 Introduction

1.1 Purpose

This Operational and Scientific Monitoring Plan (OSMP): Scientific Monitoring Guidance Note (this Guidance Note) describes the implementation of scientific monitoring if an emergency event results in an oil spill to marine or coastal waters where Chevron Australia Pty. Ltd. (CAPL) is the Nominated Titleholder (Commonwealth) or Operator (State).

This Guidance Note focuses on scientific monitoring only, as set out in the Operational and Scientific Monitoring Plan (ABU130700448; Ref. 1).

The OSMP (Ref. 1) splits scientific monitoring into individual components (Figure 1-1). Each component represents a particular assessment or study, with initiation and termination triggers to determine if and when that monitoring component will be implemented.

Note: This Guidance Note is for scientific monitoring purposes, not operational monitoring.

1.2 Scope

This Guidance Note focuses on the implementation of scientific monitoring components only. Monitoring, Evaluation and Surveillance (MES) tactics for an oil spill are excluded as they are covered in the activity-specific Oil Pollution Emergency Plans (OPEPs). Similarly, the response option selection process (including Net Environmental Benefit Analysis [NEBA]) that may use the data collected under operational monitoring programs is part of the OPEP processes and not discussed in this Guidance Note.

This Guidance Note is part of the overall oil spill preparedness and response framework in place at CAPL, which is described in the Australian Business Unit (ABU) Oil Spill Response Manual (Ref. 2), and outlined in Figure 1-2.

Field sheets and checklists that supplement this Guidance Note are contained in the Appendices.

1.3 Objectives

The objectives of this Guidance Note are to:

- provide a framework for finalising program design for scientific monitoring so that it is appropriate to the nature and scale of the event
- describe standard operating procedures for required sampling, including providing standard field sheets and checklists
- describe potential sampling and analysis design for each component, taking into consideration existing baseline data and current monitoring techniques.

1.4 Target Audience

This Guidance Note is for environmental personnel implementing scientific monitoring scopes, including those fulfilling scientific monitoring roles within the Environment Unit (Figure 1-3) of the Emergency Management Team (EMT).

1.5 Limitations

Monitoring is to be implemented in a way that meets the objectives of the OSMP (Ref. 1), while retaining operational flexibility such that abnormal conditions, access to resources (including access to vessels and aircraft and/or events beyond CAPL's control) can be accommodated. The potential survey areas occur in a remote region, with limited logistical capability and can experience extreme weather events. The need for flexibility in monitoring design, effort, and rapid deployment (possibly using a vessel of opportunity), may dictate the nature and extent of the monitoring. There may be times where it is not possible to implement or complete one or more scientific monitoring programs (SCIs) as described in this document. If this occurs, CAPL ensures the objectives of this document are bet my taking measures to alter designs and/or reprioritise its monitoring programs.

This Guidance Note provides a framework for finalising program design so that it is appropriate to the nature and scale of the emergency event. It provides details for SCIs that must be implemented by CAPL. External environmental specialists, engaged to support SCIs, will provide additional guidance where required. Although this document is intended to provide guidance on most monitoring situations, additional monitoring may be required as determined by the Health, Environment, and Safety (HES) Supervisor and/or the EMT.

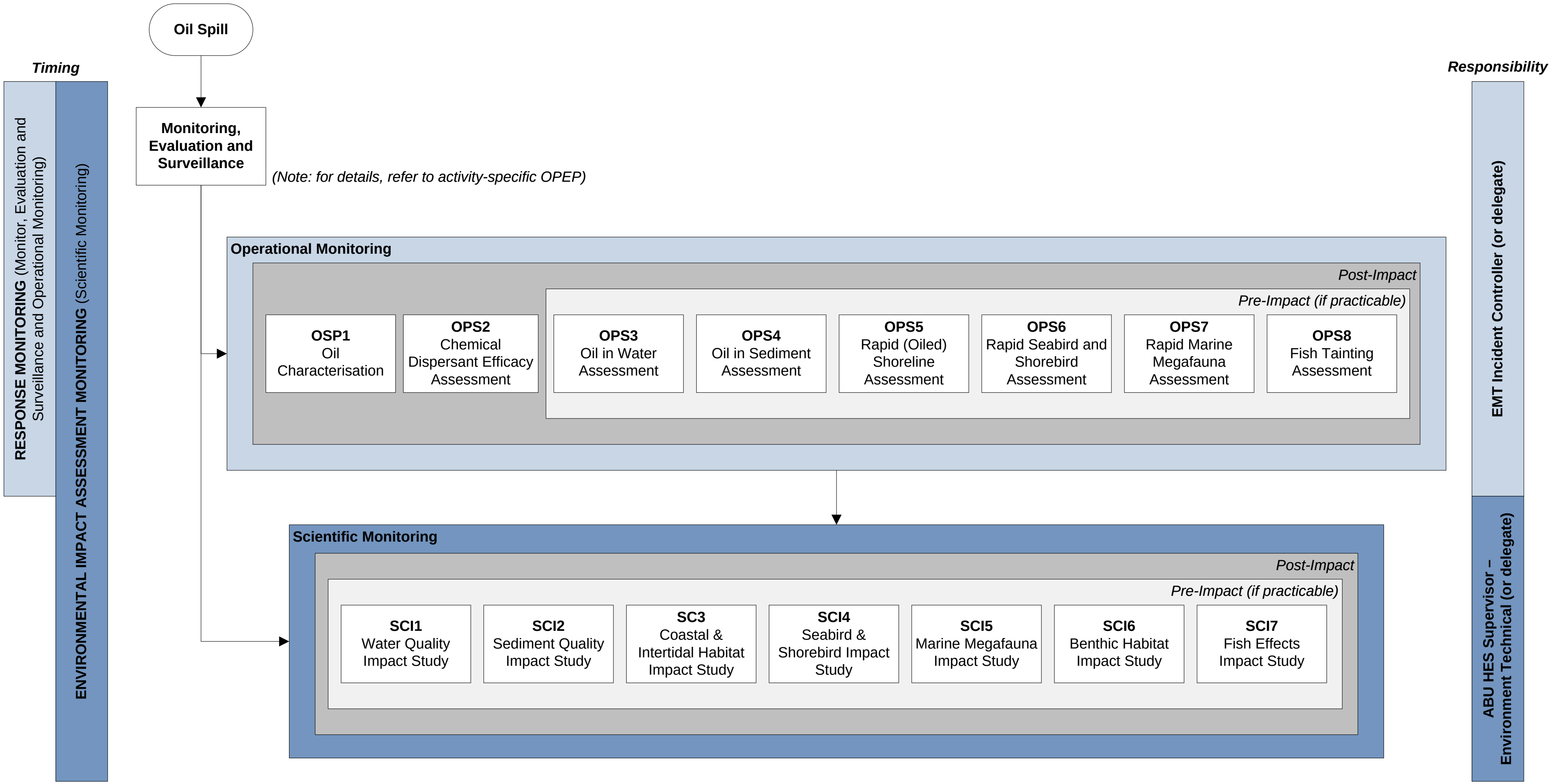


Figure 1-1: Monitoring in the Event of an Oil Spill to Marine or Coastal Waters

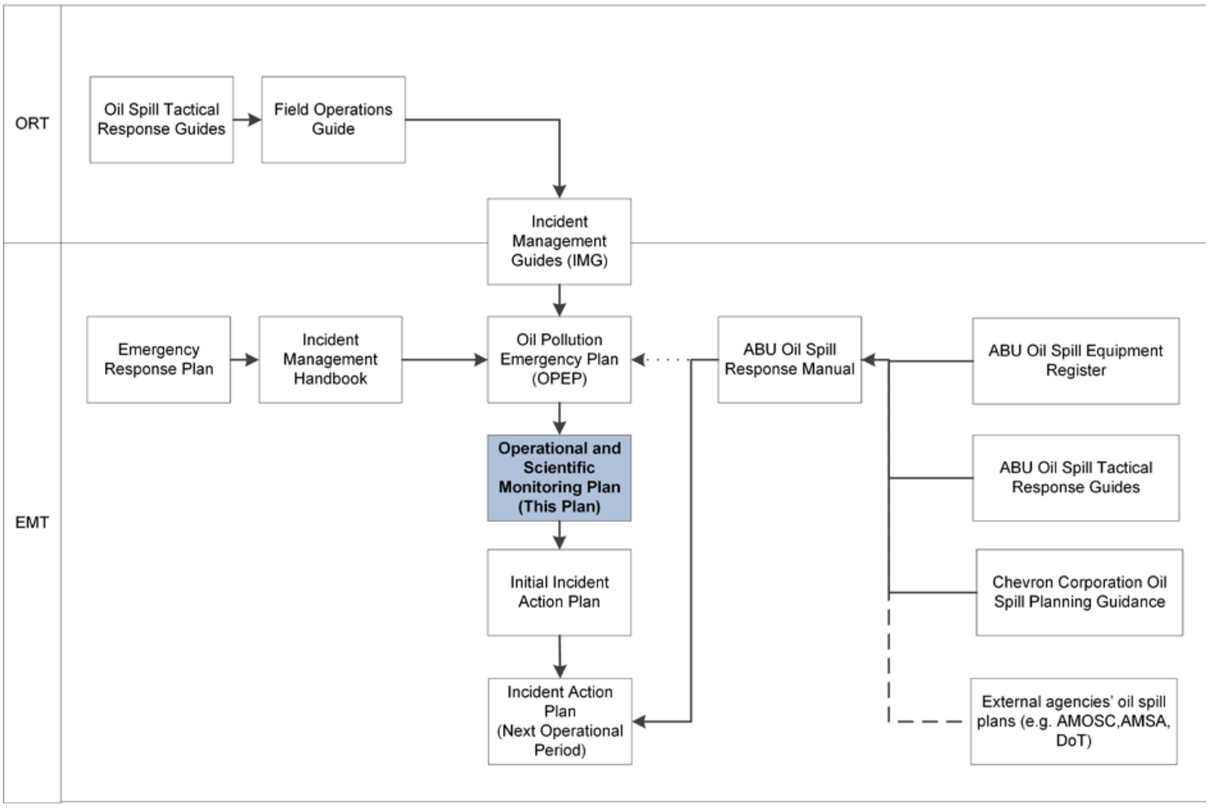


Figure 1-2: Relationship of Emergency Management and Oil Spill Documentation within CAPL

Note: Shaded cells refer to documents related to this Guidance Note.

1.6 Continual Improvement

CAPL is committed to conducting activities in an environmentally responsible manner and aims to implement best practice environmental management as part of a program of continuous improvement. This commitment to continuous improvement means that CAPL will review the OSMP (Ref. 1) every five years, or more often as required (e.g. in response to new information).

Reviews will address matters such as the overall design and effectiveness of the Plan, progress in environmental performance, changes in environmental risks, changes in business conditions and any relevant emerging environmental issues.

1.7 Acronyms and Abbreviations

Section 14.0 defines the acronyms and abbreviations used in this Guidance Note.

1.8 Roles and Responsibilities

The roles and responsibilities outlined in Figure 1-3 apply to all phases of the monitoring process. The HES Supervisor (or delegate) is responsible for ensuring the implementation of the scientific monitoring components; however, in the short term (during the event), the EMT will be closely consulted. Several specific monitoring roles (see shaded cells in Figure 1-3) will also be required.

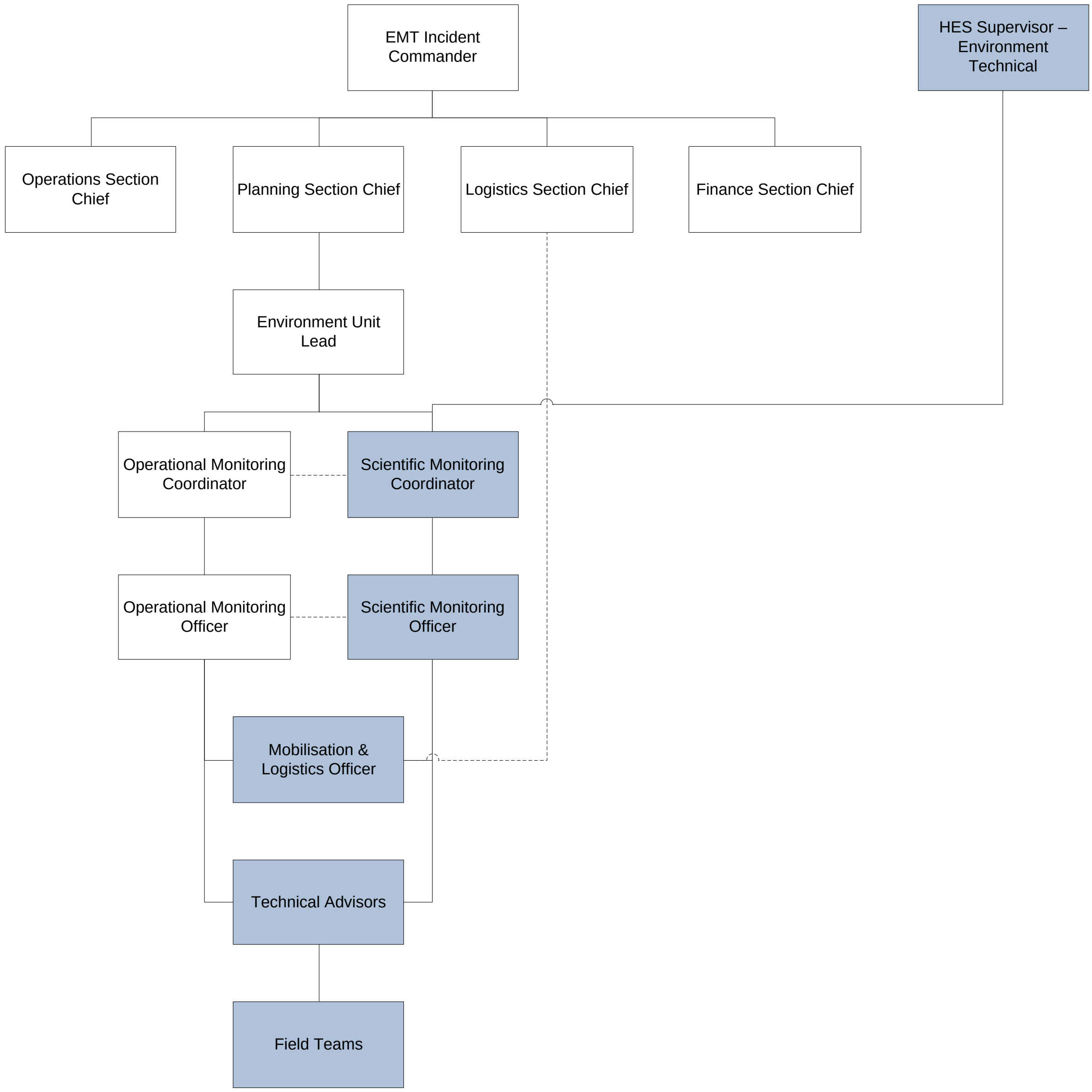


Figure 1-3: Roles Associated with Scientific Monitoring

Note: Shaded cells refer to roles related to this Guidance Note.

Table 1-1: Scientific Monitoring Roles, Responsibilities, and Rationale for using this Document

Role	Responsibilities	Reason for using this document
HES Supervisor – Environment Technical (or delegate)	Ultimately responsible for: • Ensuring that scientific monitoring is implemented in accordance with the OSMP (Ref. 1). • Setting the objectives for the scientific monitoring programs.	• Is aware of this document but does not directly implement each SCI • Refers the Scientific Monitoring Coordinator to this document for use
Environment Unit Lead	Key position for relaying information between the EMT and the Scientific Monitoring Coordinator.	• Ensures communication between Operational and Scientific Monitoring Coordinators for sharing of resources/data etc.
Scientific Monitoring Coordinator	Key program management role for the monitoring scopes. Responsibilities include: • Contact point with HES Supervisor and the EMT (through the Environment Unit Lead) • Ensuring relevant SCI components are implemented in line with the OSMP (Ref. 1) and this Guidance Note • Providing overarching technical advice • Financial tracking and management (in consultation with HES Supervisor – Environment Technical and EMT [through the Environment Unit Lead] as appropriate) • Logistics tracking (in consultation with Logistics Section in EMT as appropriate) • Engaging with required third-party contractors including consultants and laboratories.	• Communicating monitoring activities to the HES Supervisor – Environment Technical and Environment Unit Lead as appropriate • Ensuring initiation and termination criteria are met • Acquiring personnel to fulfil roles and ensuring responsibilities are met
*Scientific Monitoring Officer	Scientific Monitoring Officers are the technical leads for each monitoring type. Responsibilities include: • Understanding the data metrics that would be collected in the event of a spill • Advising the Scientific Monitoring Coordinator on data collection, logistical support required, and monitoring priorities if constraints (e.g. safety, time, or logistics) are encountered • Facilitating activation of contractors if necessary • Overseeing data analyses and interpretation • Managing data including spatial data • Presenting data in an appropriate and informative format to allow for timely decisions * The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability).	• Design of SCIs • Ensuring Standard Operating Procedures (SOPs) are appropriate for the spill scenario • Directing contractors on tasks required • Ensuring appropriate laboratory analyses are conducted

Role	Responsibilities	Reason for using this document
Mobilisation and Logistics Officer	Responsibilities include: • Ensuring field teams (CAPL personnel and/or contractors) are mobilised to site as soon as practicable, in accordance with CAPL processes and the initiation criteria outlined in this Guidance Note • Liaising with the EMT Logistics Section Chief (or delegate) during the response when planning mobilisation of operational and/or scientific monitoring field teams • Facilitating procurement of any necessary vessels or sampling equipment, if required.	• Understanding resources required (resource lists for each SCI) • Understanding requirements to mobilise people and equipment for monitoring tasks
*Technical Advisors	Technical Advisors will be assigned to monitoring scopes as required. Technical Advisors will have a thorough understanding of the receptors they are assigned. Key responsibilities include: • Overseeing and providing advice on collecting data • Advising the Operational and Scientific Monitoring Officers on data collection methods • Ensuring sampling and analysis plans (where required) are completed before mobilisation • Undertaking quality assurance/quality control (QA/QC) and interpreting data • Preparing reports. * The Scientific Monitoring Officer may undertake the responsibilities of Technical Advisor if appropriate (i.e. technical capability, availability etc.).	• Designing SCIs • Verifying SOPs • Ensuring QA/QC in data collection and reporting
Field Teams	A Field Team will include one Field Team Lead, who is the key contact point to the Technical Advisor during the survey . All Field Team members are responsible for: • Understanding the details of monitoring methods • Having adequate field data collection sheets and survey-specific equipment readily available • Ensuring awareness and understanding of QA/QC procedures • Assisting with report preparation if required • Implementing relevant HES protocols.	• SOPs for each OSMP • Resource lists

1.9 Mobilisation Times

1.9.1 Operational Areas

The operational areas of CAPL are shown in Figure 1-4; these areas represent the geographic scope of the OSMP (Ref. 1). Indicative mobilisation times for these areas is provided in Appendix A.

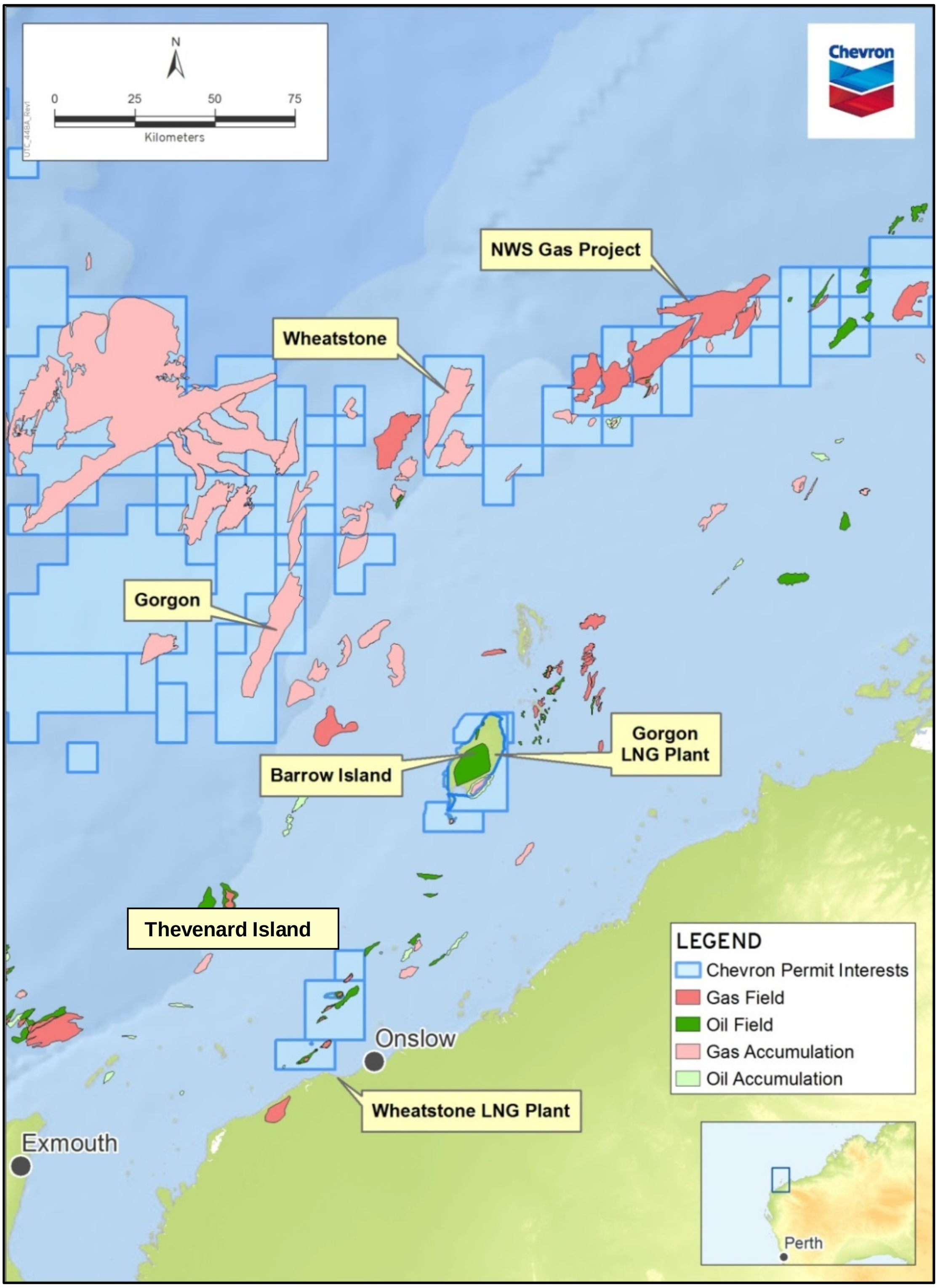


Figure 1-4: CAPL's Operational Areas

1.9.2 Non-operational Areas

For areas not under CAPL's operational control, access will be planned in conjunction with relevant statutory agencies (e.g. Western Australian [WA] Department of Transport [DoT]), other operators (e.g. Quadrant Energy for Varanus Island, Vermillion Oil and Gas Australia for the Montebello Islands), and the WA Department of Biodiversity, Conservation and Attractions (DBCA) for locations managed by the Marine Parks and Reserves Authority (MPRA).

1.9.3 Permits

Individual scientific monitoring plans have specific requirements for field sampling, with some plans requiring collection of biota. A sampling permit is required if biological samples are collected from the water column or seabed, or if an exemption requires using a specific type of sampling gear. Several permits or exemptions will be required from different government departments, depending upon where the sampling will be undertaken (based on the nature and scale of the hydrocarbon spill). Table 1-2 outlines the permits required and the issuing authority, and Table 1-3 outlines the likely permits required for each SCI. Note: This does not include any entry or research permit requirements from the WA Department of Aboriginal Affairs (http://www.daa.wa.gov.au/en/Entry-Permits/EP_Y_PermitForm/).

Table 1-2: Permits Potentially Required to Support Scientific Monitoring Plans

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
Commonwealth Department of the Agriculture, Water and the Environment (DAWE)	Application for a permit to access biological resources in Commonwealth Marine Protected Areas (MPAs) for non-commercial research	Conducting scientific research in a Commonwealth MPA, including filming and photography	
	The requirement to have a permit for access to biological resources or to kill, take, keep, or injure a listed threatened, migratory or marine species in a Commonwealth area is exempt for actions undertaken to manage or respond to a maritime environmental emergency (such as an oil spill), in accordance with the National Plan for Maritime Environmental Emergencies (Ref. 3)	Collecting any biological specimens from Listed species	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) – Part 13 Commonwealth EPBC Regulations 2000 – Part 8a http://www.environment.gov.au/epbc/notices/pubs/140306-section-303a-exemption.pdf.
Commonwealth Department of Conservation, Biodiversity and Attractions (DBCA)	Application for a licence to take (i.e. capture, collect, disturb, study) fauna for scientific purposes in State Waters out to three nautical miles (nm).	Conducting scientific research (including filming and photography) in a State MPA in State Waters out to three nm	*Biodiversity Conservation Act 2016*(WA) and Regulations – Regulation 25

Government Approval / Permit Issuing Authority	Permit Reference	Permit Required for	Legislative Requirement
WA Department of Fisheries (DoF)	Application for exemption	Collecting virtually all marine biota (flora and fauna), whether alive or dead, anywhere in marine waters out to 200 nm. Excludes aquatic mammals, aquatic reptiles, aquatic birds, amphibians, or (except in relation to Part 3 and Division 1 of Part 11) pearl oysters. Exemption for any non-standard equipment	Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* (WA) and Regulations

Table 1-3: SCIs Requiring Engagement with Government Approval / Permit Issuing Authorities to Determine Permit Requirements for Response and Post-response Phase Monitoring (excluding permits required to access Indigenous lands)

Permit	SCI1	SCI2	SCI3	SCI4	SCI5	SCI6	SCI7
DAWE (formally DotEE – 8A and 13 permit)	Exemption for maritime environmental emergencies						
DAWE (formally DotEE – MPA permit)	X	X	X	X	X	X	X
DBCA (within 3 nm)			X	X	X	X	X
DoF permit			X			X	X

** Note: Infauna sampling will be conducted as part of SCI6 and not SCI2.*

1.10 Safety and Health

Safety and health are paramount in any oil spill response. CAPL has a strong safety culture that is part of daily operations. All the usual safety practices that CAPL personnel follow in their regular activities still apply during a spill response. In addition, special safety measures will be implemented to protect personnel from the risks associated with oil spill response activities.

The potential risks and hazards associated with scientific monitoring are listed in Table 1-4. Note: Each survey will have unique hazards associated with its monitoring activities. The hazards listed in Table 1-4 are not exhaustive.

This information may be used to develop a Job Safety Analysis before undertaking scientific monitoring activities.

Table 1-4: Potential Hazards Associated with Scientific Monitoring Activities

Hazards	Impacts	Mitigation Measures
General		
Chemical Exposure to dispersant chemicals	• Eye irritant • Inhalation and ingestion hazard	• Exclude non-essential personnel from spray areas

Hazards	Impacts	Mitigation Measures
		• Supply appropriate clothing and personal protective equipment (PPE) for essential personnel • Conduct vessel spraying from upwind • Establish buffer zones (0.5 nm for vessel application, 1 nm for aerial)
Sound Noise (85–90 dB(A))	• Hearing damage from prolonged exposure to loud machinery	• Supply hearing protection • Limit exposure
Motion Manual handling (including during use of monitoring equipment)	• Back strains or injuries	• Attend manual handling training • Clearly mark weights on labels • Use lift-assist equipment and procedures
Gravity Slips, trips, and falls	• Injuries (cuts, bruises, fractures)	• Highlight risks during safety briefings • Wear appropriate footwear • Provide non-slip surfaces
Chemical Exposure to toxic components of oil (i.e. VOCs, H_2S)	• Health impacts: nausea, vomiting, fatalities in extreme cases • Explosive risk	• Monitor air emissions • Restrict site entry • Supply respiratory protection and PPE
Biological Exposure to Irukandji (jellyfish) or other dangerous marine fauna	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4). • Wear appropriate clothing and PPE
Motion Acute motion sickness	• Dehydration • Inability to undertake assigned duties	• Use premedication as needed
Aerial Operations		
Motion Injury from aircraft on taxiing or starting engines	• Impact injuries • Possible fatalities	• Follow flight crew safety instructions and pre-flight briefings • Use designated walking corridors on airfield
Gravity Emergency ditching of aircraft	• Injuries • Possible fatalities	• Attend HUET and/or Basic Offshore Safety Induction and Emergency Training (BOSIET) training (all aerial observers) • Supply PPE: aviation lifejackets, survival suits, etc.
Motion Collision with other aircraft	• Impact injuries • Possible fatalities	• Follow the communications plan • Follow the flight crew briefing regarding simultaneous operations
Vessel Operations		
Motion Unsecured loads on deck	• Potential crush injuries • Possible fatalities	• Properly secure all equipment to deck
Gravity/motion Person overboard	• Hypothermia • Drowning	• Use personal flotation devices (PFDs) on deck

Hazards	Impacts	Mitigation Measures
		• Use rails and restraints
Motion Vessel collision or grounding	• Hypothermia • Drowning • Impact injuries	• Attend vessel crew training • Use navigational safety equipment
Motion Person struck by vessel/propeller during transfer (vessel to vessel or vessel to shore)	• Hypothermia • Drowning • Impact injuries	• Follow transfer procedures • Follow Vessel Master's instructions • Be aware of sea state and conditions
Temperature Fire on board vessel	• Burns or injuries • Possible fatalities	• Comply with alarm systems • Provide firefighting equipment on board • Follow emergency fire procedures
Temperature Exposure to elements (hot/cold)	• Fatigue or confusion • Loss of consciousness • Heatstroke • Hypothermia • Possible fatalities	• Take regular work breaks to cool down or warm up • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Mechanical Propeller entanglement during deployment of survey equipment	• Loss of navigation, stranding, grounding	• Stop vessel engines or place them in neutral during deployment • Follow on-board communications
Shore Operations		
Biological Contact with Irukandji or other dangerous marine fauna (stonefish, octopus, sharks, echinoderms	• Health impacts: Sever pain, nausea, vomiting, fatalities in extreme cases	• Follow Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) • Wear appropriate clothing and PPE • Wear over-ankle hard-soled reef boots
Gravity Slips, trips, and falls, uneven ground, oiled surfaces, low visibility while wading	• Injuries (cuts, bruises, fractures)	• Wear appropriate clothing and PPE • Use PFDs if working near deep water (e.g. cliffs) • Wear over-ankle hard-soled reef boots
Temperature Exposed shorelines away from amenities Physical exertion	• Fatigue or confusion • Loss of consciousness • Hypothermia	• Take regular work breaks • Wear appropriate clothing and PPE • Hydrate • Wear sun protection/shades
Motion Person caught in rip, tide, or mudflats	• Hypothermia • Drowning • Heatstroke	• Be aware of sea state and conditions • Use PFDs

1.10.1 Personal Protective Equipment

The work described in this Guidance Note must comply with the minimum PPE requirements, as defined in ABU – Personalised Protective Equipment (PPE) Standard (OE-03.06.112; Ref. 5). For guidelines on PPE for working in the marine environment, refer to the Marine Stinger Protective Clothing Best Practice

Guidelines (Ref. 4). For scientific monitoring activities, conduct a risk assessment to determine the PPE required and consider these items as safeguards:

- wide-brimmed hat (safety hard hat when operating a crane on marine vessels)
- safety sunglasses
- PFD jackets (when working on a marine vessel)
- stinger suit (0.5 mm thickness or greater), worn under overalls or high-visibility clothing
- over-ankle reef booties (not dive booties; should have grip-on sole)
- protective gloves suitable for entering water during intertidal work, e.g. long lycra gloves, latex gloves, dishwashing gloves, or a combination of these (without causing cross-contamination of samples)
- duct-tape PPE to wrists and ankles when in contact with sea water.

1.10.2 Washdown for Marine Stinger Safety

Following potential exposure to marine stingers, particularly Irukandjis and the sea water where they live, wash down clothing and equipment before disrobing. Vinegar washdown provides the greatest measure of protection (see Marine Stinger Protective Clothing Best Practice Guidelines (Ref. 4) for the vinegar washdown procedure). Fresh water may be used; however, particular care must be taken to not expose skin to potentially contaminated surfaces until they have been treated with fresh water for at least ten minutes.

2 Scientific Monitoring

2.1 Experimental Monitoring Design

It is important that monitoring design and statistical approach are developed concurrently and given adequate consideration to ensure that the data collected can be readily analysed, and where practicable given constraints, achieve appropriate power to detect an important level of impact and meet the Plan objectives. This Section provides guidance on appropriate survey design approaches that may be used within each SCI. Although this Section provides a generalised approach to survey design and statistical methods, each SCI further details which of these approaches applies under different situations to meet the specific Plan objectives, and the level of sampling required associated with the approach.

This Section outlines five general survey approaches likely to apply to each SCI Monitoring Plan:

- Before-After-Control-Impact (BACI)
- Impact versus Control (IvC)
- Gradient of Impacts
- Lines of Evidence
- Control Chart.

The survey design(s) chosen depends on these criteria:

- scale and pattern of potential effects of the spill
- availability of baseline data and/or ability to rapidly obtain baseline data
- time frame available to gather pre- and post-spill data
- availability of Operational Monitoring Program (OPS) data
- availability of appropriate reference sites
- statistical approach proposed for data analysis
- range of possible chronic and acute effects on the parameters of concern, based on the characteristics of the spill
- monitoring frequency required to ensure short-and long-term impacts are detected
- legislative requirements
- available resources and equipment to conduct the work in terms of personnel, logistics, and access

Note: Data collection depends on several constraints (as outlined above), including but not limited to, the type and location of hydrocarbon spill, and site locations and access given logistical and safety constraints. As such, the design that was conceived before implementation of each SCI may not be implemented exactly as intended in situ. For example, there may be inadequate number of control locations because of the size of the spill. Therefore, data collected as part of SCIs may need to be analysed using alternative designs (e.g. data from an expected BACI design may need to be analysed as a Gradient Approach).

2.1.1 BACI Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are available or able to be collected post-spill but pre-impact
- where reference data are also available pre- and post-impact
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map the impact, or examine gradients of effect).

The optimal approach for assessing and inferring whether an effect has caused an impact in a study is generally considered to be a BACI design (Ref. 6). This design involves taking measurements for parameters of interest at one or more potentially impacted sites and one or more control (reference) sites, both before and after an event occurs that could potentially cause an impact (Figure 2-1). The BACI Approach provides a robust and powerful method for detecting a significant change in the parameters of interest and for inferring the cause of that change (i.e. natural factors versus unplanned hydrocarbon spill). If the change that is observed from before to after the event at impact sites is statistically greater than the before-after change observed at control (reference) sites, then the inference is that an impact from the stressor (such as hydrocarbons) has occurred. This design is most applicable when strong evidence exists that the indicator is likely to be impacted by hydrocarbons (either directly or indirectly), and this potential impact can be examined in the context of natural variation by examining natural changes at comparable reference sites.

The simplest BACI design assumes no temporal trends occur in the measured parameters across sample dates in the period before or after the impact. Although the simplest BACI design involves taking measurements at two times (before and after) and two treatments (control and impact), modifications to this design can help improve the ability to detect and infer the cause of change, if data and/or time permit. These modifications include taking samples at multiple times before and after impact in a Multiple Before-After-Control-Impact approach (MBACI; Ref. 7; see also Beyond BACI) (Figure 2-2). This approach will help examine different temporal scales of impact (acute versus chronic impact) and responses (acute versus chronic effect), and help differentiate the potential effects of hydrocarbons from natural fluctuations in the measured parameter through time.

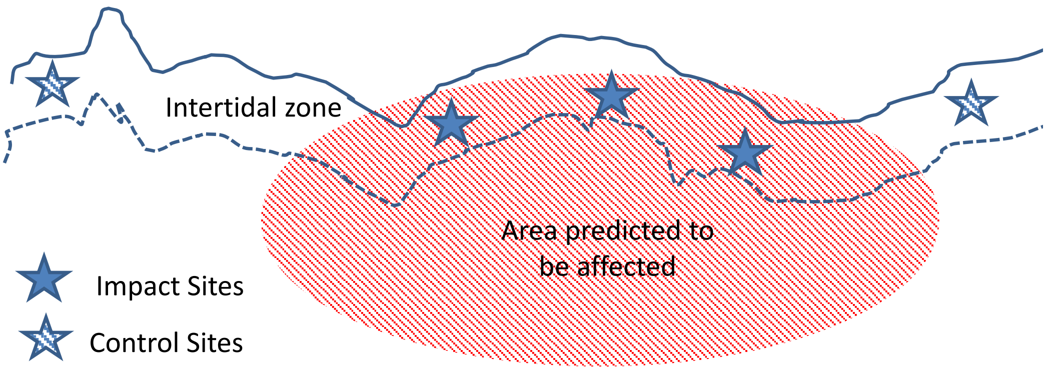
The constraints of the BACI or MBACI Approach are the availability of appropriate control (reference) areas and data collected before impact (baseline data). If an unplanned release affects a wide area, or if a unique or spatially discrete ecosystem or species is the focus of potential impacts, finding suitable controls that are comparable to impact locations may not be achievable. Likewise, the impact area may cover a region or receptor where baseline data do not exist and cannot be readily obtained post-spill, before the impact occurs. In each of these examples, it may be more appropriate to use a Gradient (see Section 2.1.3) or IvC approach (see Section 2.1.2).

If baseline data are available through monitoring programs for other Chevron projects or third-party organisations (e.g. Commonwealth Scientific and Industrial

Research Organisation [CSIRO], DBCA), then the methods used in those baseline data investigations should be repeated (if possible and practicable). Improved methods may be used that result in finer-scale data, the outputs of which can always be scaled back to compare to previously collected data. If suitable pre-existing baseline data are not available, and sufficient time is available, field sampling should be prioritised to allow post-spill/pre-impact baseline data to be collected for regions and sensitive receptors where impacts are likely to occur, to enable a subsequent BACI assessment.

Within each sampling location, sites should be replicated, and, with each site replicate, samples (e.g. transects or quadrats) should be taken into account for different spatial variation scales that may affect the outcome of the assessment. This is called a nested (or hierarchical) sampling design, where successively smaller spatial scales are nested within the scale above (similarly for temporal collections if practicable, noting the time scales of natural change within individual SCIs). Stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

Before Impact



After Impact

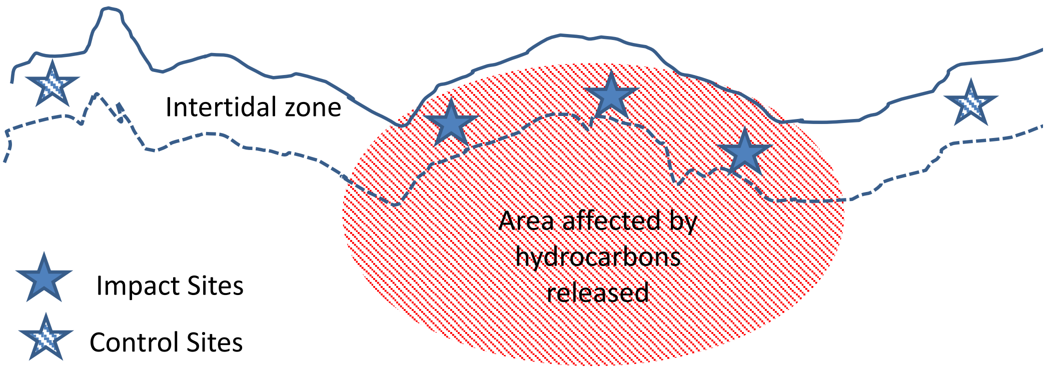


Figure 2-1: Generalised BACI Design

Note: The number of sites is for example only and is discussed in further detail in each SCI plan where this approach is likely to be used.

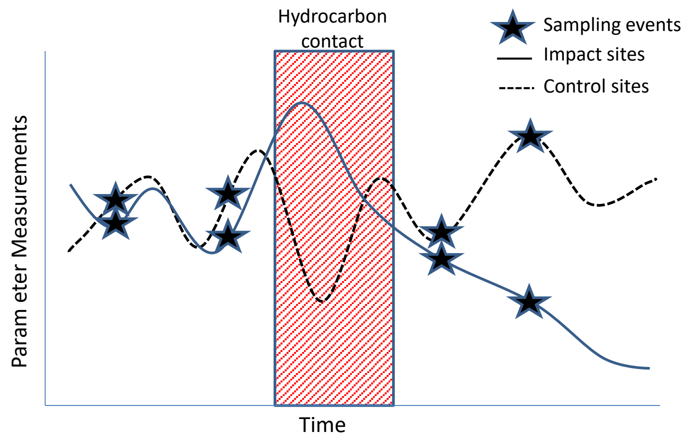


Figure 2-2: Generalised MBACI Design

Note: The number of sampling periods is for illustration only; designs would benefit from as many sampling periods as logistically feasible.

2.1.1.1 Statistical Approach

Multi-factorial analysis of variance (ANOVA)—including permutational multivariate analysis of variance (PERMANOVA) and similar non-parametric tests—that test for an interaction between treatment (impact versus reference [IvR]) and time (before versus after) can be used to test data. Components of variation may help partition a sum of squares into different sources, and describe the importance of factors within tests.

2.1.2 Impact versus Control Approach

SCI applications:

- where the physical location of the parameter to be measured, or the predicted impacts to the parameter of concern occurs in discrete locations (e.g. segments of shoreline habitat, islands) that allow for unimpacted sites (control locations)
- where baseline data are unavailable and where such data cannot be collected post-spill/pre-impact
- where suitable control (reference) locations are available
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations (not where the objective is to map impacts, or examine the gradients of effect).

For some locations and sensitive receptors it is likely that baseline data does not exist, is not recent and applicable, or was collected using methods that are unrepeatable in the current study. If there is a lack of baseline information that can feed into a BACI design, a simpler IvC approach can be used to assess impacts. However, due to the unknown status of the parameter before impact, there is a higher likelihood of encountering Type I error (falsely concluding that an impact has occurred) with this approach. For example, if the status of the parameter to be measured was already naturally lower at impact sites than reference sites before the impact occurred, but this was not measured, a conclusion may be reached using the IvC approach that an impact has occurred when it may be natural variation. For this reason, sampling designs should always try to collect or use baseline data (i.e. aim for a BACI design), and if an IvC design is used, it is important to ensure that the reference sites are comparable to the impact sites in every way possible except for the presence or absence of the studied effect (hydrocarbon). This may include, but not be limited to: site physical aspect, substrate (where applicable), current regimes, and community composition.

Because of the higher likelihood of Type I error, it is also useful to collect additional data on relevant physical environmental parameters that are likely to be different at impact and reference sites and may affect the conclusion of the assessment (e.g. physical aspect, sediment type). This is similar to collecting data for Lines of Evidence Approach (Section 2.1.4). These parameters can be examined later for any potential co-variance with the observed changes in the parameter of interest, to understand whether hydrocarbons or natural variation affected the outcome. As with the BACI Approach, when using the IvC Approach it is important to understand the scale of natural variation that may affect the outcome of the assessment by replicating sites within sampling locations, and replicating samples within each site. In addition, stratification of sites, or replicates within sites, may be required where obvious environmental gradients occur (e.g. within different areas of zonation within the intertidal zone).

2.1.2.1 Statistical Approach

Multi-factorial ANOVA (to account for nested data), including PERMANOVA and similar non-parametric tests, test whether the level of variation among treatments (IvC) is greater than the level of variation within treatments. Components of variation may help partition variance into different sources and help infer whether the effect of hydrocarbons or spatial variation was responsible for any detected change.

2.1.3 Gradient Approach

SCI applications:

- where the objective is to quantify the spatial extent of environmental effects; or
- where the objective is to provide data (e.g. water quality, sediment quality) to infer or correlate with changes in other parameters (e.g. infauna abundance); or
- where the objective is to determine whether a significant impact has occurred in a given location or set of locations, but where baseline data are unavailable and suitable reference locations are unavailable.

The Gradient Approach relies on sampling at a set of sites at increasing distance from the source of hydrocarbon impact, or a set of sites that have had different levels of exposure to the hydrocarbon spill. This method is most commonly used in investigations of point source pollution where concentrations of pollutants typically decline with distance from the source, and the level of observed impact also declines. The overall objective of the Gradient Approach is to assess if there is a relationship between distance from source or level of exposure to an impact, and level of detected impact. Such a relationship would imply the presence of an impact, and provide data on the severity, nature, and physical extent of that impact. If thresholds of change are known for receptors (i.e. physiological response of flora/fauna above which mortality occurs), then the scale or severity of an impact may be gauged in the absence BACI or IvC designs. The Gradient Approach also provides a ‘Line of Evidence’ (Section 2.1.4) that the source of potential impact (hydrocarbons) was responsible for the observed effect, rather than natural variation. However, care should be taken to ensure awareness of any natural gradients in the parameter measured and ensure that these do not confound interpretations.

The Gradient Approach can also be used in some instances where a lack of suitable reference sites prohibits using a BACI or IvC Approach. Similar to the description above, sampling should be established along a gradient of predicted effect (based on input of data from OPS or modelling), with sites established at various distances from the source of impact or along a gradient of magnitudes of concentrations of hydrocarbons (if known from OPS or SCI data). The Gradient Approach can also be used in combination with a BACI or IvC Approach to help infer the cause of a detected impact, and describe thresholds of impacts at which a response appears to have occurred.

When designing a study using a Gradient Approach, it is important to include any prior knowledge of the likely direction of any gradient of effect (e.g. is there likely to be an initial gradient of effect mainly in one direction from the release, due to prevailing currents, or 360° from the source as hydrocarbons spread?), as well as the likely magnitude of change with distance (are all observed effects within hundreds of metres of the release or do they extend over greater distances?). Relevant OPS data, SCI data (e.g. water and sediment quality), and modelling should be considered in the design. Prior knowledge or prediction of the likely gradient of effect will greatly improve the efficiency of the sampling design by minimising the collection of data points that provide no additional information in the analysis (e.g. data points showing similar or no effects that do not help to characterise the gradient of effect), though noting these may aid in statistical power of gradient description.

Typically, the level of observed impact will decline exponentially from the source of a hydrocarbon release; therefore, sampling effort can be distributed along the gradient of effect in a way that best characterises the changes in the parameter measured (see Figure 2-3). Generally, sites would be sampled close together (e.g. every few hundred metres) near the source where changes in observed effect are greatest, and would be spaced further apart at the outer limits of the affected areas (e.g. kilometres or tens of kilometres apart) (Figure 2-3). However, the gradient of environmental effects may not always be this simple—the components of the spill and elapsed time since the spill may alter this gradient. For example, hydrocarbons on the surface are likely to accumulate on shorelines, where they may have their greatest environmental effects, rather than having an exponential gradient of environmental effects with distance from the release point. These factors should be considered in each SCI Plan.

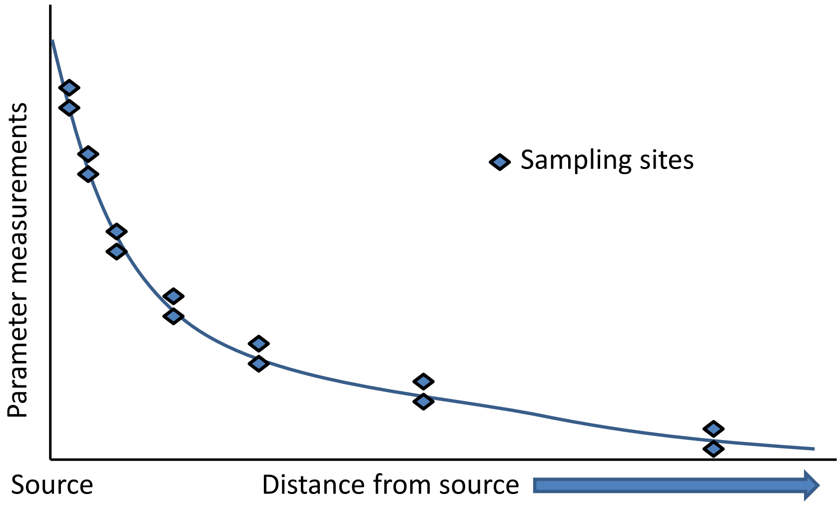


Figure 2-3: Decay in Level of Effect with Distance from Effect Source and Matching Gradient Approach Designed to Characterise the Extent of Environmental Effect

It is also useful (though not essential) to obtain replicate samples within each distance from the source to characterise natural variation and help separate this from potential effects of the release (as was the case for BACI and IvC Approaches). It is recommended that at least two sites are sampled at each distance along the gradient (if logistics and time permit) to provide an understanding of natural spatial variation. Sites should also be sampled at distances at which no environmental effect is predicted or observed, if possible, to characterise the full extent of the effects gradient (Figure 2-4 and Figure 2-5).

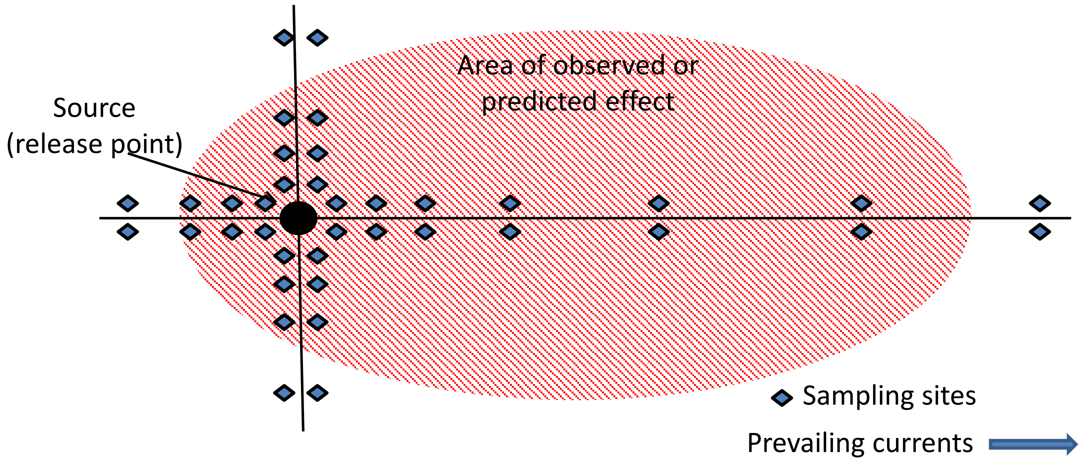


Figure 2-4: Generalised Gradient Approach where the Measured Parameter/Receptor Occurs at all Distances from the Source

Note: The number of sampling points is for illustration only.

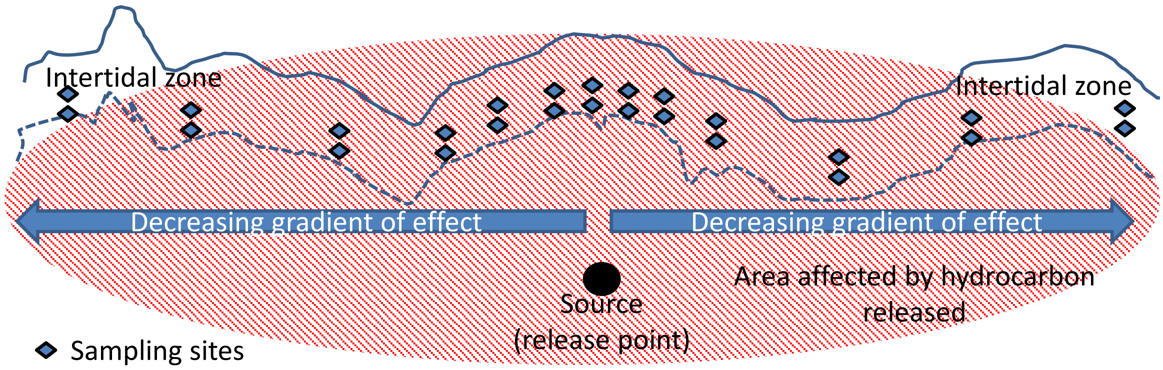


Figure 2-5: Generalised Gradient Approach for Shoreline Habitat where Lack of Baseline or Reference Sites Do Not Permit an BACI or IvR Approach

Note: The number of sampling points is for illustration only.

2.1.3.1 Statistical Approach

Correlation analysis between impact (measurements of hydrocarbon/stress; x-axis) and measurement parameter (biological and non-biological response; y-axis), and associated regression analyses, may include least-squares regression line and hypotheses testing to determine if the trend is significantly different from zero.

Descriptive approach (e.g. illustration) of changes in parameter measured with distance from source to define the spatial extent of impact.

2.1.4 Lines of Evidence Approach

SCI applications:

- can be combined with any of the above designs to provide inferential evidence of an effect
- are useful to support evidence of effect if there are limited (or only one) impact locations
- are useful to support evidence of effect if the effect radiates outward from source
- are useful to infer cause of change if limited or no baseline data exist
- are useful to infer cause of change if limited or no reference sites exist.

Although an optimal sampling design for impact assessment includes BACI or MBACI approaches (Section 2.1.1; Ref. 6; Ref. 7), unfortunately, sampling designs to assess impacts from an unplanned release of hydrocarbons are likely to be suboptimal. This may be due to limited or outdated baseline data, only one rather than multiple impact locations, and a lack of reference sites that are environmentally and ecologically comparable to the impact location(s). When a sampling design is suboptimal, the Lines of Evidence Approach can be used to help infer the cause of an observed change (i.e. attribute change to the hydrocarbon release or to other causes such as natural variation). Within the Lines of Evidence Approach, inference is developed based on carefully structured arguments. A weakness of this method is that the evidence may be largely circumstantial because it is based on correlations (Ref. 8), which does not necessarily imply causation. Each causal argument may be weak independently, but combined they may provide strong circumstantial evidence and support for a conclusion (Ref. 8).

This approach was originally developed in medicine (Ref. 9), but it has been used in more recent ecological studies (Ref. 10; Ref. 11; Ref. 12; Ref. 8; Ref. 13). Hill (Ref. 9) categorised different types of causal argument into nine criteria for studies into the effects of diseases on humans. Table 2-1 lists each causal criterion and how it relates to ecological impact assessment (adapted from Hill [Ref. 9]). With Lines of Evidence, there is a need to seek evidence not only to support the impact prediction, but evidence to rule out plausible alternative predictions, such as that the observed difference was due to natural processes (Ref. 12; Ref. 8).

Table 2-1: Hill's (Ref. 9) Causal Criteria and Description in the Context of Ecological Impact Assessment

Causal Criterion	Description
Strength of association	A large proportion of individuals are effected in the exposed area relative to reference areas
Consistency of association	The association was observed by other investigators at other times and places
Specificity of association	The effect is diagnostic of exposure
Temporality	Exposure must precede the effect in time
Biological gradient	The risk of effect is a function of magnitude of exposure
Biological plausibility	A plausible mechanism of action links cause and effect
Experimental evidence	A valid experiment provides strong evidence of causation
Coherence	Similar stressors cause similar effects
Analogy	The causal hypothesis does not conflict with existing knowledge of natural history and biology

In the Lines of Evidence Approach, a set of descriptions should be developed for all or some of the causal criteria listed in Table 2-1 before the survey is undertaken (see Ref. 8 for further criteria and examples). Data would then be collected that allows each Line of Evidence to be tested or objectively questioned. The final assessment of whether an impact is likely to have occurred will be based on the 'weight of evidence' from examining multiple Lines of Evidence. Example generalised Lines of Evidence descriptions are provided in Table 2-2. These would be modified and tailored to each SCI Plan and each parameter investigated.

Table 2-2: Causal Criteria and Example Lines of Evidence Descriptions that could be used to Assess whether a Change in a Measured Parameter was due to the Effects of a Hydrocarbon Release

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Strength of association	Larger decline in individuals in areas affected by hydrocarbon than in reference areas	Similar declines in individuals in areas affected by hydrocarbon and reference areas
Consistency of association	Consistent finding of declines in a range of biota in areas affected by hydrocarbon	Inconsistent declines in biota in areas affected by hydrocarbon (e.g. declines in one species but not in other similar species)

Causal Criterion	Evidence Supportive of a Hydrocarbon Release Impact	Evidence Unsupportive of a Hydrocarbon Release Impact
Specificity of association	Number of individuals affected correlates with hydrocarbon concentrations	No correlation between number of individuals affected and hydrocarbon concentration
Temporality	Decline in individuals immediately preceded by contact with hydrocarbon	Decline in individuals occurred before or long after hydrocarbon contact
Biological gradient	Changes in individuals aligned with exposure to hydrocarbon spills or concentrations	Decline in individuals occurs with increasing distance from a hydrocarbon spill or hydrocarbon concentrations
Biological plausibility	Evidence from literature of sensitivity to detected hydrocarbon concentration for species where declines are observed	Evidence from literature suggests lack of sensitivity to detected hydrocarbon concentration for species where declines are observed
Experimental evidence	A valid experiment provides strong evidence of causation	Not applicable (N/A)
Coherence	Evidence of a decline in species abundance, habitat, and food source with increasing hydrocarbon exposure	Evidence of a decline in species abundance, but no other evidence of expected declines associated with exposure
Analogy	Apparent declines in hatchling numbers despite no apparent decline in numbers of adults	Apparent declines in hatchling numbers associated with decreased numbers of adults

2.1.5 Control Chart Approach

SCI applications:

- when long-term (multi-year) datasets exist for the measured parameter
- when a large amount of natural variation exists in the measured parameter
- when predicting the expected range of outcomes from an impact.

One of the causal criteria described in the Lines of Evidence Approach (Section 2.1.4) is ‘Strength of Association’ (Ref. 9), exemplified by a ‘Larger decline in individuals in areas affected by hydrocarbon than in reference areas’. The Control Chart Approach takes this causal criterion a step further and uses rules to establish whether a detected change in a parameter at impact sites is outside what would be expected to occur naturally. This technique requires tracking a parameter over time and determining whether an observed change is within the bounds of what has been observed to occur naturally at that impact site or at control sites.

A control chart has a central line for the mean, an upper control limit (e.g. 3 standard deviations [SD] above the mean), and a lower control limit (e.g. 3 SD below the mean), which are all determined from historical data (Figure 2-6). This can include data from an impact site compared to its own historical data, or data from an impact site compared to the historical data from impact and/or reference locations. By comparing measurements at a given point in time to these lines, broad inferences can be drawn about whether an observed change was consistent with previous observations (in control) or not (out of control). Any inconsistent data are investigated to determine the cause of the change.

In addition, if ongoing data collection is possible following a potential impact, the Control Chart Approach is also used to examine the direction of change and whether this is consistent or inconsistent with historical data. The number of data points above or below the centreline (mean) can be tracked and used to provide a weight of evidence of a directional change in a given parameter.

The Control Chart Approach is only useful if there is an adequate historical knowledge of natural variability in a given parameter. However, if this information exists (e.g. data from the Long-term Marine Turtle Monitoring Program [Ref. 14]), the Control Chart Approach can be a powerful tool for detecting impacts for systems that are naturally highly variable.

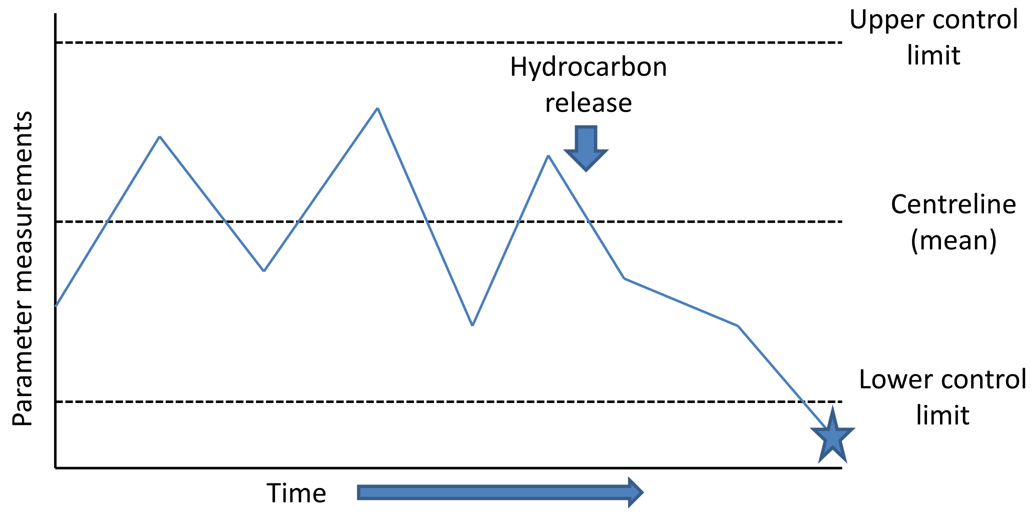


Figure 2-6: Example Control Chart showing Centreline (mean), Upper Control Limit (3 SD above mean), Lower Control Limit (3 SD below mean), and Measurements

Note: The star represents an 'out of control' measurement that needs to be investigated.

2.1.5.1 Statistical Approach

The statistical approach for Control Charts is:

- calculate the historical mean for the centreline
- calculate the upper and lower control limits from historical data, e.g. two or three SD above and below the mean (Ref. 15)
- calculate the mean (ongoing) for an impact site to compare against the control chart.

2.1.6 Effect Size and Power

Power is measured in terms of the probability of detecting an impact of a certain effect size, if an impact has actually occurred. Effect size is the magnitude of difference in a measured variable between impact and control samples, taking into account natural variation. It is important to know the power of a sampling design before commencing a study to ensure that there is a likelihood of detecting a biologically or ecologically important effect size. A study that has insufficient power can be a waste of time and effort, if statistical testing is to be used to infer impacts, as important impacts may not be detected statistically and the objectives of the study to determine significant differences (with an estimated power) may not be achieved.

The power of statistical designs and tests is largely driven by sample size, e.g. the number of sites sampled or the number of replicates within a site. Various statistical techniques are available to undertake power analysis in a study's design stage to calculate the level of replication required to detect a specified effect size. Power analysis used to determine the required level of replication depends on these inputs:

- the effect size (the desired magnitude of change to detect; this should be a biologically or ecologically important level of change)
- the population variance
- alpha (α) (the acceptable level of Type I error; the chance of falsely detecting a change that is not real; usually set at 0.05)

Generally a moderate level of power of 0.8 or higher is desired (Ref. 16) but may not always be achievable, depending on the effect size to be detected and the level of sampling that is logistically feasible. The effect size should relate to the study's objectives and should be a level of change that is biologically or ecologically meaningful, taking into account natural variability. For certain parameters, effect size may also need to consider a level of change that is meaningful to stakeholder values, such as fisheries or tourism. Natural change of varying magnitudes across temporal and spatial scales at impact and reference sites make detection of small effect sizes difficult. However, small changes due to impacts from an unplanned release are unlikely to be considered to be biologically or ecologically significant if dwarfed by large-magnitude natural variability. Therefore, the effect size chosen should take into account what is known of natural variability in the parameter to be measured, such as that observed in baseline studies or known from the literature. For example, it may be trivial to be able detect an effect size of 20% in the benthic cover of tropical seagrasses, which vary naturally from season to season by up to 100%. Detecting such an effect size may also be extremely difficult to achieve in such a highly dynamic community without a logistically unfeasible level of replication. However, detecting an effect size of 20% in a coral community, which is generally more stable over time, is important because changes of this magnitude may be outside the natural levels of change, and the coral community may take longer to recover from such a change because of its greater population stability.

Population variability can be estimated from data collected during previous studies (e.g. baseline). If these data are unavailable, natural variability may have to be estimated from published studies elsewhere that use the same parameters and similar sampling methods, or through pilot data collected during the OPS (if available), or through data collected during the initial SCI that will then need to feed back into revisions of the sampling design (i.e. increased or decreased replication based on initial findings).

Alpha—the probability of falsely detecting a change that is not real (Type I error)—is typically set at 0.05, although other values are acceptable. Although the level of Type I error (and alpha) should be kept as low as possible to avoid falsely detecting an impact, the lower the level of alpha (e.g. α=0.01), the lower the likelihood that that the null hypothesis will be rejected and hence, the lower the likelihood of a conclusion that an impact has occurred.

2.1.7 Setting the Spatial Boundaries of the Study

The spatial boundaries of a monitoring study depends primarily on the actual or potential area affected by the spill. Spatial boundaries should be sufficient to meet monitoring objectives, usually by determining impacted areas and the level of effects, linking effects to the spill source, and supporting decisions on clean-up strategies.

The boundaries should also be sufficient to cover representative areas of each:

- substrate type
- ecological community
- shoreline energy level
- degree of oiling
- clean-up method used
- reference area.

2.2 Data Management

Data need to be conveyed to appropriate response team personnel and decision makers in a suitable time frame and in a simple and usable form. This requires developing mechanisms for ensuring that data are presented appropriately and on time. The data can be collected in several ways:

- field data, including:
  - results from field sampling and observations
  - forms
  - photographs
  - video
  - maps
  - notebooks and logs
  - portable global positioning system (GPS)/geographic information system (GIS) units
  - verbal transmission
  - Chain of Custody (CoC) forms
  - laboratory reports
  - samples (biological, sediment, or oil).

Photographic and video evidence, covering coastlines to detailed quadrats, is a useful scientific monitoring tool, because collecting such evidence is fast and relatively inexpensive. Skilled interpretation of photos/videos can be done later.

Whatever the format, it is essential that data are quickly and effectively stored and transmitted, and that the accuracy of the collected data, and of any consequent analysis, is optimised.

All data should be backed up as soon as possible. This applies to data as it is acquired in the field, as it is transmitted, and when it is compiled and stored. Reliance on a single copy of data, whether on paper or digitally recorded, should be avoided. Note: Data collected as part of any scientific monitoring program will be used as part of the legal record of the incident and subsequent response effort. Therefore, data management should be comprehensive and well organised.

Appendix B is an extract from the Australian Maritime Safety Authority (AMSA) Oil Spill Monitoring Handbook (Ref. 17) that provides a guide to data management.

2.3 Laboratories

CAPL has contracts in place with these laboratories:

Australian Laboratory Services (ALS)

26 Rigali Way
Wangara WA 6065 Australia

Chevron Client Services Manager
Direct phone: +61 8 9406 1301

Chemistry Centre of WA (ChemCentre)

Resources and Chemistry Precinct
Corner of Manning Road and Townsing Drive
Bentley WA 6102 Australia

Reception: Level 2, South Wing, Building 500

Deliveries: Ground Floor, use Conlon Street entrance

Chevron Account Manager
Direct phone: +61 8 9422 9966

Before engaging ChemCentre or ALS, these tasks must be undertaken:

1. A quote must be prepared by the laboratory once there is agreement of service requirements. Supporting information that can be provided to the laboratory when requesting a quote is available in Template Request for Chevron Lab Services (ABU140601604; Ref. 18).
2. The Monitoring Coordinator must submit a Purchase Requisition to get a Service Request in the Chevron Ariba System.
3. A Service Request number must be supplied to the field team collecting the sample for use in a CoC Form (see Appendix C).
4. The CoC Form (see Appendix C) should stipulate that the report is sent to the Monitoring Coordinator and Environment Unit Lead.

Services can be directly engaged by CAPL personnel or by selected environmental contractors (with support from a CAPL contact to arrange the Service Request). Additional information regarding the correct communication process between CAPL, contracted laboratories, and any environmental contractors engaged to undertake monitoring is outlined in the ABU Contracts for the Provision of Laboratory Services – Contractor Information document (ABU140601602; Ref. 19).

The standard turnaround times for return of the analytical report is five to ten days from receipt of samples at the laboratory. However, reduced turnaround times can be requested with appropriate notice, although a surcharge applies. Note: Shorter turnaround times may not be available for some analytes due to holding time requirements for particular analysis.

2.4 Monitoring Capability

CAPL has contracts in place with environmental consultancies to provide services for scientific monitoring. As contracts change from time to time, the initial determination of the suitable contract should be sought from the HES Supervisor – Environment.

The level of services provided by CAPL's environmental consultants in relation to scientific monitoring are highlighted below:

- skills and expertise available to execute the plan
- resources available, including the number of people with skills for field deployment and office/laboratory support
- access to the required equipment for quick activation
- marine scientific expertise.

3 SCI1 – Water Quality Impact Study

3.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI1 – Water Quality Impact Study (SCI1) is to describe the influence of hydrocarbon exposure (level, duration, and type) on the water column. This information will inform other scientific monitoring programs (SCI2 – Sediment Quality Impact Study [Section 4.0], SCI3 – Coastal and Intertidal Habitat Impact Study [Section 5.0], SCI4 – Seabirds and Shorebirds Impact Study [Section 6.0], SCI5a – Marine Megafauna Impact Study: Marine Reptiles [Section 7.0], SCI5b – Marine Megafauna Impact Study: Pinnipeds [Section 8.0], SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna [Section 9.0], SCI6 – Benthic Habitat Impact Study [Section 10.0], SCI7a – Fisheries and Aquaculture Impact Study [Section 11.0], and SCI7b – Fish Effects Impact Study[Section 12.0]).

The objectives of SCI1 are to:

- quantify the temporal and spatial distribution of hydrocarbon compounds and dispersants both on and in marine waters
- assess hydrocarbon/dispersant content of water samples against accepted environmental guidelines or benchmarks to predict potential areas of impact.

Comparing data collected under SCI1 with baseline data (where available) and operational monitoring data will allow for a comprehensive interpretation of spatial and temporal trends. Therefore, the data collected during the scope of SCI1 should be as comparable as possible (in sampling methods and analysis) to baseline data and operational monitoring data.

3.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

3.3 Data and Information Requirements

Table 3-1 lists the inputs relevant to planning for the implementation of SCI1, once the notification to commence is initiated.

Table 3-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated database, including exceedances of benchmark levels.

SCI1 will likely inform other SCI studies, and as such outputs from it will be required by those plans.

3.4 Design

3.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, as determined through OPS3. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 3-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate	Monitoring Design[1]	Replicate Sites Required[2]
Spill Extent		
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC, or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)
Spill Depth	**Sampling Effort**	
Surface spill	Surface spill involving light hydrocarbons: • water column profile to 50 m (or depth indicated by other information) • minimum two water sample depths (surface 0 to 0.5 m) and subsurface (~5 to 10 m) Surface spill involving heavy hydrocarbons: • water column profile to full water depth • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • in waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	
Subsurface spill	• Water column profile to full water depth • In waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive, a surface and near-bottom sample) • In waters >50 m, a minimum of three water sample depths (as determined by fluorometer, or if inconclusive, a surface, mid-water, and near-bottom sample)	

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

3.4.2 Monitoring Sites

Sampling sites (impact and reference sites) will be selected once the outputs from MES and OPS3 are generated so that the depth and extent of the spill can be incorporated into the survey design. Location of monitoring sites will also consider the requirements of other SCIs.

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water, and weather conditions. For a spill in 300 m water depth or greater, requiring sampling of three depths and assuming 12 hours operations in good weather, it is expected that an average of four to five sites can be sampled each day. This is based on the potential to deploy the profiling equipment separately to the water sampling equipment, download the profiling data, take photographs, and write comprehensive field notes at each site.

3.4.3 Monitoring Parameters

Water column profiles will be collected for the full water depth at all sampling sites, for these parameters:

- temperature (°C)
- conductivity (mS/cm)
- pH
- dissolved oxygen (%)
- turbidity (Nephelometric Turbidity Units)
- Raw Fluorometry Units (RFU).

Water samples will be collected from all sampling sites, from multiple depths depending on the depth of the spill but from at least the surface (approximately 0 to 0.5 m), mid-water, and near-bottom (seabed >5 m). Selection of appropriate sampling equipment depends on water depth and the potential for contamination (equipment that passes through the water column in the open position may be contaminated if surface slicks are present). Samples will be collected using a stainless steel bomb sampler, Van Dorn sampler, or equivalent. Water samples will be analysed for these parameters:

- Total Recoverable Hydrocarbons (TRH)
- Polycyclic Aromatic Hydrocarbons (PAH; only analysed if TRH is detected)
- benzene, toluene, ethylbenzene, xylene (BTEX; only analysed if TRH is detected)
- dispersant compounds, depending on those used during spill response (2-Butoxyethanol, Ethylene Glycol Monobutyl Ether [EGMBE], Dipropylene Glycol n-Butyl Ether [DPnB], Propylene Glycol, Dioctyl sulfosuccinate [DOSS]).

All samples will be compared to the United States Environmental Protection Agency's (USEPA) Water Quality Benchmarks for Aquatic Life (Ref. 20)as detailed in Table 3-3. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

3.4.4 Monitoring Frequency and Duration

Following the initiation of SCI1, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI1 may reach termination criteria but still be required by other SCIs.

During each survey, sampling may be conducted during day and/or night operations.

3.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 3-3. Spare sample containers are required for redundancy.

Table 3-3: Test Parameters for SCI1

Test Parameter	ANZECC Guideline	USEPA Benchmark value (µg/L)*	Storage Container#	Preservation	Holding Time
TRH (C_6–C_{40})	7[1]		100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
PAHs			100 mL amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
Acenaphthene		116.1			
Acenaphthylene		640			
Anthracene		43.1			
Benz (a)anthracene		4.64			
Benzo(a)pyrene		1.99			
Benzo(b) fluoranthene		1.41			
Benzo(g,h,i) perylene		0.91			
Benzo(k) fluoranthene		1.34			
Chrysene		4.24			
Dibenz (a,h) anthracene		0.59			
Fluoranthene		14.8			
Fluorene		81.8			
Indeno (1,2,3-cd) pyrene		0.57			
Naphthalene		402			
Phenanthrene		39.8			
Pyrene		21.0			
BTEX			Pair of 40 mL glass vials	Chill to 4 °C	7 days
Benzene		13 500			

Test Parameter	ANZECC Guideline	USEPA Benchmark value (µg/L)*	Storage Container#	Preservation	Holding Time
Toluene		4070			
Ethylbenzene		2010			
Xylenes		1780			
Dispersant compounds			100 mL Amber glass with Teflon cap liner, zero headspace	Chill to 4 °C	7 days
2-Butoxyethanol		165			
EGMBE		50[2]			
DPnB		1000 (chronic)			
Propylene Glycol		500 000			
DOSS		40 (chronic)			

1 *ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) low reliability trigger value*

2 *Based on the ANZECC/ARMCANZ Water Quality Guidelines (Ref. 21) for freshwater*

Storage containers may vary depending on laboratory

* *Consideration is required of whether laboratory practical quantification limits can meet these guideline values*

3.4.6 Sample Analysis

Water samples will be analysed at National Association of Testing Authorities (NATA)-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is detected.

Water sample analysis will be subjected to laboratory-specific QA/QC procedures and results will be included in laboratory results reports.

3.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.
- Data received from the laboratories (including backups) will be downloaded and stored on the contractor’s computer system. These data are usually received approximately two to three weeks after receipt of that batch of

samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

3.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples to fill containers with low analyte water (ultrapure water). A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during the transport, storage, and analysis, the ultrapure water will be provided by the laboratory in the relevant sample jars and will remain unopened. The water will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Nitrile gloves must be worn at all times when handling water sampling equipment. Gloves need to be changed between each water sampling location or when contaminated.
- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the water sampling equipment.
- No smoking is to occur when sampling is undertaken.
- Avoid possible contamination from the vessel by sampling in as far forward position as possible with the vessel moving slowly up-current and into the wind.
- The insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, vessel, or potentially contaminated surfaces), and if contamination occurs, use a substitute container.
- Take care to avoid sources of airborne contamination (e.g. diesel fumes).
- Take GPS waypoints of all sites sampled from the vessel.

3.7 Mobilisation Requirements

3.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites, if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan

Task	
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check material safety datasheets (MSDSs) and chemical handling procedures
☐	Undertake hazard identification workshops (HAZIDs) as required
☐	Develop site-specific health and safety plan, including Job Hazard Analyses (JHAs)

3.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
☐	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
☐	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
☐	Assemble scientific survey team
☐	Book flights, accommodation, and car hire
☐	Confirm equipment list and availability of items; purchase consumables (as required)
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct a pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

3.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm specialist equipment requirements and availability (Profiler, Van Dorn bottle, or other water sampling devices), and any appropriate duplication of field equipment
☐	Confirm water quality profilers and sensors (including fluorometry sensor) have been calibrated before shipping, have adequate batteries, spares, and specific profiling cables, and download software
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional

Task	
☐	Check if a first aid kit or specialist PPE is required
☐	Confirm freight delivery to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently. Calibration and pre-deployment records should be kept on file.

The hydrocarbon sensor should be calibrated to an appropriate standard before mobilisation. Water samples will be sent to a NATA-accredited laboratory for TRH analysis and the laboratory measurements correlated with the sensor measurements. In this way post-calibration of the sensor to actual hydrocarbon readings can occur and profile data can be correctly adjusted.

3.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 3-4: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Technical Lead	• Develop sampling plan • Analyse statistics analysis and oversee data	• Higher degree in relevant subject • Water quality sampling experience
Water Quality Field Lead	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Manage sample contamination risk • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Water quality profiling and sampling field experience • Tropical Basic Offshore Safety Induction and Emergency Training (TBOSIET) • Offshore medical
Water Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Water quality profiling and sampling field experience • TBOSIET • Offshore medical

3.11 Equipment

This list is not exhaustive, but includes basic items that may be used for water quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Van Dorn sampler (e.g. Niskin bottle or equivalent)
☐	Dyneema or equivalent rope/cable for lowering equipment
☐	Water column profiler with appropriate sensors

Item	
☐	Stainless steel sampling buckets/containers
☐	Boom
☐	Absorbent pads
☐	Pouring jugs to fill bottles
☐	CoC documents
☐	Plastic ziplock bags to place glass jars into
☐	Insulated esky for transporting samples
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook, pens, and waterproof markers
☐	Digital camera with integrated GPS stamp, if practicable
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Fridge of appropriate size
☐	GPS unit
☐	Field laptop
☐	Hard drives for data backup
☐	Spare batteries, cable ties, tape, and other miscellaneous items

3.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- The profiler may require a weighted base that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- The type of sensor on the fluorometer is important—an ultra-violet fluorescent sensor will detect aromatics, whereas an infrared sensor will detect aliphatics.
- The sampler for water quality within the water column should allow remote opening and closing to ensure that the required sampling depth has been reached and there is no contamination as the sampler passes through an oiled area. This can be achieved using a bomb sampler, which is usually made of stainless steel but is limited to shallower depths. If a stainless steel sampler is not available, a Van Dorn sampler or similar device could be used. Choice of equipment with remote opening capabilities may be limited; therefore, the contamination potential when using equipment that is open as it passes through the water column (e.g. bomb and Van Dorn samplers) needs to be considered. Water can also be sampled from various depths using a hose and oil-free pump (depth limited).
- Water collected from each depth should be processed by transferring it into a stainless pouring jug or equivalent container easily decontaminated by

hydrocarbon components, so that the appropriate number of sample jars can be filled directly.

- Sampling equipment must be decontaminated and rinsed in ultrapure water before use and in between sites. Sampling containers that do not contain preservatives must also be rinsed before use.
- Decontamination techniques need to take into account the sensitive nature of probes on the profiler.
- Samples are to be stored in the appropriate sample containers, as provided by the laboratory.
- Nitrile rubber gloves must worn at all times when sampling and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Because the sample containers are usually glass, they must be covered with a protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be labelled and recorded, and cross-checked with field sheets and CoC forms.
- Appropriate CoC must be maintained and samples must be secured.

3.12.1 Water Profiling

Step	
☐	In the absence of equipment that can give real-time fluorometry readings (such as a YSI) or if the area is outside the depth capability of instrument (i.e. 250 m), deploy the water column profiler before using the water sampling equipment so that the depths of peaks in fluorometry readings can be determined first. If a dual profiler/sampler is available, then these steps can be done at the same time.
☐	Check that all sampling has been accomplished from the previous drop and the equipment has been decontaminated.
☐	Check that the area where the profiler is to be lowered has no surface slick (which is not expected at this stage of monitoring). If it does, follow the steps below to remove hydrocarbons before deployment.
☐	Remove any protective casings on the profiler sensors before deployment.
☐	Set the profiler to logging mode before lowering it into the water column.
☐	Deploy the profiler over the side of the vessel via a Hiab or similar. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Perform any relevant deployment checks on the profiler that are specific to that piece of equipment.
☐	Allow the profiler to sit at the surface water with sensors submerged so the sensors can equilibrate with environment.
☐	Lower the profiler into the water column at a rate of half a metre per second. Use the ship’s echo sounder and markings on the lowering cable/rope to judge water depth and the position of the profiler.
☐	For surface spills involving light hydrocarbons: • Water column profile to 50 m (or depth indicated by other information) Surface spill involving heavy hydrocarbons: • Water column profile to full water depth

Step	
☐	When the water profiler reaches the desired bottom depth, retrieve the equipment and download the data. Keep the sensors moist and protected when the profiler is not in the water. Review data for peaks in fluorometry then collect water samples at those depths.

3.12.2 Water Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. If using sampling equipment that only closes remotely (rather than opens and closes remotely), follow these steps to prevent decontamination across depths (when collecting subsurface samples). Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area . Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Drain the sampling equipment so that no water remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only. Misfires could occur if any errors are made when cocking the bottles (when Van Dorn sample bottles are used).
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	Deploy the water sampling equipment over the side of the vessel via a Hiab or winch. The Water Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Water Quality Assistant.
☐	Lower the sampling equipment into the water column at a rate of half a metre per second. Use the ship’s echo sounder and markings on the lowering cable/rope to judge water depth and the position of the water sampling system.
☐	Collect samples at the depths where peaks in fluorometry were observed, or, if this was inconclusive, at a minimum of two depths for waters <50 m deep (near surface and near bottom) or a minimum of three depths for water >50 m deep (near surface, mid-water, and near bottom). How samples are collected depends on the sampling equipment used.
☐	For surface spills involving light hydrocarbons: • minimum two water sample depths (surface 0–0.5 m) and subsurface (~5–10 m) For subsurface spills or a surface spill involving heavy hydrocarbons: • in waters <50 m, a minimum of two water sample depths (as determined by fluorometer, or if inconclusive a surface and near-bottom sample) • in waters >50 m, a minimum 3 water sample depths (as determined by fluorometer, or if inconclusive a surface, mid-water, and near-bottom sample).
☐	Retrieve the equipment once the subsurface samples have been collected, and extract the water samples. Lower a single water sampling bottle to 0–0.5 m and activate it as the near surface water sample collection.
☐	Once the sample is retrieved, empty the water into sampling containers before filling the laboratory sample jars. Filling sample containers directly from sampling equipment can be difficult and possibly lead to contamination. Decontaminate these containers (as for all sampling equipment) and cover them, if required, to prevent contamination.
☐	Place samples into laboratory provided jars/bottles and seal. Fill sample jars to zero headspace to prevent evaporative loss of volatiles.
☐	Label jars/bottles immediately with: • sample number or code

Step	
	• analysis required • depth • time and date (24-hour clock and DD/MM/YYYY).
☐	Place samples in a small esky with frozen ice bricks. Transfer to refrigerator when possible for storage at 4 °C.
☐	Complete laboratory-specific CoC forms.
☐	Send samples to the laboratory within 72 to 96 hours if possible. Maximum holding time including extraction is 7 days.
☐	At each site, complete a field log including details on: • time arrived at site • environmental conditions at the site • presence of a hydrocarbon slick • sample details for individual samples (as above) • sample description notes (oil, debris, thick slick, film etc.) • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site.
☐	Take photographs throughout the sampling process of: • sampling area (including surface of water) • sampling site • sampling jar before the sample is collected • sampling process • sample jar with contents and being sealed • sealed and secured sampling jars in the case • completed paperwork • sealed and secured case on completion of the sampling. Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.

3.13 Forms and Tools

Refer to Appendix C.

4 SCI2 – Sediment Quality Impact Study

4.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI2 – Sediment Quality Impact Study (SCI2) is to describe the influence of hydrocarbon exposure (level, duration, and type) on sediments.

The objectives of SCI2 are to:

- quantify the temporal and spatial distribution of hydrocarbons in marine sediment
- assess hydrocarbon content of sediment samples against accepted environmental guidelines or benchmarks.

Monitoring requires consistent repeat surveys to determine trends over time. SCI2 is best informed with comprehensive baseline data. The data collected as part of SCI2 should be as comparable as possible (in sampling methods, analysis, and interpretation of results) to baseline data and operational monitoring data.

4.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

4.3 Data and Information Requirements

Table 4-1 lists the inputs relevant to planning for the implementation of SCI2, once the notification to commence is initiated.

Table 4-1: Data Requirements Summary for SCI2

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data and baseline summary report/data for the relevant location • Additional baseline data may be available from I-GEMS (WA only), or from other agencies, including any information on natural hydrocarbon seeps in the area	Outputs from MES and *OPS3* activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • details of dispersants used • consolidated data file (Excel file) including exceedances of benchmark levels.

SCI2 will likely inform other SCI studies, and as such outputs from it will be required by those studies.

4.4 Design

4.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS4 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons in sediments, as determined through OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 3-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 4-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS4* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with revised centre point of gradient based on OPS monitoring, modelling, and/or other data)	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI, IvC or Gradient Approach	Minimum of **three** replicate sites at each location (impact and reference) or minimum **two** replicate sites at each distance from the centre of the gradient
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC	Minimum of **three** replicate sites at each location (impact and reference)

1 *Reference sites required for each monitoring approach are detailed in Section 1.*

2 *It is recommended that sample replication is conducted for 10% of samples.*

4.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS4 are generated so that the depth and extent of the spill can be incorporated into the survey design. The location of these sites will also be coordinated with the requirements of SCI1 – Water Quality Impact Study.

Sampling sites will be based on locations where hydrocarbons may have sunk through the water column and have contact with sediments. These include areas:

- around the well head, in the event of a loss of well control, as most hydrocarbon-contaminated deposits will be distributed close to the release site
- underlying hydrocarbons that have sunk through water column
- with high levels of suspended sediments (generally nearshore areas)
- such as shorelines and tidal flats where hydrocarbons can potentially become concentrated
- where other SCIs have been triggered

The number of sites that can be monitored each day depends on the travel distance between sites, number of replicates required, depth of water and weather conditions. As an example, for a spill in 300 m water depth or greater, assuming 12 hours operations in good weather, it is expected an average of 6 to 8 sites can be sampled each day. This is based on currently available grab sample methods and a winch speed of half a metre per second. This time also includes the requirement for comprehensive field notes and photos for each sample.

4.4.3 Monitoring Parameters

Sediment samples will be collected from all sampling sites using a stainless steel grab, box corer, or remotely operated vehicle (ROV) with corers (or equivalent) for subsequent laboratory analysis of these parameters:

- particle size distribution (PSD)
- TRH
- PAH; only analysed if TRH is detected
- BTEX; only analysed if TRH is detected
- total organic carbon (TOC).

All samples will be compared to the USEPA Sediment Quality Benchmarks for Aquatic Life (Ref. 22) or other relevant benchmarks or guidelines, as detailed in OPS4. For samples where analytical data indicate the concentration levels exceed the individual benchmark, the sample will be reviewed to assess the likelihood that the exceedance resulted from the spill.

4.4.4 Monitoring Frequency and Duration

Following the initiation of SCI2, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by examining the data collected to date and the spatial, temporal, and seasonal variability of any associated biological indicators measured in other plans. Survey frequency may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Note: SCI2 may reach termination criteria but still be required by other SCIs.

4.4.5 Sample Integrity

Sample holding times, storage containers, and preservation requirements are summarised in Table 4-3. At each site, three sample jars and one sample bag (total volume/site 1400 mL minimum) will be required. Spare sample containers are required for redundancy.

Table 4-3: Test Parameters for SCI2

Test Parameter	ANZECC Guidelines (µg/g)	USEPA Aquatic Life Benchmark Value (µg/g)	Storage Container	Preservation	Holding Time
TRH (C_6–C_{40})	550[1]		250 mL wide-mouth glass with Teflon cap liner[2]	4 °C (fridge)	14 days (plus holding extracts for up to 40 days)
PSD		N/A	300–500 mL polyethylene bag	-20 °C (freezer)	6 months
TOC		N/A	150 mL wide-mouth glass jar[3]	-20 °C (freezer)	6 months

Test Parameter	ANZECC Guidelines (µg/g)	USEPA Aquatic Life Benchmark Value (µg/g)	Storage Container	Preservation	Holding Time
PAHs			250 mL wide-mouth glass with Teflon cap liner[3]	-20 °C (freezer)	56 days (plus holding extracts for up to 40 days)
Acenaphthene		1 020 000			
Acenaphthylene		800 000			
Anthracene		1 235 000			
Benz (a)anthracene		1 750 000			
Benzo(a)pyrene		2 010 000			
Benzo(b) fluoranthene		2 035 000			
Benzo(g,h,i) perylene		2 270 000			
Benzo(k) fluoranthene		2 040 000			
Chrysene		1 755 000			
Dibenz (a,h) anthracene		2 330 000			
Fluoranthene		1 470 000			
Fluorene		1 120 000			
Indeno (1,2,3-cd) pyrene		2 310 000			
Naphthalene		800 000			
Phenanthrene		1 240 000			
Pyrene		1 450 000			
BTEX			250 mL wide-mouth glass with Teflon cap liner (taken from TRH sample)[2]	4 °C (fridge)	14 days
Benzene		1 680 000			
Toluene		2 060 000			
Ethylbenzene		2 465 000			
Xylenes		2 490 000			

1 *National Assessment Guidelines for Dredging (Ref. 23) ISQG Trigger Value*
2 *Minimise headspace in jars. Avoid exposure to light.*
3 *Room for expansion (during freezing) must be left at the top of the jar. Avoid exposure to light.*

4.4.6 Sample Analysis

Sediment samples will be analysed at NATA-accredited laboratories. PAH and BTEX analysis will only be undertaken if TRH is recorded. PSD will be analysed using laser diffraction (for <500 µm fraction) and dry sieving (≥500 µm fraction).

4.5 Data Management

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering.

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17). In summary:

- All records will be kept in a field log. This log will be copied to an electronic spreadsheet each day.
- All electronic files including those downloaded from the profiler will be backed up onto external hard drives each day.
- Original hardcopies will be transferred to a project folder and kept in a secure location (e.g. wheelhouse or vessel survey laboratory).
- GPS positional information and photographs will be downloaded and backed up onto external hard drives each day.
- Hard drives will be transported by the demobilising survey team.
- Copies of datasheets and analysis should be archived.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. These data are usually received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to CAPL as required.

4.6 QA/QC Procedures

These QA/QC samples will be taken to determine whether contamination has occurred during the sampling procedure:

- Field blank: To estimate any contamination introduced to the sample during collection. This involves following the same sampling procedure used to collect field samples, but, instead, using a sample jar pre-filled with laboratory-certified clean sediment. A minimum of one field blank per analyte per day should be taken.
- Laboratory blank: To estimate any contamination introduced to the sample during transport, storage, and analysis, laboratory-certified clean sediment will be provided by the laboratory in the relevant sample jars and these jars are to remain unopened. The sediment will then be tested to determine any contamination from a laboratory or transport source. A minimum of one transport blank per analyte per survey should be taken.

In addition, these measures will also be taken to QA the sampling:

- Sampler will be cleaned with Decon 90 and ultrapure water between sampling sites.
- Sample processing equipment (utensils/bowls) will be cleaned between replicates.
- Contaminant samples will not be taken from within 5 to 10 mm of the sides of the sampler walls.
- Samples where water has dripped into the sample from the winch wire will be discarded.
- Samples in which the grab has not closed correctly will be sampled again.
- Nitrile gloves must be worn at all times when handling sediment sampling equipment. Gloves must be changed between each sediment sampling location or when contaminated.

- Sun cream/zinc and any other potential anthropogenic contaminants are to be avoided by those in contact with the sediment sampling equipment.
- No smoking is to occur while sampling is being undertaken.
- As far as possible, the insides of the sample container lids are not come in contact with anything potentially contaminated (such as hands, surfaces, or vessel).
- A review of the deck will be undertaken before vessel departure to identify any areas of potential contamination and to define a clean area where sample processing may be undertaken to reduce contamination risk.
- Take GPS waypoints of all sites sampled from the vessel.

4.7 Mobilisation Requirements

4.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

4.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey platform (vessel, vehicle) as required to survey or access monitoring sites
☐	Confirm availability and rating certificates for any required rigging gear required on vessel (e.g. winches, Hiab), confirm size and available space in fridge/freezers
☐	Consider port logistics (e.g. access pass, berth, crane, wharf gang, fuel)
☐	Assemble scientific survey team
☐	Book flights, accommodation, and car hire
☐	Confirm equipment list and availability of items; purchase consumables (as required)

Task	
☐	Confirm availability of NATA-accredited laboratories to receive samples and analyse within holding times. Confirm sample analysis requirements, including limits of detection, and arrange provision of sample containers, CoC forms, eskies, and ice bricks
☐	Arrange delivery and freight of any sampling equipment and laboratory sample jars
☐	Confirm information on sample holding times and the requirements for transporting samples from the vessel to laboratories
☐	Develop field survey schedules, considering staff rotation and offloading of samples
☐	Communicate with all involved parties the plan to transport samples with a short holding time from the survey vessel to the laboratory
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements
☐	Print all survey documentation, including hardcopy field sheets, maps, and GPS locations

4.9 Equipment Preparation

These activities need to be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

4.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 3-4.

Table 4-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Sediment Quality Field Lead	• Develop sampling plan	• Minimum degree in relevant subject • Sediment quality sampling experience
Sediment Quality Field Technician	• Deploy equipment • Collect samples • Handle, store, and label samples according to guidelines • Provide HES support	• Sediment quality sampling field experience

4.11 Equipment

This list is not exhaustive, but includes basic items that may be used for sediment quality sampling and requires redundancy for key items.

Item	
☐	Glass sampling jars (with Teflon-lined lids) for sample collection, as provided by the laboratory
☐	Sample labels for glass jars
☐	Disposable nitrile gloves
☐	Stainless steel grab or box corer, or equivalent
☐	Glass mixing bowl
☐	Stainless steel spoons
☐	Boom
☐	Absorbent pads
☐	CoC documents
☐	Polyethylene/ziplock bags for PSD
☐	Polyethylene/ziplock bags to place glass jars into
☐	Insulated esky to place samples into
☐	Ice bricks
☐	Bubble wrap
☐	Tamper-proof security seals
☐	Sampling log book or field notebook
☐	Digital camera with integrated GPS stamp, if practicable
☐	Camera set up for sampling equipment
☐	Sampling case to hold all sampling equipment ready for transport to a spill location
☐	Field laptop
☐	Hard drives for data backup

4.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- Sediment samples will be collected using a corer/grab, either from a vessel or using an ROV, on an ongoing basis (if hydrocarbons are detected during the initial survey and attributable to the spill) until the termination criteria are reached.
- The grab or corer for sampling marine sediments should close when the equipment encounters the seabed to ensure that the bottom has been reached. This can be achieved using a grab or box corer, which is made of stainless steel.

- Sampling equipment must be decontaminated and rinsed before use and in between sites. Sampling jars that do not contain preservatives must also be rinsed before use.
- When the core or grab is retrieved, the sample should be photographed with a site label, then homogenised in a glass bowl using a stainless steel spoon.
- Samples must be placed into laboratory-provided sampling containers.
- Samples must be stored in the laboratory-provided sampling containers.
- Nitrile rubber gloves must be worn at all times when sampling, and—at a minimum—be changed between sites or when contact with contaminated material is suspected.
- Samples must be put into refrigerated storage immediately and chilled to 4 °C before shipping to a NATA-accredited laboratory.
- Sample containers must be covered in protective covering (e.g. bubble wrap) to prevent damage to the samples.
- Samples should be analysed by the analytical laboratory within 14 days of collection.
- Field duplicate samples will be taken at all sampling locations. Field blanks should be taken for every day of sampling.
- All samples will be recorded and photographed for forensic/legal purposes.
- Appropriate CoC forms must be maintained and samples must be secured.

4.12.1 Sediment Sampling

Step	
☐	Check that all sampling has been accomplished from the previous drop.
☐	Check the site for a hydrocarbon slick before setting up sampling equipment. As most sediment sampling equipment passes through the water column in the open position and only closes when it contacts bottom sediments, there is potential for contamination from a surface slick. Deploy a boom from the vessel and use absorbent pads to remove surface hydrocarbons from within this area. Note the presence of a slick and actions taken in the field notes. Hydrocarbon absorption using this method may not completely remove the risk of contamination, but may reduce it.
☐	Check the equipment is empty so that no sediment remains.
☐	Decontaminate sampling equipment by rinsing with Decon 90 or equivalent.
☐	Prepare most sampling equipment just before deployment to avoid on-deck contamination. This must be done by designated experienced personnel only.
☐	Follow manufacturer instructions for how to safely and accurately set up the sampling equipment.
☐	Check that sampling equipment triggers are correctly set up before deployment.
☐	The sediment sampling equipment will likely be deployed over the side of the vessel via a Hiab or deck winch. The Sediment Quality Lead should run the deck operations, guiding the Hiab and winch operators and the Sediment Quality Assistant.
☐	Lower the equipment into the water column at a rate of approximately half a metre per second. Use the ship's echo sounder and markings on the rope or cable to judge water depth water and the position of the sediment sampling equipment.
☐	Take samples when the sampling equipment reaches the bottom. Preferably, sampling equipment will have an attached camera that can take plan view and downward-facing photos of the seabed.

Step	
☐	Retrieve the equipment and extract the sediment samples.
☐	Assess the sediment samples before removing them from the sediment sampler to check that sufficient volume was collected and there is no indication of potential contamination or loss of sediment that could affect the integrity of the sample. Take photos of the sample before removal, including a photo slate that shows: • date • sample reference (including information on location, site, and replicate number) • scale bar
☐	Collect subsamples from the surface 2–3 cm, put into the glass mixing bowl, then homogenise. Collect subsamples from the bowl for each analyte required. TOC and PAH samples both require room for expansion as these samples will be frozen. Samples for TRH/BTEX should not have any headspace.
☐	Label jars/bottles immediately with: • sample number or code • analysis required • depth • time and date (24-hour clock and DD/MM/YYYY)
☐	Place samples in a small esky with frozen ice packs. Transfer to refrigerator/freezer (depending on sample type) when possible.
☐	Complete laboratory-specific CoC forms.
☐	Send samples to the laboratory within 10 days if possible. The maximum holding time including extraction is 14 days for TRH and BTEX.
☐	Complete a field log at each site, including details on: • time arrived at site • environmental conditions at the site • presence/absence of a hydrocarbon slick • sample details for individual samples (as above) • sample description notes (oil, debris, thick slick, film etc.) • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site
☐	Take photographs throughout the sampling process of: • sampling area • sampling site • sampling jar before the sample is collected • sampling process • sample jar with contents and being sealed • sealed and secured sampling jars in the case • completed paperwork • sealed and secured case on completion of the sampling. Keep a record of what photographs were taken (on field log) to assist with compiling the documentation at a later time.

4.13 Forms and Tools

Refer to Appendix C.

5 SCI3 – Coastal and Intertidal Habitat Impact Study

5.1 Aims and Objectives

The primary aim of SCI3 – Coastal and Intertidal Habitat Impact Study (SCI3) is to assess impacts to coastal and intertidal habitats and associated biological communities after a hydrocarbon spill. Sampling may need to be conducted on an ongoing basis throughout the spill, response activities, and for some time after termination of the response.

The intertidal zone is the focus of SCI3—it is the region that extends from the lowest astronomical tide (LAT) to the highest astronomical tide. Habitats seaward of LAT (e.g. the subtidal zone) are included in SCI6 – Benthic Habitat Impact Study.

The objective of SCI3 is to:

- determine the extent, severity, and persistence of impacts on intertidal habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities.

5.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

5.3 Data and Information Requirements

Table 5-1 lists the inputs relevant to planning for the implementation of SCI3, once the notification to commence is initiated.

Table 5-1: Data Requirements Summary for SCI3

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models, where available, for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • Oil Spill Response Atlas (OSRA) provided by AMSA	Outputs from OPS5 activities including: • intertidal habitat distribution, extent, and impact (i.e. maps, photographs, Excel datasheets) • intertidal assessment methods Outputs from MES activities including: • spill type • spill volume and duration • details of dispersants used, volumes, locations, and methods of application • observed and/or recorded spatial extent and movement of the spill • metocean data (e.g. currents, wind, sea state) • consolidated water quality and chemical characterisation data from Operational Scientific Monitoring, including locations of exceedances of benchmark levels, where available.	Information available at the commencement of SCI3 on survey design, or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI6)

5.4 Design

5.4.1 Monitoring Design

Intertidal habitats within the study area support various biological communities, which vary in their sensitivity to hydrocarbon spills. Some ecosystems have been reported to recover quickly from spills, with little or no noticeable harm, while others experience long-term harmful effects. To help inform scientific monitoring, it is essential that the pre-impact condition of the intertidal habitats of interest are known or can be reliably inferred. This can be achieved by assessing against pre-impact baseline data (if available) or inferring from reference sites that are considered comparable to impact locations.

Monitoring will concentrate on activities that help in understanding the impacts on the most sensitive areas. A combination of monitoring types will be used:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during intertidal surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from OPS5 and MES scope may be suitable). Once images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large-scale changes in some intertidal habitats.
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on intertidal habitats and associated biological communities.
- Chemical studies: To identify contamination and attribute cause and effect relationships to the impacts of a hydrocarbon spill.

The monitoring approach needs to consider the data collected during MES and OPS activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column, sediments, and shoreline, as determined through OPS3, OPS4, and OPS5. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 5-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 5-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Hydrocarbon plume has dissipated away from source	Gradient Approach (with repositioned centre point, aligned with results from OPS monitoring or SCI1 or SCI2 and/or modelling), and/or Lines of Evidence Approach.	Minimum of **two** replicate sites at each distance from the centre point
Nearshore spill or spill reaches shoreline	BACI, IvC, Gradient Approach, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); or minimum **two** replicate sites at

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
		each distance from source (Gradient); and/or multiple replicates depending on Line of Evidence type
Spill interacts with area of biological importance (bay/shoal/island)	BACI, IvC, and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each impact and control locations (BACI and IvC); and/or multiple replicates depending on Line of Evidence type

1 Reference sites required for each monitoring approach are detailed in Section 1.

2 It is recommended that sample replication is conducted for 10% of samples.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from a spill, then during and after the spill
- randomly or haphazardly select transect position for grabs, quadrats etc. within each site.

5.4.2 Monitoring Sites

Sampling sites will be defined once data and information from the sources outlined in Section 1.4 are reviewed. This review will help identify sensitive habitats, species, and protected areas.

Identify monitoring sites using these guidelines:

- likelihood of hydrocarbon impact on benthic habitats
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- the degree of hydrocarbon exposure or potential exposure of the benthic habitats
- accessibility of habitat types.

When selecting monitoring sites, follow these guidelines:

- Select several impact and reference locations over a large spatial area.
- Select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the environment that may be affected (EMBA), or those within areas of protection or conservation priority.
- When selecting reference sites, key physical factors (e.g. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between sites.
- Reference sites may also include areas impacted by the spill and left to recover naturally.
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations.

- Dispersion of a large spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

5.4.3 Monitoring Parameters

5.4.3.1 Physical Monitoring Parameters

Monitoring physical parameters complements biological monitoring where direct changes to the intertidal habitats are measured. Monitoring will be conducted at all biological monitoring sites, where practicable.

The physical character of the intertidal sites will be described by recording the parameters in Table 5-3.

Table 5-3: Physical Parameters and Methods

Parameter	Method
Surface and subsurface oil observations, mass of oil on intertidal	See AMSA [Ref. 17], Guidelines S.5, S.6, and S.9
Substrate type	See AMSA [Ref. 17], Guideline S.2
Form: geomorphological type, dimensions, profile, or gradient	See AMSA [Ref. 17], Guideline S.3
Energy: winds, waves	See AMSA [Ref. 17], Guideline S.1
Water quality	Refer to data collected from SCI1

5.4.3.2 Biological Monitoring Parameters

Cause-effect relationships based on existing literature will guide the selection of monitoring indicators that are likely to show a response in the target receptor for the intertidal habitat(s) surveyed. This risk-based approach initially focuses on response indicators that show early warning signs of effect (e.g. molluscs) in intertidal habitats. The proposed parameters, biological indicators, and monitoring methods are listed in Table 5-4.

Table 5-4: Proposed Biological Parameters and Survey Methods within Coastal and Intertidal Habitats

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
Rocky shoreline	Algae	Macroalgae	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1]	• Density/distribution of sensitive taxa[1] • Above-ground biomass[1]	• Hydrocarbon cover • Leaf/blade/thallus condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Molluscs[2], barnacles, chitons, crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/distribution of sensitive taxa • Size structure1	• Hydrocarbon cover • Tainting[2]
Sandy beach	Infauna	Amphipods, polychaetes	Stratified/haphazard sampling using quadrats/transects	• Density of organisms[3] • Diversity[3] • Distribution[3] • Dominant taxa[3]	N/A	• Tainting[2]
Low (intertidal) tidal flats	Algae and plants	Macroalgae (e.g. *Sargassum*), seagrass	Stratified/haphazard sampling using quadrats/transects	• Percentage cover[1] • Diversity[1] • Distribution[1] • Dominant taxa[1] • Canopy height[1]	• Density/distribution of sensitive taxa[1] • Above-/below-ground biomass[1]	• Hydrocarbon cover • Thallus/leaf/blade condition[1] • Plant height[1] • Tainting[2]
	Epifauna	Hard corals, soft corals, filter feeders, molluscs[2], crabs[2]	Stratified/haphazard sampling using quadrats/transects	• Percentage cover/ density of organisms • Diversity • Dominant taxa	• Density/distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Health indicators (bleaching, disease) • Tainting[2]
	Algae and plants	Samphire shrubs[4]	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution[1]	N/A

Habitat	Ecological Community	Taxa	Suggested Biological Survey Method	Community Parameters	Population Parameters	Individual Health and Condition Parameters
High (intertidal) tidal flats		Samphire shrubs[4], microalgae[4]	Stratified/haphazard sampling using quadrats/transects	• Plant density[1] • Distribution[1]	• Species density/ distribution[1] • Increase in microalgal density[1]	• Plant height[1] • Hydrocarbon cover • Seedling height and density • Tainting (microalgae)[2]
	Epifauna	Molluscs[4], burrowing crabs[4]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]
Mangrove and depositional intertidals	Plants	Mangroves	Remote sensing	• Canopy cover[1] • Distribution and extent[1]	• Species density/ distribution1	N/A
			Stratified/haphazard sampling using quadrats/transects	• Density of trees[1] • Distribution[1]	• Species density/ distribution[1]	• Foliage density[1] • Health (withered yellowing leaves, dull colouring) • Canopy height • Girth • Dead vegetation • Pneumatophore density • Seedling height and density
	Epifauna	Molluscs[3], burrowing crabs[3]	Stratified/haphazard sampling using quadrats/transects	• Density of organisms • Diversity • Distribution • Dominant taxa	• Density/ distribution of sensitive taxa • Size structure[1]	• Hydrocarbon cover • Tainting[2]

1 Some of these parameters can be expected to show large seasonal and interannual variability and this must be taken into account when designing the surveys (i.e. number of replicates required, frequency of surveys).

2 Can show strong variation in response to physical parameters such as height of tide, wind direction, position of the sun. Sampling times should be collected from similar heights on shore and similar tidal patterns.

3 *Highly variable and adequate replication is required for sampling replicates and frequency. On sandy intertidal habitats, shows strong correlations with PSDs and depth. Some species show strong behavioural cycles such as response to temperatures and inactivity during moulting (e.g. crabs in mangroves).*

4 *Can show strong variation in response to physical parameters such as rainfall patterns and salinity.*

5.4.3.3 Chemical Monitoring Parameters

Chemical monitoring of water and sediment samples should be conducted at all biological monitoring sites, where practicable. Parameters to be tested and methods for water and sediments are described in detail in SCI1 and SCI2 respectively.

Tissue samples of benthic organisms may be examined for chemicals at both impact and control sites to determine the bioavailability and bioaccumulation of hydrocarbon contaminants. The requirement for tissue sampling will be determined based on the scale and magnitude of the impact. SCI7a – Fisheries and Aquaculture Impact Study details the parameters, methods, and sampling protocols to collect samples from molluscs and similar organisms. Selection of taxa depends on their relative abundance, and consequent ability to obtain suitable sample sizes over a range of sites and treatments (impacted, non-impacted). Potential indicator taxa to be tested for bioaccumulation of hydrocarbons include:

- bivalve molluscs (Ref. 24)
- gastropod molluscs (Ref. 25)
- macroalgae
- infauna, corals and filter feeders may provide suitable alternatives (Ref. 26).

5.4.4 Monitoring Frequency and Duration

Following the initiation of SCI3, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

5.4.5 Sample Integrity

5.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

5.4.5.2 Remote Sensing Methods

Remote sensing can be used initially to determine potentially impacted habitats, habitats at risk, and reference areas (the outputs from OPS3, OPS4, OPS5, and MES scopes may also be suitable). Remote sensing may, if practicable, also be used to assess biological parameters for some habitat types within the study area to measure the condition of those habitats during scientific monitoring. For example, remote sensing is the quickest way to estimate the distribution and extent, and in some cases the condition, of upper intertidal habitats such as mangroves and samphire shrubs, and can also detect hydrocarbon spills.

A guideline for undertaking aerial surveillance of intertidal areas is provided in AMSA (Ref. 17), Guideline S.4. The remote sensing technique used (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) will depend on the intended parameter to be collected (e.g. presence/absence, percentage cover), and evaluating the pixel size required (i.e. coarse, medium, fine) as well as cost. A guideline for implementing remote sensing monitoring equipment is provided in by the Remote Sensing Research Centre (Ref. 27).

However, to correctly calibrate remote sensing imagery, ground-truthing (i.e. validating the density of trees and distribution and extent of the habitat) of imagery and measurements will be required (as discussed in the subsections below). Remote sensing has been shown to be a successful tool for estimating canopy density and extent in mangrove and high tidal flat habitats (Ref. 28), and these parameters can be used to infer the condition of these habitats during scientific monitoring.

In Situ Monitoring Methods

Intertidal systems are highly complex and demonstrate natural spatial and temporal variation in physical and biological structure. The monitoring program must target the main ecological communities, biological indicators, and key species of intertidal habitats that are sensitive indicators, and which can act as proxies for assessing wider community health. Potential biological indicators, parameters, and methods are shown in Table 5-4.

Mangrove, Saltmarsh, and Epiflora

Ground surveys provide quantitative data on the health, density, and condition of mangrove and saltmarsh habitats, as well as data for calibrating remote sensing data, validating the density and distribution of trees, and determining the extent of the habitat. Systematic sampling of quadrats along transects for mangrove and saltmarsh environments will, as far as practicable, include measures of the parameters in Table 5-3.

Ground surveys will use 0.25 m^2 quadrats for measuring seedling density and height, and, depending on the density of trees, a minimum of 1 m^2 (often 5 m^2) quadrats for tree measurements. The quadrant sizes should be adjusted according to the density of the taxa being surveyed. Quadrats will, as far as practicable, be photo documented to allow for skilled interpretation at a later stage, and to allow precise, digitised estimates of the relevant parameter.

Transects/quadrats may also be used to determine the percentage cover, diversity, and distribution of macroalgae on low tidal flats and microalgae on high tidal flats. Any assessment of the potential impact of hydrocarbons on these organisms may be influenced by large natural variability in both populations and communities.

Monitoring of macroalgae and microalgae will be of limited value unless the intention is to demonstrate and confirm that hydrocarbons have been taken up into these organisms.

Epifauna

An initial guideline for monitoring the potential impact on invertebrate intertidal fauna is provided in AMSA (Ref. 17), Guideline S.10. The recommended methods for monitoring community structure and population density on rocky intertidal (and mangrove and mudflat) habitats for epifaunal macroinvertebrates are those described in MacFarlane and Burchett (Ref. 29). Surveys would typically lay multiple quadrats (0.25 m^2 quadrats are commonly used) along a transect line.

Transect locations may be stratified in different heights in the intertidal zone (i.e. high, mid, and low intertidal).

Information recorded by field scientists for each quadrat will vary with location and assessment goals; however, it may include:

- main species (macroinvertebrates and algae) present
- range of species richness (i.e. numbers of species)
- indicator species
- ranges of mean abundances in each subzone.

Quadrats should be photo documented to allow for further skilled interpretation at a later stage, and to allow precise, digitised estimates of percentage cover, density diversity, and abundance.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). A guideline for obtaining intertidal sediment samples is provided in AMSA (Ref. 17) Guideline S.8.A. The entire sample is sieved for benthic infaunal analyses, or, if chemical subsamples are required, care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, and then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and a representative sample of the species present.

As infauna community structure is often strongly correlated with PSD, sediment samples should also be collected for PSD analysis.

If a decision is made to investigate infauna as part of SCI3, it will likely be based on assessments made during OPS5.

Dead Fauna

Any marine invertebrates, including bivalves, crabs, sea urchins, and starfish found washed up dead or moribund and discovered opportunistically during surveys should be recorded and, in some cases, collected. Dead fauna provide essential information for assessing impacts and wider ecological interest. Handling of large dead fauna and birds should be done in accordance with SCI4 – Seabirds and Shorebirds Impact Study. Numbers of individuals and species identification should be recorded, with photographs and at least some specimens taken for later analysis. Individual samples must be labelled with information that includes the location and date found.

5.4.5.3 Chemical Monitoring Methods

Chemical monitoring of water and sediment samples will be conducted at all biological monitoring sites, where practicable.

Water and Sediment Sampling

Water and sediment sampling are described in detail in SCI1 and SCI2 respectively. The general steps outlined in SCI1 and SCI2 will be followed for determining the overall sampling design and appropriate levels of replication.

Biota Tissue Sampling

Tissue samples of epibenthic organisms for chemical analysis and examination may be obtained through field sampling. Following collection, tissues samples should be extracted from shells, and holdfasts removed from algae. Material should be separated by taxa and approximately 50 g wet weight of flesh for each sample, transferred into sterile packs, then frozen until delivery to the analytical laboratory. SCI7a details the parameters, methods, and sampling protocols to collect biota specimens for analysis.

These protocols outline the sampling methodology used for SCI3:

- Sampling Surface Oil Slicks and Films (AMSA [Ref. 17] M.6)
- Sampling of Subsurface Water (AMSA [Ref. 17] M.7)
- Guideline for Handling Samples (AMSA [Ref. 17] G.1)
- sampling of invertebrate intertidal communities, based on MacFarlane and Burchett (Ref. 29)
- sampling of macro infauna intertidal communities, based on Junoy *et al*. (Ref. 30)
- Guidelines for Sediment Sampling (AMSA [Ref. 17] S.8)
- biomarker assessment of macroinvertebrate tissue, based on Brooks *et al*. (Ref. 31) for mussels
- Mangrove Tree Health Scoring System, as adapted from Eldridge *et al*. (Ref. 32).

See Section 5.13 for the SOPs associated with each of these sampling methods.

5.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Including results from field sampling and observations.
- Photo documentation: Photographic and video evidence, ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that is easily accessible for future reference.

Many of the monitored parameters collected using quadrats will be measured and quantified from the still photos taken in the field. Percentage cover of common and conspicuous organisms (e.g. macroalgae, microalgae) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. gastropods, bivalves) the density, diversity, and abundance of organisms will be recorded per quadrat or unit area.

5.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

5.6 QA/QC Procedures

QA/QC procedures will be used to objectively remove any photographic images that are not suitable for analysis (e.g. images that are blurred, smudged, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the World Register of Marine Species (WoRMS) Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove ‘ecological noise’ from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

5.7 Mobilisation Requirements

5.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)

Task	
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

5.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required, to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements, and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

5.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working(for an equipment list, see Section 5.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer, or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Check if redundancy is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

5.10 Resources

Accurate identification of marine intertidal biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct technical QA/QC of image analysis. The personnel required to undertake SCI3, their roles, and relevant qualifications are listed in Table 5-5.

Table 5-5: Field Roles and Responsibilities

Role	Responsibility	Recommended Qualifications
Field Lead/ Party Chief	• Manage survey plan • Capture survey positional data • Coordinate with aerial and ground survey teams • Manage fatigue and health and safety • Prepare daily field survey reports • Plan survey schedule	• Minimum degree in a relevant subject • Significant field experience
Marine Scientists / Field Technician (as required)	Scientific program delivery: • set up transects and quadrats • classify habitat • QA/QC still photos • manage data • collect sediment samples • sieve and preserve benthic infauna samples • conduct physical site observations • record survey and sampling data • backup digital data (including images) • maintain equipment and resolve technical issues	• Minimum degree in a relevant subject • Specialist coastal ecological knowledge of the region • As above if vessels are used

5.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment required for SCI3 is listed below.

Items	
☐	Specialist equipment: • Multiparameter probe/conductivity temperature depth (CTD) probe • Thermometer • Benthic grab and sieve • Remote sensing platform
☐	Is redundancy required?
☐	Measuring equipment: • Transect tape measure • Tape measure for establishment of 5 × 5 m^2 quadrats • 1 m^2 quadrat • 0.5 m^2 quadrat

Items	
	• 0.25 m^2 quadrat • Metal ruler • Dressmakers tape • Tree-high pole
☐	Sediment sample collection: • Trowel • Plastic sediment corers • Shovel
☐	Beach profiling tools: • Dumpy level • Staff
☐	Paperwork: • Clipboards (large enough for A4 datasheets) • Datasheets (printed on waterproof paper) • Several pencils • Tide tables • Species identification sheet
☐	Cameras, including batteries and data cables
☐	Radios, 3G data, satellite phone/data for communication
☐	First aid equipment and PPE (e.g. reef boots, lycra leggings)
☐	Field laptops with relevant software (e.g. CPCe, photo editing, Collaborative and Annotation Tools for Analysis of Marine Imagery and Video [CATAMI; Ref. 60])
☐	Backup field data storage

5.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected.

5.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives.
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives.
☐	Prepare and assemble all field equipment, including redundancies.
☐	Arrange access to vessel or other suitable monitoring platform.

5.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects.
☐	Randomly select the locations of transects at each site.

Step	
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect.
☐	Use a minimum of three replicate transects at each site.
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment).
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites.
☐	Take photos with a still camera, or as still images from video transect footage.
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable, use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage).
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale.
☐	Where possible, locate transects in similar depths within sites.
☐	After retrieval, QA/QC check and backup data on site.
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

5.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site.
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2.
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier.
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory.

5.13 Forms and Tools

Refer to Appendix C.

6 SCI4 – Seabirds and Shorebirds Impact Study

6.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI4 – Seabirds and Shorebirds Impact Study (SCI4) is to document and quantify shorebird and seabird presence and any resulting impacts and potential recovery from hydrocarbon exposure.

The objectives of SCI4 are to:

- identify and quantify, if time allows, the post-spill/pre-impact presence and status (e.g. foraging and/or nesting activity) of shorebirds and seabirds in the study area
- observe, and if possible quantify, actual exposure of shorebirds and seabirds to oil (i.e. post-impact) and to the response
- identify and quantify the post-impact status of shorebirds and seabirds (e.g. foraging and/or nesting activity) in the study area
- quantify recovery of shorebirds and seabirds from any harmful effects of hydrocarbons.

The scope of seabird and shorebird monitoring depends on the receptors identified within the EMBA of the hydrocarbon spill.

6.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

6.3 Data and Information Requirements

Table 6-1 lists the inputs relevant to planning for the implementation of SCI4, once the notification to commence is initiated.

Table 6-1: Data Requirements Summary for SCI1

Baseline Information	Operational Information
Any existing baseline data including population sizes and any known life-history parameters. Baseline data may be available from: • OSRA provided by AMSA • I-GEMS (WA only) • Species Profile and Threats (SPRAT) database (Ref. 34) • Bird Life Australia (birdlife.org and birdsinbackyards.net) • Birds Korea (birdskorea.org). Review methods undertaken during baseline studies to ensure that data collected during SCI3 can be directly compared to the existing baseline data.	Outputs from MES, OPS3, OPS 4, OPS5, OPS6, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS6) • knowledge of any proposed designs for other SCI activities • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches.

6.4 Design

Flexibility is required when implementing the scientific monitoring program to allow for changes to the trajectory of the actual hydrocarbon spill, weather conditions, seasonal presence of shorebirds/seabirds, and/or the life stages present. To prioritise monitoring, this information will be necessary to establish which species may occur in the area, and to select appropriate survey methods and effort to be used:

- review maps that characterise activities of seabirds and shorebirds in the study area
- assess the regional habitat frequency and function:
  - are the habitats rare or common?
  - are the habitats likely to be critical to the species' persistence?
  - how likely is the species to use the site? (breeding, overwintering etc.). Adjust the survey design to determine these aspects, if necessary.
- identify ecologically significant birds known to occur in the study area and determine the likelihood of occurrence, habitat requirements, and timing.

Existing information on the study area and surrounding region and the best-available information on species composition and population sizes developed from OPS6, together with available ongoing seabird and shorebird studies, should be used to develop the sampling design of the seabird and shorebird monitoring program

6.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS6 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS6. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 6-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 6-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Offshore hydrocarbon plume (pelagic surveys)	Gradient Approach	Will be determined when the program is finalised
Hydrocarbon spill reaches shoreline with known roosting habitat	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised
Hydrocarbon spill interacts with areas of biological importance, foraging areas	BACI or IvC or Control Chart Approach, and/or Lines of Evidence Approach	Will be determined when the program is finalised

1 Reference sites required for each monitoring approach are detailed in Section 1.

The scientific monitoring program may include shoreline and pelagic assessments. The program must allow for more detailed bird counts and inclusion of other parameters (e.g. nests or roosting sites) as compared to the program conducted under OPS6. The scientific monitoring program also requires repeating targeted searches of selected colonies and/or foraging grounds at frequent intervals. The procedure for moving from single measures of the diversity and abundance of populations to a monitoring program is described below:

- Select colonies, foraging grounds, and species for routine monitoring: Colonies and/or foraging grounds must support a variety of species and be reasonably accessible, allowing both aerial survey/photography and ground counts, and must include colonies and/or foraging grounds in vulnerable areas as well as reference colonies and/or foraging grounds not considered to be at risk from the hydrocarbon spill; species selected should be representative of the taxonomic and ecological variety of the region.
- Within selected colonies and/or foraging grounds, identify particular resources or habitat strata and representative study plots where birds will be counted in detail to assess changes in status. Permanently mark these plots in the field and on good-quality photographs, for future reference.

6.4.1.1 Shorebirds

Shorebird assessments will focus on monitoring species at important foraging sites. Specific shorebird monitoring techniques recommended by the former Commonwealth Department of Environment Water, Heritage, and the Arts [Ref. 35]) are outlined in Table 6-3.

Table 6-3: Recommended Survey Methods for Shorebirds

Environment	Recommended Techniques
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.1.2 Seabirds

Seabird assessments will focus on monitoring species at important breeding colonies. Table 6-4 outlines the proposed techniques for monitoring the diversity and abundance of seabird populations.

Table 6-4: Recommended Survey Methods for Seabirds

Environment	Recommended Techniques
At sea	• Shipboard transect surveys, observing in all directions from the ship • Aerial transect surveys for detecting in expansive areas • Observation from onshore vantage points using a telescope, particularly during strong onshore winds
On land	• Area searches of suitable habitat in and around the study area for nesting colonies and roosting sites. Searches for signs indicative of recent nesting activity (e.g. nests, egg shells, dead young). Spotlight searches may be suitable for some nocturnally active species • Observation from vantage points for birds arriving at or leaving nesting colonies • Aerial searches over suitable nesting and roosting habitat

Source: Ref. 35

6.4.2 Monitoring Sites

The scale of monitoring depends upon the size, location, and time of year of a spill. Sampling, and therefore monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify monitoring locations, including impact sites (all colonies/nesting sites that may have been exposed to hydrocarbons) and reference sites.

The selection of monitoring sites will be based on these criteria:

- the type of hydrocarbon spilt, weathering characteristics, and extent of the spill
- for shorebirds, the number of important foraging areas affected by the spill
- for seabirds, the number of colonies affected by the spill.

Colonies and nesting sites for ground-based surveys should be accessible by a tender from a vessel or from land. Sites that are inaccessible by land or boat may not be monitored.

6.4.3 Monitoring Parameters

Shorebird and seabird scientific monitoring programs will focus on a subset of shorebird and seabird species—indicator species—considered to be ecologically significant to the study area. These indicator species have a high number of interactions with the region (nesting and/or foraging) or have life-history characteristics that make them particularly susceptible at a population level to impacts from a hydrocarbon release (Ref. 36). Routine data on all other shorebird and seabird species that are encountered should also be gathered.

Table 6-5 summarises the monitoring methods and associated parameters that will be used to assess the impact and recovery of seabird and shorebird populations in the event of a hydrocarbon spill.

Table 6-5: Monitoring Metrics for Seabird and Shorebird Populations

Environmental Focus	Methodology	Condition Metric
Seabird and shorebird abundance	• Aerial shoreline surveys • Vessel shoreline surveys • Ground shoreline surveys • Aerial pelagic surveys • Vessel pelagic surveys	• Species diversity • Abundance of indicator species based on numbers of adults • Abundance of non-breeding birds • Abundance of breeding pairs • Species distribution • Total counts of occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • Qualitative abundance estimates (breeding presence) • Injury/mortality

6.4.4 Monitoring Frequency and Duration

Following the initiation of SCI4, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached

For robust estimates of shorebird populations, counts should be conducted at least once (preferably twice) during summer and winter and possibly repeated based on the initial results, so that natural variation can be accounted for and used to predict potential future trends. However, shorebird populations are known to vary between years and even within seasons when environmental conditions change. Estimates of seabird populations are best measured at a time of the year when their presence is most stable; e.g. breeding season.

For robust estimates of the breeding seabird population it is recommended to conduct the assessment towards the end of the incubation period. Any ongoing monitoring should to be undertaken at the same time of year (within the bounds of finding the most appropriate tidal series). Appropriate tide heights will be identified by CAPL when the study commences (e.g. the second high tide series in November may be considered appropriate based on other shorebird monitoring conducted in the north-west of Australia). Spring tides are favoured for shorebird surveys—birds are concentrated appropriately during high water, making the identification of important roost sites possible, and making the birds relatively easy to count.

6.4.5 Sample Integrity

Transect estimations for each observer will be calibrated before aerial and vessel surveys (see SOPs in Section 6.13).

6.4.6 Sample Analysis

These analyses will be used as part of this assessment:

- Observe and quantify actual hydrocarbon exposure of birds: Detail and compare records of oiled and dead birds during the spill and for a required duration after the spill.
- Identify and quantify the post-impact presence and activity/status of birds (e.g. foraging and/or nesting activity in the study area): Measure changes of selected bird populations at impact sites before and after impacts, compared to population changes recorded at reference sites.
- Quantify recovery: Monitor populations at impact and reference sites over time until they display similar dynamics.

6.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings

- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

6.6 QA/QC Procedures

These field data procedures and protocols will be implemented:

- All personnel will have training, where relevant, on species identification and procedures for shorebird and seabird surveys.
- All images will be checked to confirm that they are not blurry, etc.
- Each day, the Field Lead will review video and datasheet recordings and the database/spreadsheet to confirm accuracy and consistency in recording of data.

6.7 Mobilisation Requirements

6.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

6.8 Logistics

These activities must be considered before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points (i.e. tracks, carparks etc.)
☐	Book flights, accommodation, and car hire

Task	
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble the scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

6.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Task	
☐	Confirm specialist equipment requirements and availability (grab, corer or ROV)
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

6.10 Resources

The personnel required to undertake SCI4, their roles, and relevant qualifications are listed in Table 6-6.

Table 6-6: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Seabird/ Shorebird Field Lead	• Conduct shoreline and pelagic observations • Identify species • Prepare daily field reports	• Shorebird and seabird identification skills relevant to the species in the study area • Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Field Assistant	• Record survey observations and GPS positions during observations on datasheets	• Familiarity with shorebird and seabird behaviour • Familiarity with shorebird and seabird habitats
Oiled Wildlife Responders	• Handle oiled wildlife	• Oiled wildlife response • Fauna handling • Fauna euthanasia

6.11 Equipment

The basic set of equipment required for SCI4 is listed below.

Item	
☐	Knowledge of the area, access points, potential feeding and roosting sites – primarily derived from local topographic maps, published information, local relevant government departments, local councils, regional bird watching groups, local knowledge, exploration
☐	Field guides to help identify shorebirds and seabirds
☐	Note pad and pen (or alternative recording means e.g. laptop)
☐	GPS and spare batteries
☐	Survey plan
☐	Field datasheets
☐	Required permits, where applicable
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size (smaller or larger binoculars are inappropriate for bird watching)
☐	Spotting scope (small tripod-mounted telescope), ideally with x20 to x60 magnification
☐	Log book/observation sheets
☐	Camera, storage media, and batteries (with spares)
☐	Laptops, battery chargers
☐	Hard drives
☐	Phones, satellite or radio communications
☐	Measurement tools
☐	Gloves
☐	Refrigerator or eskies with ice
☐	Sample bags
☐	Aircraft for reconnaissance
☐	Vessel/vehicle (depending on location)

6.12 Standard Operating Procedures (SOPs)

6.12.1 Shoreline Surveys

Shoreline assessments are effective for detecting the presence and abundance of many breeding shorebird and seabird species. Shoreline assessments will be conducted using one or more of these methods:

- aerial surveys, including drone surveys (can rapidly cover large areas of land and/or water and can provide information on nesting sites for follow-up ground surveys)
- vessel surveys
- ground surveys (used to count birds, pairs, or nests).

6.12.2 Pelagic Surveys

Both vessel and aerial surveys may be used to detect and count pelagic seabirds offshore. Vessel surveys allow more time to identify the taxa and record other details such as age, sex, and behaviour, thus improving the chances of recording rare, inconspicuous, and diving taxa.

The SOPs for these survey techniques are detailed below.

Vessel Survey SOP	
Pre-survey	
☐	Calibrate distance estimation for each observer
☐	Establish transects or shoreline plots to be surveyed
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead). NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification
During Survey	
☐	Vessel speed: 10 knots (range 5–15 knots)
☐	Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger
☐	Two observers record from each side of the vessel
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Count actual numbers (direct counting) or estimate if numbers are large. If estimating: • estimate total number of birds first; then • estimate the proportion of species within the total number of birds estimate
☐	Take photographs to help identify and count species
☐	General observations: • describe the habitat in detail (including condition of the habitat at the time of the survey) • predator presence / evidence of predation.
☐	Record other variables including, as far as practicable: • location • vessel speed and direction • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.
☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas
☐	Record the presence of other vessels in the survey area, as they may affect the behaviour of the birds
☐	Count individuals following the vessel only once

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
Pre-survey	
☐	Calibrate transect estimation for each observer
☐	Establish transects or shoreline plots to be surveyed
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish strip width for transects (e.g. 200 m each side of the aircraft)
During Survey	
☐	Aircraft speed [1]: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot Altitude: below 100 m. Select aircraft speed and altitude to maximise ease of bird detection and identification and minimise the risk of collision with ground structures or airborne birds (Ref. 37) (~600 to 1000 transects can be flown in a six-hour period)
☐	Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger
☐	Two observers record from each side of the aircraft
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Count actual numbers (direct counting) or estimate if numbers are large. If estimating: • estimate total number of birds first; then • estimate the proportion of species within the total number of birds estimate
☐	Take photographs to help identify and count species
☐	General observations: • describe the habitat in detail (including condition of the habitat at the time of the survey) • predator presence / evidence of predation.

☐	Record other variables including, as far as practicable:
	• location
	• aircraft speed and direction
	• weather conditions, including:
	  – temperature
	  – precipitation
	  – wind strength and direction
	  – visibility.

☐	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas

[1] Can use a helicopter, fixed-wing aircraft, or drone (with replacement of equivalent methods)

Aerial Survey SOP (equivalent methods may be used for drone techniques)	
☐	Record the presence of vessels or other aircraft in the survey area, as they may affect the behaviour of the birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

Ground Survey SOP	
Pre-survey	
☐	Determine colonies and/or transects/shoreline plots to be surveyed
☐	Sampling units should be positioned far enough apart that individual birds are unlikely to be detected from more than one sampling location, ensuring the samples are independent
☐	The number of sampling units within the study area (or strata) should be proportional to its size, a principle referred to as 'area-proportionate sampling'
☐	Record GPS location of all sampling unties and provide maps of study area
☐	Establish points or census method for colonies and/or strip width for transects
During Survey	
☐	Breeding sites: • describe the colony in as much detail as possible to allow precise relocation in future surveys • develop a map that describes the relevant features and limits of the environment • take photographic records that include location, direction of photograph, date, time, camera, and shooting distance.
☐	Obtain GPS positioning for: • extent of the colony • survey points within the colony • start and end points for transects.
☐	Bird observations, where practicable: • Record observations of each individual bird or group of birds in real time to a dedicated handheld data logger • Conduct complete counts of dense flocks* • Count all birds observed and record their identity to the lowest taxonomic group possible, preferably species • Behaviour (including nesting activity) • Impacts from hydrocarbons (oiling, injury, and mortality)
☐	Initially assess live oiled and dead seabirds and shorebirds collected by oiled wildlife response personnel, collecting information, as far as practicable, on: • date and location of finding • identification to species level • details of rings or other markers (e.g. satellite transmitters) • oiling status of the bird (% oiled) • external ageing and sexing • external biometrics (to determine age and breeding population of origin) including: – bill length – bill shape – body mass – wing length – tarsus length • internal examination to determine sex and age

Ground Survey SOP	
□	Store dead seabirds and shorebirds in appropriate facilities (on ice in eskies and then preferably freezing facilities).
□	Take photographs to help identify and count species
□	Record other variables including, as far as practicable: • location • weather conditions, including: – temperature – precipitation – wind strength and direction – visibility.
□	Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas
□	Census techniques** for breeding sites: • count breeding pairs • count occupied sites or nests (including stages of the breeding cycle and attendance patterns of adults) • count non-breeding birds

* *Where practicable, compare direct counting and the assessment methods with those from other observers.*

** *Census techniques may vary according to the nesting behaviour of the species.*

6.13 Forms and Tools

Refer to Appendix C.

7 SCI5a – Marine Megafauna Impact Study: Marine Reptiles

7.1 Aims and Objectives

The aims of this Scientific Monitoring Program SCI5a – Marine Megafauna Impact Study: Marine Reptiles (SCI5a) are to identify and quantify the status and recovery of marine reptiles, including marine turtles and sea snakes, related to a hydrocarbon spill

The objectives of SCI5a are to:

- determine abundance (including life stage) of marine reptiles present in the EMBA
- where possible, identify mortality of marine turtles and sea snakes directly related to the oil spill or other secondary spill-related impacts (including vessel strike and/or use of dispersants)
- assess the impact of the oil spill on nesting turtles, nests, and hatchlings
- understand changes in nesting beach usage by marine turtles following the hydrocarbon spill.

The monitoring program will focus primarily on marine turtles. The highly dispersed distribution and ecology of sea snakes restricts the opportunity to monitor this group, although sea snakes will still be studied in a limited capacity.

7.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

7.3 Data and Information Requirements

Table 7-1 lists the inputs relevant to planning for the implementation of SCI5a, once the notification to commence is initiated.

Table 7-1: Data Requirements Summary for SCI5a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for marine turtle nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and marine turtle nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on nesting beaches

7.4 Design

7.4.1 Monitoring Design

Scientific monitoring for marine reptiles will be achieved by observing populations in potentially affected areas, and tissue sampling and analysis to examine direct contamination of turtles and sea snakes. The focus is on marine turtles because of the challenges of estimating sea snake population status. Monitoring of marine turtles will include, where applicable:

- assessing population size of the affected and unaffected marine turtle species (including both nesting and in-water populations)
- assessing exposure of marine turtles to hydrocarbon (e.g. oiled wildlife)
- assessing nesting site condition e.g. hydrocarbon contamination levels.

Note: There are limitations to this study. Scientific studies on marine reptiles are only likely to produce impact assessment outcomes if there is a known resident population, or reasonable confidence in the population numbers and use of an area. Often, insufficient data exists to compare the behaviour and condition of animals after a spill.

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 7-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 7-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Offshore hydrocarbon plume (in-water surveys only)	Gradient Approach	Will be determined as part of Program finalisation
Hydrocarbon spill reaches shoreline with known nesting beaches	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation
Hydrocarbon spill interacts with areas of biological importance, and/or internesting areas	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined as part of Program finalisation

1 Reference sites required for the monitoring approaches are detailed in Section 1.

2 Design implemented depends on available baseline data.

Key points on monitoring design:

- monitor, if possible, potential impact sites and control sites before any impact from the spill, then during and after the spill.

7.4.2 Monitoring Sites

The scale of monitoring depends on the size, location, and time of year of a spill. Sampling, and therefore the location of monitoring sites, needs to be balanced against the logistical constraints of sample collection in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from

MES, OPS3, OPS4, OPS5, and OPS7 will be used to understand the spill trajectory and the potential exposure of nesting beaches to spilt hydrocarbons. This data will help identify impact beaches (known turtle nesting beaches where shoreline contact has been identified) and impact in-water survey locations, as well reference beaches and in-water reference locations.

7.4.2.1 Population Abundance/Status of Marine Turtles

7.4.2.2 Marine Turtle Nesting Populations

Beaches with nesting activity in the EMBA will be divided into primary beaches (those with high nesting density) and secondary beaches (restricted sandy nesting habitat [e.g. small physical size] or low to moderate nesting activity).

7.4.3 Monitoring Parameters

7.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of marine reptiles in the EMBA will address the selection and spatial/temporal variation of measured parameters (Table 7-3).

Table 7-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameter
Population abundance/status of marine reptiles	Annual marine turtle nesting abundance	Census and snapshot track counts (aerial or field surveys)	• number (#) of tracks • species identification
	Marine turtle nesting distribution on beaches	Census and snapshot track counts (aerial or field surveys)	• # and spatial distribution of tracks • species identification
	In-water abundance (sea snakes and marine turtles) and distribution	Aerial or vessel surveys	• # of individuals • species identification
Marine reptile exposure/mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TRH levels • PAH levels • condition of individual turtles e.g. oiling, sores • # of oiled individuals (dead and alive) • # of dead marine reptiles
	Marine turtle reproductive success	Excavation of hatched nests to characterise clutch sizes, hatching success, emergence success, and record any deformities	• clutch size • hatching success • emergence success • records of hatchling conditions

Environmental Focus	Condition Metric	Methods	Parameter
Beach condition	Hydrocarbons in sediments	Results from SCI2	• TRH levels • PAH levels • USEPA priority pollutants • saturated hydrocarbons (C10 to C36) • BTEX • organochlorides • trace metals (mercury and arsenic)

Before finalising the survey plan, an assessment will be done to determine the likelihood of marine reptile presence/absence, species, and life cycle stage (e.g. nesting, mating) at the time of the hydrocarbon spill, based on the predicted EMBA and time of year.

7.4.3.2 Indicator Species

Indicator species may be selected for monitoring; selection will consider:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons.

Additionally, prioritisation of indicator marine turtle species for monitoring should follow this order, as far as practicable:

1. breeding/nesting females
2. mating males
3. incubating nests
4. hatchlings
5. foraging residents.

7.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5a, surveys will be undertaken at least once in the first year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

7.4.4.1 Population Abundance/Status of Marine Reptiles

In respect to marine turtle nesting populations, monitoring will be timed to occur during the first peak nesting period (if known and feasible for mobilisation) after the hydrocarbon release. If the peak nesting period for a particular beach is not known, monitoring will be undertaken during the nesting periods for the relevant species, based on literature for the area. However, the frequency of the monitoring plan may be determined by the extent of the spill and the spatial, temporal, and seasonal variability of the biological indicators. Ideally, the survey will occur early in the morning when the light is low and before the first high tide.

If the hydrocarbon release occurs during the nesting season, the priority will be to mobilise teams to capture pre-hydrocarbon contact data for key marine turtle nesting beaches. For impacted areas, intra-season variation will be assessed via repeated sampling within a season. Conversely, inter-season variation identifies the duration of impact over time at the impact site(s) when compared to the selected regional pre-spill baseline and/or reference site(s). Primary beaches will be assessed over five consecutive days and surveys will be conducted weekly during the spill event, then every two weeks during clean-up. Secondary beaches will be assessed twice a week during the spill event then weekly during clean-up.

7.4.4.2 Marine Reptile Exposure, Health, and Mortality

Reproductive success surveys will occur concurrently with the surveys for population abundance and status (see Section 7.5.4.1). Tissue samples will be collected opportunistically.

7.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine turtle expert.

7.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements for tissue sampling must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered dimethyl sulfoxide (DMSO) solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 7-4 summarises the storage and transport needs for tissue samples.

Table 7-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Scute (1 to 2 cm^3)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

7.4.6 Sample Analysis

Once data for biological and habitat parameters are collected, they can be conveyed to decision makers using control charts, if sufficient information from historic populations is known. These decision-aiding tools allow managers to visualise whether a management action (e.g. spill response) is having a predicted effect on the recovery of a parameter, and whether natural variation is driving the changes observed. Control charts may help managers diagnose when a parameter of interest (e.g. turtle track counts) shows deviation beyond those naturally expected by plotting through time some measure of a stochastic process with reference to its expected (baseline) value, where data are available.

7.4.6.1 Population Abundance

In-water Populations

These resources will be used for in-water population estimates:

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Florida's Wildlife Contingency Plan for Oil Spill Response – June 2012 Sea Turtle Guidelines for Oil Spill Response (Ref. 39)
- The Centre for Research into Ecological and Environmental Modelling at University of St Andrews, Scotland, has developed a statistical tool for analysing distance data. The program—DISTANCE 6.0—can be downloaded free of charge (http://www.ruwpa.st-and.ac.uk/distance/). An indication of the statistical power to detect change in monitoring criteria will be assessed following analysis of the baseline/reference data by the subject matter expert (SME) statistician/modeller

Nesting Populations

Track counts will be used as the abundance metric for the nesting female population.

7.4.6.2 Marine Reptile Exposure, Health, Mortality

Reproductive Success

Hatching and emergence success will be calculated for each nest. Formulas used to determine clutch size, hatching, and emergence successes (Ref. 40) are:

1. Clutch size = #S+ #UD + #UH + #UHT + #LE + #P
2. Hatching success = #S × 100/clutch size
3. Emergence success = #S-(#L+#D) × 100/clutch size

= numbers of:

S = shells

L = live hatchlings in nest

D = dead hatchlings in nest

UD = undeveloped eggs

UH = unhatched eggs

UHT = unhatched eggs with full-term embryos

E = emerged hatchlings

P = depredated eggs

Y = yolkless eggs

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. These standardised protocols for carcass handling and necropsy procedures will be adopted:

- A veterinarian's guide for sea turtle post mortem examination and histological investigation (Ref. 41)
- Sea turtle necropsy annual for biologists in remote refuges. (Ref. 42)

Tissue Sample Analysis

Samples collected from all stranded and live animals during the oil spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with the SME. Tissue sample analyses will, as far as practicable, include:

- PAH and the USEPA list of 16 priority pollutants, via normal phase silica chromatography and gas chromatography mass spectrometry (GCMS)
- saturated hydrocarbons in the C10 to C36 range via by flame ionisation gas chromatography (GC)
- volatile hydrocarbons via purge and trap into a GCMS (BTEX)
- organochlorides (dichlorodiphenyldichloroethylene ; dichlorodiphenyltrichloroethane)
- trace metals (mercury and arsenic) if assay indicates concentrations above detection limits
- DNA
- stable isotopes.

Turtle carcasses may also be sampled for humeri (flipper bones) and scleral ossicles (a ring of bones embedded in the sclera and surrounding the irises of the eye) to help determine the age of the animal.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the oil will be screened to confirm the oil source.

Chemical analysis of turtle tissue will consider methods outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

7.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

7.6 QA/QC Procedures

7.6.1 Data

These field data procedures and protocols will be implemented:

- The Marine Turtle Field Lead will review the hardcopies and the database/spreadsheet daily, to ensure accuracy.

7.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine turtle surveys.
- All images will be checked to confirm that they are not blurry etc.

7.7 Mobilisation Requirements

7.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

7.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

7.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 7.12).

Task	
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

7.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 7-5.

Table 7-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Turtle Expert	• Lead turtle beach surveys including track counts and nest excavations • QA/QC database each day	• Experience in marine turtle surveys from aerial surveys (desirable), track counts, and necropsy (desirable)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake ground/aerial/vessel surveys • Input data into database each day	• Experience in marine turtle surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine turtle necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in marine turtle population estimates • Marine turtle necropsy procedures • Sampling/monitoring design suitable for control charting

7.11 Equipment

The equipment required for the beach survey component of SCI5a is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing craft or marine vessels
☐	Site access to remote beaches (vessel or chopper)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining turtles
☐	Turtle stretcher big enough to take an adult turtle
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps

Item	
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)
☐	Sampling bottles and preservative (70–100% ethanol) • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

7.12 Standard Operating Procedures (SOPs)

7.12.1 Population Abundance/Status of Marine Turtles

Assessments of marine turtle populations and population status will be carried out via field studies, based on SOPs for surveying marine turtles from aerial, vessel, and track census surveys.

7.12.1.1 In-water populations

The standard survey platforms used for assessing marine reptiles at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

7.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

7.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine reptiles (marine turtles and sea snakes) are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 7-6 will apply.

Table 7-6: Survey Techniques: Guidelines

Timing	Survey Techniques	
	Vessel	Aerial[1]
Pre-survey	N/A	Preference: aircraft-mounted cameras and techniques that can photograph transects flown
	Calibrate distance estimation for each observer	
	Establish transects to be surveyed	

<table>
<tr><th rowspan="2">Timing</th><th colspan="2">Survey Techniques</th></tr>
<tr><th>Vessel</th><th>Aerial[1]</th></tr>
<tr><td></td><td>Establish strip width for transects (e.g. 50 m each side of the vessel and 100 m ahead).
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td><td>Establish strip width for transects (e.g. 200 m each side of the aircraft)</td></tr>
<tr><td rowspan="7">During survey</td><td>Vessel speed: 10 knots (range 5–15 knots)</td><td>Aircraft speed: 185 km/h^{-1} or as slow as safely possible; to be determined by the pilot
Altitude: below 100 m. Selected to maximise ease of marine turtle detection and identification, and minimise the risk of collision with ground structures or airborne birds (Ref. 37)</td></tr>
<tr><td colspan="2">Continuously record latitude and longitude (e.g. 30-second intervals) using handheld data logger</td></tr>
<tr><td colspan="2">Marine turtle (or sea snake) observations:
• Record observations of each individual turtle or group of turtles in real time to a dedicated handheld data logger
• Count all observed turtles and record their identity (preferably species), and determine their age class (if possible)</td></tr>
<tr><td colspan="2">Take photographs and/or video to help identify and count species</td></tr>
<tr><td colspan="2">Record other variables including, as far as practicable:
• location
• vessel/aircraft speed and direction
• weather conditions, including:
– temperature
– precipitation
– wind strength and direction
– visibility.</td></tr>
<tr><td colspan="2">Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
<tr><td>Record any marine reptiles close to the surface slicks and document any unusual behaviour or ill health.</td><td>N/A</td></tr>
</table>

7.12.2 Nesting Populations

Dead and injured stranded turtles will be collected (where practicable) during the ground-based snapshot and census track surveys. Track surveys may be replaced with aerial photographic surveys following data analysis and consultation with SMEs. If aerial surveys of beaches are used, these must be conducted in early morning when the sun is low and tracks can be seen.

7.12.2.1 Snapshot Track Counts – Secondary Beaches

These counts are designed to rapidly assess beaches and include a single standalone beach inspection, which provides a limited indication of the number of turtles that have visited the beach. However, no temporal inference can be made as the number of tracks present depends on several factors, including weather conditions, tide state, and substrate type.

Step	
☐	Conduct snapshot track census in the early morning after a midnight high tide and before the nest high tide washes the overnight tracks away
☐	Walk the length of the beach and record all downward tracks, or use high-resolution drone imagery
☐	Assess track patterns to identify species, where possible
☐	Follow downward tracks back to the last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record the number of clutches hatched (based on hatchling tracks)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish

7.12.2.2 Census Track Surveys – Primary Beaches

Census track surveys collect data on nesting marine turtle abundance, spatial and temporal usage, and distribution between nesting beaches. Census track surveys record the number of new overnight nesting tracks on a beach across consecutive days. Primary indicator beaches will undergo regular ground-based census track monitoring, which may be supported by aerial photographic transect surveys.

Step	
Day 1	
☐	Day 1 – see SOP for Snapshot Track counts (Section 7.13.2.1
☐	Mark all tracks to ensure they are not counted the following day
Day 2	
☐	Walk the length of the beach and record all downward tracks, if no lines are marked
☐	Follow downward tracks back to last gigging location to assess nesting success
☐	Use GPS to mark identified nest (inferred from visual observations) locations
☐	Record number of clutches hatched overnight (based on hatchling tracks) – see Reproductive Success SOP (Section 7.13.3.1)
☐	Record signs of human presence (e.g. vehicle tracks) or predators
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times

Step	
	• GPS position, latitude/longitude at start and finish

7.12.3 Marine Reptile Exposure, Health, and Mortality

7.12.3.1 Reproductive Success

Step	
□	Walk the entire beach and identify emerged nests, through hatchling tracks (the optimal time to follow hatchling tracks is early morning when there is low light)
□	Use GPS to record nest locations
□	Excavate nests using hands and/or digging implements
□	Count and record nest contents including number of: • shells • live hatchlings • dead hatchlings • undeveloped eggs • unhatched eggs • emerged hatchlings
□	Collect unhatched eggs (up to 10) and freeze for chemical analysis

7.12.3.2 Chemical Contamination

Step	
□	Only trained personnel are to handle live or dead stranded turtles and sea snakes.
□	Collect and freeze all stranded animals (as far as practicable)
□	Undertake necropsy, as required
□	Sample carcasses of oil-affected turtles/sea snakes
□	Samples may include: • necropsy and biopsy samples (e.g. serum samples, gall bladder bile, liver, gonads) • 10 g of skin or muscle for DNA and stable isotope analysis • 100 g of muscle tissue per sample for chemical (hydrocarbon, trace metal, VOC etc.) and stable isotope analysis • gut (stomach/intestinal contents) for hydrocarbon analysis • fibropapillomatosis tumours and spirorchoidiasis (spirorchid trematodes), if present
□	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage.
□	Complete laboratory-specific CoC forms
□	Label, record, and cross-check all samples with field sheets and CoC forms
□	Maintain appropriate CoC and secure samples

7.12.4 Beach Condition

See sediment SOPs in SCI2 (Section 4.13)

7.13 Forms and Tools

Refer to Appendix C.

8 SCI5b – Marine Megafauna Impact Study: Pinnipeds

8.1 Aims and Objectives

The aim of the Scientific Monitoring Program SCI5b – Marine Megafauna Impact Study: Pinnipeds (SCI5b) is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected pinniped populations (Australian Sea Lion, *Neophoca cinerea*, New Zealand Fur Seal, *Arctocephalus forsteri* and the Australian Fur Seal, *A. pusillus*) where they exist within the hydrocarbon release EMBA.

The objectives of SCI5b are to:

- where possible, identify mortality of pinnipeds directly related to the hydrocarbon spill or other spill-related impacts (including boat strike and/or use of dispersants)
- assess the impact of the hydrocarbon spill on pinniped species populations as recorded for breeding colonies and haul-out sites of hydrocarbon exposure/contact
- evaluate the recovery of pinniped breeding colonies.

The monitoring focus is onshore populations (e.g. breeding colonies and haul-out sites), which is based on the priority of the life cycle stage (e.g. breeding) and that population estimates are generally based on direct counts onshore.

8.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

8.3 Data and Information Requirements

Table 8-1 lists the inputs relevant to planning for the implementation of SCI5b, once the notification to commence is initiated.

Table 8-1: Data Requirements Summary for SCI5b

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases) for pinniped nesting beaches, which were identified as being at risk from exposure of hydrocarbons, and pinniped nesting beaches outside the predicted EMBA. Additional baseline data may be available from the following: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5b can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS 4, OPS5, OPS7, SCI1, and SCI2 activities, including: • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters • data streams from sediment quality monitoring (OPS4 and SCI2), including the location and concentrations of hydrocarbons in sediments on beaches / other terrestrial habitats

8.4 Design

Scientific monitoring for pinnipeds will be achieved by using tissue sampling and analysis to examine direct contamination of pinnipeds, as well as assessing the population status of potentially affected pinniped species. Monitoring of pinnipeds will include, where applicable:

- assessing the population size of the affected pinnipeds
- assessing the exposure of pinnipeds to hydrocarbon.

The most accepted census technique for pinnipeds is to directly count newborn pups at breeding colonies, as this is the only age class guaranteed to be on land and available at one occasion. Additionally, pups generally remain ashore when disturbed during pupping season. Trends in pup numbers can be used as an indicator of the change in population over time. A census will also be undertaken to assess impacts at haul-out sites, with observations undertaken remotely from the haul-out site (e.g. aerial, vessel, lookout location) to avoid disturbing sea lions or seals, which are highly mobile and often leave the colony when disturbed.

8.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 8-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 8-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required
Hydrocarbon spill reaches shoreline areas known to be pinniped breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Will be determined before the survey; at least **three** replicate sites within impact and control areas.
Hydrocarbon spill interacts with nearshore areas close to breeding or haul-out sites	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	

1 Reference sites required for the monitoring approaches are detailed in Section 1

8.4.2 Monitoring Sites

Sampling will address spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations , and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact sites (pinniped terrestrial habitat that may have been exposed to hydrocarbons) and reference sites.

8.4.3 Monitoring Parameters

8.4.3.1 Physical Monitoring Parameters

Sampling to assess the status of the population of pinnipeds in the EMBA will address the spatial and temporal variation of measured parameters (Table 8-3).

Table 8-3: Selection of Parameters for Assessment

Environmental Focus	Key Parameter	Methods	Metric
Population abundance of pinnipeds	Abundance at breeding colonies (pup production)	Ground surveys for pup counts at breeding colonies	• # of pups (dead, alive, brown, moulted)
	Abundance at haul-out sites	Aerial or boat census	• # of pinnipeds
Marine reptile exposure/ mortality/ health	Chemical contamination	Necropsy/tissue sampling	• TPH levels • PAH levels • condition of individual pinnipeds (e.g. oiling, sores) • # of oiled individuals

Before finalising the survey plan, an assessment will be done to determine the likelihood of pinniped presence/absence, species and life cycle stage (e.g. breeding) at the time of the hydrocarbon release, based on the predicted EMBA and time of year.

8.4.4 Monitoring Frequency and Duration

Following the initiation of SCI5b, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored (unless the termination criteria are triggered within this time). Surveys should be undertaken during the breeding season and at each breeding colony location and haul-out site. Annual variations occur in pup production (e.g. annual variation can be as high as 25% in a stable population of the New Zealand Fur Seal, *Arctocephalus forsteri*) and therefore, ongoing surveys should occur annually. Survey data will be reviewed annually, and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

Tissue samples will be collected opportunistically during the census of breeding colonies.

8.4.5 Sample Integrity

Any uncertainties concerning species identification, nesting success, etc., will be mitigated in the field by communicating with the Field Lead/marine pinniped expert.

8.4.5.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler.

Table 8-4 summarises the storage and transport needs for these samples.

Table 8-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

8.4.6 Sample Analysis

8.4.6.1 Population Abundance

Breeding Colonies of New Zealand and Australian Fur Seals

Total pup production for each breeding colony will be the maximum sum of live and dead pups counted. Total population size will be estimated by multiplying the total pup production by a factor of

- 4.79 to 4.9 based on two age-structure population models for New Zealand Fur Seals (Ref. 46; Ref. 47).
- 4.5 based on survivorship model for Australia Fur Seals (Ref. 48).

Breeding Colonies of Australian Sea Lion

Small Colonies (<40 pups)

Pup numbers will be estimated for each survey from the number of marked pups and accumulated dead pups plus the number of live unmarked pups. The maximum of the estimates from each survey will be taken as the pup production estimate for the season.

Large Colonies (<40 pups)

Pup numbers will be calculated using the Cormack-Jolly-Seber (CJS) capture-mark-recapture (CMR) model implemented in a software package (e.g. MARK) to model year-specific survival, recapture probability of pups, population size, and new individuals entering a population.

Total population size will be estimated by multiplying the total pup production by a factor of 4.08, as derived by Goldsworthy and Page (Ref. 47).

Haul-out sites

Abundance will be the total number of seals or sea lions counted at each location.

8.4.6.2 Pinniped Exposure, Health, Mortality

Necropsy

Necropsies (and subsequent pathological or toxicological tests) will help diagnose the likely cause of mortality of dead individuals collected. The standardised protocol for carcass handling and necropsy procedures to be adopted is:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue sample analyses will, as far as practicable, include:

- swabs from visibly oiled pinnipeds for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source.

All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses.

8.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

8.6 QA/QC Procedures

8.6.1 Data

These field data procedures and protocols will be implemented:

- The Pinniped Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

8.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for pinniped surveys.
- All images will be checked to confirm that they are not blurry etc.

8.7 Mobilisation Requirements

8.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale and scope of the program based on relevant species, seasonality, numbers, and potential breeding stage
☐	Examine existing literature, baseline data, and existing monitoring programs to establish priorities for data collection
☐	Determine survey field requirements
☐	Select suitable indicator species
☐	Select monitoring sites (including impact and reference sites)
☐	Select sampling approach and technique
☐	Determine sampling replication required
☐	Develop site-specific health and safety plan
☐	Determine data management requirements
☐	Apply baseline data to the design of the survey approach to ensure protocols and standards for collecting data are aligned
☐	Update and confirm survey/sampling plan, including consideration of tides for access to monitoring sites

8.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC form, eskies, and ice blocks
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to laboratories
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

8.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Task	
☐	Confirm specialist equipment requirements and availability
☐	Check GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, login credentials, and are functional
☐	Check if a first aid kit or specialist PPE is required
☐	Book freight to mobilisation port

All equipment should be checked before transport and before deployment so that the equipment can be operated safely and efficiently.

8.10 Resources

The personnel required to undertake this monitoring program, their roles, and relevant qualifications are listed in Table 8-5.

Table 8-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Pinniped Field Lead	• Lead pup production counts • Lead and undertake counts of pinnipeds at haul-out sites • QA/QC database each day	• Experience in pinniped surveys • Experience in aerial surveys (if this method is used)
Field Assistants	• Undertake pup production counts • Assist in counts at haul-out sites	• Experience in pinniped surveys

Role	Responsibility	Qualifications
	• Input data into database each day	
Veterinary and Pathology Expert	• Conduct necropsy and take tissue samples	• Relevant degree • Able to advise on cause of death • Experience in pinniped necropsy (desirable)
SME/Peer Reviewer	• Review methods	• Experience in pinniped population estimates • Pinniped necropsy procedures

Access to breeding colonies or haul-out sites may require vessels and/or vehicles and therefore, additional team members (e.g. vessel master) and qualifications may be required (e.g. offshore medical, 4WD/off-road training).

8.11 Equipment

The equipment required for the beach survey component of SCI5b is listed below.

Item	
☐	Survey platform: Access to rotary or fixed-wing aircraft or marine vessels
☐	Site access to remote beaches (vessel or helicopter)
☐	Handheld video camera
☐	Digital camera (with GPS where possible)
☐	GPS
☐	Binoculars, ideally 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Access to an NATA-accredited laboratory for processing tissue samples
☐	Haul nets
☐	Ropes for restraining pinnipeds
☐	Stretcher big enough to take an adult pinniped
☐	Containers for small juveniles and hatchlings
☐	Dip nets
☐	Disposable gloves; hand disinfectant; garbage bags
☐	Plastic aprons and rubber boots
☐	Measuring tape
☐	Disposal biopsy tool
☐	Disposable forceps
☐	Surgical scissors
☐	Clean tins and aluminium foil (for hydrocarbon samples)

Item	
☐	Sampling bottles and preservative (70–100% ethanol): • plastic bag • glass/plastic jar • vials
☐	Sharps disposal container
☐	Plain table salt
☐	Cooler for sample storage
☐	Temperature loggers
☐	Eskies
☐	Freezer capable of freezing to -20 °C

8.12 Standard Operating Procedures (SOPs)

8.12.1 Population Abundance of Pinnipeds

Different methods will be implemented depending on whether it is a breeding colony or haul-out site, or whether it is a breeding site for the Australian Sea Lion or the New Zealand/Australia Fur Seal. During the surveys, any seals or sea lions with visible oiling will be recorded.

8.12.1.1 Breeding Colonies of New Zealand and Australian Fur Seals – ‘Direct Count’

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Count and record all pups
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups brown, moulted, unclassed
☐	Once the count of live pups is complete, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.2 Breeding Colonies of Australian Sea Lion

Because of the long breeding season of Australian Sea Lions (up to 7 months), by the end of the pupping season, some pups may have dispersed or moulted (and therefore, may go unrecognised). Therefore, one of these methods will be used:

- Cumulative Mark and Count method to estimate pup numbers for small colonies (<40 pups); or
- CJS CMR model to estimate pup numbers for large colonies (>40 pups) (Ref. 50; Ref. 51; Ref. 52)

Breeding Colony

Step	
☐	Two observers will move together, as quietly as possible, along the shoreline
☐	Catch and mark all pups (marks can include clipping a patch of hair on the back, bleach on the shoulder, or tags on the fore-flipper)
☐	One observer will be responsible for maintaining the count
☐	The other will search carefully including under vegetation and in rock holes, reporting any sightings to the recorder
☐	Classify pups as marked or unmarked
☐	Record the number of pups marked (that were previously unmarked)
☐	Once the count of live pups is undertaken, go back through the colony and count dead pups
☐	Mark all dead pups to prevent recounting in subsequent surveys
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather • start and finish times • GPS position, latitude/longitude at start and finish • results from survey

Haul-out sites – 'direct count'

Step	
☐	Two observers will observe the haul-out site from aerial surveys, a vessel, or land-based (e.g. cliff lookout)
☐	Each observer will undertake an independent count; count all seals and/or sea lions and identify them to species level (if possible)
☐	If aerial surveys are undertaken simultaneously with the real-time counts, take oblique photographs to corroborate the counts
☐	Complete a field log each day, recording the: • date of survey • location • habitat type • high and low tide times • weather

Step	
	• start and finish times • GPS position, latitude/longitude at start and finish • results from survey

8.12.1.3 Pinniped Exposure, Health, and Mortality

Step	
☐	Only trained personnel can handle live or dead stranded pinnipeds
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake a necropsy, if required (see Section 8.5.6)
☐	Sample carcasses of oil-affected pinnipeds
☐	Samples may include: • swabs from externally visible oiled pinnipeds • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

8.13 Forms and Tools

Refer to Appendix C.

9 SCI5c – Marine Megafauna Impact Study: Other Marine Megafauna

9.1 Aims and Objectives

The aim of Scientific Monitoring Program SCI5c – Other Marine Megafauna (SCI5c) is to is to undertake a quantitative assessment to understand hydrocarbon impact and subsequent recovery of affected marine mammals (cetaceans and dugongs) and large cartilaginous fish (such as Whale Sharks, Great White Sharks, Manta Rays, and sawfish).

The objectives of SCI5b are:

- where possible, identify mortality of marine megafauna directly related to a hydrocarbon spill or other spill-related impacts (such as vessel strike, use of dispersants)
- assess the impact of a hydrocarbon spill on marine megafauna. If applicable, evaluate recovery of impacted species.

9.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

9.3 Data and Information Requirements

Table 9-1 lists the inputs relevant to planning for the implementation of SCI5c, once the notification to commence is initiated.

Table 9-1: Data Requirements Summary for SCI5c

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases2F2F2F2) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI5c can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS5, OPS7, and SCI1 activities, including: • identify and map sensitive resources and key receptors within the EMBA • identify and map sensitive resources and key receptors within the EMBA (OPS 5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

9.4 Design

Scientific monitoring for marine megafauna, including marine mammals (cetaceans and dugongs) and cartilaginous fish, will be achieved by determining the abundance of marine megafauna in the EMBA and using tissue sampling and analysis to examine direct contamination of marine megafauna.

[2] Access to data relevant to third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

Monitoring will include, where applicable:

- assessing the presence/absence or abundance of marine megafauna
- assessing the exposure of marine megafauna to hydrocarbons.

There are several limitations in this study, including:

- Current information on the status of marine mammal populations (e.g. stock structure; abundance; movement patterns; age structure; reproductive rates; survival rates and health) is required and can be lacking in most regions. The monitoring of cetacean health is currently considered unfeasible and although visual signs such as changes in behaviour or skin lesions can be used as indicators of health, clearly identifiable links to a particular hydrocarbon incident are unlikely to be established. It is likely statistical tests will not be feasible and interpretation will be largely qualitative.
- A quantitative assessment of cartilaginous fish species is unlikely because of the small numbers encountered. Assessing changes to the presence of adult sawfish at sea is not plausible due to the low numbers and their benthic habitat association, making their detection difficult. However, the presence/absence of populations ascertained by monitoring numbers entering the creeks (using acoustic methods) may be an appropriate proxy to assess change.
- Cartilaginous fish species strandings are unlikely—they do not have a swim bladder so are more likely to sink to the seabed.

A degree of flexibility is required in implementing the scientific monitoring program—the limitations listed above, the focus of assessment in terms of species, and locations cannot be determined until the actual spill event occurs. The methods listed in the subsections below outline several potential approaches for collecting the necessary information, with the actual methods to be selected at the time of the spill.

9.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3, OPS4, OPS5, and OPS7 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES outcomes, and hydrocarbon contact, as determined through OPS5 and OPS7. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 9-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 9-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon spill interacts with areas of biological importance (feeding areas or migration routes)	BACI or IvC or Control Chart Approach and/or Lines of Evidence Approach	Minimum of three sites within each of impact and control areas (for BACI and IvC)

1 Reference sites required for each monitoring approach are detailed in Section 1

9.4.2 Monitoring Sites

9.4.2.1 Species Presence

Sampling will address the spatial and temporal variation of the key parameters. The scale of monitoring depends on the size, location, and time of year of a spill and the potential number of breeding colonies and haul-out sites affected. Sampling needs to be balanced against the logistical constraints of collecting samples in remote locations, and the ability to provide meaningful information within a relevant time frame. Data from operational monitoring will be used to understand the spill trajectory and the potential impact and reference sites.

If marine megafauna are to be assessed, two reference sites/regions (three if possible) should be selected to compare against the EMBA. The reference sites/regions must be matched with impact areas in relation to spatial dimension, habitat, and distance from mainland and/or island coastline habitats, and must be determined during the pre-survey planning period.

The scale of likely impact will determine the spatial and temporal scale of monitoring. Any sampling design must be adaptable to different scales, as constrained by available resources, and be appropriate to the EMBA of a hydrocarbon spill incident. The priority of resources and receptors and the sites themselves, are likely to be different under different spill or weather conditions, the seasonal presence of key species, or the life stage of the species present.

9.4.3 Monitoring Parameters

Sampling to assess the status of marine megafauna populations in the EMBA will address the spatial and temporal variation of measured parameters (Table 9-3).

Table 9-3: Selection of Parameters for Assessment

Environmental Focus	Condition Metric	Methods	Parameters
Species presence	Species present	Aerial/vessel survey	• record presence of species • species identification (where possible)
	Estimate of Abundance	Aerial/vessel survey/ passive acoustic monitoring (PAM)	• # of individuals • species identification
Mortality, health, and fitness	Chemical contamination	Laboratory analysis	• hydrocarbons • biomarkers • trace metals • DNA • stable isotopes
	Oil distribution on individuals	Aerial/vessel survey	• percentage of oiled individuals • distribution of oil on individuals

9.4.3.1 Indicator Species

Depending on location of the spill and its predicted extent, potential indicator species for assessing risks to marine mammals and cartilaginous fish during the operational response have been identified. The selection of indicator species for a particular event will be based on:

- currently available information/data on abundance/distribution/migration patterns within the region
- ability to observe/detect and correctly identify the species
- likelihood of exposure to hydrocarbons
- sensitivity to hydrocarbon spills
- regulatory protection status (i.e. EPBC Act listed species).

9.4.4 Monitoring Frequency and Duration

Monitoring will be conducted at least once in the first year, although is likely to be at a greater frequency (e.g. every three months) in the first year to identify the short-term direct impacts of the hydrocarbons, unless the termination criteria are triggered within this time. Survey data will be reviewed annually; and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured, and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

9.4.4.1 Aerial Surveys

Aerial surveys work well for large marine megafauna (principally whales, Whale Sharks, and Dugongs) and where waters have good light penetration and visibility. The standard protocols for recording effort and sighting data via aerial surveys recommends line-transect distance sampling methods. The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer. Visual and photographic/video data and information on sea state and flight path (as outlined in Table 9-3) should be collected. To limit bias, double-platform line-transect and cue counting will be implemented, where possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include: location (GPS); species; group size; group composition (adults and calves); behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.2 Vessel Surveys

Vessel surveys are suitable in shallow coastal waters where waters may be turbid and therefore, visibility for aerial surveys may be limited. Vessel surveys will be undertaken, if considered practicable, to gather observational data on any marine megafauna close to where the spill occurred or inshore waters (and appropriate reference sites). The survey guidelines listed in Table 9-3 will be applied, as far as practicable, by a trained observer.

Observers will, as far as practicable, be positioned at the highest accessible point (termed ‘primary platform’) with an angle board mounted on the deck railing (preferably towards the stern) to measure the radial angle to the sighting. Increasing observer height increases the resolution with which observers can measure the downward angle to sightings, lessening the change of response movement and increasing the ability to see animals. Double-platform data collection will be implemented, when possible.

Data will be collected using digital audio recordings and/or standardised observation logbook records. For each sighting, data collected should include:

location; species; group size; group composition (adults and calves); angle to sighting (declination), behaviour (directional swimming, non-directional swimming, feeding, resting); cue (underwater, body at surface, splash, blow); swimming direction; oiling on individuals; and reaction to the survey craft.

9.4.4.3 Passive Acoustic Monitoring (PAM)

PAM uses acoustic monitoring technologies and recognition software to detect and record marine mammal vocalisations, with data coupled with visual monitoring. This tool may be used to assess relative abundance estimates of large whales in the EMBA and suitable reference sites. Vocalisation signatures for whale species exist and data are freely available via the Integrated Marine Observing System website (Ref. 53) through the acoustic observatories. Each observatory comprises four autonomous sea noise loggers deployed on the sea floor to form a triangular array of about 5 km sides, with the fourth logger installed in the centre. The Centre for Marine Science and Technology at Curtin University and the Murdoch University Cetacean Research Unit have developed, or are developing, passive acoustic methodology for monitoring marine mammals.

9.4.5 Marine Megafauna Mortality, Health, and Fitness

Data will be collected via visual observations (see Sections 9.5.4.1 and 9.5.4.2) and through chemical contamination.

Marine mammal strandings create an important opportunity for gathering information on an animal's biology, pathology, toxicology, and population genetics, as well as data on natural and human-induced mortality of cetacean populations of the concerned species. If fauna stranding is recorded, a minimum of ten carcasses will be sampled for tissue analysis (providing the necropsy criteria are met). If fewer than ten carcasses are recorded, all carcasses that meet the necropsy criteria will be sampled.

Trained professionals will be involved in handling strandings. If carcasses are observed, physical details (species, length, sex, condition, etc.) will be documented and photographs taken. Basic biological information will need to be collected, and where appropriate, tissue samples for laboratory analysis. Careful and consistent documentation of marine mammal strandings is needed and clinical pathology is required to determine whether the cause of the mortality can be attributed to the hydrocarbon spill event.

The state of decomposition of any carcasses will be evaluated to determine the viability of the samples for specific analysis (analysis is unlikely for severely decomposed carcasses). Tissue samples are required for hydrocarbon analysis and for the interpretation to be meaningful these will need to be assessed against background reference points, where possible. Immediate necropsy, or appropriate freezer storage of carcasses, is required to correlate the physiological and pathological state to any concentration of petroleum products found in tissue samples.

9.4.6 Sample Integrity

Any uncertainties concerning species identification will be mitigated in the field by communicating with the Field Lead.

9.4.6.1 Tissue Sampling

To maintain sample integrity, transport and storage requirements must be adhered to. If there may be a delay in freezing these samples, they can be stored for a limited time in an esky with ice blocks until they can be frozen. All sample storage containers will contain a small temperature logger, which will remain with the samples until delivery to the final storage location or laboratory.

DNA samples can be stored in plain table salt for transport or a salt-buffered DMSO solution. Stable isotope samples can be stored in plastic bags in a refrigerator or cooler. Samples should be kept cool (<5 °C) if kept in bags but not frozen, and they should not be held for an extended period. Table 9-4 summarises the storage and transport needs for these samples.

Table 9-4: Tissue Sample Storage and Transport Requirements

	Sample	Preservation Method	Storage Requirements	Transport Requirements
Genetics	Skin or liver (if available)	70 to 100% ethanol, in internally labelled vials	Frozen	Frozen
Stable isotopes	Tissue (other than fat)	70% ethanol	Frozen	Frozen
Toxicology	Tissue, swab, and stomach/intestine samples	• Samples stored in sterile aluminium foil and then bagged • Heavy metal testing samples stored in plastic or glass	Frozen (-20 °C)	Frozen (-20 °C)

9.4.7 Sample Analysis

In addition to contrasting between impact and reference sites, the power of a sampling design to detect real changes in system state is determined by the level of replication. In this instance, replication is unlikely to achieve sufficient power; hence statistical tests will not be conducted to compare spatial and temporal variability. However, the Marine Mammal Health and Strandings Response Program (Ref. 54), which uses the Unusual Mortality Events (UME) method to assess strandings significance, may be used.

9.4.8 Species Presence

These resources will be used for distance sampling design and analyses (Line-Transect Surveys):

- Introduction to Distance Sampling: Estimating Abundance of Biological Populations (Ref. 38)
- Design of distance sampling surveys and Geographic Information Systems (Ref. 55).

An indication of the statistical power to detect change in strandings should be provided. Data will need to be stratified and categorised accordingly. The Marine Mammal Health and Strandings Response Program (Ref. 54) uses the UME method to assess strandings significance.

9.4.9 Marine Megafauna Exposure, Health, Mortality

9.4.9.1 Necropsy

Necropsies (and subsequent pathological or toxicological tests) help diagnose the likely cause of mortality of dead individuals collected. This standardised protocol for carcass handling and necropsy procedures will be adopted:

- Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist (Ref. 49).

Lung tissue will be assessed visually to identify any hydrocarbon spots.

9.4.9.2 Tissue Sample Analysis

Samples collected from all stranded and live animals during the hydrocarbon spill event will be stored pending decisions on sample analyses. The number and types of analyses to be carried out will be determined after consultation with Scientific Monitoring Officers. Tissue samples analyses will, as far as practicable, include:

- swabs from visibly oiled marine megafauna for hydrocarbon confirmation and fingerprinting
- PAH (Cytochrome P450 may be used as a measure of hydrocarbon exposure) and TPH analysis
- stable isotopes analysis to help identify where stranded animals may have originated
- bacterial cultures for pathogen identification from fresh carcasses or live animals.

As well as reporting on tissue levels of hydrocarbons, other diagnostic chemical characteristics that can be used to fingerprint the hydrocarbon will be screened to confirm the hydrocarbon source. All onshore chemical analysis will be completed at an accredited NATA laboratory (where relevant).

Other sampling for other analyses may include:

- stomachs for prey analysis
- tissue histopathology
- genetic analyses
- teeth for determining the animal's age.

9.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

9.6 QA/QC Procedures

9.6.1 Data Collection

These field data procedures and protocols will be implemented:

- The Field Lead will review the hardcopies and the database/spreadsheet each day, to ensure accuracy.
- Backup data files will be opened once created to verify the backup was completed.

9.6.2 Samples

These procedures and protocols will be implemented for data capture:

- All personnel will have training, where relevant, on species identification and procedures for marine megafauna surveys.
- All images will be checked to confirm that they are not blurry etc.
- All samples that will be transported for laboratory analysis will be accompanied by a CoC form that provides details of the samples being sent and that will be used to verify that all samples collected were received at their intended location. The CoC form documents all aspects of sample storage and transport from collection to the final storage location or laboratory.

9.7 Mobilisation Requirements

9.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

9.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation

9.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

9.10 Resources

The personnel required to undertake SCI5c, their roles, and relevant qualifications are listed in Table 9-5.

Table 9-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Marine Mammal Observer/Field Lead	• Lead aerial/vessel surveys • QA/QC database each day	• Marine Mammal Observer certification • Experience in marine mammal aerial surveys (desirable), vessel surveys (desirable), and necropsy (essential)

Role	Responsibility	Qualifications
		• Able to identify species by tracks and hatchlings
Field Assistants	• Undertake aerial/vessel surveys • Input data into database each day	• Experience in aerial and/or vessel surveys
Veterinary and Pathology Expert	• Conduct necropsy	• Relevant degree • Able to advise on cause of death • Experience in marine mammal necropsy (desirable)

9.11 Equipment

The basic set of equipment required for SCI5c is listed below.

Item	
☐	Survey platform: e.g. rotary or fixed-wing craft (recommended AMSA Dornier 318 or CASA 212–400 fixed-wing aircraft), i.e. high-wing aircraft with downward visual capability or marine vessels, or long-distance capable drone
☐	Handheld video camera with date stamp and GPS
☐	Digital camera (with GPS) and telephoto lens
☐	GPS
☐	Clinometers
☐	Binoculars, 8 × 30 to 10 × 50 in size
☐	Nautical charts
☐	Log book/observation sheets
☐	Species Field Identification Guide
☐	Audio recorder
☐	Tissue sample collection kit

9.12 Standard Operating Procedures (SOPs)

9.12.1 Population Abundance/Status of Marine Megafauna

Marine mammal populations and population status will be assessed using field studies that are based on SOPs for surveying marine megafauna from the air and from vessels.

9.12.1.1 In-water Populations

The standard survey platforms used for assessing marine megafauna at sea are aerial (manned or unmanned) or marine vessels. This will use distance sampling population estimator using aerial transect surveys in reference and impact sites.

9.12.1.2 Aerial Surveys

The standard protocols for recording effort and sighting data recommend line-transect distance sampling methods.

9.12.1.3 Vessel Surveys

Vessel surveys for the presence of marine megafauna are likely to occur opportunistically, depending on the vessel type, and will provide a direct count of observed affected individuals. The survey guidelines listed in Table 9-6 will apply.

Table 9-6: Standard Survey Methods

<table>
<tr><th>Timing</th><th>Vessel Survey Methods</th><th>Aerial Survey Methods</th></tr>
<tr><td rowspan="3">Pre-survey</td><td colspan="2">Calibrate distance estimation for each observer</td></tr>
<tr><td colspan="2">Establish transects to be surveyed</td></tr>
<tr><td>Establish strip width for transects e.g. 400 m each side of the vessel and 100 m ahead
NOTE: For pelagic surveys, the entire area around the vessel will be scanned out to a maximum distance that still permits accurate identification</td><td>Establish strip width for transects to each side of the aircraft:
• 400 m for whales and dugong, and/or
• 750 m for Whale Sharks</td></tr>
<tr><td rowspan="6">During survey</td><td>Vessel speed: 10 knots (range 5–15 knots)</td><td>Aircraft speed: approximately 90–100 knots or as slow as safely possible; to be determined by the pilot
Altitude: approximately 500 ft
Beaufort state: <3</td></tr>
<tr><td colspan="2">Continuously record latitude and longitude (e.g. 30-second intervals) using a handheld data logger</td></tr>
<tr><td colspan="2">Marine mammal observations:
• Record observations of each individual or group in real time to a dedicated handheld data logger
• Count all observed individuals and record their identity (preferably to species level), and determine their age class (if possible)</td></tr>
<tr><td colspan="2">Take photographs and/or video to help identify and count species</td></tr>
<tr><td colspan="2">Record other variables including, as far as practicable:
• location
• vessel/aircraft speed and direction
• weather conditions, including:
– temperature
– precipitation
– wind strength and direction
– visibility (including glare)
• whether transect is in hydrocarbon-affected water.</td></tr>
<tr><td colspan="2">Confine observations to daylight hours, and suspend observations in heavy rain, heavy winds, fog, or rough seas</td></tr>
</table>

9.12.2 Marine Megafauna Exposure, Health, and Mortality

Step	
☐	Only trained personnel are to handle live or dead stranded marine megafauna
☐	Collect and freeze all stranded animals (as far as practicable)
☐	Undertake necropsy, as required (see Section 8.5.6)
☐	Take samples of carcasses of oil-affected marine megafauna

Step	
☐	Samples may include: • swabs from externally visible oiled marine megafauna • tissue from the lung, liver, and kidney • stomach and intestinal contents • bile secretions
☐	Place samples in a small esky with frozen ice bricks. Transfer to freezer when possible for storage
☐	Complete laboratory-specific CoC forms
☐	Label, record, and cross check all samples with field sheets and CoC forms
☐	Maintain appropriate CoC and secure samples

9.13 Forms and Tools

Refer to Appendix C.

10 SCI6 – Benthic Habitat Impact Study

10.1 Aims and Objectives

The primary aim of SCI6 – Benthic Habitat Impact Study (SCI6) is to determine the extent, severity, and persistence (including recovery) of impacts on subtidal benthic habitats and biological communities following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the EMBA, as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 focuses on the subtidal zone—habitats seaward of LAT, separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- determine the extent, severity, and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- collect information to determine short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time after termination of the response

10.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

10.3 Data and Information Requirements

Table 10-1 lists the inputs relevant to planning for the implementation of SCI6, once the notification to commence is initiated.

Table 10-1: Data Requirements Summary for SCI6

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.) and information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 activities, including: • consolidated data file including exceedances of benchmark levels (this information should be provided in electronic format, as it becomes available).	Information available at commencement of SCI6 on survey design or results from implemented scientific monitoring (primarily SCI1, SCI2, and SCI3)

10.4 Design

10.4.1 Monitoring Design

Benthic habitats may support various biological communities during all, or part of, the year. To help inform scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities that help understand impacts on the most sensitive areas and will involve a combination of these monitoring strategies:

- Physical: To provide observations and measurements that describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be a proxy for biological monitoring of large-scale changes on shallow benthic habitats (e.g. seagrass, macroalgae).
- Biological: To determine the extent, severity, and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by assessing commonly monitored ecological, population, and community parameters. As far as practicable, monitoring will also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae, and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 10-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 Reference sites required for each monitoring approach are detailed in Section 1

10.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide, refer to Table 10-2) are reviewed. This will help identify sensitive habitats, associated parameters, and methods.

Monitoring locations will be defined taking into account these considerations:

- likelihood of hydrocarbon impact on benthic habitats
- select several impact and reference locations over a large spatial area
- similarity and representation of habitats, physical features, and sediment type between impact and reference locations
- select and prioritise impact sites within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- degree of hydrocarbon exposure or potential exposure of the benthic habitats
- when selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case, reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

10.4.3 Monitoring Parameters

10.4.3.1 Physical Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods), as detailed in Table 10-3.

Table 10-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

10.4.3.2 Biological Monitoring Parameters

Table 10-4 lists the proposed range of biological parameters and associated survey methods that may be monitored.

Table 10-4: Proposed Biological Parameters (including remote sensing) within Intertidal Habitat

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
Coral Reef	Fine-scale benthic surveys	Coral reef	Stratified haphazard transects (e.g. within zones of: lagoon, reef flat, crest, and slope as applicable) using towed camera, drop camera, ROV camera, or diver-swum camera surveys. Divers for collection and deployment of coral reproduction parameters	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Percentage cover of other benthic organisms	• Coral recruitment (recruits) • Juvenile coral counts • Recent (whole colony) coral mortality	• Signs of bleaching, partial mortality, number of breaks • Colony and polyp level fecundity
		Coral reef	Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Macroalgae and seagrass	Broad-scale benthic surveys	Macroalgae Seagrasses	Stratified haphazard transects using towed camera or ROV and benthic grab for seagrass	• Percentage cover of taxa • Diversity • Distribution • Dominant taxa • Other benthic organisms	• Abundance (seagrass/algae) • Shoot density (seagrass) • Holdfast density (macroalgae) • Biota tissue sampling (where possible and appropriate) (macroalgae)	• Blade condition (signs of blackening and defoliation) • Growth rates
			Remote sensing	• Large-scale distribution and extent (Coastal zone)	N/A	N/A
Subtidal pavement, rocky reef, or hard substrate	Broad-scale benthic surveys	• Macroalgae • Filter feeders (sponges) • Corals • Hydroids	Stratified haphazard transects using towed camera	• Percentage cover/ density • Diversity • Distribution • Dominant taxa	• Biota tissue sampling	N/A

Habitat	Method	Biological Community	Suggested Biological Survey Method	Community Parameters	Population Parameter	Individual Parameters
		• Soft corals				
Soft-bottom	Broad-scale benthic surveys	Infauna	Sediment sampling using sediment grab	• Density • Diversity • Distribution • Dominant taxa	• e.g. ratio of polychaetes/ amphipods	N/A

10.4.3.3 Chemical Monitoring Parameters

The chemical monitoring parameters to be tested and the methods for water and sediments are described in detail in SCI1 and SCI2.

10.4.4 Monitoring Frequency and Duration

Following the initiation of SCI6, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

10.4.5 Sample Integrity

10.4.5.1 Physical Monitoring Methods

Table 5-3 details the physical monitoring parameters and sampling methods to be used.

10.4.5.2 Remote Sensing Methods

Remote sensing may initially be used to determine potentially impacted habitats, habitats at risk, and reference areas (outputs from the MES scope may be suitable). If practicable, remote sensing will be used to assess biological parameters within the study area to measure the condition of these habitats during scientific monitoring.

The remote sensing technique (e.g. infrared thermal imaging, synthetic aperture radar, side-looking airborne radar, satellite images) used will depend on the intended parameter to be collected (i.e. presence/absence, percentage cover), which requires evaluation of the pixel size required (i.e. coarse, medium, fine) and cost. A guideline for implementing appropriate remote sensing monitoring equipment is provided by the Remote Sensing Research Centre (Ref. 27).

To correctly calibrate remote sensing imagery, field surveys will be required to ground-truth or validate field measurements from the target area to be monitored. Remote sensing techniques are not always practicable and will probably not be suitable to characterise benthic habitat within turbid nearshore waters or substrate beyond the coastal zone (>20 m depth).

10.4.5.3 Biological Monitoring Methods

Subtidal systems are highly complex and natural spatial and temporal variation in physical and biological structure is almost always high. Biological monitoring must target the main ecological components of benthic communities that reflect the particular sensitivities of the subtidal location and that can be used as an indicator for wider community health. Potential indicator flora and fauna for each broad habitat type are summarised in Table 10-4.

Marine Flora and Epifauna Surveys

Benthic surveys are intended to enable broad-scale but detailed observations of the physical and biological structures of benthic habitats. The survey methodology for benthic habitats involves recording imagery from transects for real-time and later analysis (e.g. stills and video footage from handheld camera, towed video, drop-down camera, or ROV).

The imagery will be assessed for:

- real-time habitat classification—used to verify and map the variety and extent of the benthic habitats at risk. Observations of benthic habitat features will be recorded at fixed time intervals, or when a feature of interest or a change in habitat type is observed. These methods ensure data are collected instantaneously and can be immediately used for generating maps, allowing information to be passed to other teams within useful time frames
- quantitative analysis of high-quality still images taken during benthic transect surveys—used to measure community and health parameters for indicator taxa (e.g. Ref. 56; Ref. 57; Ref. 58 ; Ref. 59). The georeferenced still photo images will be subsampled at a standardised spatial separation then grouped for detailed point-intercept analysis. Choice of indicator taxa will be based on advice from SMEs, but will likely include corals, non-coral benthic macroinvertebrates, seagrass, and macroalgae.

Habitat data will be classified according to a hierarchal system of biophysical characteristics designed to consistently define benthic habitats (e.g. CATAMI classification scheme [Ref. 60]). The most common or dominant taxa within each assemblage should be classified to the greatest practicable taxonomic resolution. This classification depends on the clarity of the video footage, which will vary with weather conditions and water clarity. Database software should be used with pre-programmed habitat types or biota of interest, with the associated data on position and depth recorded. In the absence of this software, the GPS position and depth should be recorded at regular intervals.

Infauna Sampling

Infauna is the assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans). Sediment sampling collects infauna found directly below the surface in soft-substrates. Sediment samples are typically collected using a grab, although can also use trawls, dredges, box corers, suction samplers, and handheld corers (see AMSA [Ref. 17], Guideline M.9). Usually the entire sample is sieved for benthic infaunal analyses or if chemical subsamples are required; care must be taken to ensure the subsamples are very small to avoid losing organisms. Once sieving is completed, the remaining organisms are washed, fixed using formalin or ethanol (consult the identifying laboratory), stored safely, then sent to a laboratory. Because infaunal communities may be variable or patchy, it is standard practice to take replicate samples from any one site to provide an average of species richness and abundance, and provide a representative sample of the species present.

Guidance on Methods and Assessment of Potential Population Parameters

Seagrass Above- and Below-ground Biomass

Sediment grab samples will be collected within seagrass sites for above-/below-ground biomass. Sediment samples for seagrass biomass will be wet sieved with a 125 µm sieve on site and all seagrass material removed, dried on tissue paper, and weighed and frozen, before sediment and seagrass is sent to the laboratory for analysis. Seagrass material will be weighed in the laboratory.

10.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment, or tissue samples that require preservation, transport, storage, and analysis. The procedures for sampling, storage, and analysis are provided in SCI1, SCI2, and SCI7.
- Field data: Includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparison with data collected in later years. Data must be organised in a way that makes it easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software CPCe (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes), the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy appearance, partially or fully bleached; Ref. 62).

Where possible, image analysis and machine learning methods will be used (e.g. Ref. 63) after verifying they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and/or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be determined at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size, and depth.

10.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

10.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed, or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using these methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)
- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove 'ecological noise' from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the monitoring program.

10.7 Mobilisation Requirements

10.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures

Task	
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

10.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation
☐	Assemble scientific survey team
☐	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

10.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
☐	Confirm specialist equipment requirements and availability: • ROV/autonomous underwater vehicle (AUV)/drop camera/towed camera • subsea positioning (if required) i.e. ultra-short baseline (USBL) • dive spread (if required) • benthic grab • remote sensing platform
☐	Check if instrument calibration is required And that calibration certificates are on file
☐	Check if equipment redundancy is required
☐	Check if a DGPS is required
☐	Confirm installation of real-time classification software (if available)
☐	Book freight to mobilisation port

10.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate specimens. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities, and relevant qualifications are listed in Table 10-5.

Table 10-5: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• Australian Diving Accreditation Scheme (ADAS) Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

10.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment requirements for SCI6 are listed below.

Items	
☐	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
☐	Is redundancy required?
☐	DGPS
☐	Echo sounder on each vessel

Items	
☐	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
☐	Backup data storage for field data
☐	Tissue preservation material and sample jars
☐	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
☐	Specialist PPE (i.e. PFD, respiratory protective equipment [RPE])
☐	Book freight to mobilisation port

10.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques is:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.

10.12.1 Stratified Haphazard Transects – Pre-mobilisation

Step	
☐	Generate a field map with the location and coordinates of all monitoring sites, including reference sites, to meet the monitoring objectives
☐	Define monitoring parameters including habitat type, boundaries, number of sites, number of transects, length of transects, and number of quadrats per transect, to meet the monitoring objectives
☐	Prepare and assemble all field equipment, including redundancies
☐	Arrange access to vessel or other suitable monitoring platform

10.12.2 Stratified Haphazard Transects – In Situ Monitoring

Step	
☐	Assess percentage cover of each habitat type at each site using photo quadrats, taken along transects
☐	Randomly select the locations of transects at each site
☐	Record and georeference the start location (latitude and longitude) of each transect, as well as the bearing and distance of each transect
☐	Use a minimum of three replicate transects at each site
☐	Randomly locate photo quadrats along each transect. Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment)
☐	Plan for a minimum of five photo quadrats per transact. The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives. Note: Standardise the length of transects and number of quadrats across sites
☐	Take photos with a still camera, or as still images from video transect footage
☐	Maintain a consistent method of capturing photographs among surveys, and where possible, across all survey sites (Note: Technology improvements may be incorporated into surveys). If practicable,

Step	
	use sufficient lighting to capture high-quality still plan (downward-facing) images (taken from a still camera or still images from video transect footage)
☐	If practicable, mark the quadrat boundary within each image as either a solid boundary (i.e. frame placed on the transect) or use underwater lasers to mark out a scale
☐	Where possible, locate transects in similar depths within sites
☐	After retrieval, QA/QC check and backup data on site
☐	Analyse data using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats

10.12.3 Benthic Samples

Step	
☐	Use sediment grabs (e.g. Van Veen; refer to SCI2 for SOP) to collect five samples (minimum 250 mL jar) from each site
☐	Check that samples are at least 10 cm deep, with a minimum surface area of at least 125 cm^2
☐	From each sample, separate biological samples (plants, algae), place in jars that have been pre-cleaned with Teflon or aluminium cap / alfoil barrier
☐	Complete and check jar labels and CoC forms. Store samples as directed by the laboratory

10.13 Forms and Tools

Refer to Appendix C.

11 SCI7a – Fisheries and Aquaculture Impact Study

11.1 Aims and Objectives

The primary aim of SCI7a – Fisheries and Aquaculture Impact Study (SCI7a) is to determine the extent of impact from hydrocarbons on fish and aquaculture resources in regards to hydrocarbons detected in fish tissue if a hydrocarbon spill impacts an area considered ecologically important for fish and aquaculture resources.

The objectives of SCI7a are to:

- identify, report, and monitor lethal impacts on fish as related to the hydrocarbon spill and/or to the hydrocarbon spill response
- determine the spatial and temporal extent of sublethal impacts on indicator species, which may impact commercial and recreational fish species, including:
  - health effects attributable to the spill and/or response activities
  - tainting of the flesh and/or bioaccumulation of toxins in fish

The actual scope of fish and aquaculture resources monitoring depends on the receptors identified within the EMBA by a hydrocarbon spill. SCI7a outlines how the effects of hydrocarbon spills on bony and cartilaginous fish and aquaculture species, such as bivalves will be assessed, excluding those fish assessed under other studies, i.e. SCI5c, which covers Whale Sharks and large sharks.

11.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

11.3 Data and Information Requirements

Table 11-1 lists the inputs relevant to planning for the implementation of SCI7a, once the notification to commence is initiated.

Table 11-1: Data Requirements Summary for SCI7a

Baseline Information	Operational Information
• Existing baseline data (as documented in Chevron internal databases3F3F3F3) for marine megafauna, which were identified as being at risk from exposure of hydrocarbons. Additional baseline data may be available from: – OSRA provided by AMSA – I-GEMS (WA only) • Review methods undertaken during baseline studies to ensure that data collected during SCI7a can be directly compared to the existing baseline data	Outputs from MES, OPS3, OPS8, SCI1, and SCI2 activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill • identify and map sensitive resources and key receptors within the EMBA (OPS5 and OPS7) • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters Outputs from OPS8 activities, including: • consolidated data file

11.4 Design

11.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES, OPS3, and OPS8 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES, OPS3, and OPS8 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 11-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 11-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume that dissipates from source	Gradient Approach and Lines of Evidence Approach	At least two sites at each distance from source
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, wherever practicable, data representing the current state of the receptors of interest will be collected before the spill reaches them.

11.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from MES and OPS8 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

[3] Access to data from relevant third-party providers may be required for baseline information (including CSIRO and state conservation agencies e.g. DBCA)

11.4.3 Monitoring Parameters

Indicator Species

Given the number of fish species with the potential to be in an area at any one time, indicator species need to be selected for detailed tissue and health analysis. Indicator (target) fish and aquaculture species will be selected from the identified receptors at risk within the EMBA to represent impact to fish health and will include demersal and/or pelagic commercial and recreational species based on the species available in sufficient abundance within the EMBA. The selection of a fish species as an indicator species will be based on knowledge of which species represent the most sensitive component with reference to:

- abundance within the impacted area
- distribution within the impacted area
- availability of prior baseline information
- vulnerability to the impacts of a hydrocarbon spill.

The selected indicator species must be sufficiently widespread to allow sampling both inside and outside affected areas; where low numbers of preferred indicator species are collected, alternative species may need to be considered during the survey. Representative indicator fish species and aquaculture species will be collected using methods appropriate to the sampling habitat, characteristics of the target species, and the life-history stage. The samples collected in impacted areas will be compared to samples collected at suitable reference sites. If fish kill occurs, whole fish will be obtained and preserved for necropsy to attempt to determine the cause of death.

Table 11-3 summarises the monitoring parameters.

Table 11-3: Selection of Parameters for Assessment

Type	Parameter
Physiological indicators and biochemical markers	• Condition factor • Liver-somatic index • Gonadosomatic index and histological examination of gonads • Oxidative DNA damage • Liver detoxification enzymes • Biliary PAH metabolites • Sorbitol dehydrogenase (SDH) activity
Muscle tissue, biopsy, and gut content samples	• PAH and the standard USEPA list of 16 priority pollutants • Saturated hydrocarbons in the C10 to C36 range • Volatile hydrocarbons.
Blood serum	• SDH activity • Oxidative DNA damage (8-oxo-dG content)
Bile	• Biliary metabolites
Gonads	• Histology assessment
Fish mortality	• Dead fish count

11.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7a will be determined by the level of impacts from the hydrocarbon spill and achievement of the termination triggers.

11.4.5 Sample Integrity

Methods for specimen handling were derived from Gagnon and Rawson (Ref. 44; Ref. 45) and Burns *et al*. (Ref. 43). In summary, the general requirements for samples are:

- Fish flesh for chemical analysis will be wrapped in HPLC-grade solvent-rinsed aluminium foil and frozen at 20 °C.
- Fish flesh for taint testing will be wrapped in food-approved ziplock bags and frozen at 20 °C.
- Biopsies of solid tissues and bile must be placed in a sterile cryovial and immediately frozen in liquid nitrogen at 190 °C.
- Biopsies of blood need to be centrifuged, serum isolated, and placed in a cryogenic vial at 190 °C.

Care should be taken not to contaminate samples; work spaces should be thoroughly cleaned and decontaminated between samples.

White flesh samples collected for taint testing and for chemical analysis must be treated as two different samples. Chemical analysis requires 25 g of flesh whereas taint testing requires 400 g.

Jars and plastic bags must be labelled with all relevant information including: species, location, identification number, and date. The sample number is related to a record containing species name, size, type of tissue, handling details, capture location, capture depth, and all observations of health, presence of visible hydrocarbons, etc.

11.4.6 Sample Analysis

Chemical analysis of fish tissues for hydrocarbon will follow the procedures outlined in Burns *et al*. (Ref. 43) and Gagnon and Rawson (Ref. 44; Ref. 45). Equivalent procedures may also be considered provided they are capable of yielding information of equivalent or superior quality. Onshore chemical analysis will, where relevant, be completed at an ecotoxicology laboratory.

Statistical analysis of fish tissue data will be undertaken and may include regression analysis relating hydrocarbon concentrations in the water column (or other relevant exposure index) to concentrations in fish tissues and various indexes and biochemical markers of fish health. Other analytical methods including mixed-effect linear models or analysis of similarities could also be used to examine before-after and impact-reference effects (and the interaction), in accordance with the sampling design implemented.

11.5 Data Management

Monitoring activities may be undertaken over several years and are likely to result in data that may be obtained/generated from several sources in various formats. All records will be kept in a field log. This log will be copied to an electronic spreadsheet/database at the end of each day.

Data (including GPS locations and photos) will be backed up to a separate location, e.g. external hard drive. This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Data received from the laboratories (including backups) will be downloaded and stored on the contractor's computer system. This data will be received approximately two to three weeks after receipt of that batch of samples. QA/QC'd data will be presented in spreadsheet format and then transferred to Chevron as required.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

11.6 QA/QC Procedures

For each fish collected, a datasheet will be completed, which will contain this information as a minimum:

- date
- site number
- species
- sample identification
- location of capture (coordinates)
- health of specimen (including abnormalities/signs of stress) as per Section 1.5.2
- basic morphological measurements (including length, weight, gonad weight, liver weight, sex, and reproductive stage) as per Section 1.5.2
- sample types taken
- photos of specimen taken (with sample identification visible in photograph)
- preservation method
- relevant CoC reference
- notes.

11.7 Mobilisation Requirements

11.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
□	Determine the scale of the study area
□	Select study area sites (including impact and reference sites if applicable)
□	Select sampling approach and techniques
□	Determine sampling replication required

Task	
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

11.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

11.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

11.10 Resources

The personnel required to undertake SCI7a, their roles, and relevant qualifications are listed in Table 11-4.

Table 11-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish pathologist, or suitably experienced marine scientist	• Develop sampling plan • Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • Fish collection experience • TBOSIET • Offshore medical
Ecotoxicologists for collection and handling of biopsies	• Undertake on-board fish biopsies • May also assist in collecting samples if suitably qualified • Handle, store, and label samples according to guidelines	• Field biopsy experience • TBOSIET • Offshore medical

11.11 Equipment

Chemical analysis of tissue samples will require an extensive list of equipment for extracting the tissue and examining fish health; a complete list should be developed in consultation with the ecotoxicologist responsible for biopsy collection and handling.

Appropriate sampling equipment for collecting live specimens will also be required, and will depend on the specific receptors being examined, and the location of sampling. This will be established during the operational phase of the spill response.

Redundancy for key pieces of equipment should also be considered.

11.12 Standard Operating Procedures (SOPs)

11.12.1.1 Fisheries and Aquaculture Species Exposure and Health

Field studies to collect fish and other species will be undertaken at various reference and potentially impacted sites. As far as practicable, specimens collected for sampling must be sacrificed immediately for biopsy collection. These samples will be used to determine the extent of contamination in tissues (tainting), as well as assess associated physiological stress.

Table 11-5: Steps for Sampling Fish Health, Tainting, and Fish Mortality

Step	
Fish Health and Tainting Samples	
☐	Investigate potential indicator species once the location and extent of the spill is known
☐	Collect fish. Potential collection methods may include: netting, trawling, baited fish traps, spear fishing, and line fishing, depending on species selected and spill location
☐	Collect a target sample size of 20 individuals per species per site

Step	
☐	At each site, complete the field log , including details on: • weather conditions • time arrived at site • environmental conditions at the site • presence of a hydrocarbon slick • sample details for individual samples/health assessments/fish mortality • sample description notes • location of each sample (GPS coordinates, place names e.g. Sandy Island – western side) • full name of person taking sample • full name of witness (if sampling for legal purposes) • photograph numbers recorded at this site • time departed site
☐	Take photographs throughout the sampling process and add the reference number to the field log
☐	Identify samples, look for any visible signs of abnormality or physical stress, photograph the sample, and record the geographic coordinates of the place of capture
☐	Take measurements of basic morphological data, including: length, weight, gonad weight, liver weight, sex, and reproductive stage
☐	If biopsies are not to be done straight after specimen capture, then keep specimens alive in oxygenated aquariums until ready for biopsy
☐	Obtain tissue and gut contents samples: • a target of 400 g of white flesh per sample (fish) for hydrocarbon analysis (tainting) or equivalent for other species (e.g. bivalves) • a target of 25 g of white flesh per sample (fish) for chemical analysis or equivalent for other species (e.g. bivalves) Analyse tissues and gut contents for: • PAH and the standard USEPA list of 16 priority pollutants via normal phase silica chromatography and GCMS • saturated hydrocarbons in the C10 to C36 range via by flame ionisation GC • volatile hydrocarbons via purge and trap into a GCMS
☐	Blood serum, gall bladder, bile, liver, and gonad samples will be processed and analysed at a suitable laboratory for the parameters listed in Section 12.5.1
☐	Handle and preserve samples appropriately; mark all samples with appropriate sampling information as listed in Section 12.5.1.
Collecting Dead Fish	
☐	If fish kill is observed, collect and preserve (freeze) whole, dead fish for necropsy. If many dead fish are evident, estimate the total number and retain a reduced number (~20 fish per species) of representative specimens for necropsy. Comply with the standard procedure for reporting fish kills to the relevant state fisheries authorities.

11.13 Forms and Tools

Refer to Appendix C.

12 SCI7b – Fish Impact Study

12.1 Aims and Objectives

The primary aim of SCI7b – Fish Impact Study (SCI7b) is to determine the extent of impact on populations and abundance of fish and fisheries resources if a hydrocarbon spill impacts an area considered ecologically important for fish and fisheries resources.

The actual scope of the fish and fisheries resources monitoring depends on the receptors identified within the EMBA by the hydrocarbon spill. SCI7b outlines how the indirect effects on bony and cartilaginous fish populations and abundance will be assessed, excluding those fish assessed under other studies, e.g. SCI6, which covers Whale Sharks and large sharks.

The objective of SCI7b is to determine whether the spill has directly or indirectly impacted the abundance and composition of fish assemblages.

12.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

12.3 Data and Information Requirements

Table 12-1 lists the inputs relevant to planning for the implementation of SCI7b, once the notification to commence is initiated.

Table 12-1: Data Requirements Summary for SCI7b

Baseline Information	Operational Information
• Access to consolidated project-specific baseline data (Excel file) and baseline summary report/data for the relevant location • For many fish species, a range of baseline datasets exists for both pelagic (e.g. State Fisheries) and demersal species (e.g. State Governmental Environmental Agencies) • Review methods undertaken during baseline studies, if available, to ensure that data collected during SCI7b can be directly compared to the existing baseline data.	Outputs from MES activities, including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and SCI1: • data streams from marine water quality monitoring (OPS3 and SCI1), including the location and concentrations of hydrocarbons in marine waters

12.4 Design

12.4.1 Monitoring Design

The monitoring approach needs to consider the data collected during MES and OPS3 activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution, as determined through the MES and OPS3 outcomes. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values (if available). Table 12-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 12-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3, OPS8* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicates Required
Offshore hydrocarbon plume dissipating from source	Gradient Approach	Will be determined as part of program finalisation
Hydrocarbon spill interacts with nearshore areas (e.g. coral reefs, seagrass etc.)	BACI or IvC and/or Lines of Evidence Approach	Will be determined as part of program finalisation

If sufficient baseline data are not available, data representing the current state of the receptors of interest will be collected before the spill reaches them, where practicable.

Additional parameters, such as measured hydrocarbon concentrations at sample sites (obtained through other OPS and SCI activities) can help establish a cause and effect relationship. This highlights that an essential link exists between the sampling design developed for SCI7b, and that used during other OPS and SCI activities. As such, the sampling designs developed here for each objective should be considered when designing other relevant monitoring activities.

12.4.2 Monitoring Sites

Sampling sites will be selected once the outputs from the MES and OPS3 activities are generated so that the type, depth, and extent of the spill can be incorporated into the survey design.

If a spill event occurs and baseline data are not available and cannot be collected immediately before impact, greater sampling effort must be undertaken to ensure that the sampling design incorporates at least three reference sites and three potentially impacted sites (Ref. 44) to maximise the possibility for attributing cause and/or detecting change. Reference sites are those that are minimally disturbed regarding their physical, chemical, and biological characteristics (Ref. 68). Reference sites should be selected in the same bioregion as the impacted sites to have comparable physical, chemical, and biological characteristics.

12.4.3 Monitoring Parameters

Assessments of fish populations will use methods that relate to the particular species identified to be at risk.

Data will be obtained for replicate sites within the EMBA and at reference sites, and relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures. The main parameters recorded will be:

- species identification
- fish counts.

12.4.4 Monitoring Frequency and Duration

The study will be undertaken at intervals determined appropriate at the time of commencement. The frequency and number of repeat studies required to meet the objectives for SCI7b will be determined by the level of impacts from the Level 3 hydrocarbon spill and achievement of the termination triggers.

12.4.5 Sample Integrity

Observations using baited remote underwater video stations (BRUVS) will, if practicable, be conducted during SCI7a. If possible, the vessel will move away from the catch area to a suitable site to conduct BRUVS while biopsies are conducted.

BRUVS footage will be downloaded and backed up (two copies) before leaving each site.

12.4.6 Sample Analysis

Statistical analysis will be undertaken using approaches suitable to the overall sampling design established, will involve evaluating differences between impact sites and suitable reference sites, and will consider any existing baseline data (where available). Wherever possible, direct quantitative information of exposure (e.g. ancillary data on the hydrocarbon concentrations of water and sediment samples) will be used to strengthen analysis conclusions. In addition, information from other SCI activities (e.g. SCI4) will be used as additional covariates in analyses to examine potential indirect effects so as to avoid confounding effects and improve statistical power. Ancillary information—such as habitat complexity and type—should also be collected (where feasible) to serve as additional predictors in statistical models to evaluate potential confounding factors and reduce error variance, thereby improving statistical power (Ref.69).

12.4.6.1 BRUVS Analysis

High-definition stereo BRUVS footage will be converted from .m2ts to .mpeg format using Elecard Converter Studio AVC HD V 3.0. EventMeasure and PhotoMeasure software (Ref. 70) will be used to view and analyse footage for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.4.6.2 ROV Video and Towed/Diver Video Analysis

Analysis of video transects will be conducted in two stages. First, taxon counts will be determined by viewing the video at normal speed and recording identifiable fish as they pass through the ‘gate’ formed by the two laser dots. Second, frame grabs will be extracted from the video at five-second intervals. The video footage and still images will be analysed for measures of fish species richness, relative abundance for all species, and size structure for the ten most abundant species. All fish data and still reference images will be run through QA/QC procedures before being provided to Chevron.

12.5 Data Management

Field data must be stored securely and maintained. To achieve this, the field team will follow these procedures:

- enter metadata for each video file recorded into prepared electronic spreadsheets
- download data at the completion of each site.

Data will be backed up to a separate location (e.g. external hard drive). This will result in two electronic copies. All field datasheets will be kept. All electronic and field data will be transported by the demobilising survey team at the completion of the surveys. Data analysis will occur in the office.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

12.6 QA/QC Procedures

For each site sampled, a summary of high-level information will be captured in the datasheet, and will contain this information as a minimum:

- date
- site number
- GPS location
- general family/species
- numbers
- notes.

12.7 Mobilisation Requirements

12.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements (e.g. data format, metadata, storage protocols, delivery schedule, and communication methods)
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

12.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Assemble scientific survey team
☐	Undertake HAZIDs as required and consolidate/review field documentation including safety plans, emergency response plans, and daily field reports

Task	
☐	GIS team to prepare survey maps
☐	Confirm data formats and metadata requirements with data manager
☐	Purchase consumables
☐	Arrange survey platform (vessel, vehicle, aircraft) as required to survey or access monitoring sites
☐	Confirm information on sample holding times and the requirements for collecting and transporting tissue samples to Perth-based laboratories
☐	Coordinate NATA-accredited laboratories to confirm availability, limits of detection, obtain sample analysis quotes, and arrange provision of appropriate sample containers, CoC forms, eskies, and ice blocks
☐	Book flights, accommodation, and car hire
☐	Conduct pre-mobilisation meeting with the survey team
☐	Develop field survey schedules, detailing staff rotation.

12.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 3.12).

Task	
☐	Confirm equipment resources and availability
☐	Check all GPS units and digital cameras are working and that sufficient spare batteries and memory cards are available
☐	Check field laptops, ensuring they have batteries, power cable, licences, login credentials, and are functional
☐	Check video cameras, ensuring they have sufficient batteries, storage media, power cables, and are functional
☐	Arrange transport of equipment to mobilisation point

12.10 Resources

The personnel required to undertake SCI7b, their roles, and relevant qualifications are listed in Table 12-3.

Table 12-3: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Fish biologist	• Develop sampling plan • Collect samples • Ensure sample integrity and data quality	• Minimum degree in relevant subject • BRUVS and/or ROV experience • TBOSIET • Offshore medical
BRUVS/ROV Operator	• Manage deck operations • Liaise with vessel crew and master • Confirm that work is undertaken safely and conditions are safe	• Qualified BRUVS/ROV operator • TBOSIET • Offshore medical

12.11 Equipment

Depending on the exact scope of the study and the receptors being examined, other necessary equipment may include equipment to record footage to be used to determine population and community status (e.g. ROV-based still or video camera for image capture for demersal fish surveys, or BRUVS equipment).

Redundancy for key pieces of equipment should also be considered.

12.12 Standard Operating Procedures (SOPs)

Assessments of fish populations will be carried out via field studies, based on methods that relate to the particular receptors identified at risk. Because fish populations can show considerable natural fluctuations and are subject to additional anthropogenic pressures from other sources (e.g. recreational and commercial fisheries), it can be difficult to isolate impacts from a single pressure. Thus obtaining useful baseline data is particularly important, especially in the case of a large spill when reference sites may be difficult to obtain. For all fish population surveys, data will be obtained for replicate sites within and outside the EMBA, and comparison of relative abundance of fishes (both total and for selected indicator species) and species richness will be determined using standard statistical procedures.

For pelagic fish species, trolling and/or BRUVS (Ref. 71) surveys will assess fish population status. If important commercial fisheries species are potentially impacted, methods that align with usual population assessment surveys will be adopted (e.g. Ref. 72). For demersal fishes, methods should align with standard government procedures (e.g. Ref. 73) and commercial methods, where relevant, and may involve video transects (Ref. 74) captured using suitable methods, e.g. ROVs or BRUVS surveys (Ref. 71).

Table 12-4: Steps for Sampling Fish Health~~, Tainting,~~ and Fish Mortality

Step	
☐	Use appropriate survey equipment/methods (e.g. BRUVS, ROV, towed video or diver-swum video transects), depending on species selected and spill location
☐	Deploy up to eight replicate BRUVS units/transects at each site
☐	Deploy BRUVS/other equipment from vessels using Hiabs or equivalent
☐	Separate sampling stations by at least 250 m between BRUVS to avoid overlapping bait plumes and reduce the likelihood of fish moving between deployments within the sampling period
☐	Deploy for at least 60 minutes to maximise measures of diversity and relative abundance of fish
☐	A detail description of BRUVS technological requirements, methods, and recommended procedures is found in Heyward *et al*. (Ref. 75) (Section 4.2.1 for camera set up and field sampling procedures, and Section 4.2.2 for fish community analysis and video processing, pp. 128–1332)

12.13 Forms and Tools

Refer to Appendix C.

13 SCI8 – Heritage (including Shipwrecks)

13.1 Aims and Objectives

The primary aim of SCI8 – Heritage (including Shipwrecks) is to determine the extent, severity, and persistence of impacts on heritage features—including shipwrecks—following a hydrocarbon spill and associated response activities.

The final scope of the subtidal benthic habitat monitoring depends on the habitats identified within the environment that may be affected (EMBA), as well as identified reference sites outside the affected area; collectively termed the study area.

SCI6 is focused on the subtidal zone, which is defined as habitats seaward of LAT and are separated into nearshore (shallower than 20 m depth) and offshore (greater than 20 m depth) environments. Habitats landward of LAT (e.g. the intertidal zone) are included in SCI3 – Coastal and Intertidal Habitat Impact Study.

The objectives of SCI6 are to:

- Determine the extent, severity and likely persistence of impacts to subtidal benthic habitats and associated biological communities arising from a hydrocarbon spill and subsequent response activities
- Collect information for the purposes of determining; short-term and long-term (including direct and indirect) impacts of hydrocarbon (and implementation of response strategies) on benthic habitats and associated biological communities, post-spill and post-response recovery, remediation efforts, and areas where monitoring may need to continue for an extended time following the termination of the response

13.2 Initiation and Termination Criteria

The initiation and termination criteria for this scientific monitoring program are provided in Section 5 of the OSMP. Implementation times for this scientific monitoring program are directly linked to the initiation criteria and are found in the same section of the OSMP.

13.3 Data and Information Requirements

Table 13-1 lists the inputs relevant to planning for the implementation of SCI8, once the notification to commence is initiated.

Table 13-1: Data Requirements Summary for SCI8

Baseline Information	Operational Information	Scientific Monitoring
• Access to consolidated project-specific baseline data and baseline summary report/data/maps/models for the relevant study area • External datasets (e.g. DAWE, DoF etc.), information, including access to raw data and metadata statements outlining data collection methods • OSRA provided by AMSA • Additional baseline data may be available from I-GEMS	Outputs from MES including: • spill type • spill volume and duration • spatial extent and movement of the spill Outputs from OPS3 and OPS4 including: • consolidated data file including exceedances of benchmark levels • this information should be provided in electronic format, as it becomes available.	Information available at commencement of SCI6 on survey design or results from implemented Scientific Monitoring (primarily *SCI1, SCI2*, and *SCI3 – Coastal and Habitat Impact Study*).

13.4 Design

13.4.1 Monitoring Design

Benthic habitats may support a variety of biological communities during all, or part of, the year. To assist in informing scientific monitoring, it is important to first determine what benthic habitats are at risk and what biological resources inhabit these areas. Monitoring will concentrate on activities to assist in understanding impacts on the most sensitive areas and will involve a combination of:

- Physical: To provide observations and measurements used to describe the physical environmental conditions during benthic surveys.
- Remote sensing: To initially determine potentially impacted habitats, habitats at risk and reference areas (outputs from MES scope may be suitable). Once the images are ground-truthed, remote sensing can potentially be used as a proxy for biological monitoring of large scale changes on shallow benthic habitats e.g. seagrass and macroalgae.
- Biological: To determine the extent, severity and persistence (including recovery) of impacts on benthic habitats and associated biological communities.
- Chemical studies: To identify contamination in benthic habitats.

Monitoring to identify an impact on benthic habitats will be achieved by an assessing commonly monitored ecological, population and community based parameters. Monitoring will, as far as practicable, also be carried out on the health and condition of sensitive receptors, such as corals, seagrass, macroalgae and non-coral benthic macroinvertebrates. The monitoring approach needs to consider the data collected during MES and operational monitoring activities. The geographic extent of the area to be monitored will be based on the hydrocarbon distribution and predicted movement of the hydrocarbon spill, as determined through the MES outcomes, and measured hydrocarbons within the water column and sediments, as determined through OPS3 and OPS4. These outputs will identify potential impact areas to be sampled, which will allow comparison of results to baseline values. Table 10-2 summarises the monitoring designs recommended for various outcomes. Section 2.1 describes these approaches in detail.

Table 13-2: Monitoring Design Approaches Recommended for Different Spill Outcomes

MES and *OPS3* Outcomes Indicate Spill Extent	Monitoring Design[1]	Replicate Sites Required[2]
Hydrocarbon plume concentrated around source, dissipating with distance	Gradient Approach	Minimum of **two** replicate sites at each distance from source
Nearshore spill or spill reaches shoreline	BACI or IvC or Gradient Approach and/or Lines of Evidence Approach	Minimum of **three** replicate sites at impact and control locations or minimum of **two** replicate sites at each distance from source
Spill interacts with area of biological importance (bay/shoal/island)	BACI or IvC and/or Lines of Evidence Approach	Minimum of **three** replicate sites at each of impact and control locations

1 Reference sites required for each monitoring approach are detailed in Section 1

13.4.2 Monitoring Sites

Sampling sites will be defined once data and information on the habitats and biological indicators (as a guide refer to Table 3) have been reviewed. This will aid with the identification of sensitive habitats, associated parameters and methods.

Monitoring locations will be defined using the following considerations:

- Likelihood of hydrocarbon impact on benthic habitats
- Select several impact and reference locations over a large spatial area
- Similarity and representation of habitats, physical features and sediment type between impact versus reference locations
- Impact sites will be selected and prioritised within representative benthic habitats at greatest risk of impact within the EMBA, or those within areas of protection or conservation priority
- The degree of hydrocarbon exposure or potential exposure of the benthic habitats
- When selecting reference sites, key physical factors (i.e. temperature, salinity, currents, aspect, habitat type, shore profile, substrate) should not differ significantly between these and impact sites
- Determine location areas (typically 0.2–2 km^2) considering resolution needs. Replicate monitoring sites will be placed within benthic habitat locations
- Accessibility of habitat types.

During a large spill, dispersion of the spill may be influenced by seasonal patterns; in this case reference sites should be selected to allow for sufficient spatial separation from potential impact areas.

13.4.3 Monitoring Parameters

Physical monitoring will describe the physical environment during benthic surveys. Data will be sourced from SCI1 and supplemented with additional physical monitoring parameters (and methods) detailed in Table 13-3.

Table 13-3: Physical Parameters and Methods

Parameter	Method
Sea state and weather conditions	Visual observation i.e. Beaufort Scale
Observations of hydrocarbon slicks on surface	Visual observation (see AMSA [Ref. 17], Guideline M.3)
Depth, bathymetry, and bottom profiles	Vessel depth sounder
Habitat structure (e.g. substrate type)	ROV video/drop camera observation
Water currents	Visual observation

Observations on the sea state, weather, and currents can be further supplemented by data from meteorological stations and metocean buoys (if available).

Quantifying biological response to oil is dealt with under other SCI monitoring components; however, if biological growth may affect heritage features (i.e. increased bacteria causing corrosion or breakdown of material), additional biological monitoring parameters on heritage features, including shipwrecks, may be done. This may include quantifying bacteria and algae growing on structures.

13.4.4 Monitoring Frequency and Duration

Following the initiation of SCI8, surveys will be undertaken at least once a year, although are likely to be at a greater frequency (e.g. every three months) in the first year, based on the biological indicators being monitored. Survey data will be reviewed annually and the frequency of any ongoing monitoring will be determined by the data collected to date, the spatial, temporal, and seasonal variability of the biological indicators being measured and may, for example, be seasonal, six-monthly, or annual until the termination criteria are reached.

13.4.5 Sample Integrity

Table 13-3 details the physical monitoring parameters and sampling methods to be used.

13.4.6 Sample Analysis

The data collected will be obtained in various ways:

- Samples: Water, sediment or tissue samples that require preservation, transport, storage and analysis. The procedures for sampling, storage and analysis are provided in SCI1, SCI2 and SCI7.
- Field data: This includes results from field sampling and observations.
- Photo documentation: Photographic and video evidence ranging from aerial imagery to detailed still images.

Data should be recorded in a format for easy analysis and stored for comparisons with data collected in later years. It is essential that data be organised in a way, which makes them easily accessible for future reference.

Many of the monitored parameters outlined for each benthic habitat will be measured and quantified from video and still photos collected in the field. Percentage cover of common and conspicuous organisms (e.g. adult corals) will be quantified with the aid of image analysis software such as point-intercept software Coral Point Count with Excel extension (CPCe) (Ref. 33). For relatively small or discrete organisms (e.g. polychaetes) the density of organisms will be recorded per unit area.

To assess the health and condition of indicator species within each benthic habitat, qualifiers such as those in the CATAMI classification scheme (Ref. 60; Ref. 61) will apply during the point-intercept analyses described above (e.g. for corals – healthy in appearance, partially bleached or fully bleached; Ref. 62).

Image analysis and machine learning methods will be used, where possible (e.g. Ref. 63), following verification they provide data of similar quality and accuracy as manual image analysis.

Surveys relating to BACI designs are intended to be analysed using appropriate and rigorous statistical procedures such as ANOVA (univariate and or multivariate approaches) or similar. Evidence of impact will be based, in part, on whether there is a statistically significant interaction following the oil spill event (Ref. 64; Ref. 65). The appropriate number of replicates to achieve a desired level of power will be performed at the end of the monitoring period.

Surveys relating to gradient designs will be analysed, where possible, based on statistical procedures described in Ellis and Schneider (Ref. 66) and Lincoln-Smith and Cooper (Ref 67) or similar. Ellis and Schneider (Ref. 66) also proposed using ANOVA to investigate changes in abundance as a function of distance, transect area, replicate, sediment size and depth.

13.5 Data Management

A guide for data management can be found in the AMSA Oil Spill Monitoring Handbook (see Appendix B; Ref. 17).

Monitoring activities may be undertaken over many months and are likely to result in data that may be obtained/generated from several sources in various formats:

- logs and forms
- photographs and video recordings
- annotated maps
- portable GPS/GIS units.

Managing the generated data requires extensive data storage, analysis, backup, and archiving. Samples should be treated as legal evidence and secured against loss or tampering. Copies of datasheets and analysis should be archived.

13.6 QA/QC Procedures

QA/QC procedures will be used minimise observer bias during real-time habit classification. This may include a training assessment with expected habitats and indicator species to encourage consistent classification scoring between observers. A QA/QC procedure will be established to objectively remove any images that are not suitable for analysis (e.g. images that are blurred, out of focus, under-/over-exposed or otherwise of bad quality). For QA/QC of the point-intercept image analysis, a random selection of images will be re-analysed by an experienced observer to double-check for inconsistencies or misclassifications.

Species lists of benthic infauna provided by taxonomy laboratories will be QA/QC checked using the following methods:

- confirming current correct nomenclature and authorities using the WoRMS Taxon Match Tool (http://www.marinespecies.org/aphia.php?p=match)

- rationalising data to remove pelagic taxa (e.g. ctenophores, chaetognaths) that are not part of the benthic community, so as to remove 'ecological noise' from the dataset
- excluding juvenile life stages from the data for analysis. Juvenile stages can provide a false assessment of level of impact and recovery because they can exhibit significant natural post-settlement mortality, which can mask or be attributed to anthropogenic impacts. Juveniles may be analysed separately to determine potential recruitment.

It is essential that appropriate procedures for metadata recording, data storage, and data backup are implemented to avoid loss of data and information, and prevent confusion or misinterpretation of valuable data collected during the course of the monitoring program.

13.7 Mobilisation Requirements

13.7.1 Survey Planning

This checklist outlines considerations as part of the survey planning phase.

Task	
☐	Determine the scale of the study area
☐	Select study area sites (including impact and reference sites if applicable)
☐	Select sampling approach and techniques
☐	Determine sampling replication required
☐	Consider data management requirements i.e. data format, metadata, storage protocols, delivery schedule and communication method
☐	Develop site-specific health and safety plan
☐	Develop survey/sampling plan incorporating the latest operational data
☐	GIS team to prepare survey maps from the latest data
☐	Check MSDSs and chemical handling procedures
☐	Undertake HAZIDs as required
☐	Develop site-specific health and safety plan, including JHAs

13.8 Logistics

These activities must be undertaken before mobilisation to the field.

Task	
☐	Arrange survey vehicles/platform (vessel, 4WD vehicle, aircraft), as required to survey or access monitoring sites
☐	Plan site access points i.e. tracks, carparks etc.
☐	Book flights, accommodation, and car hire
☐	Confirm sample analysis requirements and arrange provision of sample containers, CoC, eskies, and ice bricks. Confirm sample holding times
☐	Arrange freight of any sampling equipment and laboratory sample jars
☐	Develop field survey schedules, considering staff rotation

Task	
□	Assemble scientific survey team
□	Conduct pre-mobilisation meeting with the survey team, confirm scope, schedule, HES requirements

13.9 Equipment Preparation

These activities must be undertaken before mobilisation to the field, to ensure equipment is working (for an equipment list, see Section 5.12).

Tasks	
□	Confirm specialist equipment requirements and availability • ROV/AUV/drop camera/towed camera • subsea positioning (if required) i.e. USBL • dive spread (if required) • benthic grab • remote sensing platform
□	Check if instrument calibration is required, and calibration certificates are on file
□	Check if equipment redundancy is required
□	Check if a DGPS is required
□	Confirm installation of real-time classification software (if available)
□	Book freight to mobilisation port

13.10 Resources

Support staff, including office-based personnel and taxonomic specialists, will be required to support onshore analysis of the data collected by the field team. Accurate identification of marine benthic biological communities and species will require specialist taxonomists, and a team to sort and curate. Specialist marine ecologists with knowledge of the region will determine indicator taxa, undertake peer review of reports, and conduct QA/QC of image analysis. Field teams will use individuals who are trained in subtidal assessment techniques, procedures, and terminology. Team members must have a thorough understanding of the response goals and objectives.

The field personnel required to undertake SCI6, their roles, responsibilities and relevant qualifications are listed in Table 13-4.

Table 13-4: Field Roles and Responsibilities

Role	Responsibility	Qualifications
Field Lead/ Party Chief	• Capture survey positional data • Coordinate with vessel master and field team • Manage HES compliance • Complete daily field survey reports • Plan survey schedule	• Minimum degree-level qualification in a relevant subject • Significant field experience (including ROV and grab operations) • Facility abandonment • Offshore medical

Role	Responsibility	Qualifications
Marine Scientists / Data Management Personnel / Field Technician (as required)	• Undertake real-time habitat classification and QA/QC of still and video footage • Data management experience • Help deploy ROVs, cameras, CTDs, cores, or grabs • Sieve and preserve benthic infauna samples • Undertake physical site observations • Record survey and sampling data • Backup digital data (including images) • Maintain equipment and resolve technical issues	• Minimum degree-level qualification in a relevant subject • Field experience • Local ecological knowledge (including benthic habitat classification and ecology) • Facility abandonment • Offshore medical
Diver / snorkeller (if required)	• Collect samples	• ADAS Pt 1 (for snorkelling) • ADAS Pt 2 (for surface supply diving)

13.11 Equipment

It may be necessary to mobilise a vessel for transport or intertidal access depending on the remoteness of the study area and scale of the hydrocarbon spill.

The basic set of equipment for SCI8 are listed below.

Items	
☐	Specialist equipment: • ROV/AUV/drop camera/towed camera • USBL positioning (if required) • dive spread • multiparameter probe/CTD • benthic grab • remote sensing platform
☐	Is redundancy required?
☐	DGPS
☐	Echo sounder on each vessel
☐	Field laptops with relevant software (e.g. CPCe, video editing, CATAMI)
☐	Backup data storage for field data
☐	Tissue preservation material and sample jars
☐	Biota/coral sampling equipment • coring or sampling tools • dissecting microscope • tissue preservation material (10% formalin and/or 70% ethanol) • sample jars
☐	Specialist PPE (i.e. PFD,RPE)
☐	Book freight to mobilisation port

13.12 Standard Operating Procedures (SOPs)

Sampling techniques will vary depending on the type and location of the hydrocarbon to be collected. Consistent across all techniques are:

- the profiler may require a base with weights that will help the unit sink and also protect the sensors from contacting the sediments on the seabed.
- haphazard transects – in situ.

Step	
☐	Percentage cover of each habitat type will be assessed at each site using photo quadrats, taken along transects.
☐	The locations of transects at each site will be selected at random
☐	The start location (latitude and longitude) of each transect will be recorded and georeferenced, and bearing and distance of each transect similarly recorded.
☐	A minimum of three replicate transects will be undertaken at each site.
☐	Photo quadrats will cover an area of 1 m^2 (either 1 × 1 m^2 photo, or 4 × 0.25 m quadrats, depending on water conditions and available equipment (e.g. quadrats) and will be randomly located along each transect
☐	The length of each transect and the number of photo quadrats along each transect will depend on habitat characteristics and the survey objectives, but a minimum of five photo quadrats per transect should be planned. Note that the length of transects and number of quadrats should be standardised across sites.
☐	Photographs will be taken with a still camera, or taken as still images from video transect footage.
☐	The methodology of photograph capture will be kept consistent among a survey and where possible, across all survey sites, noting that technology improvements may be incorporated into surveys. If practicable, high-quality still plan (downward facing) images (taken from a still camera or still images from video transect footage), should be captured with sufficient lighting.
	If practicable, the quadrat boundary should be marked within each image as either a solid boundary (i.e. frame placed on the transect) or by underwater lasers marking out a scale.
☐	Where possible, transects will be located in similar depths within sites.
☐	Upon retrieval, data will be QAQC checked and backed up on site
☐	Data will be analysed using appropriate software to determine point-intercept estimates of multiple points to define benthic habitats.

13.13 Forms and Tools

Refer to Appendix C.

14 Acronyms and Abbreviations

Table 14-1 defines the acronyms and abbreviations used in this document.

Table 14-1: Acronyms and Abbreviations

Acronym / Abbreviation	Definition
#	Number
°C	Degrees Celsius
µg/g	Micrograms per gram
µg/L	Micrograms per litre
µm	Micrometer
4WD	Four-wheel Drive Vehicle
ABU	Australian Business Unit
ADAS	Australian Diving Accreditation Scheme
ALS	Australian Laboratory Services
AMOSC	Australian Marine Oil Spill Centre
AMSA	Australian Maritime Safety Authority
ANOVA	Analysis of Variance
ANZECC	Australian and New Zealand Environment and Conservation Council
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AUV	Autonomous Underwater Vehicle
BACI	Before-After-Control-Impact
BRUVS	Baited Remote Underwater Video Station
BTEX	Benzene, toluene, ethylbenzene, and xylene
C_6, C_{40}, etc.	Carbon chain length
CATAMI	Collaborative and Annotation Tools for Analysis of Marine Imagery and Video; a classification scheme for scoring marine biota and substrata in underwater imagery
CJS	Cormack-Jolly-Seber
cm	Centimetre
cm^3	Cubic centimetre
CMR	Capture, mark, recapture
CoC	Chain of Custody
CPCe	Coral Point Count with Excel extension
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CTD	Conductivity Temperature Depth
dB(A)	Decibel, unit of sound loudness
DAWE	Department of Agriculture, Water and the Environment
DBCA	Department of Biodiversity, Conservation and Attractions (formally Parks and Wildlife)
DMSO	Dimethyl sulfoxide

Acronym / Abbreviation	Definition
DNA	Deoxyribonucleic Acid. A self-replicating material present in nearly all living organisms as the main constituent of chromosomes. It carries genetic information.
DoF	Western Australia Department of Fisheries
DOSS	Dioctyl sulfosuccinate
DoT	Western Australian Department of Transport
DotEE	Formally the Commonwealth Department of the Environment and Energy (now DAWE)
DPnB	Dipropylene Glycol n-Butyl Ether
EGMBE	Ethylene Glycol Monobutyl Ether
EMBA	Environment that May Be Affected
Emergency condition	Emergency conditions are defined in each activity-specific Environment Plan and Oil Pollution Emergency Plan
EMT	Emergency Management Team
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
g	Gram
GC	Gas Chromatography
GCMS	Gas Chromatography Mass Spectrometry
GIS	Geographic Information System
GPS	Global Positioning System
H_2S	Hydrogen sulfide
HAZID	Hazard Identification
HES	Health, Environment, and Safety
I-GEMS	Industry-Government Environmental Meta-database
IMG	Incident Management Guide
Impact Site	Site impacted by oil
Infauna	The assemblage of animals (often microscopic) that live buried or partially buried with the sediment matrix (e.g. worms, bivalves, crustaceans)
IvC	Impact versus Control
IvR	Impact versus Reference
JHA	Job Hazard Analysis
km	Kilometre
km^2	Square kilometres
kn	Knot
LAT	Lowest Astronomical Tide
LNG	Liquefied Natural Gas
m	Metre
MBACI	Multiple Before-After-Control-Impact
MES	Monitoring, Evaluation and Surveillance
mL	Millilitre

Acronym / Abbreviation	Definition
MPA	Marine Protected Area
MPRA	Marine Parks and Reserves Authority
mS/cm	Milli Siemen per centimetre; measure of conductivity
MSDS	Material Safety Data Sheet
N/A	Not Applicable
NATA	National Association of Testing Authorities
NEBA	Net Environmental Benefit Analysis
nm	Nautical mile
NMI	National Measurement Institute
NTU	Nephelometric Turbidity Unit
NWS	North West Shelf
OPEP	Oil Pollution Emergency Plan
OPS	Operational Monitoring Program
ORT	On-site Response Team
OSMP	Operational and Scientific Monitoring Plan
OSRA	Oil Spill Response Atlas
PAH	Polycyclic Aromatic Hydrocarbons
PAM	Passive Acoustic Monitoring
PERMANOVA	Permutational Multivariate Analysis of Variance
PFD	Personal Flotation Device
pH	The acidity or basicity of a solution
Photo documentation	Photographic and video evidence, ranging from aerial imagery to detailed still images
PPE	Personal Protective Equipment
PSD	Particle Size Distribution
Quadrat	A rectangle or square measuring area used to sample living things in a given site; can vary in size.
Reference Site	Specific area of the environment not at risk of being affected by the Project or existing developments, that can be used to determine the natural state, including natural variability, of environmental attributes such as coral health or water quality.
RFU	Raw Fluorometry Units
ROV	Remotely Operated Vehicle
RPE	Respiratory Protective Equipment
SCI	Scientific Monitoring Program
SD	Standard Deviation
SDH	Sorbitol dehydrogenase
SME	Subject Matter Expert
SOP	Standard Operating Procedure
SPRAT	Species Profile and Threats (database)

Acronym / Abbreviation	Definition
State Waters	The marine environment within three nautical miles of the coast of Barrow Island or the mainland of Western Australia
TBOSIET	Tropical Basic Offshore Safety Induction and Emergency Training
TOC	Total Organic Carbon
Transect	The path along which a researcher moves, counts, and records observations.
TRH	Total Recoverable Hydrocarbons
UME	Unusual Mortality Event
USBL	Ultra-short Baseline
USEPA	United States Environmental Protection Agency
VOC	Volatile Organic Compounds; organic chemical compounds that have high enough vapour pressures under normal conditions to vaporise and enter the atmosphere
WA	Western Australia
WoRMS	World Register of Marine Species

15 References

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 15-1: References

Ref. No.	Description	Document ID
1.	Chevron Australia. 2015. Operational and Scientific Monitoring Plan. Perth, Western Australia	ABU130700448
2.	Chevron Australia. 2015. ABU Oil Spill Response Manual. Perth, Western Australia.	OE-11.01.101
3.	Australian Maritime Safety Authority. 2016. National Plan for Maritime Environmental Emergencies. Available from: https://www.amsa.gov.au/forms-and-publications/Publications/national_plan.pdf. Accessed 13 July 2017.	
4.	Chevron Australia. Marine Stinger Protective Clothing Best Practice Guidelines. Perth, Western Australia.	G1-NT-GDLX0000374
5.	Chevron Australia. ABU – Personalised Protective Equipment (PPE) Standard. Perth, Western Australia.	OE-03.06.112
6.	Underwood, A.J. 1991. Beyond BACI: experimental designs for detecting human environmental impacts on temporal variations in natural populations. *Australian Journal of Marine and Freshwater Research*. 42: 569–587.	
7.	Underwood, A.J. 1992. Beyond BACI: the detection of environmental impact on population in the real, but variable world. *Journal of Experimental Marine Biology and Ecology*. 161: 145–178.	
8.	Downes, B.J., Barmuta, L.A., Fairweather, P.G., Faith, D.P., Keough, M.J., Lake, P.S., Mapstone, B.D., Quinn, G.P. 2002. Monitoring ecological impacts, concepts and practice in flowing waters. Cambridge University Press. Cambridge UK.	
9.	Hill, A.B. 1965. The environment and disease: association or causation? Proceedings of the Royal Society of Medicine. 58: 295–300.	
10.	McArdle, B.H. 1996. Levels of evidence in studies of competition, predation and disease. New Zealand Journal of Ecology. 20: 7–15.	
11.	Suter, G.W., 1996. Abuse of hypothesis testing statistics in ecological risk assessment. *Human and Ecological Risk Assessment: An International Journal* 2: 331-347.	
12.	Beyers, D.W. 1998. Casual inference in environmental impact studies. *Journal of the North American Benthological Society.* 17: 367–373.	
13.	Fabricius, K.E., De'ath, G. 2004. Identifying ecological change and its causes: a case study on coral reefs. Ecological Applications. 14: 1448–1465.	
14.	Chevron Australia. 2016. Gorgon Project: Long-term Marine Turtle Monitoring Program. Perth, Western Australia.	G1-NT-PLNX0000296
15.	Gotelli, N.J. and Ellison, A.M. 2004. A primer of Ecological Statistics. Sinauer Associates. Massachusetts, USA.	
16.	Cohen, J. 1977. Statistical power analysis for the behavioural sciences. Academic Press. New York, USA.	
17.	Australian Maritime Safety Authority. 2003. Oil Spill Monitoring Handbook. Prepared by Wardrop Consulting and the Cawthorn Institute for the Australian Maritime Safety Authority (AMSA) and the Marine Safety Authority of New Zealand (MSA). Published by AMSA, Canberra.	

Ref. No.	Description	Document ID
18.	Chevron Australia. Template Request for Chevron Lab Services. Perth, Western Australia.	ABU140601604
19.	Chevron Australia. ABU Contracts for the Provision of External Laboratory Services – Contractor Information. Perth, Western Australia.	ABU-COP-02478
20.	USEPA. 2015. Water Quality Benchmarks for Aquatic Life. http://archive.epa.gov/bpspill/web/html/water-benchmarks.html	
21.	Australian and New Zealand Environment and Conservation Council. 2000. Australian and New Zealand guidelines for fresh and marine water quality. Volume 1, The guidelines (National water quality management strategy; no.4). Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.	
22.	USEPA. 2015. Sediment Quality Benchmarks for Aquatic Life. http://archive.epa.gov/bpspill/web/html/sediment-benchmarks.html	
23.	Commonwealth of Australia, 2009. National Assessment Guidelines for Dredging, Commonwealth of Australia, Canberra.	
24.	Crowe, T.P., Smith, E.L., Donkin, P., Barnaby, D.L., and Rowland, S.J. 2004. Measurements of sublethal effects on individual organisms indicate community-level impacts of pollution. Journal of Applied Ecology. 41: 114–123.	
25.	Reid D.J., and MacFarlane G.R. 2003. Potential biomarkers of crude oil exposure in the gastropod mollusc, *Austrocochlea porcata*: laboratory and manipulative field studies. Environmental Pollution. 126: 147–155.	
26.	Denton, G.R., Concepcion, L.P., Wood, H.R., Eflin, V.S. and Pangelinan, G.T. 1999. Heavy metals, PCBs and PAHs in marine organisms from four harbor locations on Guam. Tech. Rep. 87, Water and Environmental Research Institute of the Western Pacific, Mangilao.	
27.	Remote Sensing Research Centre. 2010. Remote Sensing Toolkit. http://www.gpem.uq.edu.au/cser-rstoolkit	
28.	Human B.A., Murray, K., Zdunic, K., and Behn, G. 2010. Coastal and Marine Resource Condition Monitoring –Scoping Project. Final NRM Report – Project 073007. Part 2 – Field trial of potential resource condition indicators, and an exploration of the utility of remote sensing, for mangroves and intertidal mud flats in the Pilbara – Pilot study. Fisheries Research Report No. 205, Department of Fisheries.	
29.	MacFarlane, G.R., and Burchett, M.D. 2003. Assessing effects of petroleum oil on intertidal invertebrate communities in Sydney Harbour: preparedness pays off. Australasian Journal of Ecotoxicology 9: 29–38.	
30.	Junoy, J., Castellanos, C., Viéitez, J.M., De La Huz, M.R., and Lastra, M. 2005. The macroinfauna of the Galician sandy beaches (NW Spain) affected by the Prestige oil-spill. *Marine Pollution Bulletin.* 50: 526–536.	
31.	Brooks, T., Wright, S. and Shiel, D. 2009. Evaluating the success of conservation actions in safeguarding tropical forest biodiversity. *Conservation Biology.* Vol 23(6): 1448-1457.	
32.	Eldridge, K., J. Davidson, C. Harwood and G. Van Wyk. 1993. Eucalyptus domestication and breeding. Oxford University Press Inc., New York. 288 pp.	
33.	Kohler, K.E. and Gill, S.M. 2006. Coral Point Count with Excel Extensions (CPCe): A Visual Basic Program for the Determination of Coral and Substrate Coverage Using Random Point Count Methodology. *Computers and Geosciences*, 32, 1259-1269.	
34.	Department of the Environment. 2015. Species Profile and Threats Database. Available from: http://www.environment.gov.au/sprat Viewed 18 November 2015	

Ref. No.	Description	Document ID
35.	Department of the Environment, Water, Heritage and the Arts. 2010. Survey guidelines for Australia's threatened birds: Guidelines for detecting birds listed as threatened under the Environment Protection and Biodiversity Conservation Act 1999. Prepared by Magrath, M., Weston, M., Olsen, P., and Antos, M., and updated in 2008 by Herrold, A.	
36.	Department of Sustainability, Environment, Water, Population and Communities. 2012. Species group report card – seabirds and migratory shorebirds: Supporting the marine bioregional plan for the North-west Marine Region, prepared under the Environment Protection and Biodiversity Conservation Act 1999. Viewed on 18 November 2015. https://www.environment.gov.au/system/files/pages/0fcb6106-b4e3-4f9f-8d06-f6f94bea196b/files/north-report-card-seabirds.pdf	
37.	Howes, J., and Bakewell, D. 1989. Shorebird Studies Manual. Asian Wetland Bureau, Kuala Lumpur.	
38.	Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.L., Borchers, D.L. and Thomas, L. 2001. Introduction to Distance Sampling: Estimating Abundance of Biological Populations. Oxford University Press, Oxford, UK.	
39.	Florida's Wildlife Contingency Plan for Oil Spill Response – June 2012 Sea Turtle Guidelines for Oil Spill Response	
40.	Miller, M. 1999. Summary tables of baseline information and management tasks and projects for the specified riparian, wetland and springs/seep area within the Albuquerque Field Office. Bureau of Land Management, Albuquerque Field Office, USA.	
41.	Flint, M., Patterson-Kane, J., Mills, P., and Limpus, C. 2009. A veterinarian's guide for sea turtle post mortem examination and histological investigation. University of Queensland. Brisbane, Australia.	
42.	Work, T.M. 2000. Sea turtle necropsy manual for biologists in remote refuges. U.S. Geological Survey, National Wildlife Health Center.	
43.	Burns, K., Slee, D., Lloyed, J., Hanlon, M., Skepper, C., and Mitsopoulos, G. 2011. Monitoring Plan for the Montara Well Release, Timor Sea. Monitoring Study S3; Assessment of Fish for the Presence of Oil.	
44.	Gagnon, M.M., Rawson, C. 2011. Montara Well Release, Monitoring Study S4A – Assessment of Effects on Timor Sea Fish. Curtin University, Perth, Australia. 208 pp.	
45.	Gagnon, M.M., and Rawson, C. 2012. Montara Well Release, Monitoring Study S4A Phase IV – Assessments of Effects on Timor Sea Fish. Curtin University, Perth, Western Australia. 66 pp.	
46.	Shaughnessy, P.D., Gales, N.J., Dennis, T.E., and Goldsworthy, S.D. 1994. Distribution and abundance of New Zealand fur seals, Arctocephalus forsteri, in South Australia and Western Australia. *Wildlife Research*. 21, 667–695.	
47.	Goldsworthy, S.D., and Page, B. 2007. A risk-assessment approach to evaluating the significance of seal bycatch in two Australian fisheries. *Biological Conservation* 139, 269–285.	
48.	Gibbens, J., and Arnould, J. P. Y. (2009b). Interannual variation in breeding chronology and pup production of Australian fur seals. *Marine Mammal Science* 25, 573–587.	
49.	Pugliares, K.R., Bogomolni, A.L., Touhey, K.M., Herzig, S.M., Harry, C.T., and Moore, M.J. 2007. Marine Mammal Necropsy: An introductory guide for stranding responders and field biologist. Woods Hole Oceanographic Institute Technical Report WHOI-2007-06.	

Ref. No.	Description	Document ID
50.	Goldsworthy, S., Shaughnessy, P., Page, B., Dennis, T., McIntosh, R., Hamer, D., Peters, K., Bayliss, A., Lowther, A., and Bradshaw, C. 2007. Developing population monitoring protocols for Australian sea lions. Final report to the Department of the Environment and Water Resources. SARDI Aquatic Sciences Publication Number F2007/000554. SARDI Research Report Series No: 219. 75 pp.	
51.	Goldsworthy, S., Mckenzie, J., Shaughnessy, P., McIntosh, R., Page, B., and Campbell, R. 2009. An update of the report: Understanding the Impediments to the Growth of Australian Sea Lion Populations. Final report to the Department of the Environment and Water Resources. SARDI Aquatic Sciences Publication Number F2008/00847-1. SARDI Research Report Series No: 356. 179pp.	
52.	Shaughnessy, P., Goldsworthy, S.D., Hamer, D., Page, B., and McIntosh, R. 2011. Australian sea lions Neophoca cinerea at colonies in South Australia: distribution and abundance 2004 to 2008. *Endangered Species Research.* 13: 87–98.	
53.	Integrated Marine Observing System. Available from: http://imos.org.au/ Accessed 13 July 2017.	
54.	NOAA. 2017. Marine Mammal Health and Strandings Response Program. Available from: http://www.nmfs.noaa.gov/pr/health/MMHSRP.html. Accessed 13 July 2017.	
55.	Strindberg, S., Buckland, S.T., and Thomas, L. 2004. Design of distance sampling surveys and Geographic Information Systems. Chapter 7. In Buckland, S.T., Anderson, D.R., Burnham, K.P. , Laake, J.L., Borchers, D.L., and Thomas, L. (editors). Advanced Distance Sampling. Oxford University Press. pp. 190-228	
56.	Heyward, A., Moore, C., Radford, B and Colquhoun, J. 2010. Monitoring program for the Montara well release Timor Sea: Final report on the nature of Barracouta and Vulcan Sharks. Report prepared by the Australian Institute of Marine Science for PTTEP Australia (Ashmore Cartier.	
57.	Geo-Oceans. 2011. Ichthys Gas Field Development Project: Benthic Habitat Mapping of the Darwin region – Methods of Data Collection, Collation, and Map Production. Ichthys Technical Appendix S6.	
58.	Geo-Oceans. 2012. Towed Camera Marine Habitat Mapping Survey NT Power and Water Corporation – East Point Aquatic Life Reserve. Technical Report prepared for URS Australia. Perth, Western Australia.	
59.	Fry, B.G., Scheib, H., van der Weerd, L., Young, B., McNaughtan, J., Ramjan, S., Vidal, N., Poelmann, R.E., Norman, J.A. 2008. Evolution of an arsenal. *Molecular & Cellular Proteomics 7* (2), pp.215–246.	
60.	Althaus F, Hill N, Ferrari R, Edwards L, Przeslawski R, Schönberg CHL, et al. (2015) A Standardised Vocabulary for Identifying Benthic Biota and Substrata from Underwater Imagery: The CATAMI Classification Scheme. PLoS ONE 10(10): e0141039.	
61.	Edwards, E., Beaugrand, G., Helaouet, P. Alheit, J. and Coombs, S. 2013. Marine Ecosystem Response to the Atlantic Multidecal Oscillation. PloS ONE 8(2):e57212.	
62.	Heyward, A., Jones, R., Travers, M. Burns, K. Suosaari, G. Colquhoun, J., Case, M., Radford, B., Meekan, M., Markey, K., Schenk, T., O'Leary, R., Brooks, K., Tinkler, P., Cooper, T., Emslie, M. 2012. Montara: 2011 Shallow reef surveys at Ashmore, Cartier and Seringapatam Reefs. Final report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty. Ltd.	
63.	Steinberg, L., Vandell, D. and Bornstein, M. 2011. Development: Infancy through adolescence. Belmont, California.	

Ref. No.	Description	Document ID
64.	Green, R.H. 1979. Sampling Design and Statistical Methods for Environmental Biologists, Wiley, Chichester.	
65.	Underwood, A.J. 1994. On beyond BACI: sampling designs that might reliably detect environmental disturbances, *Ecological Applications*. 4: 3-15.	
66.	Ellis, J.I. and Schneider, D.C. 1997. Evaluation of a gradient sampling design for environmental impact assessment. Environmental Monitoring and Assessment. 48: 157-172.	
67.	Lincoln-Smith, M.P., and Cooper, T.F. 2004. Combining the use of gradients and reference areas to study bioaccumulation in wild oysters in the Hunter River estuary, New South Wales, Australia. Marine Pollution Bulletin. 48: 873-883.	
68.	Newman, M.C., and Clements, W.H. 2008. Ecotoxicology. A Comprehensive Treatment. Boca Raton, Florida, CRC press.	
69.	Merrill, S.B., Oehlert, G., and Cuthbert, F.J. 2000. Use of Blocked Design Increases Efficiency of Data Collection in Field Ornithology Study. The Auk. 117: 232-235.	
70.	SeaGIS. 2008. PhotoMeasure. SeaGIS Pty, Bacchus Marsh. Available from: www.seagis.com.au Accessed 13 July 2017.	
71.	Cappo, M., De'ath, G., and Speare, P. 2007. Inter-reef vertebrate communities of the Great Barrier Reef Marine Park determined by baited remote underwater video stations. Marine Ecology Progress Series. 50:209–221.	
72.	Marriott, R., Jackson, G., Lananton, R., Telfer, C., Lai, E., Stephenson, P., Bruce, C., Adams, D. and Norriss, J. 2012, Biology and stock status of inshore demersal scalefish indicator species in the Gascoyne Coast Bioregion, Fisheries Research Report No. 228. Department of Fisheries, WA.	
73.	Friedman, K.J., Simpson, C.J., Bancroft, K., Evans, R., Field, S., Holmes, T., Kendrick, A.J., Mayer, F., Moore, J., Shedrawi, G., Rule, M., Waples, K., and Wilson, S.K. 2013. Monitoring marine biodiversity: the Western Australian Marine Monitoring Program (WAMMP). Western Australian Department of Environment and Conservation.	
74.	Harvey, E.S., Fletcher, D., Shortis, M.R., and Kendrick, G.A. 2004. A comparison of underwater visual distance estimates made by SCUBA divers and a stereo-video system: Implications for underwater visual census of reef fish abundance. Marine and Freshwater Research. 55: 573–580.	
75.	Heyward, A., Jones, R., Burns, K., Meeuwig, J., Cappo, M., Meekan, M., Oliver, J., Wright, R. 2012. Montara: Scientific monitoring of shallow reefs and submerged shoals. International conference on Health, Safety and Environment in Oil and Gas Exploration and Production, Perth, Australia.	

Appendix A Indicative Transit Times for Mobilisation to Operational Areas

From	To	Distance in nm (sea)	Distance in nm (air)	Required					
				Vessel (hours)				Helicopter	Truck
				8 kn	11 kn	17 kn	25 kn	140 kn	60 km/h
Barrow Island	Thevenard Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Barrow Island	Onslow	63	51	7.9	5.7	3.7	2.5	22 mins	-
Barrow Island	Dampier	80	77	10.0	7.3	4.7	3.2	33 mins	-
Barrow Island	Exmouth	110	105	13.8	10.0	6.5	4.4	45 mins	-
Barrow Island	Platform	57	57	7.1	5.2	3.4	2.3	24 mins	
Thevenard Island	Barrow Island	63	47	7.9	5.7	3.7	2.5	20 mins	-
Thevenard Island	Onslow	12	12	1.5	1.1	0.7	0.5	5 mins	-
Thevenard Island	Dampier	116	107	14.5	10.5	6.8	4.6	46 mins	
Thevenard Island	Exmouth	54	65	6.8	4.9	3.2	2.2	28 mins	
Dampier	Exmouth	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Dampier	Barrow Island	80	77	10.0	7.3	4.7	3.2	33 mins	
Dampier	Thevenard Island	116	107	14.5	10.5	6.8	4.6	46 mins	
Dampier	Onslow	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Dampier	Platform	87	87	10.9	7.9	5.1	3.5	37 mins	
Exmouth	Barrow Island	110	105	13.8	10.0	6.5	4.4	45 mins	-
Exmouth	Thevenard Island	54	65	6.8	4.9	3.2	2.2	28 mins	-
Exmouth	Onslow	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Exmouth	Dampier	187	168	23.4	17.0	11.0	7.5	1.2 hrs	9.3 hrs
Onslow	Barrow Island	63	51	7.9	5.7	3.7	2.5	22 mins	-
Onslow	Thevenard Island	12	12	1.5	1.1	0.7	0.5	5 mins	-
Onslow	Dampier	230	238	28.8	20.9	13.5	9.2	1.7 hrs	9 hrs
Onslow	Exmouth	60	65	7.5	5.5	3.5	2.4	28 mins	6.7 hrs
Onslow	Platform	108	108	13.8	9.8	6.4	4.3	46 mins	

1. *Allow ~3 hours to travel from east to the west coast of Barrow Island via vessel*
2. *Total time = Activation time + travelling time, depending on the availability of the logistics*
3. *Vessel time-based on-site information and knowledge and http://ports.com/sea-route/*
4. *Estimated activation times are: Barrow Island – 2 hours; Thevenard Island – 1 hour; Onslow – 2 hours; Dampier – 1 hour; Exmouth – 2 hours*

Appendix B Guideline for Data Management

GUIDELINE FOR DATA MANAGEMENT	Q.1

Rationale

Data management is needed for all monitoring programmes but will depend on the scale, complexity and purpose of each programme. This Guideline provides a basic checklist for the development of a Data Management Plan.

Methodology

1	Data management pre-planning:	
	1.1	Develop standard forms for all field data.
	1.2	Establish a standard methodology for assigning location names, sample numbers and descriptors.
	1.3	Prepare and provide pre-printed photo or sample log forms, labels and/ or chain of custody forms.
	1.4	Establish data storage system (hard copy/computer database/GIS).
	1.5	Obtain and supply maps and other recording equipment as required.
	1.6	Establish sample handling/management procedures (Guideline G.1).
	1.7	Assign responsibilities for data management, overall and in the field.
2	Field data recording and handling:	
	2.1	Ensure that data is documented on standard format forms, log books, film, tape or disk.
	2.2	Assign the task of data recording task to one person per team. If more than one person or one team is involved in these tasks, then training and field calibration of measurements should be undertaken.
	2.3	Ensure that all data recorded in the field is recorded in a data log (data type, location, time, custodian and location of storage).
3	Initial data validation, compilation and storage:	
	3.1	Assign responsibility and procedure for checking data for errors and ensuring that corrective action is taken.
	3.2	All data (and all formats) should be backed-up as soon as possible.
	3.3	Ensure that all data and samples are properly stored.
4	Assessment and compilation of data (data reduction):	
	4.1	Assign responsibility for checking requests for analysis, calculations etc.
	4.2	Establish responsibility and procedures for assessment, verification and storage of data.
	4.3	Ensure that laboratory or third party responsibility and procedures for the internal review of all analysis, calculations etc. has been established.

Oil Spill Monitoring Handbook

Q.1	**Methodology Continued**			
5	Data validation.			
	5.1	Ensure that data is assessed for accuracy, e.g:		
		5.1.1	Analysis requested against data supplied.	
		5.1.2	Blanks, duplicates and other QA/QC samples for errors.	
		5.1.3	Detection limits, holding times.	
		5.1.4	Calculations.	
	5.2	Ensure that, if needed, data is corrected. Note: If data is corrected by management, or other third party, then changes should be recorded and initialed.		
6	Data reporting and display.			
	6.1	The format and content of final reports will vary according to the purpose of the monitoring programme. Generally it should include:		
		6.1.1	All results (raw data).	
		6.1.2	Interpretation (if required).	
		6.1.3	A discussion of any data gaps, QA/QC issues.	
	6.2	Data display and dissemination methods may include:		
		6.2.1	Status Boards.	
		6.2.2	Hard copy maps	
		6.2.3	Digital maps and data (GIS/OSRA or other)	
		6.2.4	Restricted or public bulletins. These may be	
			a	Paper copy
			b	Digital; either distributed via e-mail or displayed on the internet.

	Page 2 of 2	**Q.1**

Appendix C Forms

Form number	Description
1.	CoC forms
2.	Freight consignment form
3.	Marine Vessel Survey Log Form
4. 4.	Environmental Permit Application Forms

Form 1 – Chain of Custody

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

1.0 General Information			
Samples sent to: (contract laboratory)			
Attention:			
Chevron Charge Caption:		or Service Order No.:	

2.0 Sample Information			
Samples From:		Sampled by:	
Sample Type:		Date Sampled:	

	Description of sample	Analysis required
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
☐ Additional samples overleaf		☐ Preserved at 4°C

3.0 Tracking			
☐ **Copy 1** To Contract Lab with Sample - Lab to acknowledge receipt of samples by signing below, and faxing a copy to EH&S representative. - Lab to mail this **original** copy to EH&S representative with completed results.			
☐ **Copy 2** Contract Lab to attach a copy to the invoice for this work.			
☐ **MEJ number must be included prior to analysis of samples.**			
Acknowledge receipt signature:		**Date:**	

Document ID: OE-11.01.34
Revision ID: 3.0. Revision Date: 16 November 2011.
Information Sensitivity: Company Confidential
Printed 21 December 2015.
Page 1 of 3

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

4.0 Reporting

☐ Chevron PO Box S1580, GPO Perth WA 6001	☐ Chevron phone number: (08) 9216 4000
☐ Fax: (08) 9216 4444	
☐ Environmental Advisor:	☐ HES rep. phone number:

5.0 Additional Samples

	Description of sample	Analysis required
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		
21		
22		
23		
24		
25		

6.0 Additional Information

Chevron	Chain of Custody Form Environmental Sample Submission Sheet	

7.0 Chain of Custody

Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature
Samples Relinquished by:				
Name (Print)	Organisation	Date	Time	Signature

CHAIN OF CUSTODY

ChemCentre EXPERT SOLUTIONS

GOVERNMENT OF WESTERN AUSTRALIA

ChemCentre, Building 500 Resources and Chemistry Precinct, Off Conlon Street, BENTLEY WA 6102
Post: PO Box 1250, Bentley Delivery Centre WA 6983
PH: (08) 9422 9800 **FAX**: (08) 9422 9801 **Email**: ssd@chemcentre.wa.gov.au

PAGE No: _____ **of** _____

COURIER NAME: .... CON NOTE No:	**NOTES**	ANALYSIS REQUIRED	**ChemCentre Job No:**
CLIENT (Billing): ADDRESS: CLIENT P/O No: .... SAMPLED BY: .... RESULTS TO:			**Please indicate if QC results are required:** ☐ **Method QC** ☐ **Batch QC** ☐ **Special LOD (use comments section)** *Method QC data refers to results from a lab blank and a lab verification standard. *Batch QC data refers to results obtained from duplicate and spiked samples supplied by client and incurs extra charges.

LAB ID	SAMPLE ID / DESCRIPTION	Sample Type	Depth	DATE COLLECTED	TIME COLLECTED							*Comments/ Sampling Details*
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							
				/ /	:							

RELINQUISHED BY: DATE/TIME:	Ph No: Email:	Contract:	RECEIVED BY: DATE/TIME:
☐ **Normal Turnaround**	☐ **Urgent Turnaround (will attract a surcharge)**.	LAB COMMENTS:	

Form 2 – Freight Consignment Form

Chevron	CVX Advanced Shipping Notification (ASN)	Order Ref No:	
		Date:	

Company Name:	
Address:	
Phone No:	
A/H Contact:	
Submitted By:	
Email:	
Phone No:	
A/H Contact:	

Date Revised:	
Revision No:	
ROS Date:	

AFE/Cost Code/CVX PO:	
Project/Facility/Well Details:	

Expected Delivery/ Collection Date:	ED: CD:	Time:	
Collection Address: *(If pickup Required)*	N/A		
Contact Name:			
Email:			
Phone No:			
A/H Contact:			

Final Destination:	
Consignee:	
Delivery Address:	

Special Handling Instructions Where Applicable		YES	N/A
Lift Plan:		☐	☐
COG:		☐	☐
Oversize:		☐	☐
Fork tyne pockets in container:		☐	☐
Lifting assembly included:		☐	☐
Explosives no forklift handling:		☐	☐

Comments:

Check List confirming (with attachments where deemed necessary by business)	YES	N/A
Is all material Quarantine compliant?	☐	☐
Are Dangerous Goods present?	☐	☐
Are DG's Chemalert approved?	☐	☐
Are current (<5yrs) Australian MSDS's attached?	☐	☐
AS1604 H3 Timber treatment certs?	☐	☐
Additional Certs (Heat, Hydrostatic,	☐	☐
Are lifting points certified?	☐	☐
QA/QC release	☐	☐
Chain of custody form	☐	☐
Customs clearance for imported pkgs	☐	☐
Timber treatment certificate for imported pkgs	☐	☐
Country of Origin declaration for imported pkgs	☐	☐
Export compliance certificate for goods ex USA	☐	☐

ASN TEMPLATE INSTRUCTIONS

Advanced Shipping Notification:

- This template is designed to upload material details into Chevron iLogistics system
- All the mandatory details as specified in below table **MUST** be populated in **Advanced Shipping Notification** work sheet before submission
- Material details should only be entered at item level or package level.
- The maximum number of characters against a field are represented in the column header. Ex: **Material Description can have max 30 characters. Above the limit characters will be truncated**

FIELD TITLE	REQUIRED	DESCRIPTION
Sl No.	Not Applicable	
Order Type	Mandatory	CVX Type of order the materials being delivered against. By default this should be **external Ref** type, unless delivering against a PO number
Order Ref No. (15)	Mandatory	Reference number against which the materials are delivered. Each shipment must have its own unique number. This can be any number but **MUST** be prefixed by the first 3 letters of your company name (e.g. MONxxxxxxx)
Order Item Ref. No.(15)	Optional	Unique line item number in the Order
Invoice No.(15)	Optional	
Work Order No.(15)	Optional	
Material Description(30)	Mandatory	Description/Label of the material(s)
L(500)	Optional	Long description of material(s)
Material No.(10)	Optional	
Material type(30)	Optional	Type of material. Choose from existing list
Quantity (10)	Mandatory	Numbers of quantity
Est. Quantity-Units (10)	Mandatory	Units of Quantity. Please refer to Units table for unit code descriptions
Weight (10)	Mandatory	Weight of materials in numeric
Est. Weight-Units (10)	Mandatory	Units of weight
ROS Date(DD/MM/YYYY)	Mandatory	Required on Site Date
Remarks(500)	Optional	Remarks
Length (m) (10)	Mandatory	Length in meters
Width (m) (10)	Mandatory	Width in meters
Height (m) (10)	Mandatory	Height in meters
Delivery Type	Optional	Partial, Full or Over
HAZMAT(Yes/No)	Mandatory	Hazardous Material specification
Value of Material(10)	Not Applicable	
Currency	Not Applicable	
Custom Status	Not Applicable	
Rental(Yes/No)	Optional	Specify if the material is a rental equipment

Unit Code	Description
BD	Bundle
BE	Bale
BG	Bag
BK	Bucket
BN	Bulk
BR	Barrel
BT	Bottles
BU	Bushel
BX	Box
CA	Case
CD	Cylinder
CL	Coil
CR	Carton
CT	Caret
CU	Cubes
DR	Drum
DZ	Dozen
EA	Each
JR	Jar
JT	Joints
KI	Kit
LO	Lot
PA	Pail
PC	Pieces
PD	Pad
PK	Pack
PL	Pallet
PR	Pair
RE	Reel
RL	Roll
RM	Ream
SK	Sack
SL	Sleeve
SP	Spool
ST	Set
TB	Tube
TC	Tank Car
TI	Tin
TK	Tank
UN	Units

Header:

- Enter the Order reference number into ASN ref No field, against wich the materials can be tracked
- Fill in the collection details if pick up is required
- Please select all the special handling instructions where applicable
- Please mark the ASN check list and attach necessary documents were deemed necessary to the email

Form 3 – Marine Vessel Survey Log Form

BLUE PLANET MARINE

Gorgon LNG Project
Marine Fauna Observations

Chevron

Vessel:

Log to be maintained by the MFO

Week starting ____________

Date	Time (24 hour)	Latitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Longitude (dd.mm.mm) DEGREES & DECIMAL MINUTES	Your activity (ie transit, at anchor)	Distance in metres of fauna from vessel	Bearing of fauna from vessel	Species (if known * See note below)	Total number of animals	Mitigation activities if required (ie manoeuvred slowly away from whale)	Seastate (Beaufort)	Overall visibility (Very good, Average, Poor)

*If species unknown, use "turtle", "dolphin", "whale", "dugong" or "whale shark".

Page ____ *of* ____

Form 4 – Environmental Permit Application Forms

Department of Fisheries Western Australia
3rd Floor, The Atrium
168-170 St George's Terrace
PERTH 6000

Telephone (08) 9482 7333
Facsimile (08) 9482 7390

Office Use Only

Date Received	
Application Fee Paid	
Receipt No.	

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This application is made to the Minister for Fisheries at the Department of Fisheries.

The applicant named in Part A, in accordance with Section 7 and Regulation 6 of the *Fish Resources Management Act 1994* and *Regulations,* hereby applies in respect of the purpose set out in Part B and in respect of the proposed activities set out in Part C for the grant of an Exemption from the provisions set out in Part D.

PART A

1. **Applicant:** ....

Address: ....

.... Post Code: ....

Telephone No: (........) .... Facsimile No.: (......)................................

PART B

2.1 **Purpose for which Exemption is sought:** ....

....

....

....

....

2.2 **Identify the relevant paragraph of section 7(2) :**

....

....

PART C

3. **Proposed Activities**

....

....

....

....

15/11/11

PART D

4. **Provision of Legislation from which Exemption is sought**

....

....

....

PART E

5. **Declaration**
I/We declare that the statements made in this Application are true and correct.

6. **Execution of Application**
Please sign and date in the appropriate section below.

6.1 ***Individuals***

....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)
....	....	....
(signature)	(print name)	(date)

6.2 ***Corporation***

The Common Seal of the authorisation holder is hereunto affixed in accordance with the corporation's Constitution:

Affix
Seal
Here

Director : ....
(signature) (print name) (date)

Director/Secretary: ....
(signature) (print name) (date)

Declaration where sole director/secretary (if applicable):

I .... declare that I am the sole director and sole company secretary of
(print name)

....
(print company name) (signature) (date)

Attorney

Attorney under Power: ....
(signature) (print name) (date)

Fish Resources Management Act 1994

APPLICATION FOR EXEMPTION

Section 7 & Regulation 6

This form is to be used to **apply** for an exemption from a provision or provisions of the Act or any subsidiary legislation made under the Act.

Applications for an exemption may be made to the Minister for Fisheries..

The address at which this application is to be **lodged** is the address of the Department of Fisheries Western Australia (please refer to the head of the Application).

Section 7 of the *Fish Resources Management Act 1994* states:

7. (1) The Minister may, by instrument in writing, exempt a specified person or specified class of persons from all or any of the provisions of this Act.

(2) The Minister may only grant an exemption under subsection (1) for one or more of these purposes -

(a) research;

(b) environmental protection;

(c) public safety;

(d) public health;

(e) commercial purposes;

(f) community education about and compliance with this Act ;

(g) enforcement of this Act.

An exemption is subject to any conditions specified by the the Minister for Fisheries, or a person to whom the Minister for Fisheries has delegated, under section 12 of the Act, the power to grant exemptions. A condition may be varied or cancelled by the Minister for Fisheries (or the Minister's delegate) by notice in writing.

A person who contravenes a provision of a condition of an exemption will be liable to a penalty of $10,000 ($20,000 if a body corporate).

A person who acts beyond the authority conferred by an exemption will be liable to a penalty for breach of the Act.

Application Fee

The Prescribed Application Fee must accompany this application

Note: Application Fees are set out in *Fish Resources Management Regulations 1995*, Schedule 1, Part 2. Fees may be subject to change.

Instructions for completing this Application

Please use block letters when completing this Application.

Address the application to the "Minister for Fisheries".

PART A

1. **Applicant** - state the full name, business address of the applicant. Enter the daytime telephone number at ☎.

PART B

2. **Purpose for which Exemption is sought** - give details of the reason(s) for wanting to carry on the Proposed Activities (to be set out in Part C). Give details as to why the purpose for which the Exemption is sought is one of the purposes set out in section 7(2) of the Act, and identify the relevant paragraph of section 7(2).

PART C

3. **Proposed Activities for which Exemption is sought** - give full details of the proposed activities, including (as appropriate) by reference to quantity of fish, place or area, dates and times, persons to be involved and gear (including boats) to be used. Attach copies of relevant documents where appropriate

PART D

4. **Provision(s) of Legislation from which Exemption is sought** - specify the provisions of the Act, Regulations or other subsidiary legislation which prohibit the proposed activities (or any part of them); [e.g. Section 46 and Regulation 10 (where the take of a totally protected fish is proposed)].

PART E

5. **Declaration** - there are penalties under the *Fish Resources Management Act 1994* for making false or misleading statements.

6. **Execution of Documents -**

   6.1 **Signatures** - if the exemption is to be recorded as being held by more than one person, then all persons to be named on the exemption must sign and date this Application.

   6.2 **Body Corporate** - if the exemption is to be held by a body corporate, the Application must be signed and sealed in accordance with the sealing clause of the Corporation's Article of the Association and dated.

   6.3 **Attorney** - if the Applicant has appointed an Attorney, the Attorney signing may be requested to produce the relevant Power of Attorney instrument for viewing and a copy for recording.

NOTE: Applicants should be aware that the details disclosed in this Application will be recorded on the Public Register and be available for public search.

Appendix D Description of the Environment CAPL Planning Area

description of the environment - operational and scientific monitoring planning area

Document ID:	ABU-COP-02890
Revision ID:	5.0
Revision Date:	14/03/2025
Information Sensitivity:	Company Confidential

Controlled document

description of the environment - operational and scientific monitoring planning area

Document information

Document Number	ABU-COP-02890	Revision	5.0
Document Owner	Shane Waldeck	Department Owner	HSE Regulatory Affairs Team Lead

Revision history

Rev No.	Description	Date	Prepared By	Approved By
1.0	Issued for use	01 May 2020	A Fertch	D Salins
2.0	Updated with Offshore Areas incorporated into Planning Area	11 Sep 2020	A Fertch	D Salins
3.0	Annual review	23 Jul 2021	M Carey	D Smith
4.0	Annual review, and revision of Planning Area to incorporate IOT	01 Mar 2023	R Hill / E Rosengart	D Salins
4.1	Annual review	17 Aug 2023	R Hill	D Salins
4.2	Annual review	31 Jan 2025	T Garnica / E Rosengart	S Bowes
5.0	Annual review, and revision of Planning Area	14 Mar 2025	T Garnica / E Rosengart	S Bowes

Approvals

	Name	Signature	Date
Author:	Tatiana Garnica & Ella Rosengart HSE Advisor		
Checked:	Stan Bowes Environmental Specialist – Regulatory Approvals		
Checked:	Julian Kalau Ecologist / Environment Specialist		
Approved:	Shane Waldeck HSE Regulatory Affairs Team Lead		

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1 introduction

1.1 Overview

This document describes the environment within Chevron Australia Pty Ltd’s (CAPL’s) Planning Area (PA) (Figure 1-1), which is the ‘offshore area’ in which CAPL’s activities may interact with the environment. Offshore areas are defined under section 8 of the *Offshore Petroleum and Greenhouse Gas Storage Act 2006* Commonwealth (Cth) (OPGGS Act). This document applies to all CAPL operations and may be used to support Environment Plans (EPs) (specifically including the Operational and Scientific Monitoring Programs [OSMPs]), submitted to the National Offshore Petroleum Safety and Environmental Management Authority (NOPSEMA).

Each EP will define an environment that may be affected (EMBA) and Planning Area for Operational and Scientific Monitoring (OSM) for its specific petroleum activity. The EMBA and Planning Area for OSM for each activity will most likely be based on conservative stochastic spill modelling for a worst case credible scenario. If an EMBA or Planning Area for OSM from an individual EP extends into an offshore area that is beyond the existing PA, this document will be revised, and the PA extended to incorporate the additional ‘offshore area’.

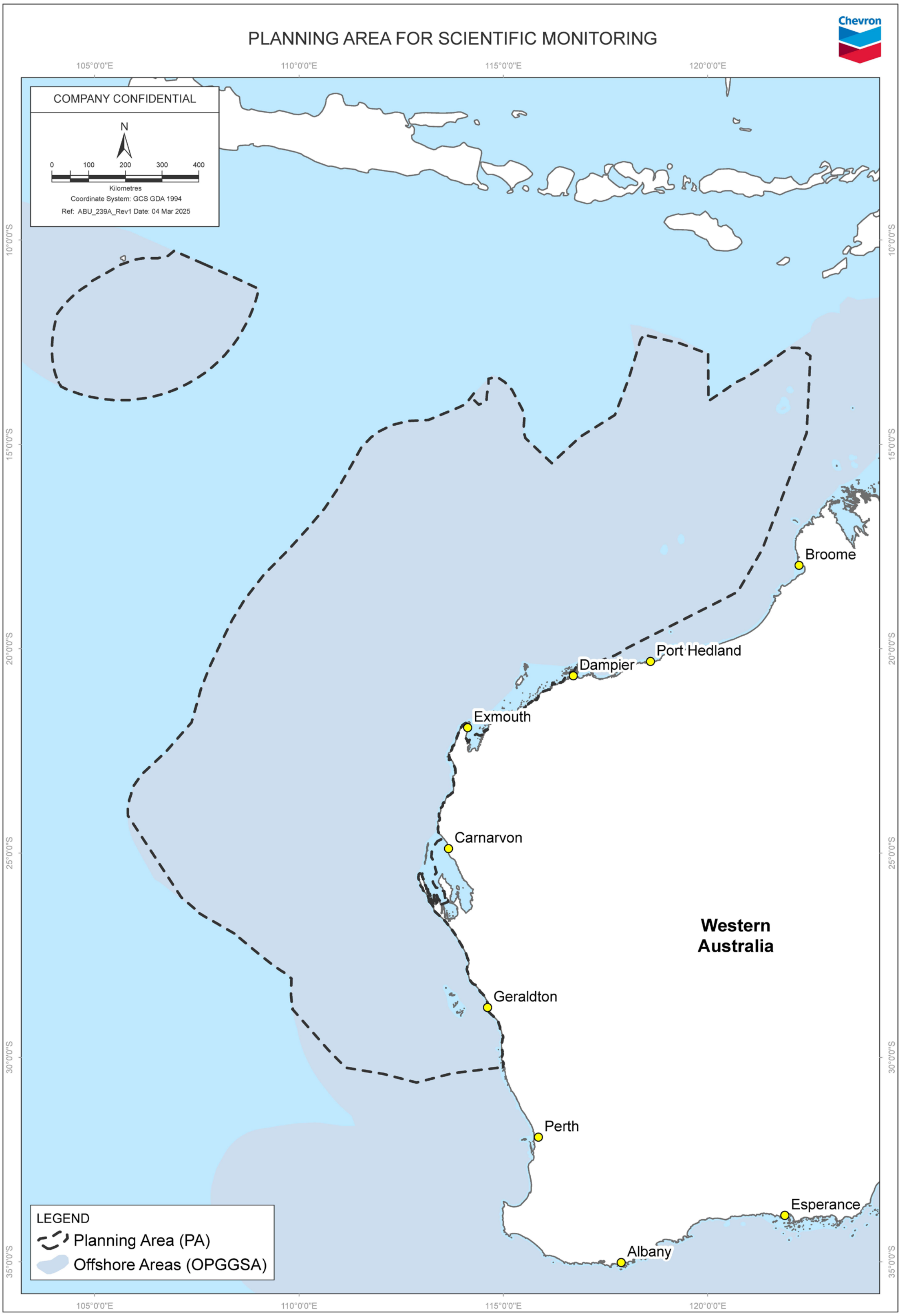

Figure 1-1: CAPL's planning area

1.2 Regulatory context

The Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023 (Cth) (OPGGS(E)R) detail the information that must be included in an EP. Specifically, regulation 21(2) states that the environment plan must:

- describe the existing environment that may be affected by the activity; and
- include details of the particular relevant values and sensitivities (if any) of that environment.

Regulation 5 defines the environment as:

a. ecosystems and their constituent parts, including people and communities; and
b. natural and physical resources; and
c. the qualities and characteristics of locations, places and areas; and
d. the heritage value of places; and includes the social, economic and cultural features of the matters mentioned in paragraphs (a), (b), (c) and (d).

Regulation 21(3) further provides that, without limiting paragraph (2)(b) of regulation 21(2), relevant values and sensitivities may include any of the following:

a. the world heritage values of a declared World Heritage property
b. the national heritage values of a National Heritage place
c. the ecological character of a declared Ramsar wetland
d. the presence of a listed threatened species or listed threatened ecological community
e. the presence of a listed migratory species
f. any values and sensitivities that exist in, or in relation to, part or all of:

– a Commonwealth marine area; or
– Commonwealth land.

Specific to the description of the environment, NOPSEMA’s Environment Plan Content Requirement guidance (Ref. 1) states:

“The level of detail within the plan should be appropriately scaled to the nature of the impacts and risks to the particular values and sensitivities. For example, the environment that may be affected by planned operations will need to be described in a greater level of detail than areas exposed to low levels of hydrocarbon in the unlikely event of a worst-case hydrocarbon release.”

Consequently, CAPL has taken the approach that this document provides information suitable for summarising the values and sensitivities in order to inform the Planning Area for OSM under an OSMP for CAPL operations.

If additional information is available for specific locations (typically an Operational Area for a specific activity) and if this information can be used to further influence or inform the impact and risk assessment, this additional information will be included in the ‘Description of the Environment’ section of the individual EP.

2 matters of national environmental significance

Matters of National Environmental Significance (MNES) are protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) (Cth). The presence of MNES within the PA has been determined from the Australian Government's online Protected Matters Search Tool (PMST) (Ref. 2). The presence of relevant marine and/or coastal MNES within the PA are summarised in Table 2-1. The full PMST report[1] is included as appendix a.

It should be noted that the EPBC Act PMST is a general database that conservatively identifies areas in which protected species have the potential to occur.

Table 2-1: Presence of MNES within the PA

MNES	PA
World Heritage properties	✓
National Heritage places	✓
Wetlands of international importance (Ramsar wetlands)	✓
Nationally listed threatened species and communities	✓ species ✓ communities
Nationally listed migratory species	✓
Commonwealth marine area	✓
Great Barrier Reef Marine Park	✗
Nuclear actions (including uranium mining)	—
Water resources (in relation to coal seam gas or large coal mining development)	—

Where ✓ = present, ✗ = not present, and — = not relevant to the petroleum activity.

[1] The PMST is a general database that includes all MNES, including species or features (such as terrestrial based species or features) that are not expected to credibly occur within the PA.

3 planning area

The PA is primarily located within the North-West Marine Region (NWMR), with its southern extent overlapping the South-West Marine Region (SWMR) and north-western extent overlapping the waters surrounding Christmas Island.

The NWMR is divided into three large-scale marine ecological systems—Kimberley, Pilbara, and Ningaloo–Leeuwin—based on the influence of major ocean currents, seafloor features, and eco-physical processes (e.g. climate, tides, freshwater inflow) within the Region (Ref. 6). The SWMR is divided into six large-scale marine ecological systems, which extend from offshore Cape Inscription in WA to the eastern end of Kangaroo Island in SA (Ref. 7).

Further details about the marine regions are provided in Section 4.6.

In alignment with these marine ecological systems, the PA has been divided into the following sections: Kimberley, Pilbara, Ningaloo, West Coast, and Christmas Island (Figure 3-1). Since CAPL's activities are concentrated within the Pilbara section, further detailed information will be provided for this region where relevant.

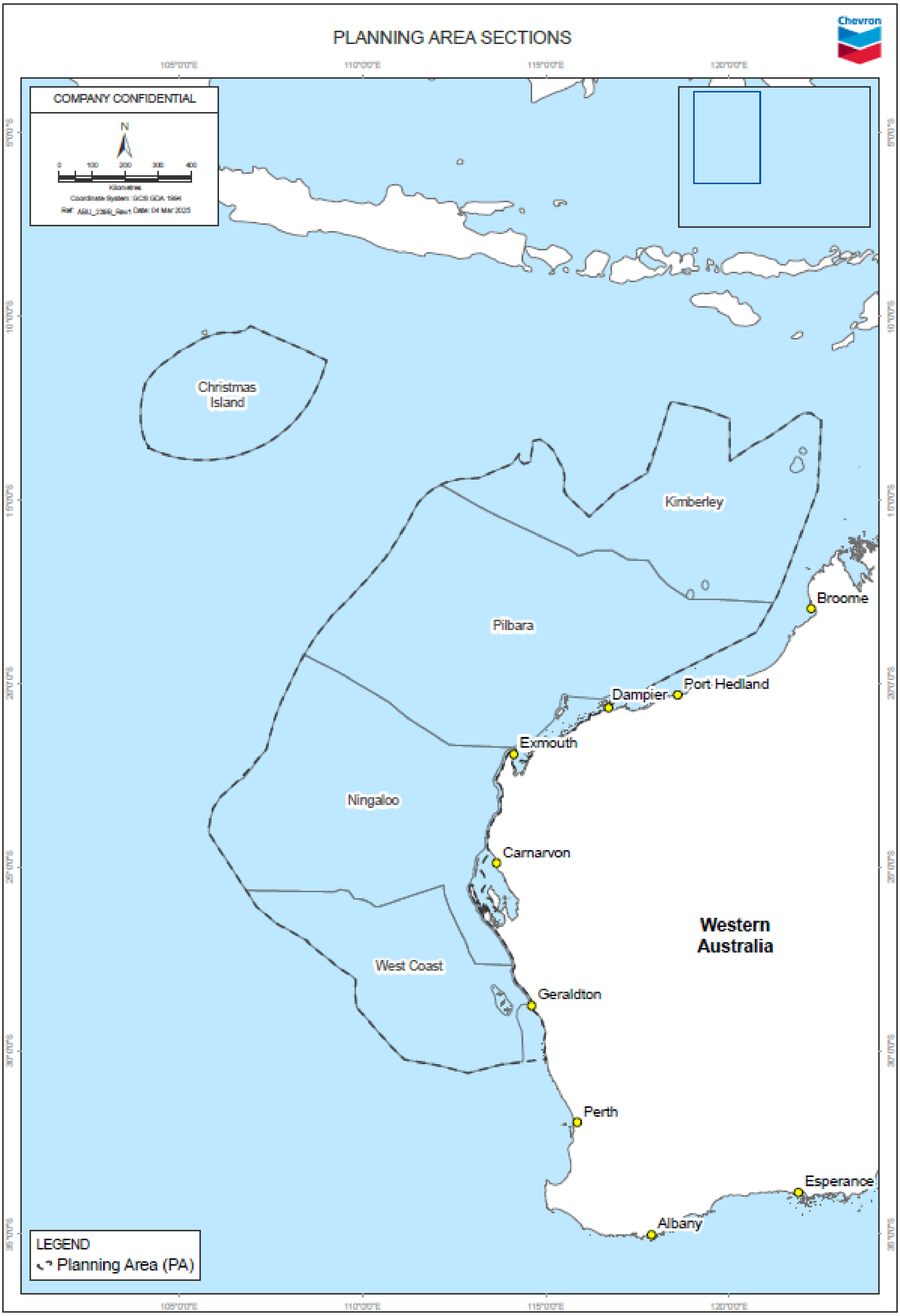

Figure 3-1: CAPL's planning area sections

4 ecosystems and their constituent parts, including people and communities

4.1 Benthic communities and habitats

Benthic communities are biological communities that inhabit the seabed and are important for primary or secondary production. Benthic habitats are areas of seabed that do, or can, support these communities. Benthic communities play an important role in maintaining the integrity of marine ecosystems and the supply of ecological services. There is strong evidence that benthic communities are also important for the maintenance of biological diversity as they provide structurally complex and diverse habitat, refuge for vulnerable life stages and a varied and increased food supply (Ref. 8).

The geomorphology of Australia’s continental margin is varied with several geomorphic features present, including basins, canyons, terraces, seamounts, ridges, and plateaus. Based on Geoscience Australia’s geomorphic classification of seabed within Australia’s exclusive economic zone (EEZ) (Ref. 9), the PA overlaps with the features outlined in Table 4-1.

Table 4-1: Geomorphic features[2]

Feature	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Abyssal-plain/deep ocean floor	✓	✓	✓	✓	✓
Apron/fan	✓	—	✓	✓	—
Bank/shoals	✓	✓	✓	✓	—
Canyon	✓	✓	✓	✓	✓
Continental-rise	✓	✓	—	✓	—
Deep / hole / valley	✓	✓	✓	✓	✓
Escarpment	✓	—	—	—	—
Knoll / abyssal-hills / hills / mountains / peak	—	✓	✓	✓	✓
Pinnacle	✓	—	✓	✓	✓
Plateau	—	✓	✓	✓	✓
Reef	✓	✓	—	✓	—
Ridge	—	✓	✓	✓	✓
Saddle	—	✓	✓	—	✓
Seamount / guyot	—	—	—	—	✓
Shelf	✓	✓	✓	✓	✓
Slope	✓	✓	✓	✓	✓
Terrace	✓	✓	✓	✓	✓
Trench/through	—	—	✓	—	✓
Tidal-sandwave/sand-bank	—	✓	✓	—	—

[2] The table is based exclusively on data from Geoscience Australia's geomorphic classification of the seabed within Australia's Exclusive Economic Zone (EEZ) (Ref. 9).

The composition, distribution, and movement of marine sediments is an important component of a marine ecosystem. These sediments can influence the primary biological production in the water column as well as the evolution and distribution of benthic habitats. The north-west WA comprises bio-clastic, calcareous, and organogenic sediments deposited from relatively slow and uniform sedimentation rates (Ref. 10). Sediments in the NWMR generally become finer with increasing water depth, ranging from sand and gravels on the continental shelf to mud on the continental slope and abyssal plain (Ref. 11). Sediments in the northern section of the SWMR are predominantly cool-water carbonates, with shelf-parallel cool-water carbonate facies on the shelf and warm-water tropical carbonate facies on reef platform (Ref. 12).

Based on CSIRO's marine benthic substrate database (Ref. 13), the predominant seafloor sediment types within the PA are "calcareous gravel, sand and silt", "calcareous ooze", "mud and calcareous clay", and "biosiliceous marl and calcareous clay". It is noted that the database does not provide information for the Christmas Island section.

The Integrated Marine and Coastal Regionalisation of Australia (IMCRA) is a biogeographic regionalisation of oceanic waters within Australia's EEZ (Ref. 14). Provincial bioregions were classified based on fish, benthic (seabed) habitat and oceanographic data at a scale that is useful for regional conservation planning and management (Ref. 4). Table 4-2 identifies and summarises the geomorphology characteristics and biological communities for each of these bioregions, as described in the Marine Bioregional Plans – Bioregional Profile (Ref. 4, Ref. 15). There is currently no Marine Bioregional Plan for the Christmas Island section so other available information has been used to populate Table 4-2.

Listed threatened ecological communities (TECs) are a MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R. Refer to Section 4.2.1 for further details.

Table 4-2: Features of provincial bioregions

<table>
<tr><th rowspan="2">IMCRA Provincial Bioregion</th><th colspan="5">Section</th></tr>
<tr><th>West Coast</th><th>Ningaloo</th><th>Pilbara</th><th>Kimberley</th><th>Christmas Island</th></tr>
<tr><td>Christmas Island Province^</td><td>—</td><td>—</td><td>—</td><td>—</td><td>✓</td></tr>
<tr><td colspan="6">Characteristics of the geomorphology and biological communities of Christmas Island Province (Ref. 775, Ref. 776, Ref. 777):
• Christmas Island is a remote island which rises sharply from the deep tropical waters of the Indian Ocean
• the bioregion varies in depth from shallow coastal areas to steep, rugged slopes and deep oceanic trenches, with depths ranging from 0–6000 m.
• result of an emergence of a series of geological uplifts over 10s of millions of years. The ocean eroded cliffs forming the terraces and inland cliffs on the islands central plateau
• is the peak of a basalt volcanic seamount which rose an estimated 60 million years ago ~5,000 m from the ocean floor
• marine environment includes ocean waters, sand flats, caves, coral reefs and walls, and coral heads or 'bommies'
• significant features such as reefs, seamounts, trench, plateau and abyssal-plain
• high species endemism.</td></tr>
<tr><td>Central Western Province*</td><td>✓</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="6">Characteristics of the geomorphology and biological communities of the Central Western Province:</td></tr>
</table>

IMCRA Provincial Bioregion	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• it is characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's Marine Regions. The continental rise is located on the edge of the Perth Abyssal Plain (103,911 km^2) • a significant feature in the bioregion is the Perth Canyon, the largest of Australia's submarine canyons, which coincides with a distinct change in the distribution of marine organisms and marks the southernmost boundary for numerous tropical and sub-tropical species (note the PA intersects the northern section of the Central Western Province and does not intersect the Perth Canyon) • the bioregion includes several eddies hundreds of kilometres in diameter that spin in an anti-clockwise direction that form off the Leeuwin Current at predictable locations • the density of demersal fish in this bioregion is low, especially when compared with the South-east Marine Region: – fish density is highest at the shelf break and uppermost parts of the slope (~200-300 m water depth) where large adult snappers dominate – at greater depth on the slope (below 400 m water depth) demersal fish communities are dominated by many relatively small, benthic species (grenadiers, dogfish and cucumber fish) • the submarine canyons of this bioregion are key ecological features because they are thought to be linked to the localised small periodic upwellings that enhance productivity and attract aggregations of marine life Features and areas of ecological importance within the Central Western Province have been identified as: • demersal slope fish communities • West Coast Canyons and adjacent shelf break • meso-scale eddies (predictable locations south-west of Shark Bay, west of the Houtman Abrolhos Islands, southwest of Jurien Bay and west of Perth Canyon) • waters off the mid-west coast, WA.					
Central Western Shelf Province^	—	✓	—	—	—
Characteristics of the geomorphology and biological communities of the Central Western Shelf Province include: • the bioregion itself varies in depth from 0–100 m and in width from less than 20 km in the north to around 125 km in the vicinity of Shark Bay • a small area of reef and tidal sandwaves or sandbanks occur at the entrance to Shark Bay and within its vicinity • the banks and shoals in this bioregion are of note because they occur at latitudes significantly south of banks and shoals elsewhere in the NWMR • sand is the dominant component of the sediments of the Central Western Shelf Province, with small amounts of gravel and muds. The substrate within Shark Bay itself is predominantly sandy, with a small area of temperate reef at the opening of the bay • This bioregion is a transitional zone between the predominantly tropical flora and fauna of the north and temperate flora and fauna further south • the fish communities predominantly comprise temperate species with very little distinction between coastal and shelf communities • biological communities of the shelf are likely to include a sparse invertebrate assemblage of sea cucumbers, urchins, crabs and polychaetes on sandier substrates • harder substrate areas are likely to contain sessile invertebrates such as sponges, gorgonians and more diverse fish than sandy habitats • coastal fish species include jewfish and periodic/seasonal swarms of hardy heads that are food for a wide variety of species, including larger fish and whales • the biological communities within Shark Bay have been studied extensively and the bay itself is a declared World Heritage Area:					

IMCRA Provincial Bioregion	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
– the bay includes a diversity of habitats including areas of seagrass, sandy plains and rocky shoreline, in both high and low energy zones – shallow fringing coral reefs occur on the eastern side of many of the bay's islands – there are extensive sponge gardens and communities of bivalves and other mollusc species that are associated with finer sediments and mobile shifting banks – it is an important site for dugongs and it also supports the largest breeding population of loggerhead turtles in Australia, a substantial population of bottlenose dolphins, and significant numbers of whales (primarily humpbacks) and manta rays occur in northern and western Shark Bay in winter – Shark Bay and the adjacent shelf are also important areas for shallow water snapper (*Pagrus auratus*), which comprise three distinct breeding populations in the area, one in each inner gulf of Shark Bay and a third in the adjacent oceanic waters. Features and areas of ecological importance within the Central Western Shelf Province have been identified as: • Shark Bay–Dirk Hartog Island and surrounding waters.					
Central Western Shelf Transition^	—	✓	✓	—	—
Characteristics of the geomorphology and biological communities of the Central Western Shelf Transition include: • the bioregion is located entirely on the continental shelf and is comprised mainly of sandy sediments • this bioregion includes both State and Commonwealth waters between water depths of 0 m to ~80 m – Commonwealth waters in this bioregion represent <1% of the total area of the NWMR • the benthic ecological communities of the bioregion, include both tropical and temperate species transitioning along a north-south gradient • Ningaloo Reef[3] is the most significant geomorphic feature of this bioregion: – it extends along the Cape Range Peninsula for over 260 km, and is the only example in the world of an extensive fringing coral reef on the west coast of a continent – it is marked by a well-developed spur and groove system of fingers of coral formations penetrating into the ocean with coral sand channels in between – a lagoon on the inshore side separates Ningaloo Reef from the mainland – the biological communities of the Ningaloo Reef differ from the hard coral reefs located elsewhere in the NWMR • a large proportion of this bioregion is covered by the State and Commonwealth Ningaloo Marine Parks, which are one of the most significant hotspots of biodiversity within the NWMR • the Ningaloo Marine Parks incorporate a diversity of habitats including the seabed of the continental slope and shelf that supports demersal and benthic plants and animals including fish, molluscs, algae, sponges, soft corals and burrowing bivalves; as well as coral reefs and intertidal areas such as rocky shores and mangroves in State waters. Features and areas of ecological importance within the Central Western Shelf Transition have been identified as Ningaloo Marine Park – North West Cape.					
Central Western Transition^	—	✓	—	—	—
Characteristics of the geomorphology and biological communities of the Central Western Transition include: • the bioregion is characterised by large areas of continental slope, with sediments dominated by muds and sands that decrease in grain size with increasing depth					

[3] Ningaloo Reef also extends into the Northwest Province, Central Western Transition Province, and a small portion of the Northwest Shelf Province. The geomorphology and biological communities of Ningaloo Reef are discussed in this bioregion summary.

<table>
<tr><th rowspan="2">IMCRA Provincial Bioregion</th><th colspan="5">Section</th></tr>
<tr><th>West Coast</th><th>Ningaloo</th><th>Pilbara</th><th>Kimberley</th><th>Christmas Island</th></tr>
<tr><td colspan="6">

about 40% of the bioregion occurs in waters depths greater than 4,000 m and the deepest areas of the bioregion occur within the Cuvier Abyssal Plain at ~5,330 m
a large part of the bioregion comprises the Cuvier Abyssal Plain
Wallaby Saddle is another important topographic feature within this bioregion and is the most extensive area of this type of topographic feature in the NWMR
the benthic slope communities of this bioregion comprise both tropical and temperate species along a north-south gradient
the biological communities of the Central Western Transition are thought to be distinctive owing to the proximity of deep ocean areas to the continental slope and shelf, resulting in close interaction between pelagic species of the Cuvier Abyssal Plain and those of the slope and shelf
the harder substrate of the slope in waters of 200–2,000 m deep is likely to support populations of epibenthos such as bryozoans, sponges and encrusting coralline algae; these support larger infauna and benthic animals such as crabs, cephalopods, echinoderms and other suspension-feeding epibenthic organisms
in the deeper waters of the abyss, the benthic communities are likely to be sparse and include meiofauna (e.g. nematodes).

Features and areas of ecological importance within the Central Western Transition have been identified as:

Wallaby Saddle
Cape Range Canyon and Cloates Canyon.

</td></tr>
<tr><td>Northwest Province^</td><td>—</td><td>✓</td><td>✓</td><td>—</td><td>—</td></tr>
<tr><td colspan="6">
Characteristics of the geomorphology and biological communities of the Northwest Province include:

bioregion occurs entirely on the continental slope and is comprised of muddy sediments
distinguished by a number of topographic features, such as the Exmouth Plateau, terraces and canyons (including the Swan and Cape Range canyons), as well as deep holes and valleys on the inner slope (including the Montebello Trough)
the benthic shelf and slope communities of this bioregion comprise both tropical and temperate species with a north-south gradient
the continental slope between North West Cape and the Montebello Trough has been identified as one of the most diverse slope habitats of Australia
the Exmouth Plateau is also likely to be an important area for biodiversity as it provides an extended area offshore for communities adapted to depths of ~1,000 m
information available on sediments in the bioregion indicates:

benthic communities are likely to include filter feeders and other epifauna
soft-bottom environments are likely to support patchy distributions of mobile epibenthos, such as sea cucumbers, ophiuroids, echinoderms, polychaetes and sea pens
biological communities within canyons in the bioregion are also poorly understood.

Features and areas of ecological importance within the Northwest Province have been identified as:

Exmouth Plateau
canyons on the slope, including the Cape Range Canyon
demersal fish communities associated with the slope.

</td></tr>
<tr><td>Northwest Shelf Province^</td><td>—</td><td>—</td><td>✓</td><td>✓</td><td>—</td></tr>
<tr><td colspan="6">
Characteristics of the geomorphology and biological characteristics of the Northwest Shelf Province include:

bioregion occurs almost entirely on the continental shelf, except for a small area to the north of Cape Leveque that extends onto the continental slope
this bioregion includes more than 60% of the continental shelf in the NWMR

</td></tr>
</table>

IMCRA Provincial Bioregion	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• continental shelf gradually slopes from the coast to the shelf break, but displays a number of seafloor features such as banks/shoals and holes/valleys, including: – Glomar Shoals occur in ~26–70 m water depth and are distinguished by highly fractured molluscan debris, coralline rubble and coarse carbonate sand – Leveque Rise (large plateau), which is one of only two shelf plateaux within the NWMR – significant areas of tidal sandwaves or sandbanks (ranging in height ~5–10 m) occur on the inner-most reaches of Exmouth Gulf, and are one of only three major occurrences of this type of feature in the NWMR – shelf also contains several terraces and steps that extend into adjacent bioregions and reflect ancient coastlines from when the sea level in the NWMR was lower; the most prominent of these occurs at a water depth of ~125 m • sediment differentiation occurs on a north-south gradient – south of Broome, sediment is relatively homogenous and dominated by sands with small proportion of gravel – north of Broome, sediment is highly variable with sand or gravel dominance in no discernable spatial pattern – mud increases within ~100 km of the coast, and within ~100 km of the shelf break, but is mostly absent from other areas • sandy substrates on the shelf within this bioregion are thought to support low density benthic communities of bryozoans, molluscs, and echinoids • sponge communities are also sparsely distributed on the shelf, but are found only in areas of hard substrate Features and areas of ecological importance within the Northwest Shelf Province have been identified as: • Browse Island and surrounding waters • Lacepede Islands and surrounding waters • Quondong Point, north of Broome and surrounding waters • West coast of the Dampier Peninsula, including Beagle and Pender bays and surrounding waters • Pilbara coast (between Exmouth and Broome) and surrounding waters • Exmouth Gulf—Muiron Islands and surrounding waters • ancient coastline at 125 m depth contour • Glomar Shoals.					
Northwest Transition^	—	—	✓	✓	—
Characteristics of the geomorphology and biological communities of the Northwest Transition include: • around half (52%) of the bioregion occurs on the continental slope, with smaller areas in the north-west of the bioregion located on the Argo Abyssal Plain and continental rise • encompasses a range of water depths, from the shelf break (~200 m water depth) to ~5,980 m over the Argo Abyssal Plain • other topographic features within the bioregion include areas of rise, ridges, canyons and apron/fans • sediments of the slope are dominated by sands, whereas the sediments of the abyssal plain/deep ocean floor are dominated by muds • the bioregion also has reefs such as Mermaid, Clerke, and Imperieuse reefs, which are collectively known as the Rowley Shoals • the benthos of the deep ocean areas are likely to support meiofauna (e.g. nematodes), larger infauna (e.g. polychaete worms, isopods), and sparsely distributed epibenthic communities (e.g. sea pens)					

IMCRA Provincial Bioregion	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• mobile benthic species (e.g. deepwater sea cucumbers, crabs, polychaetes) are likely to be associated with the seafloor, and bioregion may support sparse populations of bentho-pelagic fish and cephalopods in low densities Features and areas of ecological importance within the Northwest Transition have been identified as: • Rowley Shoals—Mermaid Reef Marine National Nature Reserve, Clerke and Imperieuse reefs and surrounding waters • fish communities associated with the slope.					
Southwest Shelf Transition*	✓	—	—	—	—
Characteristics of the geomorphology and biological communities of the Southwest Shelf Transition: • Water depth in this bioregion ranges from 200 m near the shelf break to 5,920 m on the Argo Abyssal Plain • the Leeuwin Current has a significant influence on the biodiversity of this bioregion as it pushes subtropical water southward along the western edge of the bioregion • ridges and inshore lagoons characterise the seafloor of the continental shelf of this area • the bioregion contains a diversity of tropical and temperate marine life including a large number of endemic fauna species • species diversity of seagrasses in this bioregion is the highest in the world, with 14 species occurring • the inner shelf of the bioregion, extending between 0-50 m deep, includes distinct ridges of limestone reef with extensive beds of macroalgae • benthic communities on the outer shelf and shelf break are dominated by adult snapper, while filter feeding sponges and bryozoans dominate the hard bottom • inshore lagoons are thought to be important areas for benthic productivity and recruitment for a range of marine species – the shallow water, sheltered environments are located between the shore and the inner shelf ridge system and extend south well into the Southwest Shelf Province – these lagoons are characterised by extensive beds of macroalgae, interspersed with areas of seagrass which provide the primary source of benthic production inside the 50 m depth contour – they provide important habitat for the breeding and nursery aggregations of a number of species Features and areas of ecological importance within the Southwest Shelf Transition have been identified as: • coastal reefs around Kalbarri • Houtman Abrolhos Islands and surrounding waters • inshore lagoons • Fisherman Islands • Beagle Islands • Penguin Island • Lancelin Island • waters off the mid-west coast, WA • Jurien Bay south to Rottnest Island • western rock lobster • small pelagic fish.					
Timor Province^	—	—	—	✓	—
Characteristics of the geomorphology and biological communities of the Timor Province:					

IMCRA Provincial Bioregion	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• water depth in this bioregion ranges from 200 m near the shelf break to 5,920 m on the Argo Abyssal Plain • the Timor Province is located on the continental slope and includes topographic features such as the Scott Plateau, the Ashmore Terrace, and part of the Rowley Terrace, as well as a portion of the Argo Abyssal Plain • the Scott Plateau is a significant geomorphic feature. It occurs in water depths of 2,000–3,000 m and is fringed by numerous spurs and valleys. It is separated from the Rowley Terrace by canyons including the Bowers Canyon • almost half of the reefs in the North-west Marine Region occur in the Timor Province • one of the most significant aspects of the reefs of the Timor Province is that they reflect a transition in reef type from algal-dominated reefs north of Ashmore Reef to hard-coral-dominated reefs south of, and including, Ashmore Reef • shallow reefs on the shelf break occur in close proximity to adjacent deep water muddy seabeds on the slope • the reefs and islands of the bioregion are regarded as biodiversity hotspots and include a range of important pelagic and benthic ecological communities • the reefs and islands in this bioregion are thought to be important biological stepping-stones between centres of biodiversity in the Indo–Pacific and reef ecosystems further south • coral reefs in this bioregion support a high biomass of fish species, including tropical reef fish, small pelagic fish, parrotfish and groupers as well as larger species. These reefs and their surrounding waters are also important habitats for cetaceans and seabirds • it is likely that important demersal communities also occur in the canyons, banks and deep holes of the bioregion, as well as on the Ashmore and Rowley terraces and Scott Plateau • It is likely that southern bluefin tuna travel through the bioregion on their way to and from spawning grounds between Java and Australia. Migrating whales may ‘ride’ the northward flows of the Eastern Gyral Current and South Equatorial Current enroute to breeding grounds off the Kimberley. Features and areas of ecological importance within the Timor Province have been identified as: • Ashmore Reef National Nature Reserve and Carter Island Marine Reserve and surrounding waters • Scott Reef and Seringapatam Reef and surrounding waters • Demersal fish communities associated with the upper and mid-slope • Canyons in the slope between the Argo Abyssal Plain and Scott Plateau and the north of Scott Reef.					

^Source: Ref. 4.

**Source: Ref. 15.*

4.2 Coastal communities and habitats

Coastal communities are biological communities that inhabit the coastal zone. Coastal habitats are areas of shoreline types that do or can support these communities. Similar to benthic communities (as described in Section 4.1), coastal communities are likely to play roles in maintaining the integrity and diversity of coastal ecosystems, and the supply of ecological services.

Based on Smartline (Ref. 16), a spatial database containing geomorphic classifications for Australia’s coasts, the shoreline types within the PA include various classifications along the coast (Table 4-3). It is noted that the database does not include information for the Christmas Island and Kimberley sections.

Table 4-3: Types of shorelines

Feature	Section				
	West Coast	Ningaloo	Pilbara	Kimberley ^	Christmas Island*
Hard bedrock shore	✓	✓	✓	—	—
Hard rock cliff (>5 m)	—	✓	—	—	
Muddy tidal flats	—	✓	✓	—	—
Sandy beach	✓	✓	✓	—	—
Sandy tidal flats	—	✓	—	—	—
Tidal flats	—	✓	✓	—	—

^ The Smartline database categorises shoreline features within the Kimberley region as 'unclassified.'

**There is currently no available data for Christmas Island in the Smartline database.*

The Seamap Australia spatial database collates and classifies marine and coastal habitats on the Australian continental shelf (Ref. 17). Table 4-4 outlines sensitive marine or coastal habitats (such as mangroves) within the PA as identified in the Seamap Australia spatial database. It is noted that the database does not include information for the Christmas Island section.

Table 4-4: Marine and coastal habitats

Feature	Brief overview of location
West Coast	Mangroves: • patches along the coast
Ningaloo	Mangroves: • Exmouth Gulf • Coral Bay • Shark Bay Saltmarsh: • Exmouth Gulf • Shark Bay Seagrass: • Shark Bay • Dorre Island • Bernier Island
Pilbara	Mangroves: • patches along the coast • presence around Forestier, North, Middle, South, Muiron, Bessieres, Barrow and Montebello Islands • west coast of Weerdee Island • east coast of Dixon and East Islands
Kimberley	Mangroves: • northeast coast of West Island
Christmas Island	N/A

4.2.1 Threatened ecological communities

Listed TECs are MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R. In Australia, three categories exist for listing TECs under the EPBC Act: critically endangered, endangered, and vulnerable.

A search of the TEC spatial database (Ref. 18) and searches of the online PMST (appendix a) identified one TEC, Subtropical and Temperate Coastal Saltmarsh classified as vulnerable, within the PA[4]. This TEC is present only in the Ningaloo section.

The Subtropical and Temperate Coastal Saltmarsh ecological community occurs within a relatively narrow margin of the Australian coastline, within the subtropical and temperate climatic zones south of the South-east Queensland IBRA bioregion boundary at 23° 37′ latitude along the east coast and south of (and including) Shark Bay at 26° on the west coast (Ref. 19).

The physical environment of this ecological community consists of coastal areas subject to regular or intermittent tidal influence Ref. 19). It is typically restricted to the upper intertidal zone, occurring within the astronomical tidal limit, often between the elevations of the mean high tide and the mean spring tide (Ref. 20). However, exceptions exist where areas maintain a regular or intermittent tidal connection; these are still considered part of the ecological community (Ref. 19). The Coastal Saltmarsh ecological community may also include areas with groundwater connectivity to tidal water bodies (Ref. 19).

Western Australian coastal areas support a diverse range of saline coastal wetlands that are closely linked to typical coastal saltmarshes. These include saline lakes on the coast and offshore islands, coastal lagoons (both open and closed), and the birridas (gypsum claypans) of Shark Bay (Ref. 19).

The Coastal Saltmarsh ecological community is predominantly associated with soft substrate shores of estuaries and embayments, such as sandy and/or muddy environments, and occasionally with low wave-energy open coasts (Ref. 21). The associated sediments are typically poorly sorted, anoxic sandy silts and clays, and often exhibit salinity levels significantly higher than seawater due to evaporation (Ref. 22).

The Coastal Saltmarsh ecological community primarily consists of salt-tolerant vegetation (halophytes), including grasses, herbs, sedges, rushes, and shrubs. This community is generally dominated by succulent herbs, shrubs, and grasses, with vegetation typically <0.5 m in height, although some reeds and sedges may exceed this height (Ref. 23).

A notable characteristic of this community is the high degree of endemism at the species level (Ref. 24; Ref. 25), although it also supports a variety of non-endemic species (Ref. 19).

A review of the Conservation Advice and/or Recovery Plans identified key threats associated with the Subtropical and Temperate coastal saltmarsh TEC. Where relevant to petroleum activities, these threats and relevant management advice are listed in Table 4-5.

[4] Only TECs with a coastal and/or marine interface have been identified and described.

Table 4-5: Summary of relevant conservation plans

Relevant Plan / Advice	Key threats	Relevant management advice
Conservation Advice for Subtropical and Temperate coastal saltmarsh (Ref. 19)	Invasive species	• manage shipping practices to minimise potential invasion of exotic macroinvertebrates, fish, meiofauna, and pathogen species; and include Coastal Saltmarsh in the sites monitored for such arrival
	Climate change	• enhance the resilience of the ecological community to the impacts of climate change by reducing other pressures
	Pollution/litter	• Identify Coastal Saltmarsh as important habitat in all oil spill contingency planning at national and State levels, and monitor the application of protocols on the management of spills involving saltmarshes
	Eutrophication	• none identified

4.2.2 Wetlands of international importance (listed under the Ramsar Convention)

Wetlands of international importance (Ramsar wetlands) are MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R.

At the time of writing this document, Australia has 67 Ramsar wetlands that cover >8.3 million ha. Ramsar wetlands are those that are representative, rare, or unique wetlands, or that are important for conserving biological diversity (Ref. 26). These are included on the List of Wetlands of International Importance held under the Ramsar Convention (Ref. 26).

A search of the Ramsar Wetlands of Australia spatial dataset (Ref. 27) and searches of the online PMST (appendix a) identified the presence of two Ramsar wetlands within the PA[5]. (Table 4-6), both of them in the Christmas Island section. The Ramsar Convention defines ecological character as the combination of the ecosystem components, processes, benefits, and services that characterise the wetland at a given point in time (Ref. 28). A summary of the ecological character of the wetlands is described in Table 4-6.

Table 4-6: Ramsar wetlands

Description	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Hosnies Spring	—	—	—	—	✓
Hosnies Spring Ramsar site is located on the eastern side of Christmas Island in the Indian Ocean ~2,800 km west of Darwin and ~900 km northeast of the Cocos Islands. The site is located within the Christmas Island National Park. At the time of listing (1990) Hosnies Spring comprised <1 ha of freshwater spring. In 2010 the boundary of Hosnies Spring was expanded from 0.33 ha to 202 ha (Ref. 29; Ref.30). Hosnies Spring Ramsar site is an area of permanent, shallow freshwater wetland, fed by a natural spring system located ~30 metres above sea level and 120 metres inland of the seaward cliff (Ref. 29). The Ramsar site includes surrounding terrestrial areas with rainforest grading to coastal scrub and includes an area of shoreline and coral reef (Ref. 31). The following summary of ecosystem components, processes and services has been extracted from Hale and Butcher (Ref. 30). *Ecosystem components and processes*					

[5] Only TECs with a coastal and/or marine interface have been identified and described.

Description	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• climate: warm tropical climatic zone; high rainfall (2,000 mm per year); warm to hot year round • geomorphology settings: site is located within shore terrace on gravel overlying phosphoric soils; spring is situated at the base of the inland cliffs where spring water flows over a limestone flowstone • hydrological regime: groundwater is dominant, source for Hosnies Spring in a perched, unconfined aquifer that, discharges where impermeable volcanic rocks are close to the surface, flow rate is not known, but is expected to be low • water quality[6]: typical of limestone karst systems with alkaline conditions and relatively high concentrations of calcium; trace elements and metals are all low; nitrogen is predominantly in the form of nitrate; high concentrations of sulphate result in a sulphurous odour • mangroves: stand of mangroves from the genus *Bruguiera* covers the majority of the wetland, comprises a range of age classes with evidence of active regeneration, a number of very large trees (large than typical for the species), with the largest tree measuring 82 cm diameter at breast height and exceeding 40 m, between 300 and 600 trees in total (>2.5 cm diameter at breast height) and a density of between 10 and 20 trees per 100 m^2 • land crabs: supports large populations of at least three species: red crab (*Gecarcoidea natalis*), robber crab (*Birgus latro*), blue crab (*Discoplax hirtipes*). *Ecosystem services* • recreation and tourism: while the site is open to the public, tourism is not promoted at the site. Rather, the site is managed to provide a limited number of visitors an opportunity to visit a unique wetland that is largely undisturbed by humans • scientific and educational: the unique nature of the site and the pristine condition, provide excellent opportunities for research • supports near-natural wetland types: the spring at the Ramsar site is in near-natural condition and significant within the bioregion • food webs: interactions between land crabs and mangroves form an important food web at the site • distinct wetland species: blue crabs are reliant on the few permanent freshwater sites on Christmas Island (including Hosnies Spring) for reproduction, and for survival in the dry season • biodiversity: supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species • ecological connectivity: red crabs migrate from the plateau to the ocean to breed each year.					
The Dales	—	—	—	—	✓
The Dales, Christmas Island Ramsar site (The Dales) is located on Christmas Island in the Indian Ocean approximately 2,800 km west of Darwin, 2,600 km north-west of Perth, Australia, 900 km northeast of the Cocos Islands (Ref. 32). The Dales is located entirely within the Christmas Island National Park, in the west of the island, with the western boundary of the site extending to 50 m seaward from the low water mark. The site was listed as a Ramsar site in 2002. The Dales Ramsar site includes a series of seven watercourses, of which three support permanent springs and four support intermittent streams (Ref. 29; Ref. 32). The following summary of ecosystem components, processes and services has been extracted from Butcher and Hale (Ref. 32). *Ecosystem components and processes* • climate: warm tropical climatic zone. High rainfall (2,000 mm per year); warm to hot year round					

[6] Limited information (two snap shot surveys only).

Description	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• water quality[7]: water quality is good, with higher concentrations of some trace metals and major ions compared to upstream reference sites, due to the presence of volcanic rocks and significant crab populations • terrestrial vegetation[8]: general descriptions provided by Mitchell (1985) and Du Puy (1993) for vegetation associations indicate five major associations, with tall rainforest the dominant type • coral reef: The coral reef is limited and dominated by abiotic and hard corals of low diversity • fish: community predominantly of Indo-Pacific origin. Endemism is low, seven endemic or near endemic species or sub-species. One endemic freshwater species recorded from the site. • invertebrates (non-crab fauna): the site supports a low diversity of benthic marine invertebrates, but may also support anchialine fauna although no site specific data has been sourced to confirm this • geomorphic setting: the island is a karstic landscape with key geomorphic features including the terrace formations, sea cliffs, and caves and other karst features • hydrology: karstic drainage system of groundwater and surface ephemeral stream flow post heavy rainfall events during the wet season. Spring outflow of groundwater at three of the Dales is permanent • land crabs: all 20 species of land crab occur within the boundary of the site. The Dales provide a major migration pathway for crabs to and from the ocean during spawning. The site is important for blue crabs in particular • waterbirds: 11 waterbirds, including nine endemic species, one nationally listed vulnerable and one endangered species are found at the site. The site supports breeding seabirds including Abbott's booby and red-footed booby. *Ecosystem services* • recreation and tourism: The Dales is a popular recreational area for both tourists and locals. Two timber board walks have been installed. The Dales is the most popular sight-seeing destination on the island with the waterfall at Hugh's Dale being the greatest attraction • science and education: Parks Australia undertakes and supports a range of research programs across the National Park, many of which are directly relevant to The Dales • food webs: crab spawning provides a rich food supply to marine biota including whale sharks. In addition, the land crabs play a significant role in the energy dynamics of the forest affecting seedling recruitment and ultimately the structure of the forest. The invasion of the yellow crazy ant has significantly affected trophic relationships on Christmas Island • provides physical habitat (for breeding waterbirds): terrestrial vegetation provides roosting and breeding sites for several species of waterbirds • biodiversity: supports a variety of wetland species, communities and habitats including marine, terrestrial and freshwater dependent species • special ecological, physical or geomorphic features: provides critical habitat for the Blue Crabs and Freshwater Crabs, provides examples of karst features such as tufa deposits at the Hugh's Dale waterfall, and possibly anchialine cave communities • distinct or unique wetland species: red crabs are considered keystone species on the island • threatened wetland species, habitats and ecosystems: The Dales Ramsar site supports nesting sites for the endangered Abbotts booby. The Christmas Island frigatebird has also been recorded from the site • priority wetland species: Christmas Island supports a number of vagrant species listed under various international agreements • supports near-natural wetland types: springs and karst systems are representative of the bioregion and considered in near natural condition at the time of listing					

[7] Limited site-specific data, information from one survey in 2003 for Hugh's Dale may provide baseline data for time of listing

[8] Limited site specific data; descriptions of the vegetation are limited.

Description	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
• ecological connectivity: the streams of The Dales provide critical migration pathways for downward migration red, blue and robber crabs and return pathways for juvenile blue crabs in particular.					

4.3 Marine fauna

Listed threatened or migratory species are MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R. The following sections identify the presence of these species within the PA.

The Biologically Important Areas (BIAs) (Ref. 33) are located anywhere within the Australian marine environment including state, Commonwealth, and adjacent waters. They can also be designated over terrestrial areas used for biologically important behaviours, for example, nesting habitats for marine turtles and seabirds which are found on land. BIAs are spatially defined areas where aggregations of individual species are known to display biologically important behaviours (including breeding, foraging, resting, or migration) (Ref. 33).

The following information was generated from searches of the online PMST (appendix a), noting that the Commonwealth Climate Change, Energy, Environment and Water (DCCEEW) Australian Marine Spatial Information System (AMSIS) Map View (Ref. 34) and the dataset from the DCCEEW website (Ref. 35) were used to verify the presence of BIAs and habitat critical to survival of the species within the PA.

4.3.1 Marine mammals

Table 4-7 lists the threatened and/or migratory marine mammals that may be present within the PA. Additional information on these species is provided in the following subsections. The full list of marine species identified from the PMST is provided in appendix a.

Table 4-8 lists the individual BIAs for marine mammals and their known seasonal presence within the PA.

A review of the Conservation Advice and/or Recovery Plans identified key threats associated with threatened and/or migratory marine mammals that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are listed in Table 4-9.

In addition to the threatened and/or migratory marine mammal species identified in the tables below, an additional 28 listed marine mammal species (27 cetaceans, one pinniped) were identified as having the potential to occur within the PA (appendix a)

Table 4-7: Threatened and/or migratory marine mammals

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Cetaceans (whales)								
Antarctic Minke whale	*Balaenoptera bonaerensis*	—	Migratory	SLO	SLO	SLO	—	—
Blue whale	*Balaenoptera musculus*	Endangered	Migratory	MRKO	MRKO	MRKO	MRKO	SLO
Bryde's whale	*Balaenoptera edeni*	—	Migratory	SLO	SLO	SLO	SLO	SLO
Fin whale	*Balaenoptera physalus*	Vulnerable	Migratory	FBLO	FBLO	FBLO	FBLO	SLO
Humpback whale	*Megaptera novaeangliae*	—	Migratory	SKO	BKO	BKO	BKO	SMO
Pygmy right whale	*Caperea marginata*	—	Migratory	SMO	—	—	—	—
Sei whale	*Balaenoptera borealis*	Vulnerable	Migratory	FBLO	FBLO	FBLO	FBLO	SLO
Southern right whale	*Eubalaena australis*	Endangered	Migratory	SLO	SLO	SLO	—	—
Sperm whale	*Physeter macrocephalus*	—	Migratory	SMO	SMO	SMO	SMO	SMO
Cetaceans (dolphins)								
Australian humpback dolphin	*Sousa sahulensis*	—	Migratory	—	SKO	SKO	SKO	—
Australian snubfin dolphin	*Orcaella heinsohni*	—	Migratory	—	SMO	SKO	SKO	—
Killer whale	*Orcinus orca*	—	Migratory	SMO	SMO	SMO	SMO	SMO
Spotted bottlenose dolphin (Arafura / Timor sea populations)	*Tursiops aduncus (Arafura/Timor Sea populations)*	—	Migratory	—	SKO	SKO	SLO	—
Pinnipeds								
Australian sea lion	*Neophoca cinerea*	Endangered	—	BKO	SMO	—	—	—
Sirenians								
Dugong	*Dugong dugon*	—	Migratory	—	BKO	BKO	FBLO	—

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Legend: *BKO: Breeding known to occur within area* *FBLO: Foraging, feeding or related behaviour likely to occur within area* *MRKO: Migration route known to occur within area* *SKO: Species or species habitat known to occur within area* *SLO: Species or species habitat likely to occur within area* *SMO: Species or species habitat may occur within area*								

Table 4-8: BIAs for regionally significant marine mammals

Common name	Behaviour	Seasonal presence	Occurrence description	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Cetaceans (whales)								
Humpback whale	Calving	Winter	Known to occur	—	—	—	✓	—
	Migration	Northern migration, late July to September	Known to occur	✓	—	—	—	—
	Migration	Winter	Known to occur	—	—	—	✓	—
	Migration (north)	Northern migration, late July to September	Known to occur	✓	—	—	—	—
	Migration (north and south)	Northern migration, late July to September	Known to occur	✓	✓	✓	✓	—
	Migration (north and south)	Northern peak July and southward peak October to November (Ref. 36)	Known to occur	✓	—	—	—	—
	Migration (north and south)	Southbound peak late September to mid-October. Northward peak mid-June to mid-July	Known to occur	✓	—	—	—	—
	Nursing	Winter	Known to occur	—	—	—	✓	—

Common name	Behaviour	Seasonal presence	Occurrence description	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Resting	Winter	Known to occur	✓	✓	✓	✓	—
Pygmy blue whale	Foraging	Not identified in dataset	Known to occur	—	✓	✓	✓	—
	Known foraging area	Not identified in dataset	Known to occur	✓	—	—	—	—
	Migration	Northern migration (enter Perth canyon January to May; pass Exmouth April to August; continue north to Indonesia). Southern migration (follow WA coastline from October to late December)	Known to occur	✓	✓	✓	✓	—
Southern right whale	Migration	Approximately from April to October	Not identified in dataset	✓	✓	✓	—	—
	Reproduction	Approximately from May to September	Not identified in dataset	—	✓	✓	—	—
Pinnipeds								
Australian sea lion	Foraging (male)	Year-round	Likely to occur	✓	—	—	—	—
	Foraging (male and female)	Year-round	Known to occur	✓	—	—	—	—
	Breeding site	Not identified in dataset	Not identified in dataset	✓	—	—	—	—
	Haul out site	Not identified in dataset	Not identified in dataset	✓	—	—	—	—
Sirenians								
Dugong	Breeding	May to September	Known to occur	—	✓	—	—	—
	Breeding	Year-round	Known to occur	—	✓	✓	—	—
	Calving	Year-round	Known to occur	—	✓	✓	—	—
	Foraging	May to September	Known to occur	—	✓	—	—	—

Common name	Behaviour	Seasonal presence	Occurrence description	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Foraging	June to November	Known to occur	—	✓	—	—	—
	Foraging (high density seagrass beds)	June to November	Known to occur	—	✓	—	—	—
	Foraging (high density seagrass beds)	October to April	Known to occur	—	✓	—	—	—
	Foraging (high density seagrass beds)	Year-round	Known to occur	—	✓	✓	—	—
	Migration	June to November	Known to occur	—	✓	—	—	—
	Nursing	Year-round	Known to occur	—	✓	✓	—	—

Table 4-9: Summary of relevant conservation plans—marine mammals

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Blue whale	Conservation Management Plan for the Blue Whale 2015–2025 (Ref. 37)	Climate variability and change	• Continue to meet Australia's international commitments to reduce greenhouse gas emissions.
		Noise interference	• assessing the effect of anthropogenic noise on blue whale behaviour • anthropogenic noise in biologically important areas will be managed such that any blue whale continues to utilise the area without injury, and is not displaced from a foraging area • EPBC Act Policy Statement 2.1—Interaction between offshore seismic exploration and whales is applied to all seismic surveys • ensuring behavioural impacts are considered when developing and updating policy documents on the management of cetaceans and anthropogenic noise
		Habitat modification	• none identified
		Vessel disturbance	• ensure all vessel strike incidents are reported in the National Ship Strike Database • ensure the risk of vessel strikes on blue whales is considered when assessing actions that increase vessel traffic in areas where blue whales occur and, if required, appropriate mitigation measures are implemented.
Fin whale	Conservation Advice for the Fin Whale (Ref. 38)	Climate and oceanographic variability and change	• continue to meet Australia's international commitments to reduce greenhouse gas emissions.
		Anthropogenic noise and acoustic disturbance	• once the spatial and temporal distribution (including BIAs) of fin whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species • if required, additional management measures should be developed and implemented to ensure the ongoing recovery of fin whales.
		Habitat degradation including coastal development, port expansion and aquaculture	• none identified

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
		Pollution (persistent toxic pollutants)	• none identified
		Vessel strike	• ensure all vessel strike incidents are reported in the National Vessel Strike Database.
Humpback whale	Listing Advice for the Humpback Whale (Ref. 39)	Climate and oceanographic variability and change	• none identified
		Vessel disturbance and strike	• none identified
		Entanglement	• none identified
		Noise interference	• none identified
		Habitat degradation	• none identified
Sei whale	Conservation Advice for the Sei Whale (Ref. 40)	Climate and oceanographic variability and change	• continue to meet Australia's international commitments to reduce greenhouse gas emissions.
		Anthropogenic noise and acoustic disturbance	• once the spatial and temporal distribution (including BIAs) of sei whales is further defined, an assessment of the impacts of increasing anthropogenic noise (including seismic surveys, port expansion, and coastal development) should be undertaken on this species • if required, additional management measures should be developed and implemented to ensure the ongoing recovery of sei whales.
		Habitat degradation including coastal development, port expansion and aquaculture	• none identified
		Pollution (persistent toxic pollutants)	• none identified
		Vessel strike	• ensure all vessel strike incidents are reported in the National Vessel Strike Database.
Southern right whale	National Recovery Plan for the Southern Right Whale (Ref. 41)	Anthropogenic climate change and climate variability	• continue to meet Australia's international commitments to address causes of climate change including greenhouse gas emissions • increase understanding of the effects of anthropogenic climate change on environmental conditions, including the impacts on prey availability in high latitude

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
			foraging areas and links with southern right whale foraging ecology, health, and population demographics (e.g. reproductive success).
		Entanglement - Marine debris	• none identified
		Habitat degradation	• coastal and offshore development actions are assessed according to principles of ecological sustainable development to ensure the risk of injury, auditory impairment and/or disturbance to southern right whales is minimised • baseline surveys and monitoring undertaken during activity implementation are conducted in accordance with best practice standards and guidelines to ensure standardised datasets are obtained and suitable to inform environmental management decision making that can reduce the risk of threats to southern right whales • current information on species' occurrence, particularly in HCTS, BIAs, and historic high use areas, are used to inform planning, assessment, and decision-making on marine infrastructure development actions.
		Anthropogenic underwater noise	• improve baseline understanding of southern right whale acoustic communication to better inform potential impacts from anthropogenic underwater noise • actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that it does not prevent any southern right whale from utilising the area or cause auditory impairment • actions within and adjacent to southern right whale BIAs and HCTS should demonstrate that the risk of behavioural disturbance is minimised • ensure environmental assessments associated with underwater noise generating activities include consideration of national policy (e.g. EPBC Act Policy Statement 2.1) and guidelines related to managing anthropogenic underwater noise and implement appropriate mitigation measures to reduce risks to southern right whales to the lowest possible level • quantify risks of anthropogenic underwater noise to southern right whales, including studies aimed to measure physiological effects, behavioural disturbance, and changes to acoustic communication (e.g., masking of vocalisations) to whales.

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
		Collision	• assess risk of vessel strike to southern right whales in BIAs • improve understanding of the behavioural response of southern right whales in close vicinity to vessels (e.g. type, number, distance) in BIAs to inform risk assessments of vessel strike • ensure environmental impact assessments and associated plans consider and quantify the risk of vessel strike and associated potential cumulative risks in BIAs and HCTS • ensure all vessel strike incidents are reported in the National Ship Strike Database managed through the Australian Marine Mammal Centre, Australian Antarctic Division.
		Disturbance from vessels and water activities	• none identified
		Pollution	• none identified
		Cumulative effects from threats	• none identified
Australian sea lion	Conservation Advice for the Australian Sea Lion (Ref. 42)	Marine debris	• assess the impacts of marine debris on Australian sea lion populations, and identify the sources of marine debris which have an impact • develop and implement measures to mitigate the impacts of marine debris on the species (including reducing the amount of these marine debris entering the oceans), noting linkages with the Threat Abatement Plan for the Impact of Marine Debris on Vertebrate Marine Life.
		Habitat degradation and pollution	• investigate the nature, extent and consequence of interactions between Australian sea lions and aquaculture activities, and mitigate any impacts (e.g. reduced habitat availability) • require all vessels to have oil spill mitigation measures in place, and implement jurisdictional oil spill response strategies as required • protect all sea lion habitat from habitat degradation due to onshore and offshore developments.
		Human disturbance	• monitor and mitigate impacts (including cumulative impacts) of human interactions on Australian sea lion colonies • control access to breeding colonies to minimise the impacts of disturbance on Australian sea lions.
		Climate change	• none identified

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (Ref. 43)	Key threats listed are limited to fisheries related activities	• none identified
		Other factors that may be contributing to the lack of recovery include: • habitat degradation • pollution and oil spills • climate change.	• none identified

4.3.1.1 Antarctic minke whale

The Antarctic minke whale (*Balaenoptera bonaerensis*) is known to occur from approximately 21° S off Australia's east coast (Ref. 44) to 65° S in the Australian Antarctic Territory (Ref. 45). Records show sightings off all Australian states, except the Northern Territory (NT) (Ref. 44). In high-latitude winter breeding grounds outside Australia, these whales are typically found along the continental shelf edge (Ref. 46; Ref. 47), which may suggest a similar winter distribution in Australian Antarctic waters.

Antarctic minke whales are generally solitary or found in pairs, though large feeding aggregations of up to 400 individuals may form in high-latitude feeding areas (Ref. 48). The distribution of newly weaned calves is unknown, but likely to be in lower latitudes (Ref. 49).

In winter breeding grounds, Antarctic minke whales appear to occupy pelagic waters exceeding 600 m depth (Ref. 47). During the summer, they migrate to higher latitudes for feeding, primarily on Antarctic krill (*Euphausia superba*), but also on smaller krill species (*E. spinifera and E. crystallorophias*) and occasional copedods (Ref. 50; Ref. 51). Krill are pelagic and tend to occur in the upper layers of Antarctic waters, suggesting that Antarctic minke whales do not require deep diving to forage (Ref. 49).

Whaling data suggest that mature male Antarctic minke whales arrive in high-latitude Antarctic waters earlier than mature females, indicating possible sexual segregation in feeding grounds (Ref. 50; Ref. 52; Ref. 53; Ref. 54). Calls of Antarctic minke whales have been recorded in the Perth Canyon in July–August and December (Ref. 55).

There are currently no population estimates for this species in Australian waters (Ref. 49), and information on their timing of presence, distribution, and behaviours, including migration and breeding patterns within Australian waters, is lacking. Additionally, no Biologically Important Areas (BIAs) have been identified in Australian waters.

4.3.1.2 Bryde's whale

Bryde's whale (*Balaenoptera edeni*) occur in temperate to tropical Australian waters, with two recognised provisional subspecies: the smaller coastal form, known as Eden's whale, and the larger oceanic form, the Bryde's whale (Ref. 56, Ref. 57). Both forms are typically distributed within latitudes of 40° N and 40° S, or the 20 °C isotherm (Ref. 44). The coastal whale is generally limited to the 200 m depth isobar and moves along the coast based on prey availability (Ref. 58), while the offshore form resides in deeper waters (500 m to 1,000 m) (Ref. 59). Their relatively short dive times suggest that these whales use the ocean's upper layers, making them pelagic (Ref. 59).

Bryde's whales have been recorded in all Australian states except the NT (Ref. 44). They are typically solitary or found in pairs, with occasional groupings likely related to shared activities such as feeding (Ref. 59, Ref. 60). Bryde's whales are known to be income breeders (i.e. feed year-round in less productive waters), using adaptable foraging capabilities to exploit abundant and time-sensitive resources (Ref. 61). Coastal Bryde's whales primarily feed on schooling fish, while the offshore form consumes small crustaceans and cephalopods (Ref. 62, Ref. 63; Ref. 64).

The offshore Bryde's whale may migrate seasonally, moving to warmer tropical waters in winter (Ref. 59). Limited data suggest a possible preference for lower latitudes during breeding season (Ref. 65).

In Australian waters, data on the distribution, ecology, and behaviour of Bryde's whales remain limited (Ref. 61). Foraging behaviour has only been documented along the east coast of Australia, with Pirotta et al.(Ref. 61) observing feeding in both deep and shallow waters throughout all seasons, peaking in winter. Additionally, Paterson and Van Dyck (Ref. 66) have recorded feeding behaviour in shallow eastern Australian waters.

McCauley (Ref. 67) detected Bryde's whales through acoustic loggers around Scott Reef from 2006 to 2009, noting year-round presence in low numbers and a slight peak in calling density in April to May. Acoustic signals attributed to Bryde's whales have been recorded from north of Darwin to off Exmouth, showing consistent patterns without clear seasonality (Ref. 67).

No BIAs have been identified for Bryde's whales in Australian waters.

4.3.1.3 Fin whale

Fin whales (*Balaenoptera physalus*) occur globally, from polar to tropical waters, but rarely in inshore waters (Ref. 68). Their distribution spans both hemispheres between latitudes 20–75° S (Ref. 69), and they exhibit well-defined migratory patterns moving between polar, temperate, and tropical waters (Ref. 70). Fin whales may travel in groups of 6 to 10, though solitary individuals and pairs are more common (Ref. 71).

In Australian waters, fin whale distribution is primarily known through stranding events and historical whaling records, with occurrences reported in Western Australia (WA), South Australia (SA), Victoria, and Tasmania (Ref. 44). Migration likely involves movement between Australian waters, warm breeding grounds, and cold feeding grounds (Ref. 72). Group size and movement are thought to adapt to long-term food availability rather than short-term environmental changes (Ref. 73).

Migration times are not well-documented, but sightings in Australian waters have occurred during summer and autumn (Ref. 72). Fin whales have been observed inshore near the Bonney Upwelling, Victoria, in summer and autumn during aerial surveys (Ref. 74). Acoustic detections have also been reported off the Perth Canyon, WA, between January and April 2000 (Ref. 75) and at Cape Leeuwin in April (Ref. 76, Ref. 77). Fin whales typically inhabit the Perth Canyon from May to late October, with peak activity in July, before returning to Antarctic waters (Ref. 77).

Passive acoustics monitoring (Ref. 76, Ref. 77) indicate that fin whales migrate northward along the WA coast from Cape Leeuwin to the Perth Canyon, with some individuals reaching as far north as Dampier (19°S). However, no fin whale vocalizations have been detected at Scott Reef, Onslow, or Montebello Islands (Ref. 76).

Sightings of fin whales feeding in the Bonney Upwelling suggest it may be a significant feeding ground (Ref. 72). Additionally, the Perth Canyon is likely an important feeding area (Ref. 76) due to its high zooplankton density (Ref. 78).

The total abundance and population trends of fin whales in Australian waters remain unknown (Ref. 68; Ref. 72). There are no known mating or calving areas, nor are any BIAs identified for fin whales in Australian waters.

4.3.1.4 Humpback whale

Humpback whales (*Megaptera novaeangliae*) (WA subpopulation) migrate annually between their feeding grounds in Antarctic waters and their calving grounds in Kimberley waters (Ref. 79). The exact timing of the migration period can vary from year-to-year, however in general the species are sighted in southern Australian waters in May, they then migrate northwards and southwards along the coast, with sightings rare after November (Ref. 80; Ref. 81).

Northbound humpback whales tend to remain around the 200 m water depth contour, while southbound humpback whales tend to travel closer to Barrow Island and generally occur between 50 m and 200 m water depths (Ref. 79). The migration (north and south) BIA corridor extends from the coast to out to ~100 km offshore in the Kimberley and Pilbara regions, reducing to ~50 km offshore south of North West Cape.

The humpback whale breeding and calving grounds in the southern Kimberley region extend from Broome to the northern end of Camden Sound, particularly between Lacepede Islands and Camden Sound (Ref. 79). Breeding and calving occur in the region between mid-August and early-September (Ref. 79), followed by the start of the southern migration. Exmouth Gulf and Shark Bay are both important resting areas for migrating humpback whales, particularly for cow-calf pairs on the southern migration (Ref. 79). The southerly migration, from around the Lacepede Islands (north of Broome) extends parallel to the coast on approximately the 20–30 m depth contour (Ref. 79, Ref. 82). Southbound migration is more diffuse and irregular, lacking an obvious peak. An increase in southerly migrating individuals may be observed between the North West Cape and the Montebello Islands between August to early September (Ref. 79). The predicted peaks in humpback whale migration in the Montebello Islands region are late-July (northern migration) and early-September (southern migration) (Ref. 79). Females and calves are known to stop and rest in Exmouth Gulf and Shark Bay (Ref. 79). Peak densities of lactating females were observed in late September to early October around Exmouth Gulf (Ref. 79).

Calving, migration, nursing and resting BIAs for the humpback whale have been identified in the PA (Table 4-8,Figure 4-1)

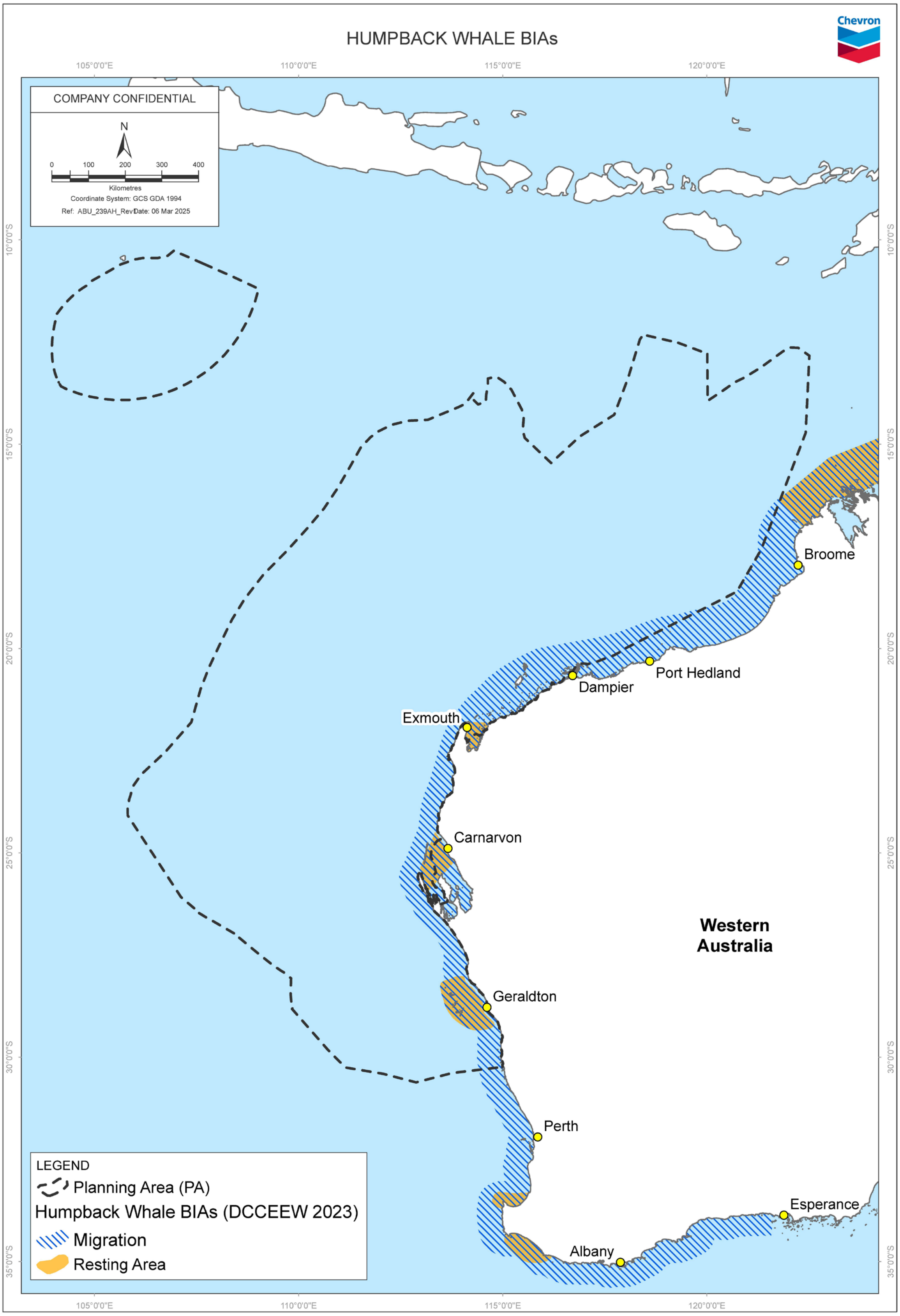

Figure 4-1: Biologically important areas for humpback whales

4.3.1.5 Omura's whale

Omura's whale (*Balaenoptera omurai*) was first described in 2003 and is distributed globally in tropical waters, though there remains limited knowledge of the species' behaviour and ecology, particularly in Australian waters (Ref. 83). The population of Omura's whales studied off northwest Madagascar is understood to be resident and non-migratory, with movements confined to a restricted range (Ref. 83).

A higher presence of Omura's whales has been identified in tropical to subtropical waters (Ref. 83, Ref. 84). Browne et. al. (Ref. 83) used passive acoustic monitoring from 2005 to 2023 in Australian waters to identify Omura's presence. The findings include:

- the southerly detection was at North West Cape, while the northerly was in the Timor Sea
- vocalisations were detected year-round near Browse Island and Scott Reef in the Kimberley region
- around the Montebello islands, vocalisations were present from October to June, and near Barrow Island, vocal presence was noted from December to May. In the Pilbara and Gascoyne regions, acoustic presence mostly peaked from February to April but was not observed during austral winter (June–August) and early spring (September)
- in nearshore areas (e.g. Thevenard Island, Port Hedland, Onslow), vocalisations were low or not detected
- most detections were from the continental shelf, with some in deeper waters, aligning with global observations.

An offshore trial of Distributed Acoustic Sensing (DAS) from December 2023 to mid-January 2024 recorded Omura's whales along the outer edge of the North West Shelf (Ref. 85). Similarly, soundscape monitoring in the Janz-Io field has identified the presence of Omura's whales.

No BIAs have been identified for Omura's whales in Australian waters.

4.3.1.6 Blue whale

4.3.1.6.1 Antarctic blue whale

The Antarctic blue whale (*Balaenoptera musculus intermedia*) is the largest animal to exist on the planet (Ref. 778). It migrates seasonally along Australia's west coast, traveling between its high-latitude feeding grounds in the Southern Ocean and breeding areas off the coast of WA (Ref. 773). These mammals primarily feed on krill during the austral summer in the nutrient-rich waters of the Southern Ocean, before embarking on their long migration northward to calve in the warmer waters off Australia's coast during the winter months (Ref. 774). The WA coastline, particularly around the Augusta and Albany regions, provides an important migratory habitat for these whales, offering a vital stopover for rest and rejuvenation before they return to the colder southern waters (Ref. 774).

Antarctic blue whales are classified as endangered, and their population is still recovering from the historical impacts of whaling (Ref. 778). As a result, Australian waters, including those off WA, are important to their protection (Ref. 778).

No BIAs have been identified for the Antarctic blue whale in the PA.

4.3.1.6.2 Pygmy blue whale

Pygmy blue whales (*Balaenoptera musculus brevicauda*) migrate along the west coast of Australia in the northern direction to their breeding grounds near the Indonesian Archipelago from mid-February to early-June, and in the southern direction to the feeding grounds in the Southern Ocean from mid-November to early-January (Ref. 86). Recent information collected from satellite tags shows that the Banda and Molucca seas in Indonesia are the likely destination for the northern migration of whales that feed off the Perth Canyon (Ref. 87; Ref. 88; Ref. 89). These seas are considered the northern terminus of the migration and potentially the breeding and calving ground, but may also act as a feeding area (Ref. 90; Ref. 91).

Acoustic monitoring conducted by McCauley and Jenner (Ref. 92) in the Exmouth and northern Montebello Islands region identified a peak period in the northern migration of pygmy blue whales from May to June, and from November through to late-December during the southern migration. It was estimated by McCauley and Jenner (Ref. 92) that between 700 and 1,500 pygmy blue whales migrated southward past Exmouth in 2004.

It is known the pygmy blue whales tend to follow the WA continental shelf edge between their feeding grounds at the Perth Canyon and the North West Cape. However, the migratory pathway of whales north of the North West Cape is less defined.

The migration BIA for pygmy blue whales has been historically described as occurring along the continental shelf edge between 500 m and 1,000 m water depths (Ref. 3; Ref. 37). However, more recent studies (e.g. Ref. 86; Ref. 87) suggest that pygmy blue whales are likely to transit through deeper and further offshore waters north of the North West Cape. Satellite tracking data showed pygmy blue whales on their northern migration travelled relatively near to the Australian coast (100±1.7 km) in water depths of 1,369.5±47.4 m, until reaching the North West Cape, after which they travelled further offshore (238±14 km) into progressively deeper water (2,617±143.5 m) (Ref. 87). Data from tagged pygmy blue whales also indicates that during their northern migration, the width of the migration path increases north of Montebello Islands, from ~175 km to ~690 km at its widest point (Ref. 93). Gavrilov et al. (Ref. 86) conducted a study using an array of ocean bottom seismographs to detect pygmy blue whales traversing the area to the northwest of the North West Cape during their southern migration. This study found that pygmy blue whales migrated southward much further from the WA coast compared to the northbound migration, at distances of up to 400 km from shore (Ref. 86). Pygmy blue whales have demonstrated extensive use of continental slope habitat off WA and only limited use of shelf waters (Ref. 93). This contrasts with southern Australia, where use of the shelf and shelf break by pygmy blue whales is more common.

McCauley and Jenner (Ref. 92) recorded 24-hour average counts of pygmy blue whales along the WA coast during their migrations periods and found that the migratory habits are short and sharp pulses for the southbound pygmy blue whales and a more protracted pulse of northbound pygmy blue whales. This suggests that the southern migration pygmy blue whales are swimming purposefully through the area to reach their southern feeding grounds, thus resulting in the data collected for pygmy blue whales migrating through the area is not confounded by lingering pygmy blue whales but they are swimming steadily past. A difference in travel speed was also reported by Thums et al (Ref. 93), where median speed during northward migration was 2.4 km/h (<0.1–15.4 km/h, n=22), and southward migration was 4.0–5.0 km/h (n=2).

A recent study incorporating data collected from both passive acoustic monitoring and satellite telemetry data, was analysed and determined the 'most important areas' for migration[9] along the WA coast as an almost continuous stretch from southern WA to around the latitude of Rowley Shoals, and thereafter was more dispersed (Ref. 93).

Ferreira et. al (Ref. 94) compiled satellite tracking data for 38 pygmy blue whales and used movement models to distinguish between low and high move persistence and correlated the data with environmental variables. Typically, high move persistence is indicative of migration, while low move persistence is generally indicative of foraging or reproduction (Ref. 93). In alignment with other studies, the continental slope off the north-west Australian coast was predicted to be suitable habitat for migration (Ref. 94). Predictions from modelling based on passive acoustic data indicate greatest numbers of pygmy blue whales during April and June/July (northern migration), and November and December (southern migration) (Ref. 93). Monthly spatial predictions indicated higher densities around the Montebello Island region during May and June (northern migration) and November and December (southern migration) (Ref. 93; Ref. 94).

Pygmy blue whales aggregate in the Austral summer to feed at known locations on or adjacent to the continental shelf including the Perth Canyon, Great Southern Australian Coastal Upwelling System, and the sub-tropical convergence zone (Ref. 93). The areas around the Perth Canyon and Australian Coastal Upwelling System correspond to 'Foraging Areas' and 'Known Foraging Areas' within the *Conservation Management Plan for the Blue Whale* (Ref. 37). The C*onservation Management Plan for the Blue Whale* (Ref. 37) also identifies 'Possible Foraging Areas'[10], including two in WA, one off the Ningaloo coast, and another around Scott Reef. These 'Possible Foraging Areas' have been characterised as foraging BIAs.

Thums et al (Ref. 93) determined that pygmy blue whale movement off northwest WA was predominantly relatively fast, directed travel (high move persistence) interspersed with relatively short (median 28 hr) periods of low move persistence (Ref. 93).

The satellite tracking data reviewed in the recent study by Ferreira et. al., indicates 17 out of 38 tracked whales (~45%) displayed foraging movement behaviour in north-west WA (Ref. 94). Suitable foraging habitat was identified as a large semi-continuous area from the southern extent (28°S) to the northeastern edge of the modelled region (11.5°S) (Ref. 94). This area occurred almost exclusively on slope (91%), with a small amount of suitable habitat on deep ocean floor (7%) and on the shelf (2%) (Ref. 94).

Owen et. al. (Ref. 95) deployed a multi-sensor tag on a single pygmy blue whale, tracked its movement from the Perth Canyon region to Geraldton, and examined its dive behaviour. The whale completed a total of 1,677 dives over the duration the tag was attached (7.6 days). A total of 21 feeding dives were identified, with a mean maximum depth of 129 ± 183 m (range 13–505 m). Feeding behaviour

[9] Grid cells with overlap between two metrics: largest percentage of whales and high move persistence, were designated as the 'most important areas' for migration (Ref. 93)

[10] "Evidence of feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity to whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route" (Ref. 216).

appears to be largely a function of prey availability (krill) and their associated oceanographic drivers (i.e. surface currents, light attenuation, upwellings and seabed features) (Ref. 78; Ref. 96).

Data collected from both passive acoustic monitoring and satellite telemetry data, was analysed and determined the 'most important areas' for foraging along the WA coast included the Perth Canyon and vicinity, the shelf edge off Geraldton, and discontinuous use of the shelf edge from Ningaloo Reef to Rowley Shoals (Ref. 93). Although foraging areas are described as static, they are likely to be dynamic given their dependence on presence of prey (Ref. 93; Ref. 97). Studies (Ref. 78; Ref. 96; Ref. 98) have identified that variability in chlorophyll-a and oceanographic conditions (e.g. sea surface temperature, surface height anomaly) had a moderate to strong influence on probability of occurrence of whales suggesting suitable habitats and migratory occurrence may vary.

Data from a tagged pygmy blue whale off Exmouth (Ref. 99) suggests that pygmy blue whales within the waters off the North West Cape demonstrate preferential surface foraging in response to the vertical distribution of krill within these waters, primarily within the upper 100 m of the water column. Thums et al. (Ref. 93) states that ten of the 24 pygmy blue whales that were encountered during the 2020 field trip were observed to be surface feeding (implied by the visible baleen and pleats on the surface).

Biologically, surface feeding is an optimal behavioural response for pygmy blue whales, given the significantly reduced energetic costs associated with this strategy over lunge feeding at depth, which requires a significant oxygen and energetic demand (Ref. 95). Studies in several locations where pygmy blue whales are known to aggregate (New Zealand [Ref. 100]; California [Ref. 101], SA [Ref. 74]; Canada [Ref. 102]; Chile [Ref. 98]) have demonstrated evidence of surface or sub-surface (<100 m) foraging, determined through visual observations of lunge feeding and/or analysis of tagged data. In these instances, surface foraging was driven by the aggregation of krill at the surface (or sub-surface). Torres et al. (Ref. 100) noted that surface foraging adheres to the principles of the 'optimal foraging theory', which states that to maximise fitness, an animal adopts a foraging strategy that provides the most benefit (i.e. energy) for the lowest cost, thereby maximising the net energy gained.

Foraging and migration BIAs for the pygmy blue whale have been identified in the PA (Table 4-8, Figure 4-2).

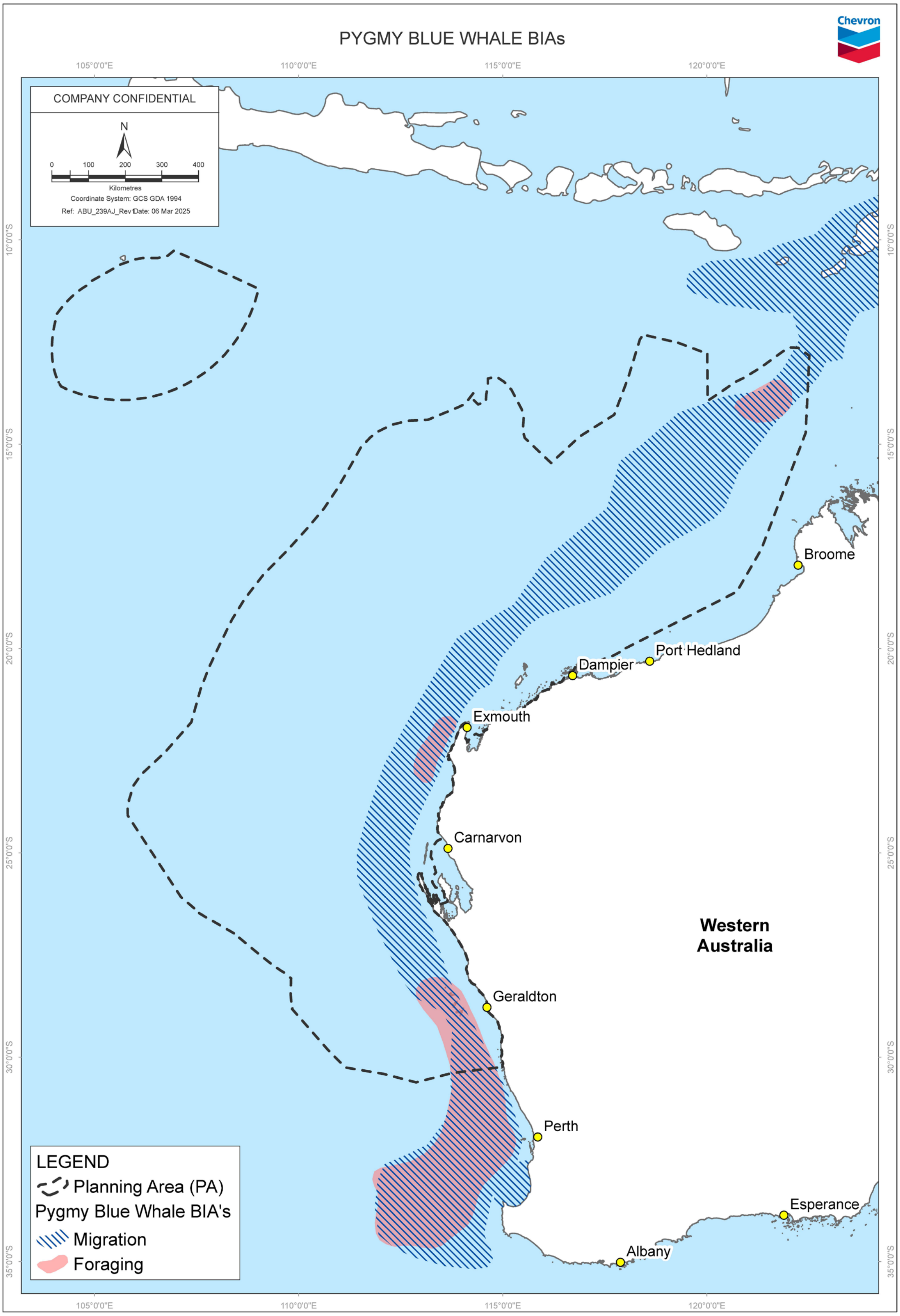

Figure 4-2: Biologically important areas for pygmy blue whale

4.3.1.7 Pygmy right whale

Pygmy right whales (*Caperea marginata*) are the smallest and least conspicuous of all baleen whales (Ref. 103), making them one of the least studied marine mammal species (Ref. 104). Unlike other balaenopterids, they do not undertake large-scale migrations, although juveniles may move further south into waters beyond 41°S (Ref. 103). Globally, they have a circumpolar distribution, favouring water temperatures of 5°C to 20°C (Ref. 105) and staying north of the Antarctic Convergence (Ref. 106).

In Australian waters, their range extends between 32°S and 47°S (Ref. 104). Their northern distribution on the west and east coasts is likely limited by the warm, south-flowing Leeuwin and East Australian currents (Ref. 103). Coastal upwelling zones are critical to their distribution (Ref. 103), while offshore areas like the Subtropical Convergence may serve as key habitats for sub-adults and adults (Ref. 103; Ref. 107). Juveniles weaned in Australian waters are thought to migrate south of 41°S to areas with greater prey availability (Ref. 103).

Dedden et al. (Ref. 108) suggest that pygmy right whales remain year-round in mid-latitude waters, feeding primarily in upwelling regions between southern Australia's coastal zones and the Subtropical Convergence, with no evidence of foraging in Antarctic waters. Sightings and strandings have been observed throughout the year; however, they are more frequent during austral spring and summer (September to February) than in autumn and winter (March to August) (Ref. 109), indicating possible seasonal movements (Ref. 110).

Key locations for pygmy right whales include Bass Strait, southeastern Tasmania, Kangaroo Island, southern Eyre Peninsula, and possibly southwestern WA (Ref. 44). These nutrient-rich areas provide an abundant supply of prey, including copepods, euphausiids, and small plankton (Ref. 44; Ref. 103; Ref. 111). Stomach content analyses have further supported this dietary preference, revealing evidence of these prey items. These analyses, which have also identified non-food items such as feathers and plastic bags, suggest that pygmy right whales employ surface-feeding strategies, such as skimming (Ref. 111).

No BIAs have been identified for pygmy right whales in Australian waters.

4.3.1.8 Sei whale

Sei whales (*Balaenoptera borealis*) are a cosmopolitan species, ranging from polar to tropical waters (Ref. 112, Ref. 113) and primarily inhabiting deep oceanic habitats. Their distribution, abundance and latitudinal migrations are largely determined by seasonal feeding and breeding cycles (Ref. 114). Generally, sei whales exhibit north-south migratory movements between polar, temperate, and tropical zones (Ref. 70). However, specific movement patterns and distributions within Australian waters remain largely undocumented (Ref. 112).

In Australian waters, sei whales are infrequently documented (Ref. 44), with sightings reported across all states and territories except Victoria (Ref. 44, Ref. 115, Ref. 116, Ref. 117, Ref. 118). Sightings along the continental shelf in the Bonney Upwelling, SA, 20–60 km offshore (Ref. 119), suggest opportunistic feeding occurs between November and May (Ref. 112, Ref. 120). These whales typically feed on planktonic crustaceans, particularly copepods and amphipods (Ref. 112).

Sei whales are usually seen in small pods of three to five individuals, with group compositions sometimes influenced by age, sex, and reproductive status

(Ref. 112). The diversity of habitat for sei whales may be influenced by varying physical conditions and prey availability (Ref. 112). Mating and calving occur mainly in winter, though specific breeding grounds in low latitudes have not been identified (Ref. 118, Ref. 114). Currently, there are no known mating or calving areas (Ref. 115), nor BIAs, identified for sei whales in Australian waters.

4.3.1.9 Southern right whale

The southern right whale (*Eubalaena australis*) occurs seasonally in coastal waters of Australia, with a circumpolar distribution between latitudes 20°S and 65°S (Ref. 121). Two populations, the western and eastern, are present in Australian waters (Ref. 41). While there is evidence of population growth in the western group, southern right whale numbers remain below historical estimates (Ref. 41). The western population primarily occupies coastal waters between Exmouth/Ningaloo Reef off WA (Ref. 44) and Ceduna in SA (Ref. 122, Ref. 123).

From May to October, southern right whales inhabit calving and nursing grounds, with peak calving occurring in late July and August (Ref. 41). Female-calf pairs generally occupy these ground for 2 to 3 months from June to September, while non-calf-bearing whales display more variability in their seasonal presence (Ref. 124, Ref. 125). Distribution is concentrated in shallow waters <10 meters deep, usually within 1 km of the coastline (Ref. 125, Ref. 126).

Female southern right whales display strong site fidelity to specific areas for breeding and feeding, often preferring shallow, sloping sandy bays along the southern Australian coast (Ref. 41). Despite this site fidelity, a small percentage of breeding females occasionally shift their calving locations (Ref. 127). Female-calf pairs have an average calving interval of three years (Ref. 41).

As capital breeders, southern right whale reproductive cycles are closely tied to their migratory behaviour (Ref. 41). Migration occurs between feeding and breeding grounds. Feeding whales are observed near the Subtropical Front (41–44°S) in January and December, where they consume copepods, while whales caught at higher latitudes (south of 50°S) primarily consume krill (Ref. 128, Ref. 129, Ref. 130). Coastal foraging in Australian waters has not been observed, and foraging ecology remains poorly understood (Ref. 41).

A migratory and reproductive BIA was identified for the southern right whale in the PA (Table 4-8,Figure 4-3). The migratory BIA in WA spans 3 nm from Exmouth to Augusta and extends to the Exclusive Economic Zone bordering SA. The reproductive BIA covers Exmouth Gulf and stretches from Mandurah to the South Australian border. Critical habitats for the species' survival have been identified within all reproductive BIAs across the species range (Ref. 41).

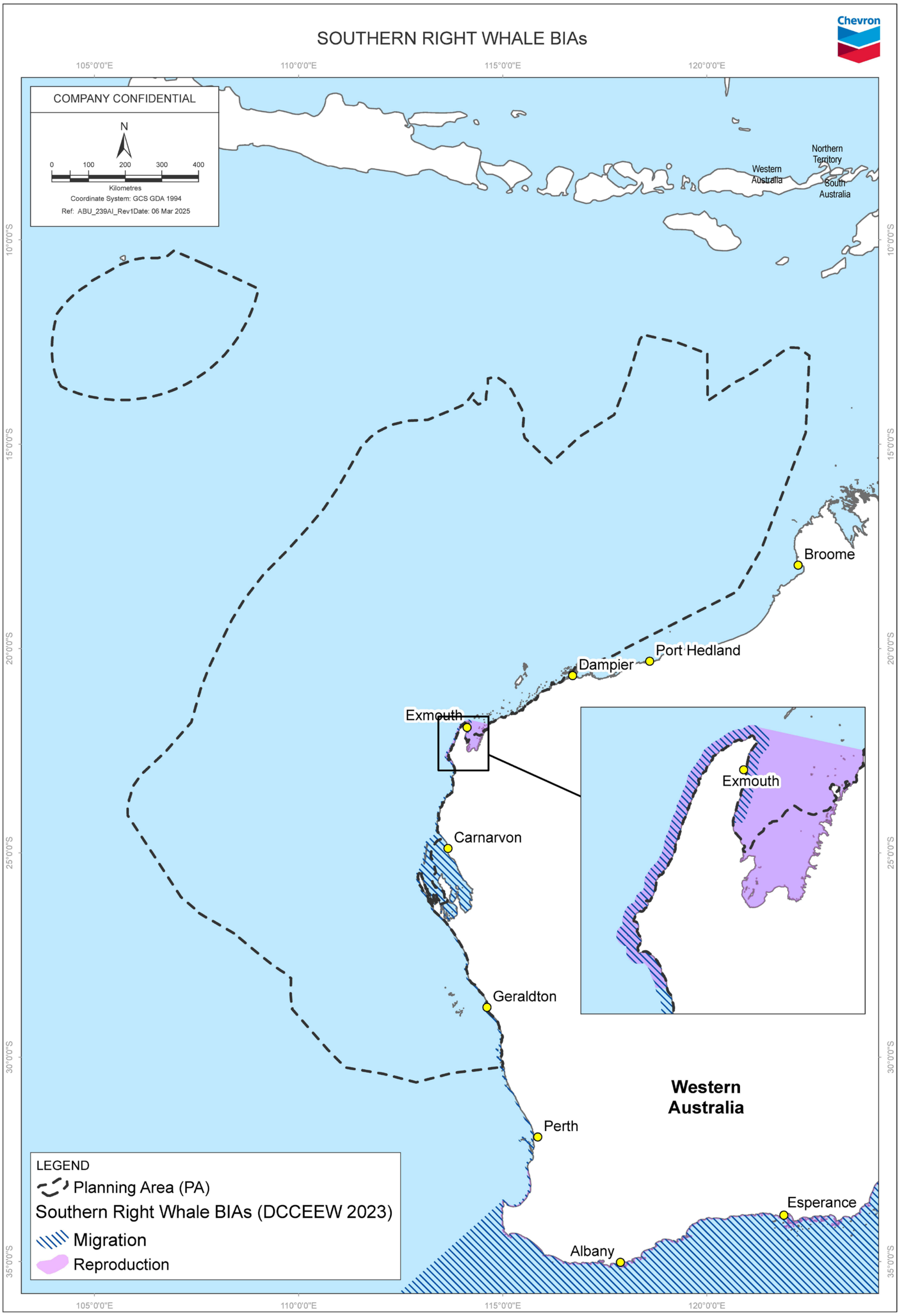

Figure 4-3: Biologically important areas for southern right whale

4.3.1.10 Sperm whale

Sperm whales (*Physeter macrocephalus*) have been recorded in all Australian states (Ref. 44). Gregarious by nature, sperm whales live in groups of up to 50 individuals, although males are sometimes solitary at higher latitudes (above 40°N) (Ref. 131). Typically, they inhabit deep waters (>600 m) and are uncommon in shallow waters (<300 m) (Ref. 131).

Female and young male sperm whales tend to remain in warmer waters, while adult males migrate between warmer and colder waters, such as those near Antarctica (Ref. 44). In Australian waters, they concentrate along a narrow area on the shelf edge off Albany, moving westward over the year (Ref. 44). Along the WA coast, where the continental shelf is less steep, sperm whales appear more widely dispersed offshore (Ref. 44).

Sperm whales are seasonal breeders, with a prolonged mating season extending from late winter to early summer (Ref. 132). In the Southern Hemisphere, conceptions occur from July to March, peaking in September and December (Ref. 133).

These whales feed regularly year-round, primarily on medium- to large-sized squids. Their diet also includes cephalopods and demersal fishes (Ref. 134, Ref. 135, Ref. 136, Ref. 137). Sperm whales are known to coordinate foraging dives that often reach depths of over 500 m, spreading out underwater while hunting (Ref. 132, Ref. 138).

Currently, there are no population estimates for sperm whales in Australian waters (Ref. 131). During seismic surveys conducted from December 2016 to April 2017 off North West Cape (Ref. 139), marine mammal observers recorded 23 sightings of sperm whales, with pod sizes ranging from one to six animals. These whales were observed in deep waters over the Montebello Saddle (up to 90 km from North West Cape) and in waters above canyons connecting the Cuvier Abyssal Plain and the Cape Range Peninsula KEF (Ref. 139).

No BIAs were identified within the PA. Foraging BIAs for sperm whales have been identified in southern WA (e.g. between Cape Leeuwin and Esperance) and across SA.

4.3.1.11 Australia humpback dolphin

Australian humpback dolphins (*Sousa sahulensis*) are found in tropical/subtropical waters (Ref. 140). In Australia, their range extends from Shark Bay in WA, northward and eastward to southern Queensland (Ref. 141). The North West Cape and Exmouth Gulf coastal waters report the highest density of Australian humpback dolphins within this range (Ref. 142). Observations of humpback dolphins up to 60 km offshore recorded near Barrow Island and the western Lowendal Islands in WA (Ref. 143).

Australian humpback dolphins typically occur close to the coast (within 20 km from land) and in relatively sheltered offshore waters near shallow bays, inshore reefs, and coastal archipelagos or islands (Ref. 141). In the western Pilbara region, Australian humpback dolphins frequent intertidal areas, with coral reef and shallow waters identified as highly suitable habitats (Ref. 144).

Observations suggest year-round dolphin presence in the Montebello Islands, indicating some site fidelity to these areas (Ref. 146).

Australian humpback dolphins feed across a wide range of inshore-estuarine coastal habitats in waters up to 40 m deep (Ref. 147). Their feeding behaviour varies, with dolphins sometimes dispersing over large areas or forming tight groups targeting localised prey. They are occasionally seen chasing fish into shallows and beaching themselves to catch their prey (Ref. 148). Reports also suggest they feed near fish farms and on baited drumlines (Ref. 141).

Australian humpback dolphins do not appear to undergo large-scale seasonal migrations, though seasonal fluctuations in abundance have been observed (Ref. 141). School sizes vary significantly based on behaviour, with larger groups observed while socialising compared to when foraging or traveling (Ref. 140).

No BIAs were identified within the PA. Breeding, calving foraging and resting BIAs for Australian humpback dolphins have been identified in northern WA (from Broome to the NT border) and around Darwin, NT. The draft Conservation Advice for Australian humpback dolphin (Ref. 147) defines shallow (≤15 m depth) inshore coastal waters and estuarine habitats within sub-tropical and tropical zones of Australia, up to 20 km from a coastline or landmass, as habitat critical to the survival of the species. Areas with high densities of teleost fish, cephalopods, and bivalves are considered important potential foraging habitats (Ref. 147).

4.3.1.12 Australian snubfin dolphin

Australian snubfin dolphins (*Orcaella heinsohni*) occur in northern Australian waters, ranging from Broome in WA to the Brisbane River in Queensland (Ref. 149). This population is believed to be continuous with that of Papua New Guinea, though separate from populations in Asia (Ref. 150).

Within Australia, snubfin dolphins are primarily found in shallow coastal and estuarine waters, often near freshwater sources and at depths of <20 m (Ref. 149, Ref. 151, Ref. 152, Ref. 153). Surveys conducted by D'Cruz et al. (Ref. 154) from 2007 to 2019 in the Yawuru Nagulagun (Broome coast) region suggest this area supports one of the largest known populations of Australian snubfin dolphins. Results showed that 56% of the dolphins displayed some residency, while 44% appeared to lack site fidelity—though this may be due to data restrictions or limited sampling intensity (Ref. 154).

The snubfin dolphin has also been recorded along the Kimberley coast in WA, including key areas such as Beagle and Pender Bays on the Dampier Peninsula and the tidal creeks between Kuri Bay and Cape Londonderry (Ref. 155). Group sizes vary from single individuals to 15 animals, typically forming small groups of 2–6 (Ref. 156) with an average school size of around five dolphins (Ref. 157).

Observations in Cleveland Bay, Queensland, indicate that Australian snubfin dolphins may mate and give birth year-round, as calves are seen throughout the year (Ref. 150, Ref. 152). These dolphins spend most of their time foraging and travelling, with less time devoted to socialising (Ref. 150). The prevalence of foraging in shallow coastal and estuarine waters (<20 m) suggests these areas are crucial feeding habitats (Ref. 152), where they prey primarily on fish, squid, cuttlefish, octopus, and shrimp (Ref. 158).

No BIAs were identified within the PA. Breeding, calving foraging and resting BIAs for Australian snubfin dolphins have been identified in northern WA (from Broome to the NT border) and around Darwin, NT.

4.3.1.13 Killer whale

Killer whales (*Orcinus orca*) are recorded in all Australian states, with notable concentrations around Tasmania (Ref. 159) and additional sightings in SA and Victoria (Ref. 160). Populations may be highly fragmented in Australian waters, though overall population numbers remain unknown (Ref. 159). While killer whales are typically associated with cold, deeper waters, they are most frequently sighted along Australia's continental slope and shelf, particularly near seal colonies (Ref. 159). During summer, they are regularly observed along the ice edge in Australian territorial waters (Ref. 45).

No specific key localities are known for killer whales within continental Australian waters, but Macquarie Island (in the Australian subantarctic territory) is considered a key location, with regular sightings reported during the southern summer (Ref. 161). Additionally, the Bremer Canyon Sub-Basin, south of WA, hosts one of the largest congregation of killer whales in the southern hemisphere (Ref. 162).

Killer whales are known to make seasonal movements, likely following migratory routes of their prey, although little is documented about these movements within Australian waters (Ref. 159). While foraging, they are capable of traveling 125–200 km per day (Ref. 163). Group sizes vary, with some gatherings reaching several hundred individuals, though typical groups contain <30 animals (Ref. 159).

Killer whales mate year-round, though the calving season spans several months. Currently, no specific calving areas have been identified within Australian waters (Ref. 159). As top-level carnivores, killer whales have a varied diet. While their specific diet in Australia remains uncertain, they have been reported preying on dolphins, young whales, dugongs, and Australian sea lions (Ref. 44). Additionally, Pitman et al. (Ref. 164) noted that killer whales target calves of humpback whales off Ningaloo Reef during the southern migration season (June to November).

No BIAs have been identified for killer whales in Australian waters.

4.3.1.14 Spotted bottlenose dolphin (Arafura/Timor Sea populations)

In Australia, the spotted bottlenose dolphin (*Tursiops aduncus*) ranges from northern NSW near Port Macquarie, through Queensland and the NT, and extends south along the WA coast to Perth (Ref. 44). However, the number and sizes of the Arafura/Timor Sea populations are unknown (Ref. 165).

The spotted bottlenose dolphin typically inhabits warmer, inshore waters in Australia, often at depths <10 m depth and potentially up to 10 km offshore (Ref. 44). Jefferson et al. (cited in Ref. 165) described this species as primarily found in coastal and inshore areas, with higher population densities near the shore. Haughey et al. (Ref. 166) also found that the probability of dolphin sightings was highest within 1–2 km of the coast, extending up to 7 km. The extent of migrations or seasonal movements by the spotted bottlenose dolphin in the Timor and Arafura Seas remains unknown (Ref. 165), though Bannister et al. (Ref. 44) suggest the spotted bottlenose dolphin species may be migratory in temperate waters.

Haughey et. al (Ref. 166) further identified that the coastal waters of the North West Cape host a relatively large population of spotted bottlenose dolphins, with sightings primarily during winter (June–August). In spring, sightings were more frequent outside the Ningaloo Marine Park, though summer data was not included in this study (Ref. 166). This population includes 141 individuals with moderate site fidelity and 229 with low site fidelity (Ref. 166).

Bottlenose dolphins are described as catholic feeders, consuming a diverse diet of demersal, benthic, and reef-associated teleosts, cephalopods, elasmobranchs, and crustaceans (Ref. 44). Breeding, calving and foraging BIAs for spotted bottlenose dolphins in WA have been identified around Broome and Kimbolton. However, no BIAs have been identified in the PA.

4.3.1.15 Australian sea lion

The Australian sea lion (*Neophoca cinerea*) is the only pinniped species endemic to Australia (Ref. 167). Female sea lions typically remain within 60 km of their natal site (Ref. 168), while males may disperse up to 200 km (Ref. 169). Migration patterns for adult and juvenile males have been observed on the west coast of WA, between breeding colonies near Jurien Bay and non-breeding sites on islands near Perth (Ref. 170).

Australian sea lions inhabit a variety of environments (Ref. 171), including breeding sites (rookeries) and haul-out sites used during the non-breeding season. Haul-out sites are essential for predator avoidance, thermal regulation, and social activities (Ref. 172). Onshore habitats include exposed islands, reefs, rocky terrain, sandy beaches, vegetated foredunes, and swales. Caves and deep cliff overhangs also provide critical haul-out and breeding habitats (Ref. 173; Ref. 174).

A notable feature of breeding colony sites is the presence of shallow, protected pools where pups congregate. On the west coast of WA, breeding occurs on low-lying limestone islands well-protected by perimeter reefs (Ref. 171). Shelter, such as rock crevices or vegetation, is vital for adult females to conceal their pups (Ref. 175). Breeding colonies are confined to SA and WA waters, ranging from Kangaroo Island in SA to the Houtman Abrolhos Islands in WA (Ref. 171). However, the species also forages in adjacent Commonwealth waters (Ref. 43).

Foraging activities are typically restricted to the continental shelf, with juveniles, adult females, and adult males diving to depths of 90 m, 130 m, and 150 m, respectively (Ref. 176). As benthic foragers, Australian sea lions target a wide variety of demersal prey (Ref. 42; Ref. 43; Ref. 175), including fish, cephalopods, sharks, rays, crustaceans, penguins, eels, and gastropods (Ref. 177; Ref. 178; Ref. 179; Ref. 180). They forage continuously while at sea, both during the day and at night (Ref. 181). Foraging behaviour varies geographically, with sea lions in WA spending more time foraging than those in SA, likely due to the less productive conditions of the Leeuwin Current (Ref. 182).

Foraging, breeding, and haul-out sites BIAs were identified for the Australian sea lion in the PA (Table 4-8, Figure 4-5). Australian sea lion pups have been recorded at 76 sites between WA and SA, with 58 of these identified as breeding colonies. These colonies are considered critical habitat for the survival of the species, as they fulfill essential life cycle requirements, such as reproduction (Ref. 43).

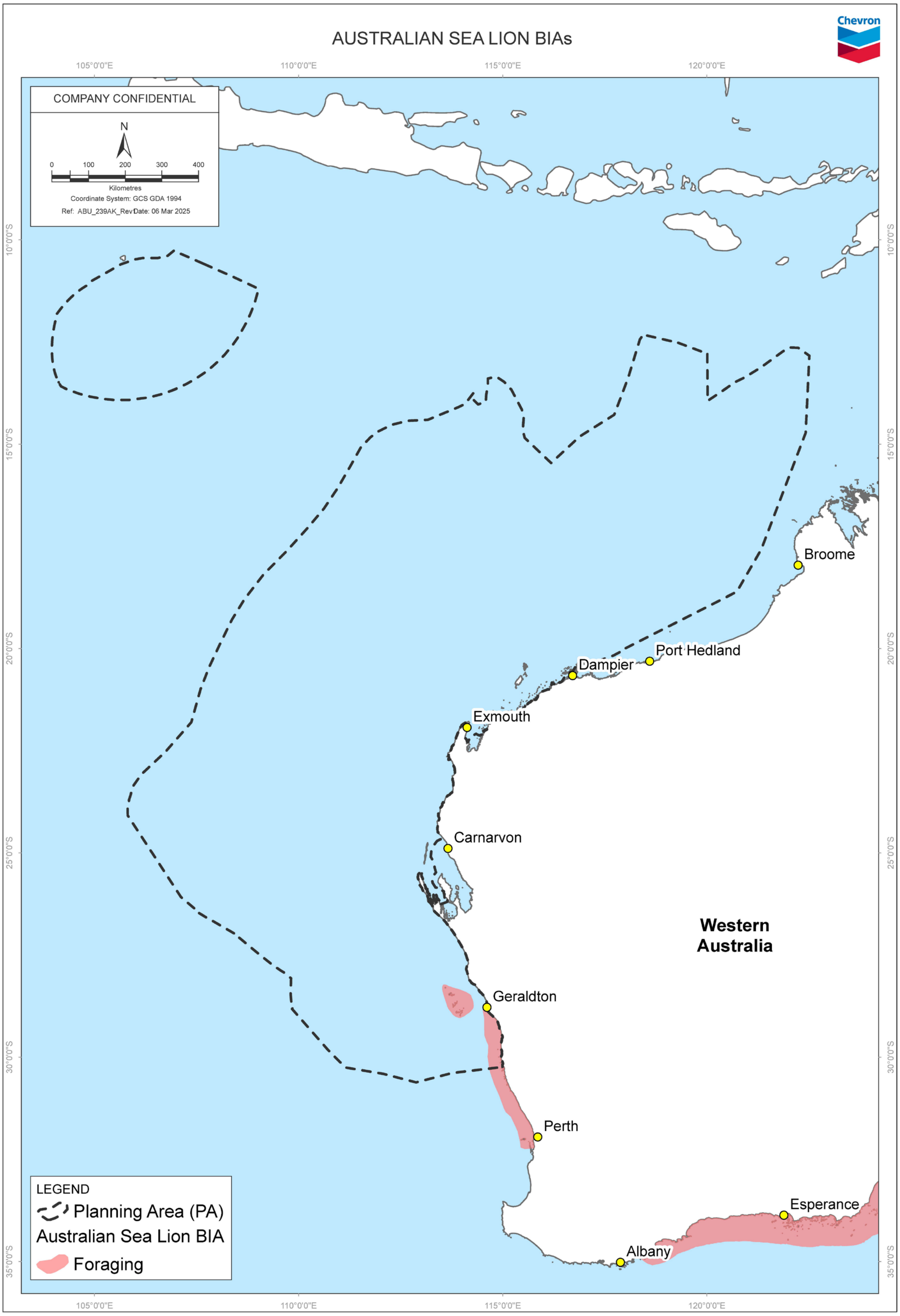

Figure 4-4: Biologically important areas for Australian sea lion

4.3.1.16 Dugong

Dugong (*Dugong dugon*) occur in the tropical and subtropical waters of the Indo-West Pacific (Ref. 183) and inhabit seagrass meadows in coastal waters, estuarine creeks, and streams (Ref. 155). In Australia, dugongs are found in the shallow coastal waters of northern Australia. Specific areas supporting dugongs in WA include Shark Bay (which has the largest population), Ningaloo and Exmouth Gulf, the Pilbara coast (from Exmouth Gulf to De Grey River; Ref. 184), and Eighty Mile Beach and the Kimberley Coast Region, including Roebuck Bay (Ref. 185).

Population estimates are unavailable (Ref. 186); however, aerial surveys since the mid-1980s suggest that dugong populations are now stable at a regional scale in WA (Ref. 187). Dugong feeding aggregations are typically found in extensive seagrass meadows, mangrove channels, and sheltered areas behind large inshore islands (Ref. 188). They also feed in offshore seagrass areas on wide, shallow, and protected sections of the continental shelf (Ref. 186), with feeding occurring at depths of up to 33 m (Ref. 189).

Dugong migration is variable, ranging from <15 km (micro-scale), to 100–560 km (macroscale; Ref. 190). Males, females, and females with calves all undertake large-scale movements (Ref. 186). Although dugong migration patterns are not well known in WA, it is believed that water temperature and the presence of seagrass influence their movements (Ref. 191).

Mating herds of dugongs have been observed in Moreton Bay, Shark Bay, and the northern Great Barrier Reef region (Ref. 188; Ref. 192; Ref. 193). A female may have one calf every three to seven years (Ref. 194).

Several BIAs for dugongs in WA have been identified around Exmouth and Broome, some of which are within the PA (Table 4-8, Figure 4-5).

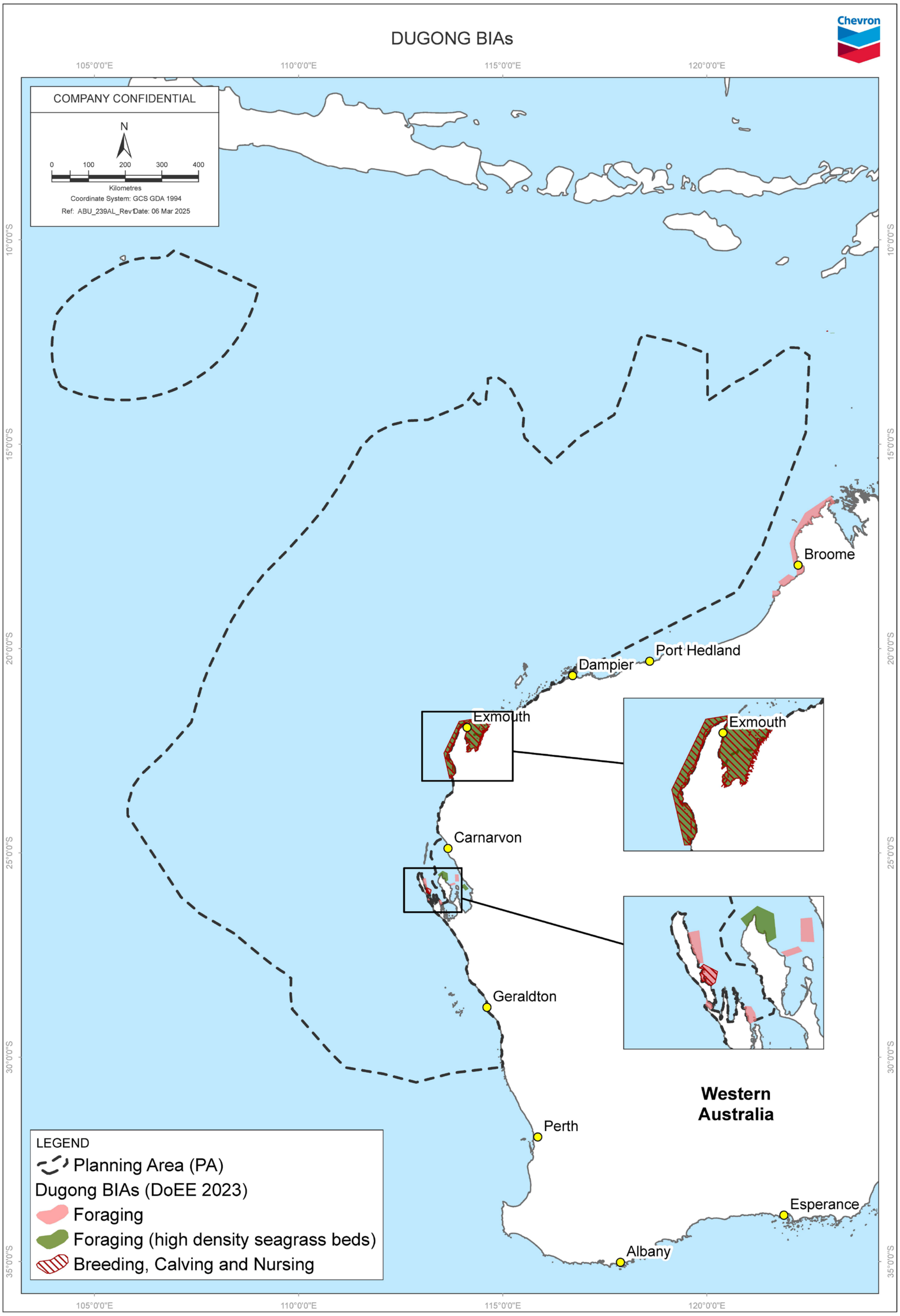

Figure 4-5: Biologically important areas for dugong

4.3.2 Reptiles

Table 4-10 lists the threatened and/or migratory marine reptile species that may be present within the PA. Additional information on these species is provided in the following subsections. The full list of marine species identified from the PMST is provided in appendix a.

Table 4-11 identifies habitats critical to the survival of marine turtles (Ref. 198) within the PA. Table 4-12 outlines the BIAs for marine reptiles and their known seasonal presence within the PA.

A review of the Conservation Advice and Recovery Plans identified key threats associated with threatened and/or migratory marine reptiles that may be present within the PA. Where relevant to petroleum activities these threats and relevant management advice are listed in Table 4-13.

In addition to the threatened and/or migratory marine reptile species identified in the tables below, an additional 20 listed marine reptile species (all sea snakes except the freshwater crocodile [*Crocodylus johnstoni*]) were identified as having the potential to occur within the PA (appendix a).

Studies (Ref. 212; Ref. 222; Ref. 223; Ref. 227; Ref. 228; Ref. 238; Ref. 239) note that sea snakes have shallow benthic feeding patterns and are rarely observed in water >20 m deep, indicating that these species are likely to be present in shallow waters.

Table 4-10: Threatened and/or migratory marine reptiles

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Crocodiles								
Salt-water crocodile	*Crocodylus porosus*	—	Migratory	—	SMO	SLO	SLO	—
Sea snakes								
Dusky sea snake	*Aipysurus fuscus*	Endangered	—	—	—	—	SKO	—
Leaf-scaled sea snake	*Aipysurus foliosquama*	Critically Endangered	—	—	SKO	SKO	SKO	—
Short-nosed sea snake	*Aipysurus apraefrontalis*	Critically Endangered	—	—	SLO	SKO	SLO	—
Turtles								
Flatback turtle	*Natator depressus*	Vulnerable	Migratory	FBKO	BKO	BKO	FBKO	SLO
Green turtle	*Chelonia mydas*	Vulnerable	Migratory	FBKO	BKO	BKO	FBKO	SLO
Hawksbill turtle	*Eretmochelys imbricata*	Vulnerable	Migratory	—	BKO	BKO	FBKO	SLO
Leatherback turtle	*Dermochelys coriacea*	Endangered	Migratory	FBKO	FBKO	FBKO	FBLO	SLO
Loggerhead turtle	*Caretta caretta*	Endangered	Migratory	FBKO	BKO	BKO	SKO	SLO
Olive ridley turtle	*Lepidochelys olivacea*	Endangered	Migratory	—	—	—	FBLO	SLO

Legend:
BKO: Breeding known to occur within area
FBLO: Foraging, feeding or related behaviour likely to occur within area
FBKO: Foraging, feeding or related behaviour known to occur within area
SKO: Species or species habitat known to occur within area
SLO: Species or species habitat likely to occur within area
SMO: Species or species habitat may occur within area

Table 4-11: Habitats critical to survival for marine turtles

Common name	Nesting location	Internesting buffer	Seasonal presence	Occurrence description	Section				
					West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Flatback turtle	Barrow Island, Montebello Islands, coastal islands from Cape Preston to Locker Island	60 km internesting buffer	October to March	Known to occur	—	—	✓	—	—
	Cemetery Beach, Port Hedland	60 km internesting buffer	October to March	Known to occur	—	—	✓	—	—
	Dampier Archipelago, including Delambre Island and Hauy Island	60 km internesting buffer	October to March	Known to occur	—	—	✓	—	—
	Eco Beach - coastal beach near Broome	60 km internesting buffer	July	Known to occur	—	—	✓	✓	—
	Eighty-mile beach - coastal beach	60 km internesting buffer	July	Known to occur	—	—	✓	—	—
	Lacepede Islands	60 km internesting buffer	October to March	Known to occur	—	—	—	✓	—
	Mundabullangana Beach	60 km internesting buffer	October to March	Known to occur	—	—	✓	—	—
Green turtle	Adele Island, Lacepede Islands	20 km internesting buffer	November to March	Known to occur	—	—	—	✓	—
	Barrow Island, Montebello Islands, Serrurier Island, and Thevenard Island	20 km internesting buffer	November to March	Known to occur	—	—	✓	—	—
	Dampier Archipelago	20 km internesting buffer	November to March	Known to occur	—	—	✓	—	—
	Exmouth Gulf and Ningaloo Coast	20 km internesting buffer	November to March	Known to occur	—	✓	✓	—	—
	Scott Reef	20 km internesting buffer	November to March	Known to occur	—	—	—	✓	—

Common name	Nesting location	Internesting buffer	Seasonal presence	Occurrence description	Section				
					West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Hawksbill turtle	Cape Preston to mouth of Exmouth Gulf including Montebello Islands and Lowendal Islands	20 km internesting buffer	October to February	Known to occur	—	—	✓	—	—
	Dampier Archipelago, including Delambre Island and Rosemary Island	20 km internesting buffer	October to February	Known to occur	—	—	✓	—	—
Loggerhead turtle	Exmouth Gulf and Ningaloo Coast	20 km internesting buffer	November to May	Known to occur	—	✓	✓	—	—
	Gnaraloo Bay and beaches	20 km internesting buffer	November to May	Known to occur	—	✓	—	—	—
	Shark Bay, all coastal and island beaches out to the northern tip of Dirk Hartog Island	20 km internesting buffer	November to May	Known to occur	—	✓	—	—	—

Table 4-12: BIAs for regionally significant marine reptiles

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Flatback turtle	Aggregation	—	Known to occur	—	—	✓	—	—
	Foraging	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Foraging	January	Known to occur	—	—	✓	—	—
	Foraging	—	Known to occur	—	—	✓	✓	—
	Foraging	Observations during July, no evidence of turtle activity October to November for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur	—	—	✓	—	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Foraging	Summer	Known to occur	—	—	✓	—	—
	Foraging	Summer (nesting/internesting) year-round	Known to occur	—	—	✓	—	—
	Foraging	Year-round	Known to occur	—	—	✓	—	—
	Internesting	None identified in dataset	Known to occur	—	—	✓	✓	—
	Internesting	Summer (nesting/internesting) year-round	Known to occur	—	—	✓	—	—
	Internesting buffer	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Internesting buffer	January	Known to occur	—	—	✓	—	—
	Internesting buffer	—	Known to occur	—	—	✓	✓	—
	Internesting buffer	Summer	Known to occur	—	✓	✓	—	—
	Internesting buffer	Summer (nesting/internesting), year-round	Known to occur	—	—	✓	—	—
	Mating	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Mating	—	Known to occur	—	—	✓	—	—
	Mating	Summer (nesting/interesting) year-round	Known to occur	—	—	✓	—	—
	Migrating Corridor	Summer (nesting/interesting) year-round	Known to occur	—	—	✓	—	—
	Nesting	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Nesting	January	Known to occur	—	—	✓	—	—
	Nesting	—	Known to occur	—	—	—	✓	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Nesting	Short summer nesting season, predominantly November to March with peak in January	Known to occur	—	—	✓	—	—
	Nesting	Summer	Known to occur	—	—	✓	—	—
	Nesting	Summer (nesting/interesting) year-round	Known to occur	—	—	✓	—	—
Green turtle	Aggregation	Early summer	Known to occur	—	—	✓	—	—
	Aggregation	—	Known to occur	—	—	✓	—	—
	Basking	Summer	Known to occur	—	—	✓	—	—
	Foraging	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Foraging	January	Known to occur	—	—	✓	—	—
	Foraging	March to May	Likely to occur	—	—	—	✓	—
	Foraging	—	Known to occur	—	—	✓	✓	—
	Foraging	Observations during July, no evidence of turtle activity October to November for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur	—	—	✓	—	—
	Foraging	Summer	Known to occur	—	—	✓	—	—
	Foraging	Summer (nesting/interesting) year-round	Known to occur	—	—	✓		
	Foraging	Summer / possibly year-round	Known to occur	—	—	✓	—	—
	Foraging	Year-round	Known to occur	—	—	✓	—	—
	Foraging	Year-round	Likely to occur	—	—	✓	✓	—
	Internesting	December to February	Known to occur	—	—	—	✓	—
	Internesting	—	Known to occur	—	—	✓	—	—
	Internesting	Peak season December to January	Known to occur	—	—	—	✓	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Internesting	Summer	Known to occur	—	—	✓	—	—
	Internesting	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Internesting	Year-round	Likely to occur	—	—	—	✓	—
	Internesting buffer	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Internesting buffer	January	Known to occur	—	—	✓	—	—
	Internesting buffer	—	Known to occur	—	—	—	✓	—
	Internesting buffer	Peak season December to January	Known to occur	—	—	—	✓	—
	Internesting buffer	Summer	Known to occur	—	✓	✓	✓	—
	Internesting buffer	Summer (nesting/internesting) year-round	Known to occur	—	—	✓	—	—
	Mating	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Mating	—	Known to occur	—	—	✓	—	—
	Mating	Summer	Known to occur	—	—	✓	—	—
	Mating	Summer (nesting/internesting) year-round	Known to occur	—	—	✓	—	—
	Migrating Corridor	Summer (nesting/interesting) year-round	Known to occur	—	—	✓	—	—
	Nesting	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Nesting	January	Known to occur	—	—	✓	—	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Nesting	—	Known to occur	—	—	—	✓	—
	Nesting	Peak season December to January	Known to occur	—	—	—	✓	—
	Nesting	Summer	Known to occur	—	—	✓	✓	—
	Nesting	Summer (nesting /internesting) year-round	Known to occur	—	—	✓	—	—
Hawksbill turtle	Foraging	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Foraging	—	Likely to occur	—	—	✓	—	—
	Foraging	Observations during July no evidence of turtle activity October to November for Solitary, Steamboat, Carey, Preston Islands, and Cape Preston	Known to occur	—	—	✓	—	—
	Foraging	Spring and early summer, peak nesting October	Known to occur	—	—	✓	—	—
	Foraging	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Foraging	Year-round	Known to occur	—	—	✓	—	—
	Foraging	Year-round	Likely to occur	—	—	✓	—	—
	Internesting	Spring and early summer, peak nesting October	Known to occur	—	—	✓	—	—
	Internesting	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Internesting buffer	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Internesting buffer	—	Known to occur	—	✓	✓	—	—
	Internesting buffer	Peak nesting in spring and early summer	Known to occur	—	—	✓	—	—
	Internesting buffer	Peak nesting in spring and early summer	Likely to occur	—	—	✓	—	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
	Internesting buffer	Peak season December to January	Likely to occur	—	—	—	✓	—
	Internesting buffer	Spring and early summer, peak nesting October	Known to occur	—	—	✓	—	—
	Internesting buffer	Summer (nesting/internesting) year round	Known to occur	—	—	✓	—	—
	Internesting buffer	Year-round	Known to occur	—	—	✓	—	—
	Mating	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Mating	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Mating	Spring and early summer, peak nesting October	Known to occur	—	—	✓	—	—
	Mating	Year-round	Known to occur	—	—	✓	—	—
	Migration corridor	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Nesting	Aggregation inside of NW Island. Early in summer	Known to occur	—	—	✓	—	—
	Nesting	—	Known to occur	—	✓	✓	—	—
	Nesting	Peak nesting in spring and early summer	Known to occur	—	—	✓	—	—
	Nesting	Peak season December to January	Likely to occur	—	—	—	✓	—
	Nesting	Spring and early summer, peak nesting October	Known to occur	—	—	✓	—	—
	Nesting	Summer (nesting /internesting) year round	Known to occur	—	—	✓	—	—
	Nesting	Year-round	Known to occur	—	—	✓	—	—
	Foraging	—	Known to occur	—	—	✓	✓	—

Common name	Behaviour	Seasonal presence*	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Loggerhead turtle	Foraging	Year-round	Known to occur	—	—	✓	—	—
	Internesting	December to March	Known to occur	—	✓	—	—	—
	Internesting buffer	December to March	Known to occur	—	✓	—	—	—
	Internesting buffer	—	Known to occur	—	✓	✓	—	—
	Internesting buffer	Peak season monitored	Known to occur	—	✓	—	—	—
	Nesting	December to March	Known to occur	—	✓	—	—	—
	Nesting	—	Known to occur	—	✓	✓	—	—
	Nesting	Peak season monitored	Known to occur	—	✓	—	—	—

**in the seasonal presence column "—" indicates there is no supporting information in the database.*

Table 4-13: Summary of relevant conservation plans—marine reptiles

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Dusky sea snake	Conservation Advice for dusky sea snake (Ref. 195)	Climate change and severe weather	• none identified
		Fossil fuel exploration and extraction, including: • oil pollution • excessive marine noise • pollution from heavy metals and other toxins • sedimentation and coral smothering	• use scientifically informed planning and regulation to avoid impacts across the known and likely distribution of the dusky sea snake. This includes (but is not limited to) eliminating: – the risk of discharged cooling water, or other heat sources, increasing water temperature for the dusky sea snake and its habitat – the risk of oil spill affecting the dusky sea snake and its habitat – the risk of other pollutants affecting the dusky sea snake and its habitat – all sources of excessive or constant marine noise that may impact the dusky sea snake. • should an oil spill occur that may impact the known or likely distribution of the dusky sea snake: – urgently use herding agents, bioremediation agents and mechanical means to contain and break down the oil – urgently cap or otherwise isolate the source of the oil to prevent further contamination – immediately resource and mobilise multiple expert wildlife care teams to search for, and rehabilitate, ill dusky sea snake.
		Marine vessels associated with constant marine noise	• develop minimal-noise operating guidelines that address constant noise exposure and distribute these to captains of vessels operating in waters where the dusky sea snake is known or likely to occur. Ensure vessels are operating under minimal-noise guidelines in these areas.
Leaf-scaled sea snake	Conservation Advice for leaf-scaled sea snake (Ref. 196)	Degradation of reef habitat	• ensure there is no disturbance in areas where the leaf-scaled sea snake occurs, excluding necessary actions to manage the conservation of the species.
Short-nosed sea snake	Conservation Advice for short-nosed	Degradation of reef habitat	• ensure there is no anthropogenic disturbance in areas where the short-nosed sea snake occurs,

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
	sea snake (Ref. 197)		excluding necessary actions to manage the conservation of the species.
Flatback turtle Green turtle Hawksbill turtle Leatherback turtle Loggerhead turtle Olive ridley turtle	Recovery Plan for Marine Turtles in Australia (Ref. 198)	Climate change and variability	• none identified
		Marine debris	• describe and quantify the impact of ingestion of debris on marine turtles, particularly those life phases using the open ocean • support the implementation of the EPBC Act Threat Abatement Plan for the impacts of marine debris on vertebrate marine life.
		Chemical and terrestrial discharge	• ensure spill risk strategies and response programs adequately include management for marine turtles and their habitats, particularly in reference to 'slow to recover habitats', e.g. nesting habitat, seagrass meadows or coral reefs • quantify the impacts of decreased water quality on stock viability • quantify the accumulation and effects of anthropogenic toxins in marine turtles, their foraging habitats and subsequent stock viability.
		Light pollution	• artificial light within or adjacent to habitat critical to the survival of marine turtles will be managed such that marine turtles are not displaced from these habitats • develop and implement best practice light management guidelines for existing and future developments adjacent to marine turtle nesting beaches • identify the cumulative impact on turtles from multiple sources of onshore and offshore light pollution.
		Habitat modification	• manage infrastructure, coastal development, dredging and trawling to ensure ongoing biologically important behaviours for marine turtle stocks continues • use up-to-date information regarding nesting, internesting and foraging habitat to inform future development proposals and approval decisions.
		Vessel disturbance	• none identified
		Noise interference	• none identified

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
		Diseases and pathogens	• none identified
Leatherback turtle	Approved Conservation Advice for leatherback turtle) (Ref. 199)	Ingestion of marine debris	• none identified
		Boat strike	• none identified
		Degradation of foraging areas	• identify and protect migratory corridors between nesting beaches and common foraging areas to facilitate colonisation
		Changes to breeding sites	• none identified

4.3.2.1 Salt water crocodile

The salt-water crocodile (*Crocodylus porosus*) inhabits Australian coastal waters, estuaries, lakes, inland swamps, and marshes (Ref. 200), reaching up to 150 km inland from the coast (Ref. 201). Its range extends across northern Australia, from Rockhampton in Queensland (Ref. 202; Ref. 203) to King Sound near Broome in WA (Ref. 204; Ref. 205). Despite its common name, the salt-water crocodile can persist in freshwater habitats (Ref. 206).

In WA, the species is found in most major river systems of the Kimberley region and in Parrys Creek, with the largest population located in the northwest (Ref. 207). There are also isolated records in rivers of the Pilbara region, around Derby near Broome, and as far south as Carnarvon on the mid-west coast (Ref. 208). The distribution and behaviour of salt-water crocodiles are influenced by temperature; they frequently move in and out of water for thermoregulation (Ref. 206). Out of water, they commonly bask, seek shade, and gape their mouths to manage body temperature (Ref. 209).

Preferred nesting habitats include elevated, isolated freshwater swamps that are not affected by tidal movements, as well as floating vegetation rafts (Ref. 200). Nesting occurs during the wet season, from November to May, with a peak between January and February (Ref. 206).

The salt-water crocodile's diet varies by habitat and size. Primary food sources include crustaceans (in higher salinity waters), insects (in freshwater swamps and upper mangroves), and mammals (Ref. 206), though only larger individuals consume mammals. Their prey includes a wide range of species, such as mud crabs, birds, sea turtles, fish, flying foxes, dingoes, domestic animals, livestock, and occasionally, humans (Ref. 210).

No BIAs for salt-water crocodiles have been identified in Australian waters.

4.3.2.2 Dusky sea snake

The dusky sea snake (*Aipysurus fuscus*) is endemic to Australian waters (Commonwealth and WA) in the Timor Sea off northwest WA, within the NWMR (Ref. 195). It has been sparsely recorded across reefs and shoals on the outer margin and mid-shelf of the Australian continental shelf, particularly at the Scott Reef complex and nearby Seringapatam Reef, Heywood Shoal, Ashmore Reef, and Cartier Island (Ref. 211; Ref. 212). However, since the late 1990s and early 2000s, the dusky sea snake has not been detected at Ashmore Reef, Cartier

Island, or Hibernia Reef, coinciding with a notable decline in the sea snake community in these regions (Ref. 211; Ref. 213; Ref. 214).

As a reef specialist, the dusky sea snake inhabits complex hard coral reefs and shoals, both emergent and subsurface, typically on seamounts that rise from depth >100 m (Ref. 211; Ref. 212; Ref. 215). It is primarily observed in shallow reef areas (0–20 m) (Ref. 212), though it may occur in deeper areas that have had limited survey effort (Ref. 216). Observations at the Scott Reef complex in 2014 and Heywood Shoal in 2018 noted this species around coral reef-sand edges (Ref. 195; Ref. 217).

The dusky sea snake, an air-breathing marine reptile with toxic venom (Ref. 218), forages along reef-sand edges (Ref. 217) and open sandy substrates at low tide (Ref. 219). Observed behaviours include shifting small coral and shell fragments and probing the sand to locate prey (Ref. 219). Known prey species include long-finned goby, dartfish, three spot wrasse, and knife wrasse (Ref. 220; Ref. 221; Ref. 222).

The movement patterns and reproductive biology remain unknown (Ref. 195). No BIAs have been identified for this species in Australian waters. Habitat critical to the survival of the dusky sea snake includes shallow (<20 m), complex coral reef and shoal ecosystems with substantial coral cover, such as the Scott Reef complex and Seringapatam Reef. Deeper reef areas adjoining critical habitat may also be considered essential if deeper populations are confirmed (Ref. 195).

4.3.2.3 Leaf scaled sea snake

The leaf-scaled sea snake (*Aipysurus foliosquama*) is primarily known from Ashmore and Hibernia Reefs off the north-west coast of WA (Ref. 196), though it has not been detected there since 2001 (Ref. 212; Ref. 223). Anecdotal records suggest this species may also inhabit other WA coastal areas, including Shark Bay, Exmouth Gulf, Barrow Island, and offshore near Port Hedland (Ref. 224; Ref. 225). Model predictions have identified Ashmore Reef, Shark Bay, Exmouth Gulf, Barrow and the Montebello Islands as potentially suitable habitats for the leaf-scaled sea snake (Ref. 212). Supporting these predictions, the leaf-scaled sea snake has been recorded as bycatch by the Shark Bay trawl fishery (Ref. 226). The exact area of occupancy of these WA coastal subpopulations remain unknown (Ref. 223).

This sea snake typically inhabits shallow waters (<10 m) in protected reef flats near living coral and coral substrates (Ref. 223; Ref. 227; Ref. 228). However, findings suggest it can also tolerate cooler waters and non-coral habitats, including seagrass beds with sparse or no coral cover (Ref. 212; Ref. 223; Ref. 225). In other regions, access to fresh water has also been an important factor in sea snake distribution and habitat selection (Ref. 229).

As air-breathing reptiles, leaf-scaled sea snakes must surface to breathe but can remain submerged for 30 minutes to two hours between breaths (Ref. 230). They are generally solitary but sometimes gather in groups around specific coral outcrops, especially where gravid (pregnant) females are present (Ref. 228; Ref. 219).

Leaf-scaled sea snakes forage on reef flats by searching for prey in fish burrows (Ref. 219). Their diet includes coral-associated wrasse (*Halichoeres spp.)*, gudgeons (*Eleotridae*), clinids (*Tripterygion spp.*), and eels (*Anguilliformes*) (Ref. 228; Ref. 231; Ref. 221).

No BIAs have been identified for this species in Australian waters.

4.3.2.4 Short-nosed sea snake

The short-nosed sea snake (*Aipysurus apraefrontalis*) endemic to WA, inhabits offshore waters of north-western Australia, including coastal areas between Exmouth and Broome and remote reefs on the NWS (Ref. 225; Ref. 232; Ref. 233). Most specimens have historically been collected from Ashmore and Hibernia Reefs (Ref. 197; Ref. 234), where they disappeared between 1998 and 2002 (Ref. 235; Ref. 236). However, in April 2021, a short-nosed sea snake was observed 67 m below the ocean surface at Ashmore Reef during a deep-sea expedition (Ref. 237).

Model predictions have identified Ashmore Reef, Exmouth Gulf, Murion, and the Montebello Islands, as well as regions near Rowley Shoals, as suitable habitats for the short-nosed sea snake, despite the lack of historical sea snake records in the latter area (Ref. 212). These predictions are supported by recent captures of short-nosed sea snakes in prawn trawl bycatch in the Exmouth Gulf and a specimen found washed ashore near Broome (Ref. 225).

The species typically inhabits reef flats or shallow waters along the outer reef edge, at depths of up to 10 m (Ref. 222; Ref. 238; Ref. 239). During daylight hours, it is often seen resting under small coral overhangs or coral heads in 1–2 m of water (Ref. 239). Guinea and Whiting (Ref. 219) noted that few short-nosed sea snakes venture >50 m from the reef flat (Ref. 233).

Like other sea snakes, short-nosed sea snakes are air-breathing and surface regularly, although they can remain submerged for 30 minutes to two hours (Ref. 233). Their diet consists of fish, such as Eviota spp. (*Gobiidae*; Ref. 240), and eels, which they capture by probing burrows in the sand (Ref. 197).

No BIAs for short-nosed sea snakes have been identified in Australian waters.

4.3.2.5 Flatback turtle

The Montebello and Lowendal Islands and Barrow Island support flatback turtle (*Natator depressus*) nesting, occurring from October to March, with a peak in November to January (Ref. 241). The Montebello and Lowendal Islands and Barrow Island are identified as important nesting habitat for the Pilbara stock, as is the associated 60 km internesting buffer (Ref. 198, Ref. 241).

On Barrow Island, nesting activity is concentrated on the central east coast on sandy, low-sloped, low-energy beaches with wide, shallow intertidal zones (Ref. 242; Ref. 243). Limited nesting activity has also been recorded on the south-west, north, and north-east beaches of Barrow Island (Ref. 244).

During internesting, turtles remain close to the nesting beach or rookery (Ref. 198) The 60 km internesting buffer defined within the *Recovery Plan for Marine Turtles in Australia* (Ref. 198) is based primarily on the movements of tagged internesting flatback turtles in WA (Ref. 245). The study tracked 56 turtles from four different rookeries, which demonstrated varying internesting movements, with distances ranging from 3–62 km, with some turtles at all four rookeries remaining within 10 km of their nesting beaches. However, tracking data showed these movements were largely longshore movements in nearshore coastal waters or travel between island rookeries and the adjacent mainland, which represent the greater distances (Ref. 245). There is little evidence to suggest that flatback turtles move to deep offshore waters during internesting periods.

A habitat suitability modelling study for internesting flatback turtles in the NWS region of WA (Ref. 246) was conducted to identify areas of suitable flatback turtle internesting habitat and determine overlap with identified industrial hazards. The study used a turtle tracking dataset of 47 nesting female turtles from five important rookeries in the NWS study area, including Barrow Island. The results showed internesting flatback turtles from all rookeries remained within water depths of <44 m, with a mean depth of <10 m (Ref. 246). Results also showed internesting turtles from all rookeries remained within <28 km of the nearest coast, with a mean distance from the coast of <6.1 km. The habitat suitability modelling study defined suitable flatback turtle internesting habitat as water depths of 0–16 m within 5–10 km of the coast. Unsuitable flatback turtle internesting habitat was defined as waters >25 m deep and >27 km from the coast (Ref. 246).

Another recent study involving satellite tracking data for 11 flatback turtles following nesting on the Lacepede Islands (Ref. 247) found that flatback turtles remained at an average distance of 15.75±12.25 km from the nesting beach in water depths of <20 m.

Other previous studies (e.g. Ref. 248; Ref. 249; Ref. 250) have also presented findings that internesting behaviour was only observed in water depths of <40 m. One of these studies (Ref. 250) further indicates that internesting flatback turtles have relatively shallow dives, with 85% of the time during spent in ≤20 m water depth, of which most was spent in 5–10 m (27±2.7%) and 10–15 m (22.3±3.5%) water depths.

Habitat critical to the survival of flatback turtles, along with BIAs, have been identified within the PA (Table 4-11, Table 4-12, Figure 4-6).

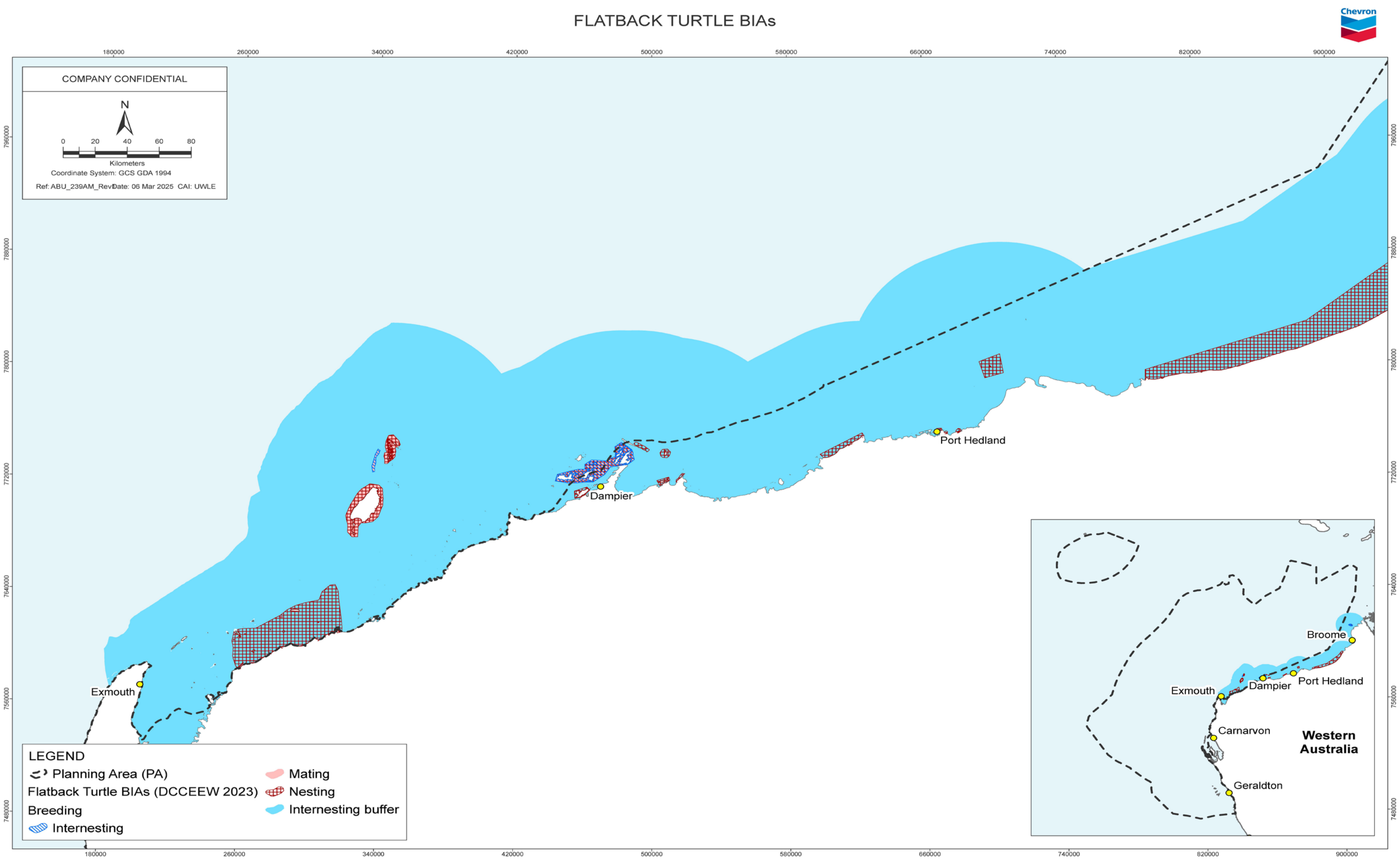

Figure 4-6: Biologically important areas and habitat critical to the survival of the species, for flatback turtles

4.3.2.6 Green turtle

The Montebello Islands and Barrow Island supports green turtle (*Chelonia mydas*) nesting, occurring from November to March. The Montebello Islands are identified as nesting habitat critical to the survival of the NSW stock, as is the 20 km internesting buffer around the Montebello Islands (Ref. 198).

The NWS stock is one of the largest green turtle stocks in the world and the largest in the Indian Ocean (Ref. 251). Nesting occurs over a large geographic range with nesting on offshore islands and the mainland. The principle rookeries include:

- Lacepede Islands
- Montebello Islands
- Barrow Island
- North West Cape
- Browse Island (Ref. 242)

Green turtle nesting usually occurs on the south, west and north-east coasts of Barrow Island between September and March each year, with a remigration interval of approximately five years (Ref. 252) and peak nesting activity occurring between December and February (Ref. 253; Ref. 242). Mating can also occur in this region between September and December (Ref. 241).

During internesting, turtles remain close to the nesting beach or rookery (Ref. 198). Analysis of satellite tracking data for Barrow Island on green turtles suggests internesting habitat occurs throughout the rocky intertidal and subtidal platforms common on the west coast, around to the north-eastern beaches and waters (Ref. 242; Ref. 253). Satellite tracking of internesting green turtles on Barrow Island were recorded to remain in shallow water within 5 km of Barrow Island (Ref. 242).

Satellite tracking of post-nesting female green turtles has shown that green turtles nesting on Barrow Island and Sandy Island (Scott Reef, WA) feed between 200 km and 1,000 km from their nesting beaches (Ref. 242). Following nesting at Barrow Island, green turtles that were tracked migrating to foraging grounds extending from Legendre Island in the Dampier Archipelago to waters in the southern Kimberley (Ref. 242).

The Ningaloo Coast is a crucial ecological area for green turtle populations, offering vital foraging and nesting grounds. The peak nesting season occurs from December to February, while hatching peaks between February and March (Ref. 198, Ref. 780). A study by Pillans et al. (Ref. 781) using acoustic receivers along the Ningaloo coast, revealed high site fidelity in both juvenile and adult turtles. This strong attachment to the area may be due to the protection of their habitat, abundant food sources, and reduced human impact (Ref. 781).

Despite the significance of Ningaloo for green turtles, there is limited information on the behaviour of juvenile turtles. Research indicates that some juveniles settle in continental shelf waters, where they inhabit sub-tidal and intertidal coral reefs, rocky outcrops, and seagrass meadows (Ref. 198, Ref. 779). These juvenile turtles are known to migrate to the shallow lagoons of Ningaloo after completing their pelagic life stage (Ref. 780).Habitat critical to the survival of green turtles, along with BIAs, have been identified within the PA (Table 4-11, Table 4-12, Figure 4-7).

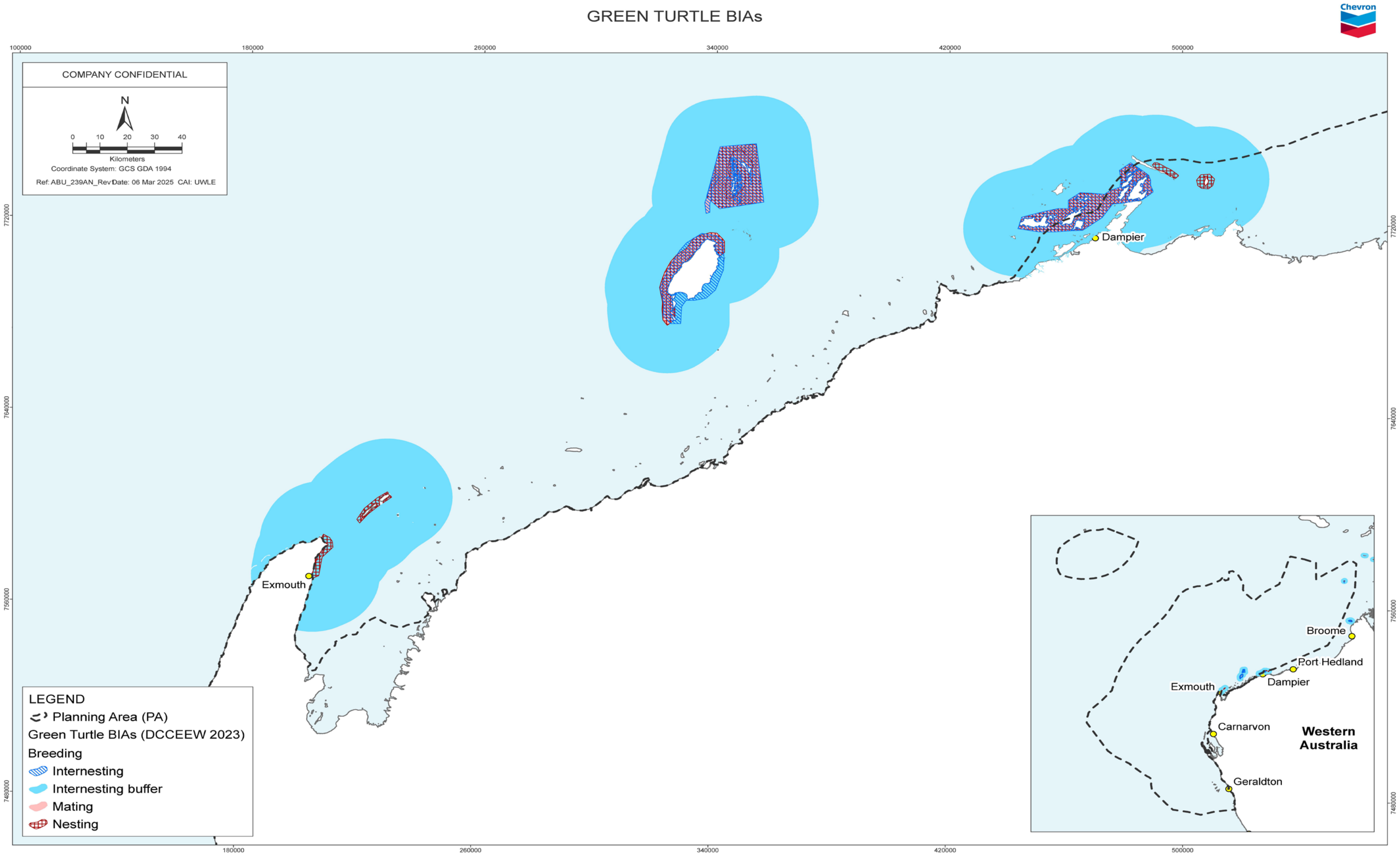

Figure 4-7: Biologically important areas and habitat critical to the survival of the species, for green turtles

4.3.2.7 Hawksbill turtle

The Montebello Islands and Lowendal Islands are identified as nesting habitat critical to the survival of the WA stock, as is the 20 km internesting buffer around the Islands (Ref. 198). Hawksbill turtles (*Eretmochelys imbricata*) are expected to be present within these areas between October and February (Ref. 198).

The WA hawksbill turtle stock is one of the three stocks within Australia (Ref. 198). Most of the nesting for this stock is located in the Pilbara (Ref. 198). The key nesting and inter-nesting areas in Australia include the Dampier Archipelago (including Rosemary Island and Delambre Island), Montebello Islands (including Ah Chong Island, South East Island and Trimouille Island), Lowendal Islands (including Varanus Island, Beacon Island and Bridled Island), Sholl Island (Ref. 254). The estimated size of the reproductive population of WA stock is small (Ref. 241). For example, it has been estimated as an overall reproductive population at Barrow Island of 100, an additional 1,000 in the Lowendal Islands, and 1,300 in the Montebello Islands (Ref. 241).

Monitoring of Barrow Island hawksbill turtle nesting has found that nesting activity is more temporally and spatially diffuse than flatback and green turtle nesting activity and occurs predominantly on small, rocky, east coast beaches. Nesting on Barrow Island peaks in October (Ref. 255) and hawksbill turtles typically have an internesting interval of 14.5 days and a remigration interval of approximately three years (Ref. 253; Ref. 254).

During internesting turtles remain close to the nesting beach or rookery (Ref. 198). Satellite tracking of hawksbill turtles found that they remained in shallow coastal waters (<10 m deep) post nesting (Ref. 242).

Although BIAs have been identified, hawksbill turtle mating, internesting, and foraging grounds have not been identified for Barrow Island (Ref. 241). However, data from hawksbill turtles tracked from nearby Varanus Island indicate potential internesting habitat in waters north-east of Barrow Island (Ref. 242).

Habitat critical to the survival of hawksbill turtles, along with BIAs, have been identified within the PA (Table 4-11 Table 4-12,Figure 4-8).

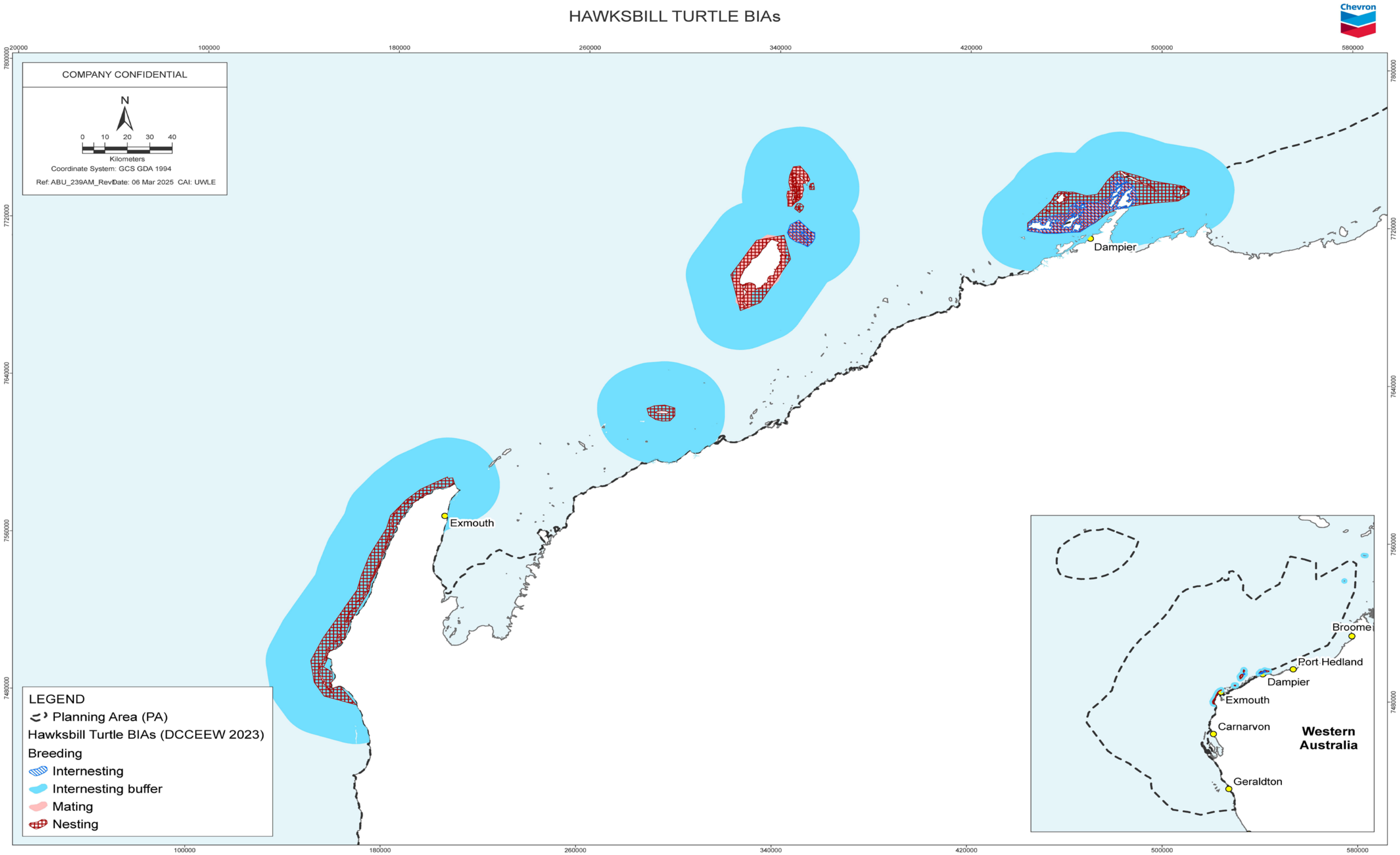

Figure 4-8: Biologically important areas and habitat critical to the survival of the species, for hawksbill turtles

4.3.2.8 Leatherback turtle

Leatherback turtle (*Dermochelys coriacea*) is a pelagic feeder found worldwide in tropical, subtropical, and temperate waters (Ref. 256). In Australia, they have been recorded in coastal waters offshore of all Australian States and NT (Ref. 257; Ref. 258; Ref. 259) inhabiting waters from coastal shallows to depths >5,000 m (Ref. 260).

A study by Hazel et. al (Ref. 260), suggests that leatherback turtles may be present year-round in WA waters, with peak sightings in June and July. Swaminathan et al. (Ref. 261) also indicates that up to 50% of Andaman-nesting leatherbacks may reach Australia's northwestern waters mid-year. Leatherbacks spend most of their lives in the open ocean, traveling vast distances while foraging (Ref. 262). Although generally solitary and pelagic, they may aggregate in areas with abundant food or near nesting beaches (Ref. 199).

Leatherbacks display site fidelity to broad nesting zones rather than specific beaches (Ref. 267).

Most leatherback turtles in Australian waters are likely foraging migrants from breeding populations in neighbouring countries (Ref. 260; Ref. 268). They are commonly observed foraging along the east coast and in Bass Strait (Ref. 198; Ref. 269; Ref. 270), and aerial surveys have recorded leatherbacks in NT waters (Ref. 271). Their diet mainly consists of pelagic soft-bodied prey like jellyfish and tunicates (Ref. 198; Ref. 199; Ref. 269).

Despite this, significant gaps remain in knowledge about leatherback turtle biology in Australia beyond nesting beaches (Ref. 199; Ref. 264).

No BIAs or habitat critical to the species were identified within the PA. Internesting and nesting BIAs for leatherback turtles have been identified in the NT and eastern Queensland. The *Recovery Plan for Marine Turtles in Australia* (Ref. 198) established a 20 km internesting buffer around all sandy beaches from Coburg Peninsula to Cape Arnhem in the NT for leatherback turtles, which is classified as habitat critical to the species' survival.

4.3.2.9 Loggerhead turtle

Loggerhead turtles (*Caretta caretta*) are globally distributed in tropical, sub-tropical waters and temperate waters. Loggerheads are carnivorous, feeding primarily on benthic invertebrates in habitat ranging from nearshore to 55 m depth (Ref. 272). Loggerhead turtles forage in all coastal states and the NT (Ref. 198).

The primary Australian breeding areas for loggerhead turtles are within southern Queensland and WA (Ref. 273). Loggerhead turtles will migrate over distances in excess of 1,000 km and show a strong fidelity to their feeding and breeding areas (Ref. 262).

In WA nesting occurs from Shark Bay (including on the mainland near Steep Point) to the North West Cape with major nesting at Dirk Hartog Island; Gnaraloo Bay; the Muiron Islands; and the beaches of the North West Cape (Ref. 274).

Occasional late summer nesting crawls have also been recorded as far north as Barrow Island, the Lowendal Islands and Dampier Archipelago (Ref. 275). During internesting, turtles remain close to the nesting beach or rookery (Ref. 198). Once breeding and nesting is complete, turtles return to their favoured foraging areas (Ref. 198).

The *Recovery Plan for Marine Turtles in Australia* (Ref. 198) established a 20 km internesting buffer around key nesting and internesting areas for loggerhead turtles, which is classified as habitat critical to the species' survival. Habitat critical to the survival of loggerhead turtles, along with BIAs, have been identified within the PA (Table 4-11, Table 4-12, Figure 4-9).

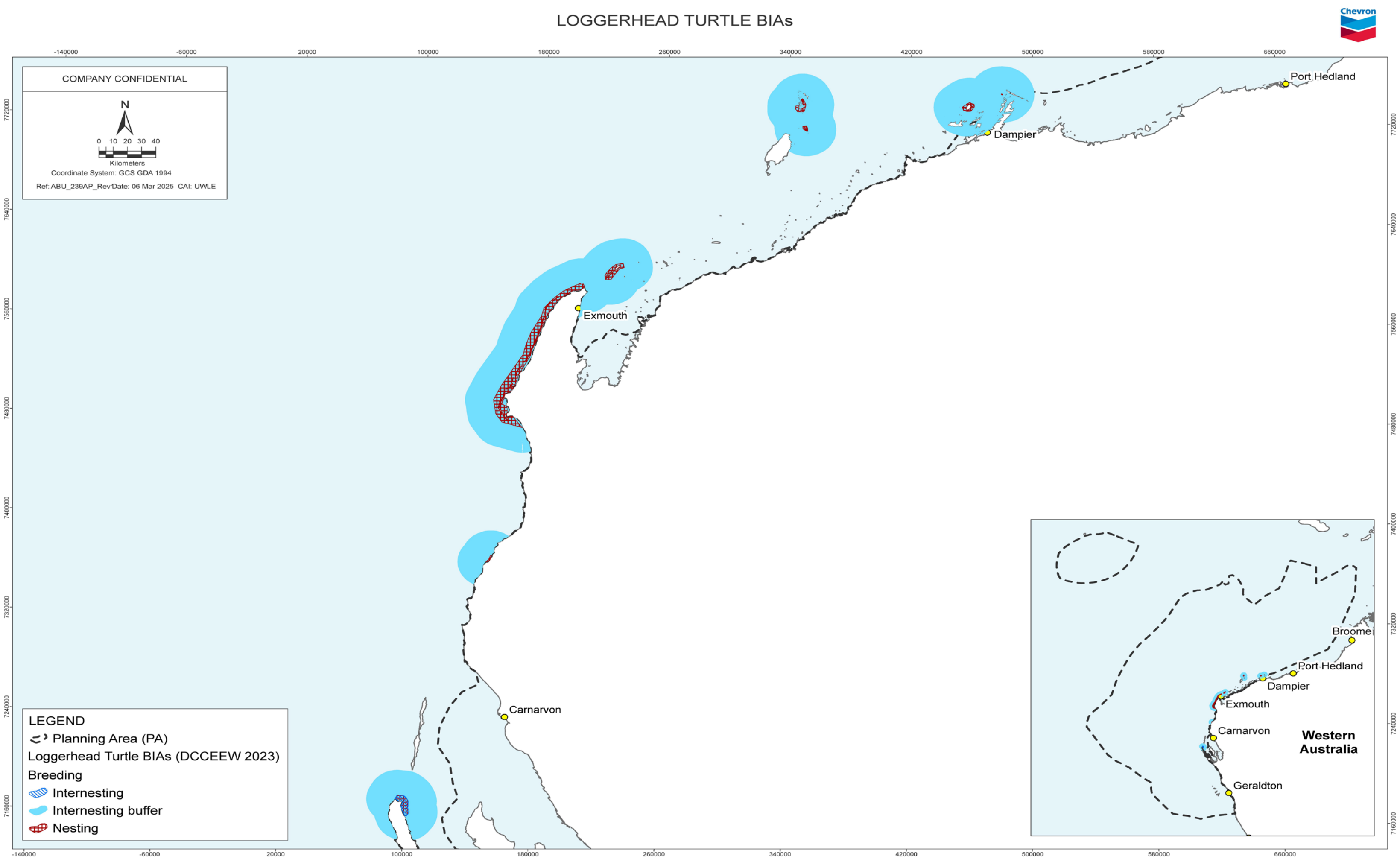

Figure 4-9: Biologically important areas and habitat critical to the survival of the species, for loggerhead turtles

4.3.2.10 Olive ridley turtle

Olive ridley turtles (*Lepidochelys olivacea*) are found in tropical and subtropical waters across all oceans (Ref. 276). In Australia, there are two main stocks: one that nests in the NT and another in QLD (Ref. 277; Ref. 278). Low-density nesting has also been observed on the Kimberley coast, north of Broome and the PA, though genetic relatedness to known stocks remains unknown (Ref. 198).

There is no record of olive ridley nesting in the PA, however foraging, feeding or related behaviour is likely to occur within the Kimberley section. Habitat for olive ridley turtles is likely to occur in the Christmas Island section. The species is not known to occur in the West Coast, Ningaloo or Pilbara sections (Table 4-10).

Similar to other marine turtle species, female olive ridleys lay eggs on sandy beaches, and hatchlings disperse into offshore currents, undergoing a pelagic phase of unknown duration (Ref. 286). Adults occupy soft-bottomed habitats along the northern Australian continental shelf year-round (Ref. 286). Migratory movements of olive ridley turtles are less studied compared to other marine turtle species but are known to span the coastal waters of over 80 countries. Very few individuals cross between ocean basins (Ref. 282). In Australia, satellite tracking indicates they generally remain on the continental shelf, occasionally extending into waters off Indonesia (Ref. 283; Ref. 284). Studies from northern Australia have recording migration distances of 180 to 1,050 km, remaining within 240 km of land and frequenting waters 45–55 m deep (Ref. 284, Ref. 285). Foraging primarily occurs over soft-bottomed substrates along northern Australia's coastal zone, at depths ranging from a few meters to 200 m (Ref. 284; Ref. 287; Ref. 288). They feed on soft-bodied invertebrates such as sea pens, soft corals, sea cucumbers, and jellyfish (Ref. 198). They are rarely observed in coral reefs or shallow inshore seagrass flats, except in one recorded instance (Ref. 262).

No BIAs or habitat critical to the species were identified within the PA.

4.3.3 Fishes, including sharks and rays

Table 4-14 lists the threatened and/or migratory fishes, sharks and rays that may be present within the PA. Additional information on these species is provided in the following subsections. The full list of marine species identified from the PMST is provided in appendix a.

Table 4-15 outlines the BIAs for fishes, sharks and rays and their known seasonal presence within the PA.

A review of the Conservation Advice and Recovery Plans identified key threats associated with threatened and/or migratory fishes, sharks and rays that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are included in Table 4-16.

In addition to the threatened and/or migratory marine fish species identified in the tables below, an additional 65 listed marine fish species (all syngnathids – seahorses, pipefishes and seadragons) were identified as having the potential to occur within the PA (appendix a). Bray (Ref. 289) notes that syngnathids are mostly benthic on coastal reefs, amongst marine algae and seagrass beds, or on sandy and rubble substrates and in caves and crevices. Syngnathids are mostly found in water depths above 50 m (Ref. 289).

Almost all syngnathids live in nearshore and inner shelf habitats, usually in shallow coastal waters, among seagrasses, mangroves, coral reefs, macroalgae dominated reefs, and sand or rubble habitats (Ref. 290; Ref. 291; Ref. 292). Although two species have been identified in the NWMR in deeper waters (winged seahorse [*Hippocampus alatus*] and western pipehorse [*Solegnathus sp. 2*]; Ref. 293), these species were not identified by the PMST search (appendix a).

Table 4-14: Threatened and/or migratory fishes, sharks and rays

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Sawfish								
Dwarf sawfish	*Pristis clavata*	Vulnerable	Migratory	—	SKO	SKO	SKO	—
Freshwater sawfish#	*Pristis pristis*	Vulnerable	Migratory	SMO	SMO	SKO	SLO	—
Green sawfish	*Pristis zijsron*	Vulnerable	Migratory	—	SKO	BKO	SKO	—
Narrow sawfish	*Anoxypristis cuspidata*	—	Migratory	—	SLO	SKO	SLO	—
Sharks								
Grey nurse shark	*Carcharias taurus*	—	Migratory	SLO	CKO	CKO	SMO	—
Grey nurse shark (west coast population)	*Carcharias taurus (west coast population)*	Vulnerable	—	SLO	CKO	CKO	—	—
Little gulper shark	*Centrophorus uyato*	Conservation Dependent	—	SLO	SLO	—	—	—
Longfin mako	*Isurus paucus*	—	Migratory	SLO	SLO	SLO	SLO	SLO
Northern river shark#	*Glyphis garricki*	Endangered	—	—	—	—	SMO	—
Oceanic whitetip shark	*Carcharhinus longimanus*	—	Migratory	SLO	SLO	SLO	SMO	SMO
Porbeagle	*Lamna nasus*	—	Migratory	SMO	SMO	—	—	—
Scalloped hammerhead	*Sphyrna lewini*	Conservation Dependent	—	SLO	SKO	SKO	SKO	SLO
Shortfin mako	*Isurus oxyrinchus*	—	Migratory	SLO	SLO	SLO	SLO	SLO
Whale shark	*Rhincodon typus*	Vulnerable	Migratory	SMO	FBKO	FBKO	FBKO	SMO
White shark	*Carcharodon carcharias*	Vulnerable	Migratory	FBKO	SKO	SKO	SMO	SMO
Rays								
Giant manta ray	*Manta birostris*	—	Migratory	SLO	SKO	SKO	SLO	SKO
Reef manta ray	*Mobula alfredi*	—	Migratory	SKO	SKO	SKO	SKO	—

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Legend: *BKO: Breeding known to occur within area* *CKO: Congregation or aggregation known to occur within area* *FBKO: Foraging, feeding or related behaviour known to occur within area* *SKO: Species or species habitat known to occur within area* *SLO: Species or species habitat likely to occur within area* *SMO: Species or species habitat may occur within area* *# Species mainly located inland (freshwater and estuarine habitats) identified in the Protected Matters Search Report but with the potential to be exposed to CAPL's activities.*								

Table 4-15: BIAs for regionally significant fish, sharks and rays

Common name	Behaviour	Seasonal presence	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Whale shark^	Foraging	Spring	Known to occur	—	—	✓	✓	✓
	Foraging (high density prey)	April to June, autumn	Known to occur	—	✓	—	—	—
White shark	Foraging	None identified in dataset	Known to occur	✓	—	—	—	—
Southern bluefin tuna*	Breeding (spawning)	Spawning is between September and April, with peaks in October and February	Known to occur	—	—	—	—	✓

^ Includes proposed Christmas Island foraging BIA (Ref. 294).

**Although spawning has also been identified in the Pilbara and Kimberley Sections, this refers to the proposed bluefin tuna breeding BIA in Christmas Island (Ref. 294).*

Table 4-16: Summary of relevant conservation plans—fishes, sharks and rays

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Dwarf sawfish Freshwater sawfish Green sawfish Northern river shark	Sawfish and river Sharks Multispecies Recovery Plan (Ref. 295)	Habitat degradation and modification	• all future assessments of proposed developments are undertaken in accordance with: – the EPBC Act, and the associated guidelines and policy documents – the sawfish and river shark recovery plan, issues paper and other sources of information. • advice on likely impacts and potential mitigation measures is sought from sawfish and river shark experts for all developments proposed to occur in habitat critical to survival of the species • report/s produced identifying risks to important habitat and recommendations on mitigation actions, including spatial protection.
		Marine debris	• none identified
		Not associated to an specific threat	• BIAs for sawfish and river sharks are adequately taken into account when assessing the impact of proposed activities in the marine environment and adequately protected
Dwarf sawfish	Approved Conservation Advice for dwarf sawfish (Ref. 296)	Habitat degradation due to increasing human development in northern Australia	• none identified
Freshwater sawfish	Approved Conservation Advice for freshwater sawfish (Ref. 297)	Habitat degradation and modification	• implement measures to reduce adverse impacts of habitat degradation and/or modification
		Marine debris	• none identified
Green sawfish	Approved Conservation Advice for green sawfish (Ref. 298)	Habitat loss, disturbance and modification	• none identified
Grey nurse shark	Recovery Plan for the Grey Nurse Shark (Ref. 299)	Pollution and disease	• BIAs for grey nurse sharks are adequately taken into account when assessing the impact of proposed activities in the marine environment and adequately protected.
		Ecosystem effects as a result of habitat modification and climate change	• none identified

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Little gulper shark	Listing Advice for southern dogfish (Ref. 300)	The main threat was population reduction caused by past fishing	• not applicable
Northern river shark	Conservation Advice for northern river shark (Ref. 301)	Habitat degradation and modification	• implement measures to reduce adverse impacts of habitat degradation and/or modification.
		Marine debris	• none identified
Scalloped hammerhead	Listing Advice for Scalloped Hammerhead (Ref. 302)	The current main threat is fishing	• not applicable
Shortfin mako	Listing Advice for shortfin mako (Ref. 303)	The main threat is fishing	• not applicable
Whale shark	Conservation Advice for the Whale Shark (Ref. 304)	Boat strike	No specific management actions were identified to address the threats; however, the following measure was noted: • minimise offshore developments and transit time of large vessels in areas close to marine features likely to correlate with whale shark aggregations (Ningaloo Reef, Christmas Island and the Coral Sea) and along the northward migration route that follows the northern WA coastline along the 200 m isobath.
		Habitat disruption	
		Disturbance	
		Marine debris	
		Climate change	
White shark	Recovery Plan for the White Shark (Ref. 305)	Ecosystem effects as a result of habitat modification and climate change	Biologically important areas for white sharks, particularly juvenile aggregation sites, pupping grounds and foraging areas are adequately taken into account when assessing the impact of proposed activities in the marine environment and adequately protected.

4.3.3.1 Dwarf sawfish

The dwarf sawfish (*Pristis clavata*) ranges from Cairns, around the Cape York Peninsula in Queensland, to the Pilbara coastline in WA (Ref. 306; Ref. 307).

Typically inhabiting shallow coastal and estuarine waters (2–3 m), the dwarf sawfish relies on these areas as nurseries for juveniles (Ref. 308). Adults seasonally migrate to inshore waters (Ref. 309).

While specific reproductive data are limited, dwarf sawfish are ovoviviparous, with pupping observed from the northern Australian wet season through early May (Ref. 310). In the Kimberley region, juveniles remain in nursery estuaries until around three years of age (Ref. 311). Adults generally occupy small coastal ranges and demonstrate site fidelity (Ref. 312).

Dwarf sawfish use their rostrum to stun schooling fish by sideswiping through groups, primarily preying on popeye mullet (*Rhinomugil nasutus*) (Ref. 313) as well as molluscs and crustaceans dislodged from the substrate (Ref. 314).

Peverell (Ref. 310) noted that dwarf sawfish move into marine waters post-wet season and enter estuarine or freshwater environments during the wet season to breed. Stevens et al. (Ref. 312) observed that at high tide, individuals rest in mangrove forests, typically within 100 m of prior resting sites, and during tidal changes, move into shallow waters for foraging.

No BIAs were identified within the PA. However, foraging, juvenile, nursing and pupping BIAs for the dwarf sawfish have been identified from Port Hedland to Augustus Island, northwest of WA. The *sawfish and river sharks multispecies Recovery Plan* (Ref. 295) highlights that areas where aggregations display biologically important behaviours are considered critical to the survival of the species unless population survey data suggests otherwise.

4.3.3.2 Freshwater (largetooth) sawfish

The freshwater sawfish (*Pristis pristis*) may potentially inhabit all large rivers in northern Australia, ranging from the Fitzroy River in WA to the western side of the Cape York Peninsula in Queensland (Ref. 315). There are few reports of adults at sea, with limited records of individuals over 3 m in total length from the Pilbara coast, and a single record from Cape Naturaliste in southwestern WA (Ref. 316). Globally, this sawfish is known to occur in four distinct regional populations (Ref. 295).

Freshwater sawfish prefer fresh or weakly saline water (Ref. 315) and are commonly found over mud bottoms in river embayments and estuaries (Ref. 315). Juveniles live in freshwater rivers and upper estuarine areas before moving to estuarine and marine areas as adults, to depths of up to 25 m (Ref. 295; Ref. 317; Ref. 318). Larger individuals may also move to deeper water at dawn, returning to shallower waters in the afternoon (Ref. 315). The species has been recorded in rivers as far as 400 km inland (Ref. 316).

Freshwater sawfish are believed to breed in freshwater (Ref. 319). Females may return to their natal rivers to give birth, while males may disperse across regions for breeding. Another possibility is that sawfish gather in breeding aggregations, with females returning to their natal areas to pup (Ref. 320; Ref. 321). In the Fitzroy River, an area identified as an important nursery site, pupping is correlated with high water levels in the late wet season (Ref. 316; Ref. 322). Spawning also occurs in Queensland (Ref. 315).

The freshwater sawfish feeds on fish and benthic invertebrates (Ref. 315), using its saw to stun schooling fish, such as mullet, and to extract molluscs and small crustaceans from the sediment (Ref. 323).

No BIAs were identified within the PA. However, foraging, juvenile, nursing and pupping BIAs for the freshwater sawfish have been identified from Port Hedland to Derby, northwest of WA. The *sawfish and river sharks multispecies Recovery Plan* (Ref. 295) highlights that areas where aggregations display biologically important behaviours are considered critical to the survival of the species unless population survey data suggests otherwise.

4.3.3.3 Green sawfish

The green sawfish (*Pristis zijsron*) is found in inshore coastal environments, including estuaries, river mouths, embayments, and along sandy and muddy beaches, as well as offshore marine habitats (Ref. 318; Ref. 324; Ref. 325). Movement within these preferred habitats is often correlated with tidal changes

(Ref. 312). Green sawfish have been recorded in water depths ranging from very shallow areas (<1 m) to offshore trawl grounds >70 m deep (Ref. 318).

In Australian waters, the species is distributed from the Whitsundays in Queensland (Ref. 326) across northern Australian waters to Shark Bay in WA (Ref. 295; Ref. 327). Limited data exists on the relative abundance of this species in WA (Ref. 327).

Green sawfish are known to occur in offshore waters, with documented pupping areas in coastal waters from north of Port Hedland to Roebuck Bay (Ref. 295). Additional likely pupping areas include regions south of Port Hedland, Exmouth Gulf, and North West Cape (Ref. 295). A recent study (Ref. 322) identified Exmouth Gulf as a globally significant refuge and pupping area for this species. Baseline surveys (Ref. 328) also indicate that the Ashburton estuary near Onslow serves as a habitat and nursery area for juveniles. Pupping is thought to coincide with the wet season (Ref. 310).

Green sawfish feed primarily on shoaling fish, such as mullet, which they stun by sideswiping with their rostrum (Ref. 329). They also sweep molluscs and small crustaceans from the sand and mud using their saw (Ref. 323; Ref. 330) and actively pursue schools of baitfish and prawns (Ref. 331).

No BIAs were identified within the PA. However, foraging, nursing and pupping BIAs for the green sawfish have been identified from Port Hedland to Augustus Island, northwest of WA. The *sawfish and river sharks multispecies Recovery Plan* (Ref. 295) highlights that areas where aggregations display biologically important behaviors are considered critical to the survival of the species unless population survey data suggests otherwise.

4.3.3.4 Narrow sawfish

The narrow sawfish (*Anoxypristis cuspidata*) is distributed patchily across the Indo-West Pacific (Ref. 332; Ref. 333). In Australia, it has a broad range, occurring from Rockhampton, Queensland, to the Pilbara coast, WA (Ref. 334). A study found the Narrow Sawfish to be the most abundant sawfish species sampled in the Gulf of Carpentaria (Ref. 310).

This species is benthopelagic, inhabiting estuarine, inshore, and offshore waters on the continental shelf at depths of up to 128 m, but is typically found in waters <40 m deep (Ref. 335; Ref. 336). Adults primarily occur offshore, while juveniles and pupping females rely on inshore and estuarine habitats (Ref. 310).

According to an assessment of the Great Barrier Reef, the narrow sawfish is known to form aggregations of mature females during October and November (Ref. 337). No BIAs have been identified for this species in Australian waters.

4.3.3.5 Grey nurse shark

The grey nurse shark (*Carcharus taurus*) is primarily found in inshore coastal regions within cool temperate to sub-tropical waters (Ref. 338; Ref. 339). In Australian waters, it primarily occupies continental shelf areas in sub-tropical to cool temperate waters (Ref. 299), and is divided into two genetically distinct populations—one on the east coast and one on the west coast (Ref. 340). The western population is mostly found in southwestern WA coastal waters, with sightings extending as far north as the NWS (Ref. 331; Ref. 341). Population size estimates for this region remain unavailable (Ref. 299).

Evidence suggests that the grey nurse shark is migratory across its WA distribution (Ref. 338). In a 2012 monitoring project, a tagged male shark moved from Augusta to Rottnest by early September and north to Coral Bay by mid-October, marking the first documented case of male migration in WA (Ref. 342). Tagged sharks of the western population have also been observed at depths of 20–160 m, indicating extensive use of the continental shelf (Ref. 343). Their diet consists of a variety of fish, other sharks and rays, squids, crabs, and lobsters (Ref. 338).

Grey nurse sharks commonly aggregate around inshore rocky reefs or islands, typically near the seabed at depths of 10–40 m, within sandy or gravel-filled gutters or rocky caves (Ref. 339; Ref. 344; Ref. 345; Ref. 346). Key aggregation sites have been identified in Queensland, NSW and Commonwealth Waters off the NSW Coast, which are considered critical for the species' survival (Ref. 299). A study near Exmouth from 2007–2012 identified a small aggregation with strong site fidelity from May to November each year (Ref. 347). Additional aggregation sites are likely between Rottnest and Lancelin, and possibly along the WA coast in caves deeper than 30 m (Ref. 346). Mature sharks show seasonal presence from March to June, peaking in April, while immature sharks are present almost year-round (Ref. 346).

No BIAs for this species have been identified in WA (Ref. 346).

4.3.3.6 Little gulper shark

The little gulper shark (*Centrophorus zeehaani*) inhabits the upper slopes of the southern continental shelf at depths ranging from 180 m to 900 m (Ref. 348). Its range extends along the southern Australian coast from near Warrnambool to south of Ceduna and from the western Great Australian Bight up the west coast to around Mandurah, south of Perth. However, it appears absent along parts of the South Australian coast in the Ceduna Terraces and off southern Tasmania through Bass Strait (Ref. 300). Current data (Ref. 348) indicates the existence of three distinct stocks, with the western stock spanning from the western Great Australian Bight to south WA.

The little gulper shark’s reproduction is considered to be continuous and non-seasonal (Ref. 339; Ref. 349; Ref. 350). Its diet consists primarily of fish and invertebrates, such as lanternfish and squid (Family Myctophidae), which are key prey items (Ref. 349; Ref. 350).

While the specific migratory patterns of this species remain unknown (Ref. 300), little gulpers are known to undertake diel (day-night) vertical migrations. They move from deeper daytime depths, ~1,000 m, to shallower feeding depths at night, sometimes reaching depths as shallow as 200 m (Ref. 348).

No BIAs have been identified for this species in Australian waters.

4.3.3.7 Longfin mako

The Longfin Mako (*Isurus paucus*) is found in tropical and warm temperate waters but is rarely reported in Australian waters (Ref. 351), with no available information on population trends in the region (Ref. 352). In Australia, its range extends from Geraldton, WA, across the NT and Queensland, down to Port Stevens, NSW (Ref. 339).

Based on its diet, the Longfin Mako is likely to inhabit deep waters (Ref. 353) and has been recorded at depths up to 1,752 m (Ref. 335).

No BIAs for longfin mako have been identified in Australian waters.

4.3.3.8 Northern river shark

Northern river sharks (*Glyphis garricki*) also known as New Guinea river sharks or northern speartooth sharks, are found in rivers, estuaries, and marine environments in WA and the NT (Ref. 295; Ref. 301). In WA, they have been recorded in both the west and east Kimberley regions (Ref. 318; Ref. 354) and offshore near the Wessel Islands (Ref. 354).

These sharks use a range of habitats, including rivers, tidal sections of large estuarine systems, macrotidal embayments, and both inshore and offshore marine areas (Ref. 355; Ref. 356). While adults have only been observed in marine environments, neonates, juveniles, and subadults are found across freshwater, estuarine, and marine habitats (Ref. 355).

The presence of individuals well offshore suggests that northern river sharks move between river systems, but the extent and distances of these movements remain unknown (Ref. 301). In northern Australia, observations include a single female with nine pups and free-swimming young in October, indicating that birthing likely occurs during this month (Ref. 355).

As apex predators, northern river sharks primarily feed on various fish and crustaceans (Ref. 318). No BIAs for northern river sharks have been identified in Australian waters.

4.3.3.9 Oceanic whitetip shark

Oceanic whitetip sharks (*Carcharhinus longimanus*) are a widespread pelagic species found in tropical and temperate waters, from inshore regions to open ocean (Ref. 357; Ref. 358). In Australian waters, their range extends from Cape Leeuwin, WA, through the NT and Queensland, to Sydney, NSW, with a single specimen recorded in SA (Ref. 339).

They typically inhabit the upper 200 m of the water column but have been observed diving to depths of around 1,000 m, likely in relation to foraging behaviour (Ref. 359; Ref. 360). Oceanic whitetip sharks are top predators and opportunistic feeders, primarily consuming bony fish and cephalopods like squid, as well as large pelagic fish, seabirds, other sharks and rays, and marine mammals (Ref. 361).

No BIAs for oceanic whitetip sharks have been identified in Australian waters.

4.3.3.10 Porbeagle (mackerel shark)

The porbeagle (*Lamna nasus*) has a wide range, inhabiting temperate, subarctic, and subantarctic waters of the North Atlantic and Southern Hemisphere (Ref. 362). In Australia, it occurs from southern Queensland to southwestern Australia (Ref. 339). Porbeagles are primarily found in oceanic waters off the continental shelf but may occasionally enter coastal areas (Ref. 362), with recorded depths ranging from the surface to 370 m (Ref. 335; Ref. 339).

This species appears flexible in its foraging habits (Ref. 363) and preys on various species, including teleost fish, elasmobranchs, and cephalopods (Ref. 339; Ref. 364). Porbeagles are known for their seasonal migrations, although the specifics of these movements are not well-understood (Ref. 365). Migrations may be driven by the search for feeding grounds or mates, with Southern Hemisphere populations thought to give birth off New Zealand and Australia in winter (Ref. 366).

No BIAs for porbeagle have been identified in Australian waters.

4.3.3.11 Scalloped hammerhead

Scalloped hammerhead sharks (*Sphyrna lewini*) are found in tropical and temperate seas worldwide, inhabiting both coastal and offshore waters (Ref. 367). In WA, scalloped hammerheads are commonly seen in the Montebello Islands Marine Park and Rowley Shoals Marine Park and are rarely sighted south of the Houtman Abrolhos Islands (Ref. 367). Bartes & Braccini (Ref. 368) also documented sightings of the species east of Geographe Bay, southwestern WA.

Hammerheads are sociable and, in some areas have been observed in schools of up to 200 (Ref. 367). Adult scalloped hammerheads typically inhabit deep waters adjacent to continental shelves, ranging from the surface to depths of at least 275 m, while juveniles are more commonly found near shore (Ref. 369). It is thought that adult females occupy deeper waters and move into shallower areas to mate and give birth (Ref. 369), with mating generally hypothesised to occur in deeper waters (Ref. 370).

Hammerheads in other oceans are known to migrate to shallow nursery areas for birthing (Ref. 302). Similarly, observed demographic structuring in Australian populations suggests that some adult females may migrate to waters in Indonesia or Papua New Guinea and return to northern Australia for birthing, indicating that northern Australia may provide important nursery areas for the Indo-Pacific scalloped hammerhead stock (Ref. 302).

No BIAs for scalloped hammerhead have been identified in Australian waters.

4.3.3.12 Shortfin mako

The shortfin mako (*Isurus oxyrinchus*) inhabits tropical and temperate waters (Ref. 353; Ref. 303). In Australian waters, this species is found offshore around most of the continent’s coastline, excluding the Arafura Sea, Gulf of Carpentaria, and Torres Strait (Ref. 303). Tagging studies indicate that shortfin makos spend most of their time at depths <50 m, with occasional dives reaching up to 880 m (Ref. 371; Ref. 372). There is a slight trend for the species to occupy shallower water at night and deeper water during daylight hours (Ref. 373).

The shortfin mako is highly migratory, capable of traveling vast distances, and has been observed migrating from Australian waters to areas well beyond the Australian Exclusive Economic Zone (Ref. 373). It is believed that the Australian population gives birth offshore along the NSW coastline (Ref. 339).

The diet of the Shortfin Mako primarily consists of fish, cephalopods, and crustaceans, with occasional predation on marine mammals (Ref. 374; Ref. 375; Ref. 376).

No BIAs for shortfin mako have been identified in Australian waters.

4.3.3.13 Whale shark

Whale sharks (*Rhincodon typus*) have a global distribution in tropical and warm temperate waters, including within Australian waters (mainly NT, Queensland and northern WA) (Ref. 304; Ref. 377).The whale shark is a suction filter feeder, with a diet consisting of planktonic and nektonic prey, and feeds at or close to the water's surface by swimming forward with mouth agape, sucking in prey (Ref. 377). While the species is generally encountered close to or at the surface, it will regularly dive and move through the water column.

Feeding, foraging and related behaviour is known to occur in the Ningaloo, Pilbara, Kimberley and Christmas Island section of the PA. Seasonal aggregations are thought to be linked to localised events of food productivity (Ref. 304)

Ningaloo Reef is considered the main known seasonal aggregation area between March and July, where their presence has been linked to coral mass spawning timing (Ref. 304, Ref. 377, Ref. 378). Following the aggregation period around Ningaloo Reef, their movements are largely unknown, although three migration routes from Ningaloo reef have been identified through various surveys (Ref. 380):

- north-west, into the Indian Ocean
- directly north, towards Sumatra and Java
- north-west, passing through the NWS region, travelling along the shelf break and continental slope.

Whale sharks are known to aggregate to the south of the Kimberley region and sometimes pass through the Kimberley marine park as part of their long migrations (Ref. 782). Similarly, whale sharks aggregate at Christmas Island between November and March to feed on the billions of larvae released into the water during the annual red crab spawning (Ref. 304)

Foraging and aggregation BIAs have been identified in northern of Australia. In WA and within the PA (Table 4-15, Figure 4-10), the BIA is associated with foraging behaviours during northward migration from Ningaloo Reef / North West Cape along the 200 m isobath during July to November (Ref. 304).

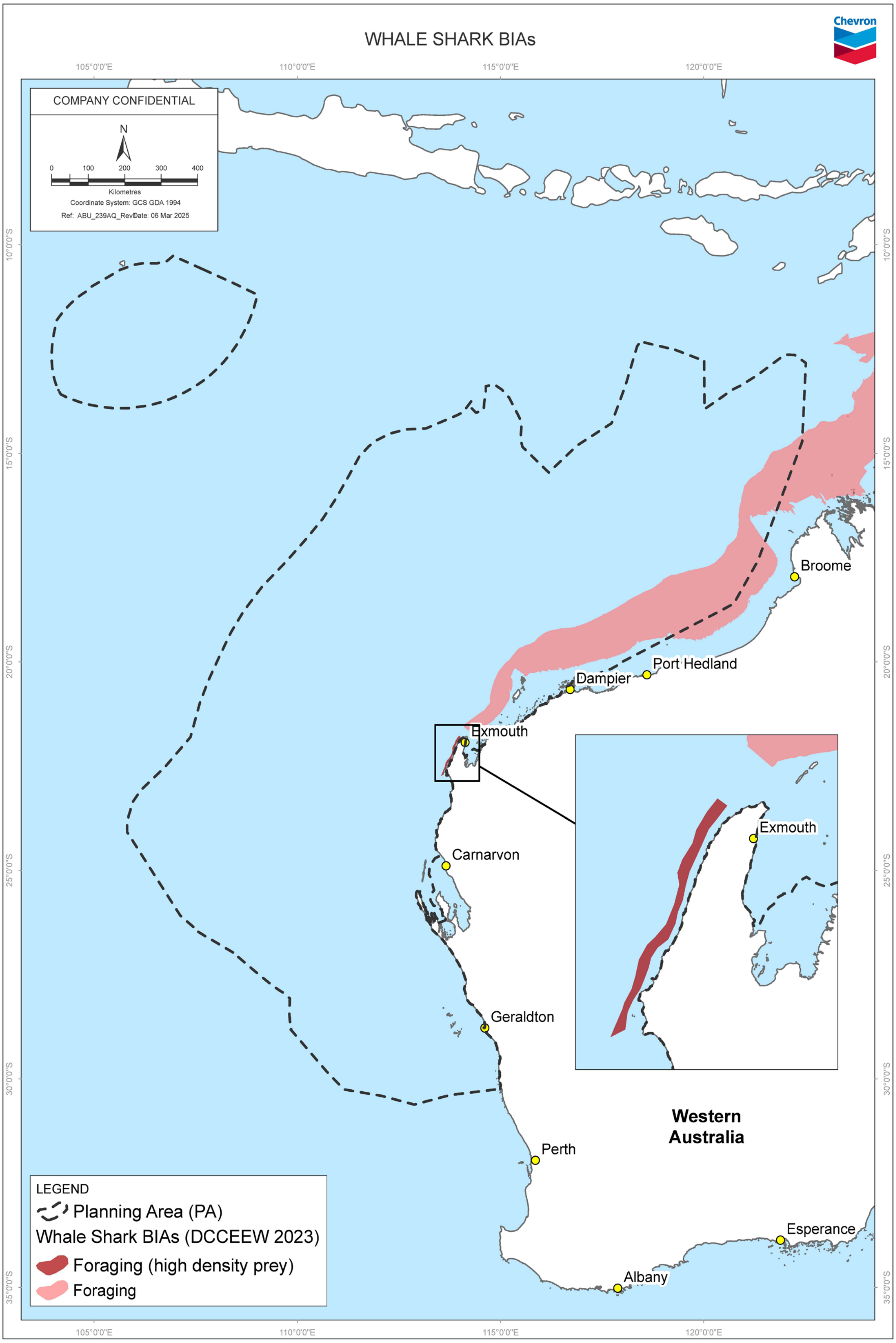

Figure 4-10: Biologically important areas for whale sharks

4.3.3.14 White shark

The White shark (*Carcharodon carcharias*) is widely but sparsely distributed across the world's oceans, including cold temperate waters in both hemispheres (Ref. 381). In Australia, genetic and tracking data reveal two distinct populations: an eastern and a southern-western population (Ref. 305; Ref. 382; Ref. 383). The southern-western population ranges from Bass Strait along the southern coast to north-western WA, with occasional records farther north (Ref. 339; Ref. 384; Ref. 385; Ref. 386).

Tagging data indicate that white sharks are present off most of the south and lower west coasts of WA year-round, with higher occurrences along the lower west coast (including Perth, Mandurah, and Bunbury) in spring and early summer, and fewer sightings during late summer and autumn (Ref. 383).

White shark habitat preferences shift with age: pups and juveniles inhabit nearshore, shallow continental shelves (Ref. 381), while adults and juveniles have been recorded diving to depths of up to 1,000 m (Ref. 385; Ref. 386). Most movements, however, occur in waters over 50 m deep and more than 10 km offshore (Ref. 383).

Notable aggregation sites for white sharks are observed from mid-September to mid-December, followed by migration toward the Bass Strait (Ref. 386). Sightings north of North-West Cape are rare, and no aggregation sites are identified in the NWMR (Ref. 387).

White sharks are opportunistic predators, feeding on diverse prey such as finfish, other sharks, rays, marine mammals (seals, sea lions, dolphins, whales), squid, crustaceans, and seabirds (Ref. 381). They are also known to follow humpback whale migrations along the WA coast, preying on vulnerable young and sick adults (Ref. 388). Typically, solitary or in pairs, white sharks may aggregate near food sources like pinniped colonies (Ref. 381; Ref. 389).

Although white sharks do not permanently inhabit a single area, they exhibit notable site fidelity (Ref. 381). Aggregation, breeding, and foraging BIAs have been identified for white sharks along the southern Australian coast, from Kalbarri, WA, to Gladstone, Queensland. and the PA (Table 4-15), foraging BIAs are identified in the southwest and southern regions. Identified foraging areas, aggregation areas, along with sites where white sharks consistently return, may represent habitats critical to their survival; however, further research is needed to fully understand and identify such essential habitats (Ref. 305).

4.3.3.15 Giant manta ray

Giant manta rays (*Mobula birostris*) inhabit tropical marine waters worldwide, with occasional sightings in temperate seas. In Australia, their range extends from Montague Island, NSW, to Shark Bay, WA (Ref. 339; Ref. 390; Ref. 391). Photo-identification data show that giant manta rays are most commonly observed in the Ningaloo Reef region, WA, with fewer sightings at Cocos Keeling Island, Christmas Island, the Great Barrier Reef, and the Coral Sea. Despite this range, they are rarely encountered in Australian waters overall (Ref. 390). The Ningaloo coast serves as an important habitat for giant manta rays from March to August (Ref. 392).

Giant manta rays have a notably patchy distribution, with most sightings occurring around specific aggregation sites, particularly near cleaning stations located adjacent to deep waters (Ref. 390). These rays are highly migratory and are known to seasonally visit productive coastal areas with regular upwelling, as well as oceanic island groups, offshore pinnacles, and seamounts (Ref. 393). Their diet consists primarily of plankton and planktonic larvae, which they filter from the water through specialised gill structures (Ref. 390). Giant manta rays are primarily pelagic, inhabiting depths from the surface down to 1,000 m (Ref. 335; Ref. 394).

No BIAs for giant manta ray have been identified in Australian waters.

4.3.3.16 Reef manta ray

The reef manta ray (*Manta alfredi*) is a large pelagic ray found in tropical and subtropical waters across the Indo-Pacific region (Ref. 395). In Australia, it occurs from Coffs Harbour, NSW, to Shark Bay, WA, with occasional sightings as far south as South West Rocks (NSW) and Perth (WA) (Ref. 390; Ref. 396).

Reef manta rays are mainly found in inshore waters, often around coral and rocky reefs from the surface to depths of 432 m (Ref. 335; Ref. 336; Ref. 397). Although capable of traveling distances of at least 1,100 km (Ref. 390), they typically exhibit shorter-range movements and strong site fidelity (Ref. 398; Ref. 399; Ref. 400; Ref. 401).

Tagging studies at Ningaloo Reef (Ref. 390) have identified a primary activity hotspot around Shark Bay World Heritage Area, with additional hotspots extending north to Coral Bay within the Ningaloo World Heritage Area. Distribution data suggest connectivity between the Ningaloo Reef and Shark Bay. Tagged reef manta rays showed a preference for shallow coastal shelf waters (<50 m), where they are observed year-round (Ref. 390). A peak in sightings within Exmouth Gulf may correlate with spawning activity, though further research is required to understand prey composition (Ref. 390).

No BIAs for reef manta ray have been identified in Australian waters.

4.3.4 Seabirds and shorebirds

Table 4-17 lists the threatened and/or migratory seabirds and shorebirds that may be present within the PA. Additional information on these species is provided in the following subsections. The full list of marine species identified from the PMST is provided in appendix a.

Table 4-18 outlines the BIAs for seabirds and shorebirds and their known seasonal presence within the PA.

A review of Conservation Advice and Recovery Plans identified key threats associated with threatened and/or migratory seabirds and shorebirds that may be present within the PA. Where relevant to petroleum activities, these threats and relevant management advice are included in Table 4-19.

In addition to the threatened and/or migratory marine seabirds and shorebird species identified in the tables below, an additional 20 listed marine seabirds and shorebird species were identified as having the potential to occur within the PA (appendix a).

Table 4-17: Threatened and/or migratory seabirds and shorebirds

Common name	Scientific name	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Abbott's booby	*Papasula abbotti*	Endangered	—	SLO	—	SMO	SMO	SKO
Amsterdam albatross	*Diomedea amsterdamensis*	Endangered	Migratory	SLO	SLO	—	—	—
Asian dowitcher*	*Limnodromus semipalmatus*	Vulnerable	Migratory	—	SKO	SKO	SKO	—
Australian fairy tern	*Sternula nereis nereis*	Vulnerable	—	FBKO	BKO	BKO	—	—
Australian lesser noddy	*Anous tenuirostris melanops*	Vulnerable	—	BKO	FBLO	—	FBKO	—
Australian painted snipe	*Rostratula australis*	Endangered	—	SMO	SKO	SLO	SMO	—
Bar-tailed godwit*	*Limosa lapponica*	—	Migratory	SKO	RKO	SKO	SKO	—
Black-browed albatross	*Thalassarche melanophris*	Vulnerable	Migratory	FBLO	SMO	—	—	—
Black-tailed godwit*	*Limosa limosa*	Endangered	Migratory	—	RKO	SKO	SKO	—
Blue petrel	*Halobaena caerulea*	Vulnerable	—	SMO	—	—	—	—
Bridled tern	*Onychoprion anaethetus*	—	Migratory	BKO	BKO	BKO	BKO	—
Broad-billed sandpiper*	*Limicola falcinellus*	—	Migratory	—	SKO	SKO	—	—
Brown booby	*Sula leucogaster*	—	Migratory	—	—	BKO	BKO	BKO
Campbell albatross	*Thalassarche impavida*	Vulnerable	Migratory	SMO	SMO	SMO	—	—
Caspian tern	*Hydroprogne caspia*	—	Migratory	BKO	BKO	BKO	BKO	—
Christmas Island frigatebird	*Fregata andrewsi*	Endangered	Migratory	—	—	—	—	BKO
Christmas Island white-tailed tropicbird	*Phaethon lepturus fulvus*	Endangered	—	SMO	SMO	SMO	FBLO	BKO
Common greenshank*	*Tringa nebularia*	Endangered	Migratory	SKO	SKO	SKO	SKO	—
Common noddy	*Anous stolidus*	—	Migratory	SLO	SLO	SLO	FBKO	SLO
Common redshank*	*Tringa totanus*	—	Migratory	—	—	SKO	SKO	—
Common sandpiper*	*Actitis hypoleucos*	—	Migratory	SKO	SKO	SKO	SKO	SKO

Common name	*Scientific name*	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Curlew sandpiper*	*Calidris ferruginea*	Critically Endangered	Migratory	SKO	SKO	SKO	SKO	SKO
Eastern curlew*	*Numenius madagascariensis*	Critically Endangered	Migratory	SLO	SKO	SKO	SKO	—
Flesh-footed shearwater	*Ardenna carneipes*	—	Migratory	FBLO	FBLO	SLO	—	—
Fork-tailed swift	*Apus pacificus*	—	Migratory	SLO	SLO	SLO	—	—
Great frigatebird	*Fregata minor*	—	Migratory	—	—	SMO	SKO	BKO
Great knot*	*Calidris tenuirostris*	Vulnerable	Migratory	—	RKO	SKO	SKO	—
Greater crested tern*	*Thalasseus bergii*	—	Migratory	BKO	BKO	BKO	BKO	—
Greater sand plover*	*Charadrius leschenaultii*	Vulnerable	Migratory	SMO	SKO	SKO	SKO	—
Grey plover*	*Pluvialis squatarola*	Vulnerable	Migratory	—	RKO	SKO	SKO	—
Grey-tailed tattler*	*Tringa brevipes*	—	Migratory	SKO	RKO	SKO	SKO	—
Indian yellow-nosed albatross	*Thalassarche carteri*	Vulnerable	Migratory	SLO	SMO	SMO	—	—
Lesser frigatebird	*Fregata ariel*	—	Migratory	SLO	SKO	BKO	BKO	SKO
Lesser sand plover*	*Charadrius mongolus*	Endangered	Migratory	—	SKO	SKO	SKO	—
Little curlew*	*Numenius minutus*	—	Migratory	—	RLO	SKO	—	—
Little tern	*Sternula albifrons*	—	Migratory	SMO	BKO	BKO	BKO	—
Long-toed stint*	*Calidris subminuta*	—	Migratory	—	SKO	SKO	—	—
Marsh sandpiper*	*Tringa stagnatilis*	—	Migratory	—	SKO	SKO	—	—
Masked booby	*Sula dactylatra*	—	Migratory	—	—	BKO	BKO	—
Northern giant petrel	*Macronectes halli*	Vulnerable	Migratory	FBLO	SMO	—	—	—
Northern Siberian bar-tailed godwit	*Limosa lapponica menzbieri*	Endangered	—	SKI	SKO	SKO	SKO	—
Oriental plover*	*Charadrius veredus*	—	Migratory	—	SKO	SKO	—	—

Common name	*Scientific name*	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Osprey*	*Pandion haliaetus*	—	Migratory	BKO	BKO	BKO	SKO	—
Pacific golden plover*	*Pluvialis fulva*	—	Migratory	SKO	SKO	SKO	SKO	—
Pectoral sandpiper*	*Calidris melanotos*	—	Migratory	SMO	SKO	SKO	SMO	SMO
Pin-tailed snipe*	*Gallinago stenura*	—	Migratory	—	RLO	—	—	—
Red knot*	*Calidris canutus*	Vulnerable	Migratory	SKO	SKO	SKO	SKO	SMO
Red-footed booby	*Sula sula*	—	Migratory	—	—	—	BKO	BKO
Red-necked phalarope*	*Phalaropus lobatus*	—	Migratory	—	SKO	SKO	—	—
Red-necked stint*	*Calidris ruficollis*	—	Migratory	SKO	RKO	SKO	SKO	—
Red-tailed tropicbird	*Phaethon rubricauda*	—	Migratory	BKO	SKO	—	BKO	BKO
Red-tailed tropicbird (Indian Ocean)	*Phaethon rubricauda westralis*	Endangered	—	—	—	SLO	—	BKO
Roseate tern	*Sterna dougallii*	—	Migratory	BKO	BKO	BKO	BKO	—
Ruddy turnstone*	*Arenaria interpres*	Vulnerable	Migratory	SKO	RKO	SKO	SKO	—
Sanderling*	*Calidris alba*	—	Migratory	SKO	RKO	SKO	SKO	—
Sharp-tailed sandpiper*	*Calidris acuminata*	Vulnerable	Migratory	SKO	SKO	SKO	SKO	SKO
Shy albatross	*Thalassarche cauta*	Endangered	Migratory	SMO	SMO	—	—	—
Soft-plumaged petrel	*Pterodroma mollis*	Vulnerable	—	FBKO	FBLO	FBLO	—	—
Sooty albatross	*Phoebetria fusca*	Vulnerable	Migratory	SMO	—	—	—	—
Southern giant-petrel	*Macronectes giganteus*	Endangered	Migratory	SMO	SMO	SMO	—	—
Southern royal albatross	*Diomedea epomophora*	Vulnerable	Migratory	SMO	—	—	—	—
Streaked shearwater	*Calonectris leucomelas*	—	Migratory	—	SMO	SKO	SKO	—
Swinhoe's snipe*	*Gallinago megala*	—	Migratory	—	RLO	—	—	—
Terek sandpiper*	*Xenus cinereus*	Vulnerable	Migratory	—	RKO	SKO	SKO	—

Common name	*Scientific name*	Threatened status	Migratory status	Presence				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Wandering albatross	*Diomedea exulans*	Vulnerable	Migratory	SLO	SMO	—	—	—
Wedge-tailed shearwater	*Ardenna pacifica*	—	Migratory	BKO	BKO	SKO	—	—
Whimbrel*	*Numenius phaeopus*	—	Migratory	—	RKO	—	SKO	—
White-capped albatross	*Thalassarche steadi*	Vulnerable	Migratory	SMO	SMO	—	—	—
White-tailed tropicbird	*Phaethon lepturus*	—	Migratory	SMO	SKO	SKO	BKO	BKO
Wood sandpiper*	*Tringa glareola*	—	Migratory	—	RKO	SKO	—	—

Legend:
BKO: Breeding known to occur within area
FBKO: Foraging, feeding or related behaviour known to occur within area
FBLO: Foraging, feeding or related behaviour likely to occur within area
RKO: Roosting known to occur within area
RLO: Roosting likely to occur within area
SKO: Species or species habitat known to occur within area
SLO: Species or species habitat likely to occur within area
SMO: Species or species habitat may occur within area
** Migratory wetland species*

Table 4-18: BIAs for regionally significant seabirds and shorebirds

Common name	Behaviour	Seasonal presence	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Australian lesser noddy	Foraging (provisioning young)	Year-round	Known to occur	✓	—	—	—	—

Common name	Behaviour	Seasonal presence	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Bridled tern	Foraging (in high numbers)	Almost entirely a breeding visitor, arriving in late September or October and leaving between late February and early May.	Known to occur	✓	—	—	—	—
Brown booby	Breeding	Breeding February to October (but mainly in autumn)	Known to occur	—	—	✓	✓	—
Caspian tern	Foraging (provisioning young)	Not identified in dataset	Known to occur	✓	—	—	—	—
Common noddy	Foraging (provisioning young)	Breeding visitor in Abrolhos (mid-August to late April) and further north (May to at least November).	Known to occur	✓	—	—	—	—
Fairy tern	Breeding	Breeding from July to late September, birds from SWMR dispersing northwards in winter	Known to occur	—	✓	✓	—	—
	Foraging (in high numbers)	Year round, but southern birds disperse north in winter	Known to occur	✓	—	—	—	—
Great frigatebird	Breeding	Breeding in May–June and August	Known to occur	—	—	—	✓	—
Lesser crested tern	Breeding	Breeding March to June	Known to occur	—	✓	✓	✓	—
Lesser frigatebird	Breeding	Breeding March to September	Known to occur	—	—	✓	✓	—
Little shearwater	Foraging (in high numbers)	Early January to early December, mainly April to November	Known to occur	✓	✓	—	—	—
Little tern	Resting	Breeding recorded in June, July and October.	Known to occur	—	—	✓	✓	—
Pacific gull	Foraging (in high numbers)	Not identified in dataset	Known to occur	✓	—	—	—	—
Red-footed booby	Breeding	Breeding in May-June	Known to occur	—	—	—	✓	—

Common name	Behaviour	Seasonal presence	Occurrence descriptor	Section				
				West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Roseate tern	Breeding	Breeding from mid-March to July. Also birds from SWMR dispersing north in winter.,	Known to occur	—	✓	✓	✓	—
	Foraging (provisioning young)	Winter	Known to occur	✓	—	—	—	—
Soft-plumaged petrel	Foraging (in high numbers)	Mainly March to late September	Known to occur	✓	—	—	—	—
Sooty tern	Foraging	Late August to early May	Known to occur	✓	✓	—	—	—
Wedge-tailed shearwater	Breeding	Breeding visitor arriving in mid-August and leaving in April in Pilbara and mid-May in Shark Bay.	Known to occur	✓	✓	✓	✓	—
	Foraging (in high numbers)	Mid-August to May	Known to occur	✓	—	—	—	—
White-faced storm petrel	Foraging (in high numbers)	Not identified in dataset	Known to occur	✓	—	—	—	—
White-tailed tropicbird	Breeding	Breeding recorded in May and October	Known to occur	—	—	✓	✓	—

Table 4-19: Summary of relevant conservation plans—seabirds and shorebirds

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Albatrosses and petrels	National Recovery Plan for Albatrosses and Petrels (Ref. 406)	Marine pollution, including fuel and oil spills, chemical contaminants and marine debris	• undertake, as feasible, monitoring of breeding colonies for marine debris, plastics and marine pollution impacts including, as a priority: – incidence of oiled birds at nest – levels of marine debris egestion and entanglement at nest – effect of plastics and marine pollution – develop baseline measures of levels of heavy metals and persistent organic pollutants. • Risk based response strategies for marine pollution incidents are developed
		Marine infrastructure interactions	• none identified
		Climate variability and change	• none identified
Migratory shorebirds	Wildlife Conservation Plan for Migratory Shorebirds (Ref. 407)	Habitat loss and modification	• investigate the significance of cumulative impacts on migratory shorebird habitat and populations in Australia
		Anthropogenic disturbance	• ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes
		Climate variability and change	• investigate the impacts of climate change on migratory shorebird habitat and populations in Australia
Seabirds	Wildlife Conservation Plan for Seabirds (Ref. 408)	Habitat loss and modification	• manage the effects of anthropogenic disturbance to seabird breeding and roosting areas
		Climate variability and change	• none identified
		Anthropogenic disturbance	• enhance contingency plans to prevent and/or respond to environmental emergencies that have an impact on seabirds and their habitats
		Transport	• none identified
		Pollution	• obtain baseline data and continue to monitor pollutant

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
			concentrations in seabirds and their habitats
Abbott's booby	Conservation Advice for Abbott's Booby (Ref. 409)	Climate change	• none identified
		Marine debris - plastics	• none identified
Asian dowitcher	Conservation Advice for Asian Dowitcher (Ref. 410)	Climate change	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Invasive species	• none identified
		Pollution	• none identified
Australian fairy tern	Conservation Advice for Fairy Tern (Ref. 411)	Increasing salinity in waters adjacent to fairy tern colonies and oil spills	• manage any changes to hydrology that may result in changes to tide levels, increase salinity or pollution
	National Recovery Plan for the Australian Fairy Tern (Ref. 412)	Habitat degradation and loss of breeding habitat	• none identified
		Disturbance	• none identified
		Climate variability and change	• use climate modelling techniques to investigate the potential influence of climate change on breeding and foraging habitats
		Water management and increased salinity	• monitor, and adaptively manage changes to hydrology at breeding and foraging sites
		Pollution	• monitor contaminant levels in Australian Fairy Terns
Australian lesser noddy	Conservation Advice Australian Lesser Noddy (Ref. 413)	Habitat loss, disturbance and modification	• Houtman Abrolhos and its surrounds continue to be managed in such a way that human disturbance is minimised
Australian painted snipe	Conservation Advice Australian Painted Snipe (Ref. 414)	Habitat loss, disturbance and modification	• ensure there is no disturbance in areas where the species is known to breed, excluding necessary actions to manage the conservation of the species • manage any changes to hydrology that may result in changes to water table levels, run-off, salinity, algal blooms, sedimentation or pollution
	National Recovery Plan	Deterioration of water quality	No specific management actions were identified to address the

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
	for the Australian Painted Snipe (Ref. 415)	Climate variability and change	threats; however, the following measure was noted: • manage threats at known breeding and non-breeding habitats • investigate the impact of potential threats such as human disturbance, fire and predation
		Human disturbance	
Black-tailed godwit	Conservation Advice for Black-tailed Godwit (Ref. 416)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers
		Climate change	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Pollution	• none identified
Blue petrel	Conservation Advice for Blue Petrel (Ref. 417)	Nest destruction or predation	• continue to manage Macquarie Island and its surrounds in such a way that human disturbance is minimised
Christmas Island frigatebird	Conservation Advice for the Christmas Island Frigatebird (Ref. 418)	Disturbance of habitat	• preventing activities in habitat critical to the survival that will remove nesting and roosting habitat • preventing activities in buffer areas identified in Map 1 that may disturb nesting and roosting birds e.g. clearing vegetation that would result in increased wind turbulence or weed invasion in nesting and roosting habitat or burning of vegetation that would result in smoke entering nesting and roosting habitat
		Heavy metal contamination	• none identified
		Marine debris - plastics	• assess levels of ingestion of marine debris by Christmas Island frigatebirds and other breeding seabirds in the Indian Ocean territories and determine its impact on survival or breeding success

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
	National Recovery Plan for Christmas Island Frigatebird (Ref. 419)	Habitat loss	• ensure protection of habitat critical to survival outside the national park
Christmas Island white-tailed tropicbird	Conservation Advice for White-tailed Tropicbird (Christmas Island) (Ref. 420)	The primary threat is introduced predators	• not applicable
Common greenshank	Conservation Advice for Common Greenshank (Ref. 421)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies, and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Pollution	• none identified
Curlew sandpiper	Conservation Advice for Curlew Sandpiper (Ref. 422)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies, and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• identify and protect inland wetlands and coastal drought refuges in Australia. • quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Pollution	• none identified
Eastern curlew	Conservation Advice for far Eastern Curlew (Ref. 423)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
			opportunities as identified by species experts, local studies, and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Pollution	• none identified
Flesh-footed shearwater	Conservation Advice Ardenna carneipes Flesh-footed Shearwater (Ref. 424)	The main threat is fishing	• not applicable
Great knot	Conservation Advice for Great Knot (Ref. 425)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies, and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• none identified
		Pollution	• none identified
Greater sand plover	Conservation Advice for Greater Sand Plover (Ref. 426)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies, and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• none identified
		Pollution	• none identified

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Grey plover	Conservation Advice for Grey Plover (Ref. 427)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• none identified
		Pollution	• none identified
Lesser sand plover	Conservation Advice for Lesser Sand Plover (Ref. 428)	Habitat loss and habitat degradation	No specific management actions were identified to address the threats; however, the following actions were noted: • protect important habitat in Australia • maintain and improve protection of roosting and feeding sites in Australia • manage disturbance at important sites which are subject to anthropogenic disturbance when lesser sand plovers are present – e.g. discourage or prohibit vehicle access, horse riding and dogs on beaches, implement temporary site closures
		Climate change	
		Pollution/contamination impacts	
		Disturbance	
Northern Siberian bar-tailed godwit	Conservation Advice for Yakutian Bar-tailed Godwit (Ref. 429)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers.
		Anthropogenic disturbance	• none identified
		Climate change	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and non-breeding distribution of the species
		Pollution	• none identified
Red knot	Conservation Advice for Red Knot (Ref. 430)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
			upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies, and site managers.
		Anthropogenic disturbance	• none identified
		Climate change	• none identified
		Pollution	• none identified
Red-tailed tropicbird (Indian Ocean)	Conservation Advice for Indian Ocean Red-tailed Tropicbird (Ref. 431)	Climate change	• none identified
Ruddy turnstone	Conservation Advice for Ruddy Turnstone (Ref. 432)	Habitat loss, fragmentation, and degradation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers
		Anthropogenic disturbance	• none identified
		Climate change	• none identified
		Pollution	• none identified
Sharp-tailed sandpiper	Conservation Advice for Sharp-tailed Sandpiper (Ref. 433)	Habitat loss, degradation, and fragmentation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers
		Climate change	• none identified
		Pollution	• none identified
	Conservation Advice for Shy	Climate change	• the likely impacts on albatrosses and giant petrels breeding and

Species	Relevant Plan / Advice	Key threats	Relevant management advice/action
Shy Albatross	Albatross (Ref. 434)		foraging within Australian jurisdiction are assessed and reported and knowledge gaps identified (long term monitoring strategies are important for understanding and tracking impacts of climate change)
		Marine pollution	• none identified
		Human disturbance	• none identified
Soft-plumaged petrel	Conservation Advice for Soft-plumaged Petrel (Ref. 435)	The only potential threat is accidental introduction of predators	• not applicable
Terek sandpiper	Conservation Advice for Terek Sandpiper (Ref. 436)	Habitat loss, degradation, and fragmentation	• ensure that future development projects avoid any activities that disproportionately affect the upper tidal flats and/or areas providing major foraging opportunities as identified by species experts, local studies and site managers
		Anthropogenic disturbance	• quantify and predict changes to important habitat because of climate change and identify potential shifts in the breeding and nonbreeding distribution of the species.
		Climate change	• none identified
		Pollution	• none identified

4.3.4.1 Abbott’s booby

The Abbott's booby (*Papasula abbotti*) is a large seabird that occurs on Christmas Island in the Indian Ocean, primarily inhabiting its forested areas of the plateau and in upper terrace forests for nesting and roosting (Ref. 409; Ref. 439). Approximately 83% of known nesting habitat on Christmas Island occurs within the National Park (Ref. 409). These birds prefer emergent rainforest trees at elevations 100 m above sea level for their nests, often using the same sites year after year (Ref. 409; Ref. 440). The Abbott’s booby spends most of its life at sea and has a range that covers Christmas Island and the NWS off WA up to the southern end of Timor-Leste in the Timor Sea (Ref. 409).

Abbott's boobies are known for their unique foraging behaviour, diving from heights to catch fish and squid, which constitute the bulk of their diet (Ref. 441). Their physiological adaptations include long, pointed wings that facilitate gliding over the ocean, allowing them to cover large distances while searching for food (Ref. 442).

The *Conservation Advice for Abbott’s Booby* (Ref. 409) defines all known nesting trees and all forest vegetation within a 200 m radius of known nesting trees as habitat critical to the survival of the species. No habitat critical to the survival of the species or BIAs have been identified in the PA.

4.3.4.2 Amsterdam albatross

The Amsterdam albatross (*Diomedea amsterdamensis*) is native to Amsterdam Island in the southern Indian Ocean (Ref. 443), ~3,000 km southwest of WA. Satellite tracking has shown that adult birds range from the coast of eastern South Africa to waters south of WA during non-breeding years (Ref. 444).

The Amsterdam albatross primarily feeds on squid and fish found in subantarctic waters (Ref. 445), some of which extend toward parts of Australia. This species shares its habitat with other seabird species commonly found in Australian waters, such as the wandering albatross and various species of petrels (Ref. 406). Although breeding occurs on Amsterdam Island (Ref. 406), the species' migratory patterns and feeding habitats connect it to the broader ecological networks that involve Australian waters (Ref. 445).

No BIAs have been identified for this species in Australia.

4.3.4.3 Asian dowitcher

The Asian dowitcher (*Limnodromus semipalmatus*) is a large migratory shorebird found in tidal mudflats, estuaries, and coastal lagoons in WA during migration and non-breeding seasons (Ref. 446; Ref. 447). The species is a regular visitor to coastal areas between Broome and Port Hedland (Ref. 448; Ref. 449; Ref. 450) and the Port McArthur tidal wetlands in the Gulf of Carpentaria (Ref. 451).

The Asian dowitcher breeds in Siberia, Mongolia and north-east China, forming small colonies of 6-20 pairs. Clutch sizes typically consist of two eggs, occasionally three (Ref. 410). In Australia, Asian dowitchers are observed from August to April, with no recorded internal movements (Ref. 452). While predominantly found in northern Australia, occasional sightings occur in the NT, with rare records from southwest WA and the east coast (Ref. 452).

Asian dowitchers primarily feed on small fish, insect larvae, and oligochaetes during the breeding season and polychaetes, molluscs, and insect larvae while migrating or overwintering (Ref. 450; Ref. 453). Foraging, often synchronised with tidal cycles, occurs during low tides on exposed mudflats (Ref. 454). During the non-breeding season, they roost in sheltered coastal environments such as mudflats, lagoons, creeks, and saltworks (Ref. 410).

The *Conservation Advice for Asian dowitcher* (Ref. 410) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, genetic diversity, and recovery. However, no habitat critical to the survival of the species or BIAs have been identified in the PA.

4.3.4.4 Australian lesser noddy

The Australian lesser noddy (*Anous tenuirostris melanops*) is a small seabird primarily found along the coast of WA (Ref. 459). The species typically inhabits tropical and subtropical regions of the Indian Ocean (Ref. 413). In WA, the species is known to breed exclusively in the Houtman Abrolhos, nesting in mangroves (Ref. 413). The species is largely sedentary, with birds remaining near their breeding islands throughout the year (Ref. 452).

The lesser noddy feeds predominantly on small fish and invertebrates, which it catches through plunge diving or surface foraging (Ref. 460). Australian lesser noddy diet is influenced by the availability of prey in coastal waters, and while it typically stays near its breeding colonies, individuals may forage extensively offshore (Ref. 452).

A foraging BIA has been identified (Figure 4-11, Table 4-18) around a group of islands off the mainland coast, including Pelsaert Island, Abrolhos Island, and North Island. This BIA overlaps with the PA, specifically the West Coast section.

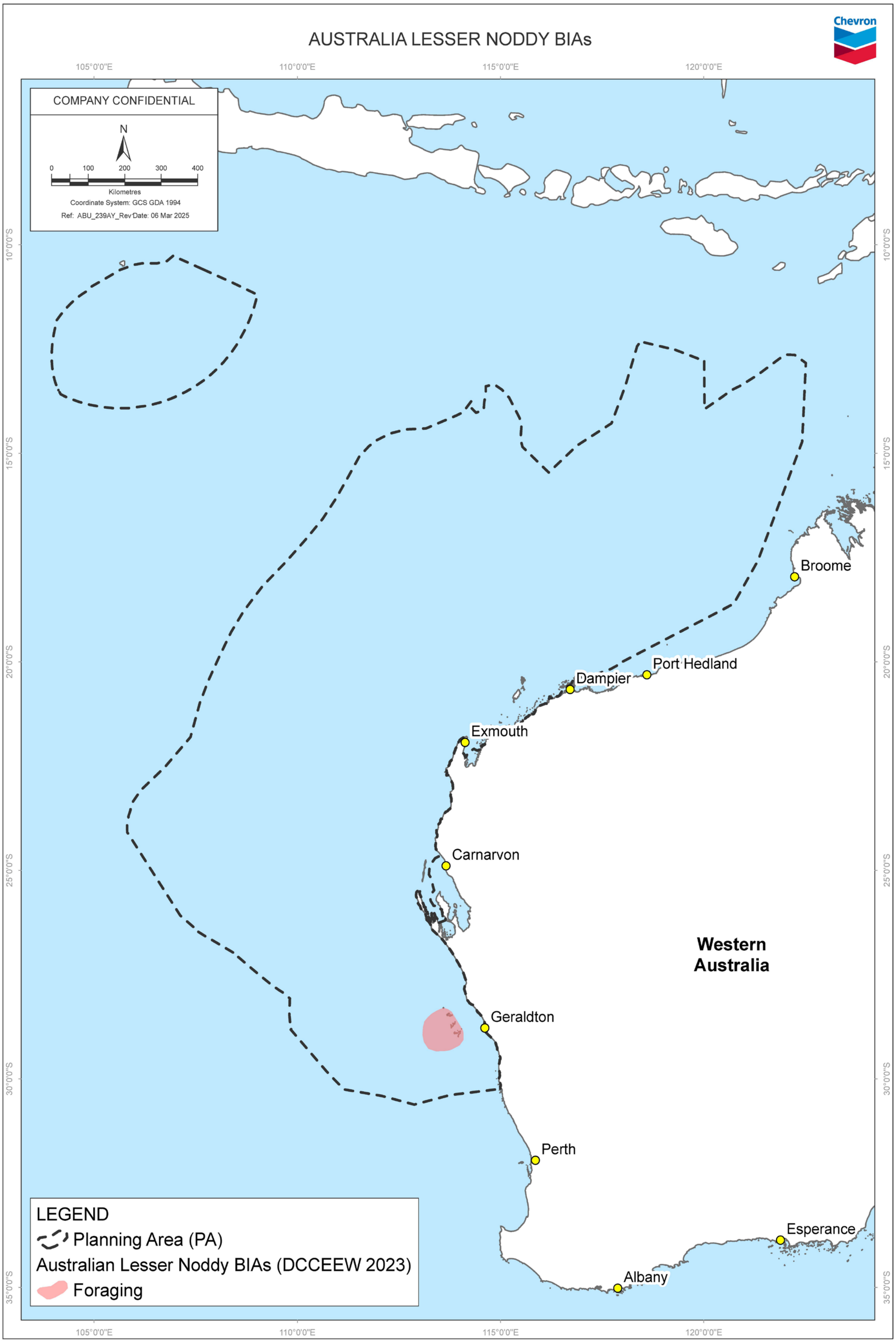

Figure 4-11: Biologically important areas for Australian lesser noddy

4.3.4.5 Australian painted snipe

The Australian painted snipe (*Rostratula australis*) is endemic to Australia and has been recorded in wetlands across all states and territories (Ref. 415; Ref. 461; Ref. 462). The species is most commonly found in eastern Australia, particularly in scattered locations throughout Queensland, NSW, Victoria, and southeastern SA. Less frequent records exist from western SA, the NT, and WA (Ref. 461; Ref. 462; Ref. 463). The species primarily inhabits shallow freshwater wetlands with dense emergent vegetation, such as grasses, reeds, and sedges, which provide concealment (Ref. 414; Ref. 415; Ref. 464).

Movement patterns are not well understood, but the species is thought to be dispersive or migratory (Ref. 465) but might be best described as nomadic, moving unpredictably in response to rainfall and wetland availability (Ref. 415). It often appears in areas recently inundated by flooding (Ref. 414).

The Australian painted snipe is primarily crepuscular, feeding during dawn and dusk. It forages in shallow water and soft mud, probing for insects, crustaceans, and seeds (Ref. 414; Ref. 463). While generally solitary, the birds may gather in small groups during foraging or breeding (Ref. 466).

Nests are typically located among tall tussocks on small, muddy islands or mounds surrounded by shallow freshwater, or on swamp shores and channel banks (Ref. 415). Breeding sites are often ephemeral wetlands with complex shorelines, featuring a mix of shallow water, exposed mud, and dense low cover (Ref. 463). Nesting occurs from December to May in northern Australia and from October to December in the south (Ref. 467)

No BIAs have been identified for this species in Australia.

4.3.4.6 Bar-tailed godwit

The bar-tailed godwit (*Limosa lapponica*) has been recorded in the coastal areas of all Australian states (Ref. 468). Two subspecies of the Bar-tailed Godwit are recognised, *L. l. menzbieri* that breeds in northern central Russia, and *L. l. baueri* that breeds in eastern Russia and Alaska (Ref. 446). The distribution of *L. l. baueri* in the non-breeding period is New Zealand and eastern Australia, while *L. l. menzbieri* occurs predominantly in the north of WA and south-eastern Asia (Ref. 446).

The bar-tailed godwits are primarily found in coastal habitats such as estuaries, intertidal mudflats, and sandy beaches, where they usually roosts (Ref. 468). They have been observed roosting at high tide on a claypan 2 km inland of Roebuck Bay, WA (Ref. 469). The birds do not seem to move between south-east and north-west Australia, with high fidelity to non-breeding sites apparent in both areas (Ref. 468).

The bar-tailed godwit is a long-distance migrant, typically visiting Australia from September to April. Godwits from north-west Australia typically depart early to mid-April and may fly non-stop to China (Ref. 470).

This species feeds by probing its long, slightly upturned bill into mud and sand, extracting marine invertebrates, including worms, bivalves, and crustaceans (Ref. 468). This feeding strategy is highly effective on exposed tidal flats, and feeding is often synchronised with tidal cycles (Ref. 468). Bar-tailed godwits are social birds, foraging and migrating in large flocks.

No BIAs have been identified for this species in Australia.

4.3.4.7 Black-browed albatross

The black-browed albatross (*Thalassarche melanophris*) is a seabird commonly found in subantarctic and Antarctic waters during the breeding season, with some individuals ranging as far south as 70ºS or north into temperate waters (Ref. 473). The species predominantly breeds on subantarctic islands, such as Heard Island and Macquarie Island (Ref. 473), both part of Australia's remote territories. Breeding occurs between September and December, after which fledglings and adults leave the breeding colonies (Ref. 474).

This species primarily forages on crustaceans, fish, squid, carrion, and fishery discards (Ref. 475). Known for its highly migratory behaviour, the black-browed albatross spends much of the year over open oceans, far from land, returning to breeding colonies for reproduction (Ref. 474; Ref. 475). The species undertakes long-distance foraging flights, using strong winds and thermals to glide efficiently over vast stretches of water.

During the breeding season, the albatross nests in colonies on cliffs or steep slopes (Ref. 474; Ref. 475). The nests, constructed as mounds of soil and vegetation, are reused annually (Ref. 474; Ref. 441).

From May to November, this species migrates to waters off the continental shelf (Ref. 474). Foraging BIAs for the black-browed albatross extend off the coast of SA, running eastward along the Australian coastline, encompassing Tasmania, and continuing north toward Queensland. The BIAs do not intersect with the PA.

4.3.4.8 Black-tailed godwit

The black-tailed godwit (*Limosa limosa*) is a migratory wader species with a large, discontinuous breeding range extending from Iceland to the Russian far east (Ref. 416). During the austral summer non-breeding season, black-tailed godwits are found across all Australian states and territories, with the highest densities occurring in coastal regions (Ref. 416).

Highly migratory, black-tailed godwits travel vast distances between breeding and wintering grounds. They nest solitarily during the breeding season in grasslands or wetlands but are typically observed in small to moderate-sized flocks in Australia (Ref. 416). These birds are known for their long-distance flight capabilities, migrating thousands of kilometres to reach their southern wintering grounds (Ref. 476).

The species' feeding habitats include mudflats, soft wet sand in intertidal zones, saltmarshes, and beaches along coastlines, bays, and estuaries (Ref. 453). While they forage across the tidal range, they often spend significant time feeding on upper tidal flats (Ref. 477). As opportunistic feeders, black-tailed godwits play a vital ecological role, primarily consuming invertebrates such as worms, molluscs, and small crustaceans by probing mud with their long, slender bills (Ref. 416).

The *Conservation Advice for black-tailed godwit* (Ref. 416) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, genetic diversity, and recovery. However, no habitat critical to the survival of the species or BIAs have been identified in the PA.

4.3.4.9 Blue petrel

The blue petrel (*Halobaena caerulea*) is a small seabird with a global distribution in the Southern Ocean (Ref. 478). These birds breed on remote islands, including Macquarie Island, and is typically observed in Australian waters during the non-breeding season (Ref. 417). Adults are generally sedentary, while younger birds are more dispersive (Ref. 479).

Blue petrels primarily feed on small crustaceans, fish, and squid, foraging near the ocean surface in cold, nutrient-rich waters, which provide productive feeding grounds (Ref. 479; Ref. 480).

Like most small petrels, they are nocturnal at their breeding sites and nest in burrows within large colonies. Blue petrels are monogamous, with both parents sharing incubation of the single egg and feeding the chick regurgitated food until fledging (Ref. 481).

No BIAs have been identified for this species in Australia.

4.3.4.10 Bridled tern

The bridled tern (*Onychoprion anaethetus*) is a medium-sized seabird found in tropical and subtropical regions (Ref. 408). This species is widespread in Australia, breeding on offshore islands in western, northern, and north-eastern regions. Its range extends from Cape Leeuwin in the south-west, around northern Australia, to north-eastern and mid-eastern Queensland, including the Great Barrier Reef and Coral Sea as far south as Lady Elliott Island (Ref. 482). During the breeding season, they show high site fidelity to natal colonies (Ref. 482).

In WA, a nearly all bridled terns return to breeding colonies between late September and mid-October, departing from early to mid-April. In some years, they leave as late as mid-May (Ref. 482). During the breeding season, they remain close to their nesting islands, foraging in nearby waters and breed in small to large colonies (hundreds to thousands of birds) (Ref. 483).

In WA, bridled terns breed on islands along the coast from Cape Leeuwin to the Pilbara and Kimberley regions. They nest in sheltered areas such as rock crevices, under vegetation, or beneath debris to protect against predators and harsh environmental conditions (Ref. 482; Ref. 484).

Bridled terns moving along the WA coast to search for food in oceanic waters, where they hunt for small fish, squid, and crustaceans (Ref. 484). Foraging often involves hovering and diving from a height to capture prey just below the water's surface (Ref. 482).

Breeding and foraging BIAs have been identified (Figure 4-12, Table 4-18) in Australia. In WA, foraging BIAs extend off the coast from Kalbarri to Esperance, intersecting with the southern section of the PA, specifically the West Coast section.

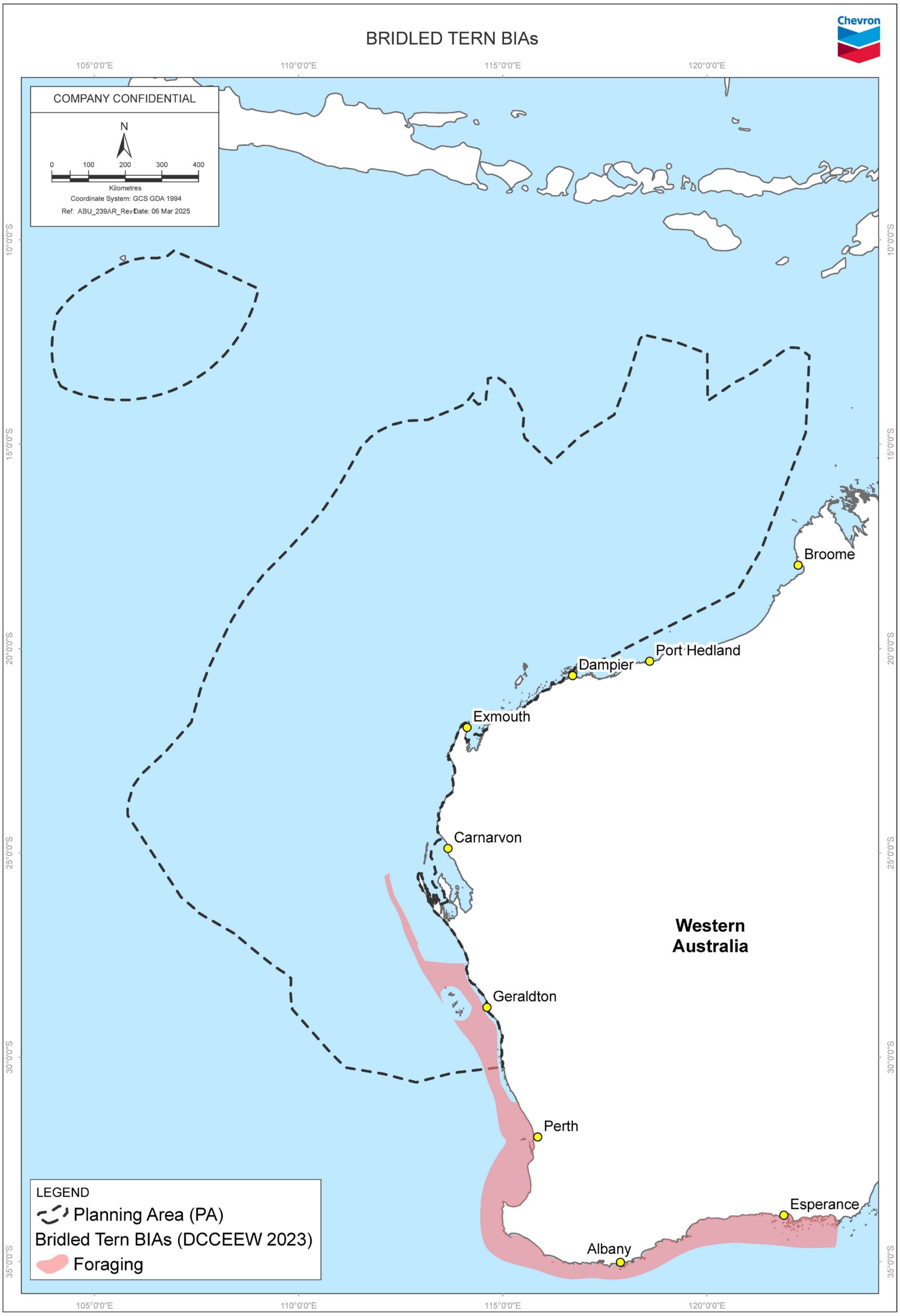

Figure 4-12: Biologically important areas for Bridled tern

4.3.4.11 Broad-billed sandpiper

The broad-billed sandpiper (*Limicola falcinellus*) is a migratory wader species that visits Australia occasionally, primarily during the austral summer. It breeds in the northern hemisphere and migrates south during the non-breeding season (Ref. 485). In WA, the species is mainly found along the coasts of the Pilbara and Kimberley regions, from Onslow to Broome, with additional sightings near the mouth of the Lawley River and inland at Lake Daley (Ref. 485).

This sandpiper forages on a variety of invertebrates, including marine nereid worms, small bivalves, snails, crustaceans (e.g. amphipods), and both adult and larval insects (Ref. 486). The broad-billed sandpiper prefers sheltered coastal habitats, such as estuarine mudflats, but it can also be found in saltmarshes, shallow freshwater lagoons, saltworks, and sewage farms. Areas with extensive soft intertidal mudflats, often accompanied by nearby shell or sandbanks, are ideal. Occasionally, the species is observed on reefs or rocky platforms (Ref. 485).

In Australia, the broad-billed sandpiper is typically seen in small flocks during migration or in suitable feeding habitats. In north-western Australia, very few adults arrive during August and early September (Ref. 485). By late October, both adults and first-year birds are present. Peak numbers occur in March and April, with most birds departing around mid-April (Ref. 485).

No BIAs have been identified for this species in Australia.

4.3.4.12 Brown booby

The brown booby (*Sula leucogaster*) is a seabird commonly found across all tropical oceans (Ref. 487). In Australia, the brown booby is found from Bedout Island in WA, along the coasts of the NT to the Bunker Group of islands in Queensland, with occasional sights further south in NSW and Victoria (Ref. 441). Brown boobies inhabit coastal islands, rocky outcrops, and cliff faces, where they nest in colonies, but they are also frequently seen in open ocean areas, spending much of their time flying or diving for prey (Ref. 441; Ref. 488).

This marine species primarily feeds in inshore waters. Its diet consists mainly of flying fish and squid, with additional prey such as halfbeak, mullet, and anchovy (Ref. 408). Brown boobies hunt by diving from great heights into the water, often at remarkable speeds (Ref. 489).

They are social birds, often gathering in large groups, especially during the breeding season (Ref. 489). While breeding is seasonal in some regions, in others, it occurs opportunistically or continuously. Nests are built on the ground, typically in vegetation on rocky islands or coral atolls. Colonies tend to be smaller than those of other *Sula* species (Ref. 479.)

Breeding and foraging BIAs for this species have been identified (Figure 4-13, Table 4-18) around Australia's northern coastline, ranging from northern WA to Queensland. Breeding BIAs overlap with the PA, particularly in the Pilbara and Kimberley sections.

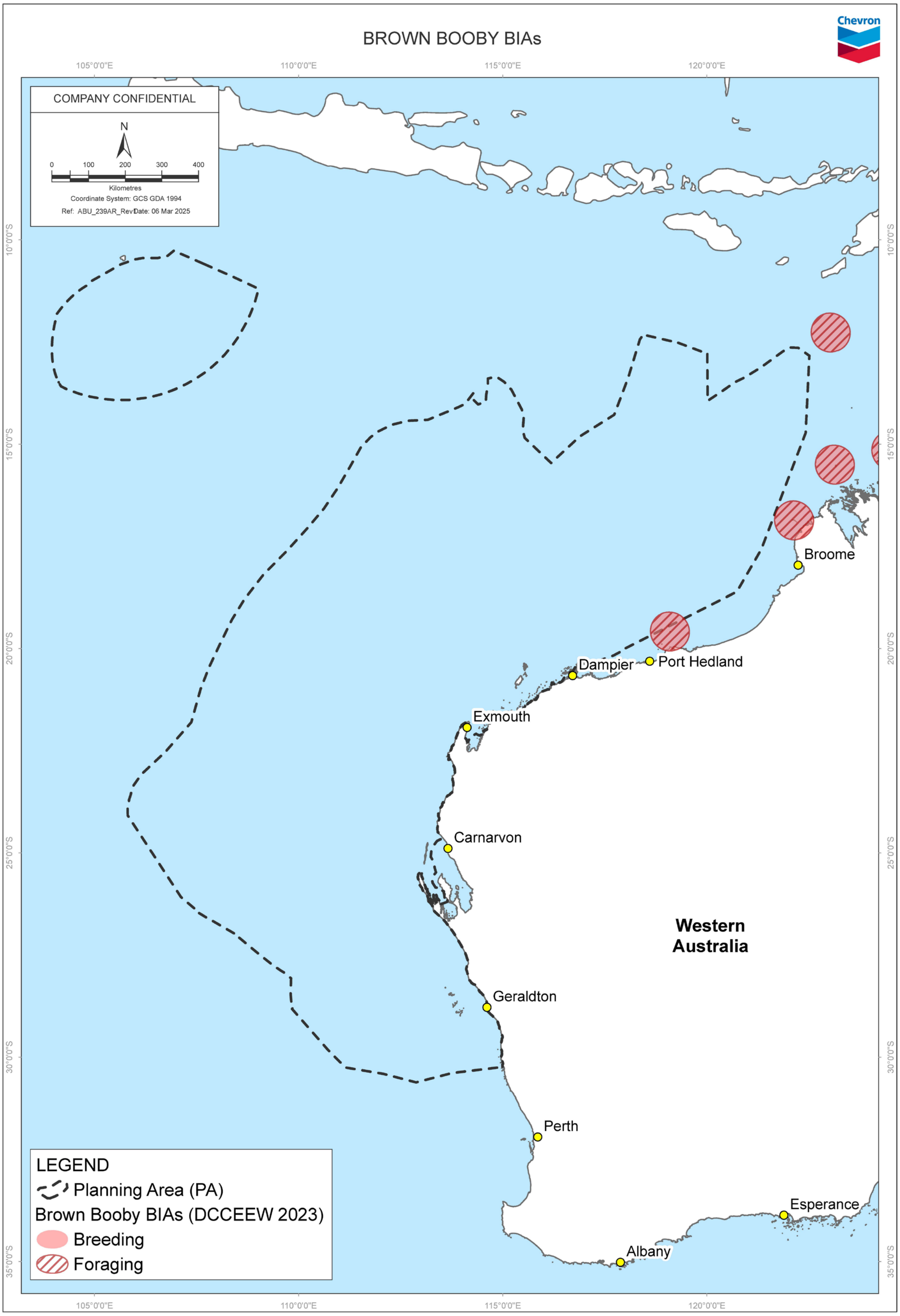

Figure 4-13: Biologically important areas for brown booby

4.3.4.13 Campbell albatross

The Campbell albatross (*Thalassarche impavida*) is a medium sized albatross, identified by its black brow, bright yellow-orange bill, and broad black leading edge on the underwing (Ref. 490). Although it breeds on Campbell Island, south of New Zealand, where it exhibits strong site fidelity, Australia lies within its foraging range (Ref. 406).

Campbell albatrosses are primarily pelagic, spending most of their lives in open oceanic waters. Their diet consists mainly of krill and fish, with occasional consumption of cephalopods, salps, and jellyfish (Ref. 490). They are enthusiastic scavengers, often following fishing boats (Ref. 441; Ref. 491) and foraging alongside other seabirds, such as albatrosses and petrels (family Diomedeidae) (Ref. 490).

In Australian waters, Campbell albatrosses are commonly found over the oceanic continental slopes off Tasmania, Victoria, and NSW (Ref. 490). This migratory species moves from its breeding colonies to the continental shelf waters of Australia and New Zealand (Ref. 490). Adults and fledglings leave the breeding grounds on Campbell Island by mid-April, with breeding birds returning between late August and early September. Non-breeding immatures and adults disperse throughout the South Pacific and across southern Australian waters (Ref. 441).

Foraging BIAs for this species have been identified in the South-east Marine Region, including Macquaire Island. These BIAs are outside of the PA.

4.3.4.14 Caspian tern

The Caspian tern (*Hydroprogne caspia*), the largest tern species in Australia, is a widespread and powerful seabird known for its distinctive large size, thick red-orange bill, and striking black cap (Ref. 492). It is found globally and commonly inhabits both coastal and inland waters throughout Australia (Ref. 452).

In WA, the Caspian tern occupies diverse habitats, ranging from the Great Australian Bight to the Dampier Peninsula. Sparse records exist east of King Sound and in inland regions. Breeding occurs from the Recherche Archipelago to Dirk Hartog Island and Faure Island in Shark Bay, as well as in the Pilbara region from Point Cloates to North Turtle Island. Rare breeding events have also been recorded in the Kimberley (Ref. 452).

This species is an opportunistic forager, thriving in both freshwater and marine environments due to its adaptability to varying salinity levels. Its diet consists primarily of fish, which it captures by hovering over water and performing high, plunging dives to snatch prey near the surface (Ref. 452).

The Caspian tern is a year-round resident at many breeding sites in Australia, with some locations supporting year-round or protracted breeding activity. At non-breeding sites, seasonal patterns suggest migratory passage (Ref. 492).

During the breeding season, Caspian terns form small colonies and are gregarious, though they prefer solitary foraging, unlike other tern species (Ref. 492; Ref. 452). Nests are shallow scrapes situated on sandy or gravel islands, with females typically laying one to three eggs per clutch (Ref. 452; Ref. 453).

Foraging BIAs for this species have been identified (Figure 4-14, Table 4-18) in WA within the SWMR, spanning from Kalbarri to Esperance, and around Port

Lincoln, SA. These BIAs overlap with the southern section of the PA, the West Coast section.

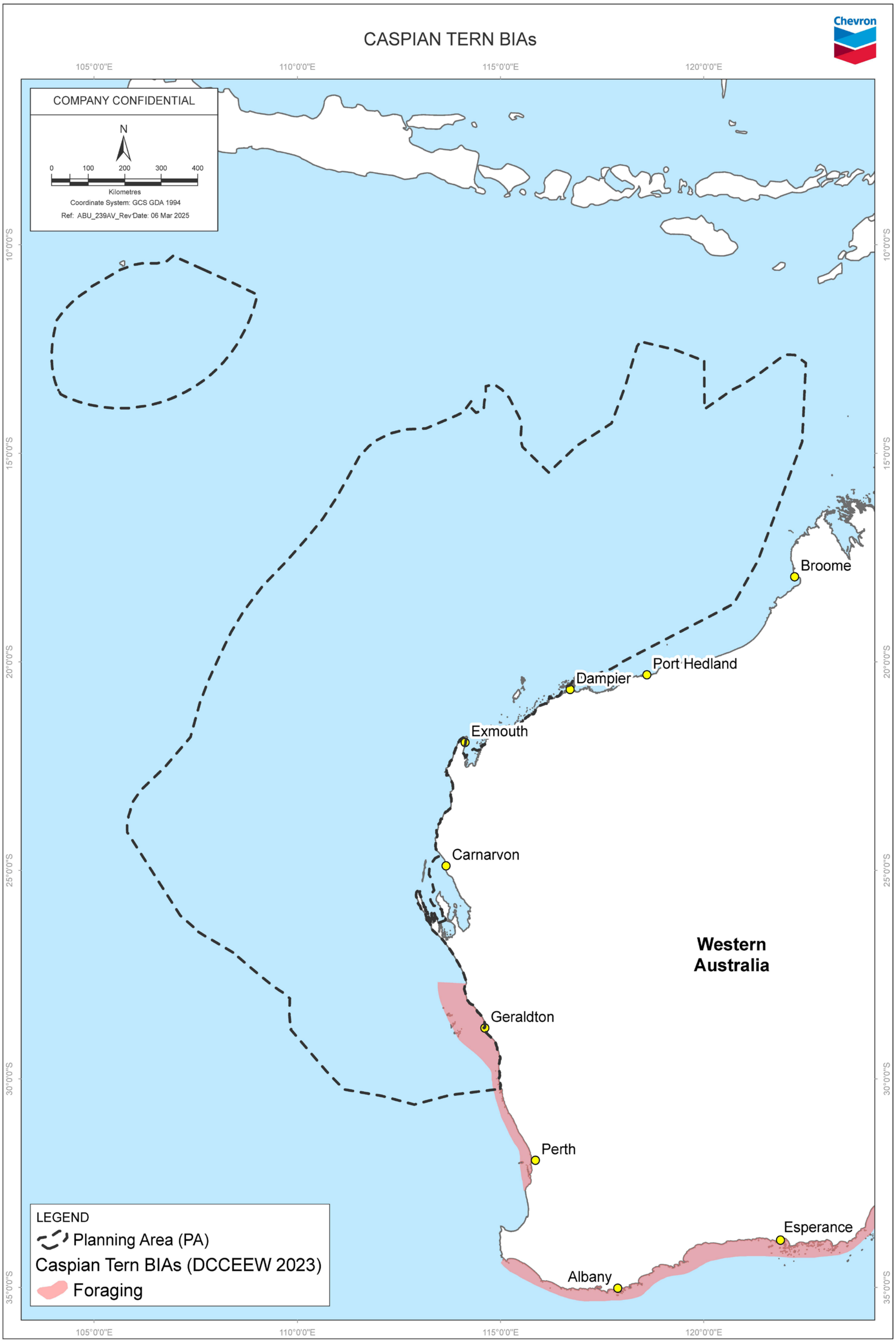

Figure 4-14: Biologically important areas for Caspian tern

4.3.4.15 Christmas Island frigatebird

The Christmas Island frigatebird (*Fregata andrewsi*), is a seabird endemic to Christmas Island, where it exclusively breeds (Ref. 493). Although breeding is restricted to Christmas Island, from January to September, the species forages and roosts widely across Southeast Asia and the Indian Ocean (Ref. 441).

During early chick-rearing, females primarily forage in the waters surrounding Christmas Island. As chicks grow, both sexes undertake longer and more distant foraging trips, including to the coastal waters off Java (Ref. 494). The Christmas Island frigatebird is an adept aerial predator, feeding by scooping marine organisms or offal from the water's surface and exhibiting kleptoparasitic behavior by harassing other seabirds to force them to regurgitate their meals. Their primary diet includes flying fish and squid (Ref. 495). Occasionally, they forage on land, consuming carrion, offal from beaches, and even stealing eggs and nestlings (Ref. 419).

Breeding occurs in forested colonies on Christmas Island's terraces. Smaller nesting clusters have also been observed in the Settlement and at Smith Point on the foot slopes of inland cliffs (Ref. 418). Females lay a single egg between mid-February and early June. Both parents share incubation duties, which last ~50 days (Ref. 418).

The *Conservation Advice for the Christmas Island Frigatebird* (Ref. 418) identifies *a*ll nesting and roosting areas, in known colonies and smaller groups of nests away from the colonies, are critical to the survival of the species. While the PA overlaps Christmas Island, no habitat critical to the species' survival is expected to occur within the PA. Furthermore, no BIAs have been identified for this species in Australia.

4.3.4.16 Christmas Island white-tailed tropicbird

The Christmas Island white-tailed tropicbird (*Phaethon lepturus fulvus*) is a seabird endemic to Christmas Island, Australia, which is its only known breeding location (Ref. 420). This subspecies is widely distributed across the island, roosting and foraging over the Indian Ocean (Ref. 420; Ref. 496). While it primarily occurs north of 18°S, it has been recorded up to 1,500 km from Christmas Island, including near the continental shelf off WA at 21°S (Ref. 497; Ref. 498).

The species nests in deep, shaded hollows or crevices and utilises a variety of sites, including rainforest tree hollows, rock crevices, cliffs, and quarries (Ref. 420; Ref. 498). Potential nesting sites are abundant, and breeding occurs across most parts of Christmas Island. In both interspecific and intraspecific competition, multiple pairs often use the same nest cavities (Ref. 497). Outside the breeding season, this tropicbird roams the open ocean, foraging over vast distances (Ref. 496).

The Christmas Island white-tailed tropicbird is primarily piscivorous, feeding on flying fish and squid. It captures prey with precision through high-diving strikes, aided by its strong, pointed beak and powerful diving muscles (Ref. 420). Aerial displays and tail streamers are prominent during courtship, serving as communication and mating signals. Chicks are fed a regurgitated mix of fish and squid until fledging (Ref. 496).

The *Conservation Advice for the Christmas Island white-tailed tropicbird* (Ref. 420) identifies all areas on Christmas Island, including surrounding inshore waters, as habitat of primary importance for the species. No BIAs have been identified for this subspecies in Australia.

4.3.4.17 Common greenshank

The common greenshank (*Tringa nebularia*) is a widely distributed shorebird found across Europe, Africa, Asia, Melanesia, and Australasia (Ref. 499). Its breeding range extends from the northern British Isles and Scandinavia to eastern Russia (Ref. 441). Although it does not breed in Australia, this species occupies various wetland habitats and has the broadest distribution of any shorebird in the country (Ref. 452). In WA, it occurs along much of the coast, from Cape Arid in the south to Carnarvon in the northwest, and is also recorded in the southwest and northeast Kimberley, with isolated sightings in the Bonaparte Archipelago (Ref. 452).

During migration, common greenshanks typically arrive in Australia in August, passing mainly through WA and the Torres Strait. They begin moving southward in WA from November onwards, with numbers increasing at coastal and inland sites during August and September (Ref. 421; Ref. 500). During the austral summer, individuals are found as far south as south-east Tasmania (Ref. 452). Northward migration occurs from March, peaking in April, when numbers decline across Australia (Ref. 421). Most individuals exhibit limited movement within Australia during the non-breeding season, though some dispersive movements may occur (Ref. 452).

Common greenshanks are carnivorous, foraging in shallow waters where they probe the mud or sand with their bills to capture invertebrates, small fish, and crustaceans (Ref. 421). They favour habitats with soft substrates, which allow easier access to prey.

The *Conservation Advice for common greenshank* (Ref. 421) defines habitats critical to the survival of the species as those essential for foraging, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA. No BIAs have been identified for this species in Australia.

4.3.4.18 Common noddy

The common noddy (*Anous stolidus*) is widespread in tropical and subtropical seas and land masses (Ref. 501). In WA, it is typically found off the northwest and central coast (Ref. 501).

During the breeding season, common noddies inhabit islands, rocky islets, and stacks with cliffs, as well as coral or sand shoals and cays. They nest in a variety of habitats, including bushes, saltbush, or other low vegetation, and on the ground among pigface, grass, bare rock, or coral rubble. Nests are also built in tall trees, coconut palms, dead timber, and tree stumps (Ref. 501). When not nesting, individuals remain near their breeding sites, foraging in surrounding waters. Breeding seasonality varies greatly by location, with some populations breeding annually, others breeding twice a year (spring to early summer and autumn), and some breeding year-round (Ref. 501).

This highly pelagic species migrates extensively during breeding. Birds from the Houtman Abrolhos Islands, their primary breeding ground in the Eastern Indian Ocean, migrate up to 950 km north into the NWMR (Ref. 502). Smaller breeding populations occur on offshore islands throughout the NWMR (Ref. 503).

Common noddies are social birds, often seen flying in flocks with graceful and agile flight patterns (Ref. 452). They primarily forage for fish, squid, and crustaceans by diving or skimming the water's surface. They are also frequently observed feeding on fish scraps near fishing boats (Ref. 452).

Breeding and foraging BIAs have been identified (Figure 4-15, Table 4-18) for this species along the east and west coasts of Australia. In WA, only foraging BIAs have been identified, specifically around Lancelin Island (off Perth) and the Houtman Abrolhos Islands (off Geraldton), which overlaps with the southern extend of the PA.

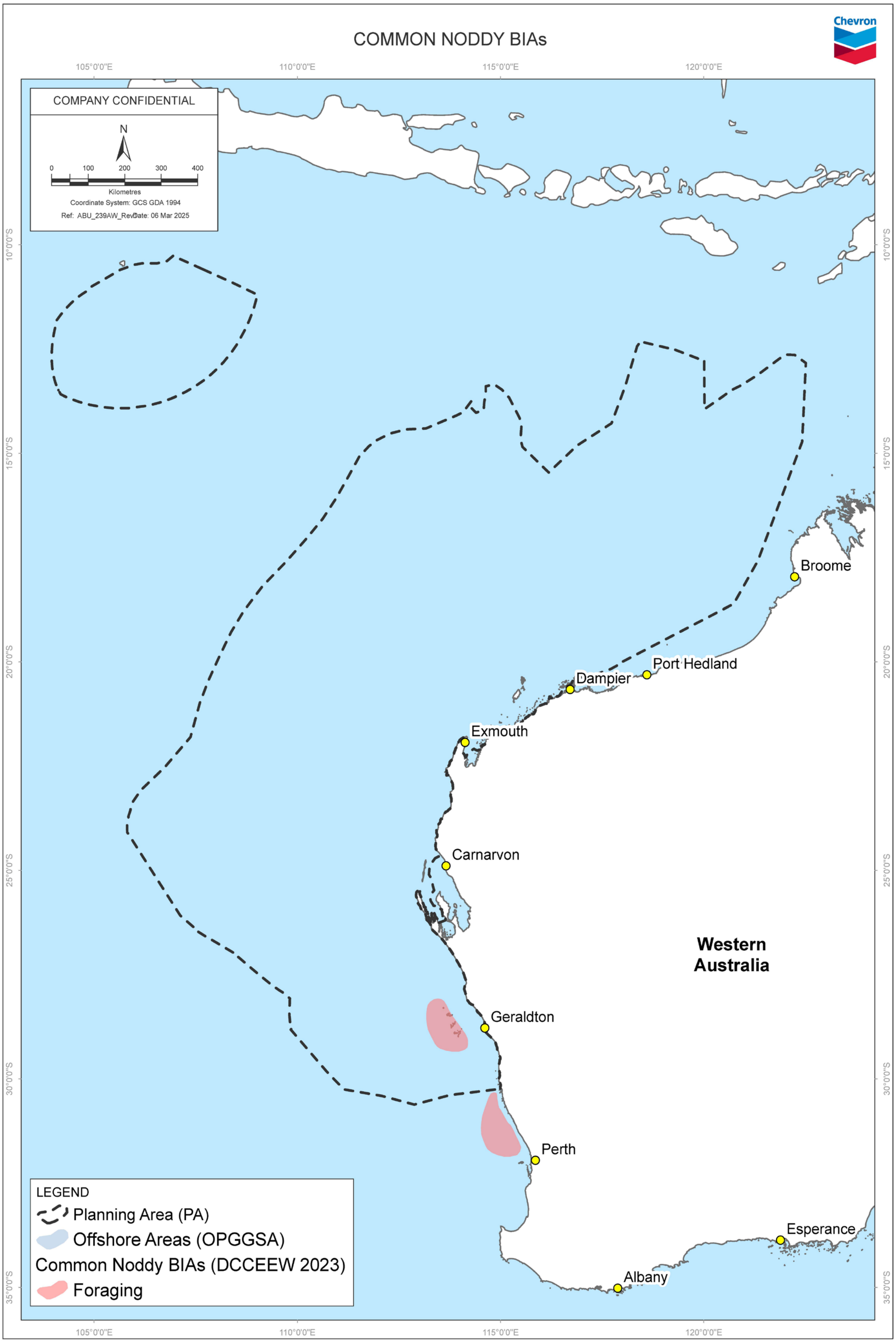

Figure 4-15: Biologically important areas for common noddy

4.3.4.19 Common redshank

The common redshank (*Tringa totanus*) migrates to Australia from northern Europe and Asia, where it occupies coastal mudflats, tidal wetlands, salt marshes, and estuarine areas during the non-breeding season (Ref. 504). In WA, the species is a vagrant in the southwest, with records from Peel Inlet, Coodanup, the Gascoyne region, Coral Bay, and Carnarvon (Ref. 452). It is regular and widespread in the northwest, from the Dampier Saltfields to Roebuck Bay and Broome, with an additional record from Ashmore Reef (Ref. 504).

The common redshank feeds in shallow water, wet bare mud or sand, algal deposits, and areas near rocks or samphire (Ref. 452). This species is carnivorous, consuming worms, molluscs, crustaceans, spiders, and insects, as well as fish and tadpoles. It is active during both day and night, locating prey visually by day and through touch at night (Ref. 452). Roosting occurs on small elevated areas, such as estuarine sandbars and muddy islets surrounded by water (Ref. 452).

Common redshanks are usually seen in small groups or alone, particularly in Australian coastal areas. They are highly vocal, often emitting sharp calls when agitated or threatened (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.20 Common sandpiper

The common sandpiper (*Actitis hypoleucos*) is a small shorebird with a wide distribution, including the British Isles, western and central continental Europe (Ref. 505). In Australia, it is found along all coastlines and in many inland areas, though typically in small numbers (Ref. 505).

This species primarily breeds in parts of Europe and Asia, with occasional breeding in Africa (Ref. 452). The population migrating to Australia breeds in the Russian far east (Ref. 505).

The species inhabits a variety of coastal and inland wetlands with varying salinity levels. It is most often seen around muddy margins or rocky shores and rarely on expansive mudflats (Ref. 505). Foraging occurs in shallow water or on soft mud at the edges of wetlands, often near obstacles such as rocks or mangrove roots. Birds may also venture into grassy areas adjacent to wetlands (Ref. 452).

Roost sites are typically on rocks or in roots or branches of vegetation, especially mangroves. The species is known to perch on posts, jetties, moored boats and other artificial structures, and to sometimes rest on mud or 'loaf' on rocks (Ref. 505).

The common sandpiper primarily feeds on invertebrates, including insects, molluscs, and small crustaceans, using quick, flicking movements to probe the mud or sand. Its adaptability allows it to occupy both inland and coastal habitats, particularly during migration (Ref. 505; Ref. 506).

No BIAs have been identified for this species in Australia.

4.3.4.21 Curlew sandpiper

The curlew sandpiper (*Calidris ferruginea*) is widely distributed along the Australian coast and in some inland areas. In WA, they are commonly observed in coastal and sub-coastal plains from Cape Arid to the southwest Kimberley (Ref. 507). This species does not breed in Australia.

Curlew sandpipers breed in the high Arctic regions of Siberia and migrate south to spend the non-breeding season in Australia and other parts of the Southern Hemisphere. WA serves as an important stopover during their long migratory journey, with significant populations utilizing the region's productive coastal wetlands (Ref. 508).

These birds migrate in flocks, often flying at night to minimize predation risk and take advantage of favourable wind conditions (Ref. 422). They forage on mudflats and shallow waters and typically roost on bare, dry shingle, shell, or sandy beaches, as well as on sandspits and islets in coastal lagoons or wetlands. Occasionally, they forage on wet mats of algae or waterweed, or among banks of beach-cast seagrass or seaweed. At high tide, curlew sandpipers are often found foraging in low, sparse vegetation such as saltmarshes or within flooded paddocks and inundated saltflats (Ref. 452).

Their diet consists primarily of small invertebrates, including molluscs, crustaceans, and polychaete worms, which they extract from mud and sand using their long, slender bills (Ref. 509).

The *Conservation Advice for curlew sandpiper* (Ref. 422) defines habitats critical to the survival of the species as those essential for foraging, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.22 Eastern curlew

The Eastern curlew (*Numenius madagascariensis*) is the largest species of curlew and is endemic to the East Asian–Australasian Flyway. It breeds in Siberia, far eastern Russia (Ref. 423; Ref. 510) and northeastern China (Ref. 510). During the austral summer non-breeding season, most of the global population migrates to Australia (Ref. 446; Ref. 511). In Australia, the species has a predominantly coastal distribution and is rarely observed inland. In WA, its range extends continuously from Barrow Island and the Dampier Archipelago through the Kimberley region and into the NT (Ref. 423).

Eastern Curlews begin arriving in northwest and eastern Australia as early as July (Ref. 500). The peak arrival in north-west Australia occurs in mid-August (Ref. 512), with onward dispersal to the rest of Australia by October (Ref. 500). Most birds depart Australia between late February and April (Ref. 452).

During the non-breeding season, Eastern Curlews rely on a network of suitable habitats, including freshwater lake shores and various wetlands. For example, at Roebuck Bay, WA, they have been observed flying from tidal flats to roosting sites 5 km inland on a claypan (Ref. 423). Their preferred foraging habitats are sheltered intertidal sandflats or mudflats, which are open and largely devoid of vegetation or seagrass. They also forage near mangroves, on saltflats, saltmarshes, rockpools, coral rubble, and occasionally along ocean beaches near the tideline (Ref. 423).

The Eastern Curlew primarily feeds on crustaceans, including crabs, shrimps, and prawns, but occasionally consumes small molluscs and insects (Ref. 452). Its long legs are well-suited for wading in shallow waters, while its elongated, down-curved bill allows it to probe deep into mud for prey (Ref. 509).

The *Conservation Advice for eastern curlew* (Ref. 423) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.23 Flesh-footed shearwater

The flesh-footed shearwater (*Ardenna carneipes*) is widely distributed across the southern Indian and southwestern Pacific Oceans. This species primarily breeds on subantarctic islands and migrates to the warmer waters of the Southern Hemisphere (Ref. 513). The flesh-footed shearwater is a locally common visitor to waters of the continental shelf and continental slope off southern Australia, including south-western WA (Ref. 513).

Breeding usually occurs from late September to early January in southwestern WA, with eggs laid in burrows (Ref. 513). The species nests on offshore islands and cliffs, favouring sandy or gravelly substrates for burrow excavation. Major breeding sites include islands such as the Houtman Abrolhos (off Geraldton) and the Recherche Archipelago (off Esperance) (Ref. 514).

The flesh-footed shearwater primarily feeds on fish, squid, and crustaceans, which it captures by foraging on the water’s surface or diving (Ref. 424).

Aggregation, breeding, and foraging BIAs have been identified for this species along the east and southwest coasts of Australia. In WA, an aggregation BIA is located around the Perth Canyon, and a foraging BIA extends from Cape Naturaliste to Nuytsland Nature Reserve in southern WA. No BIAs have been identified in the PA.

4.3.4.24 Fairy tern

The fairy tern (*Sternula nereis*) is a small seabird found along Australia's southern and eastern coasts, primarily inhabiting sandy beaches, estuaries, and offshore islands. It nests in colonies on bare sand or shingle, often near tidal zones and freshwater sources, where it forages for small fish and invertebrates (Ref. 441).

Fairy terns dive from the air to capture prey, often hovering over the water before plunging. They are opportunistic feeders, targeting schools of small fish or foraging in areas with abundant planktonic organisms (Ref. 441).

The species is adapted for aerial foraging, with lightweight wings for quick, agile flights (Ref. 452). These birds are also well-suited to breeding in hot, exposed environments, with plumage offering some protection against the harsh sun. However, they are vulnerable to heat stress during extreme weather events, particularly in summer (Ref. 452).

Outside the breeding season, fairy terns are more solitary and migrate to other coastal areas in search of better foraging conditions (Ref. 441).

4.3.4.24.1 Australian fairy tern

The fairy tern (species name) has a large geographic range between Australia, New Zealand and New Caledonia, with three subspecies identified based on phenotypic, genotypic and geographic differences (Ref. 412). The Australian fairy tern occurs in coastal southern Australia, from the Montebello Islands in the Pilbara, WA, to Botany Bay, NSW, including Tasmania (Ref. 412). The Great Australian Bight forms a distribution gap between western and eastern populations (Ref. 452).

Australian fairy tern has been found in embayments of a variety of habitats including offshore, estuarine, or lacustrine (lake) islands, wetlands and mainland coastline (Ref. 411). They nest above the high-water mark, typically in sandy areas with sparse vegetation, often in clear view of the water. Nests are shallow scrapes in the sand lined with small shells and vegetation (Ref. 411).

In WA, two subpopulations have been identified (Ref. 412):

- a sedentary subpopulation based along the Pilbara and upper Gascoyne coasts from Exmouth Gulf to the Dampier Archipelago, including Barrow, Montebello, and Lowendal Archipelagos; these Australian Fairy Terns nest from late July to late-September
- a migratory subpopulation that disperses south along the coast from Shark Bay to breed between the Houtman Abrolhos Islands to the Recherche Archipelago between September and May, with active breeding flocks appearing at various locations between October and February.

Australian fairy terns are present on Barrow Island year-round, predominantly on the southeast and southwest coasts, with peak counts recorded between November and April (Ref. 455). Nesting has been observed on offshore islands between Barrow and the Montebello Islands (Ref. 456), including intermittently nesting on North and/or South Double Island (Ref. 455).

These terns are diurnal plunge-diving feeders that prey exclusively on small (<60 mm) surface-schooling baitfish, such as sprats, hardyheads, and larvae of some demersal fish species (Ref. 452). Their foraging occurs in nearshore waters adjacent to nesting colonies and around island archipelagos (Ref. 452).

In WA, colony formation and egg-laying are closely tied to food availability, with colonies typically forming near areas of high prey abundance (Ref. 457). While colonies may remain in the same general area for several seasons, they occasionally shift locations (Ref. 458).

Behaviours used to define BIAs for seabirds in Commonwealth marine areas include breeding with a foraging buffer, and roosting (Ref. 408). BIAs for seabird species are buffers around islands that the species is known to nest on as they may forage in the waters surrounding the islands during nesting seasons.

Breeding and foraging BIAs have been identified (Figure 4-16, Table 4-18) along the south and southwest coasts of Australia. In WA, breeding BIAs are located in the NWMR, and foraging BIAs are found in the SWMR. These BIAs overlap the PA.

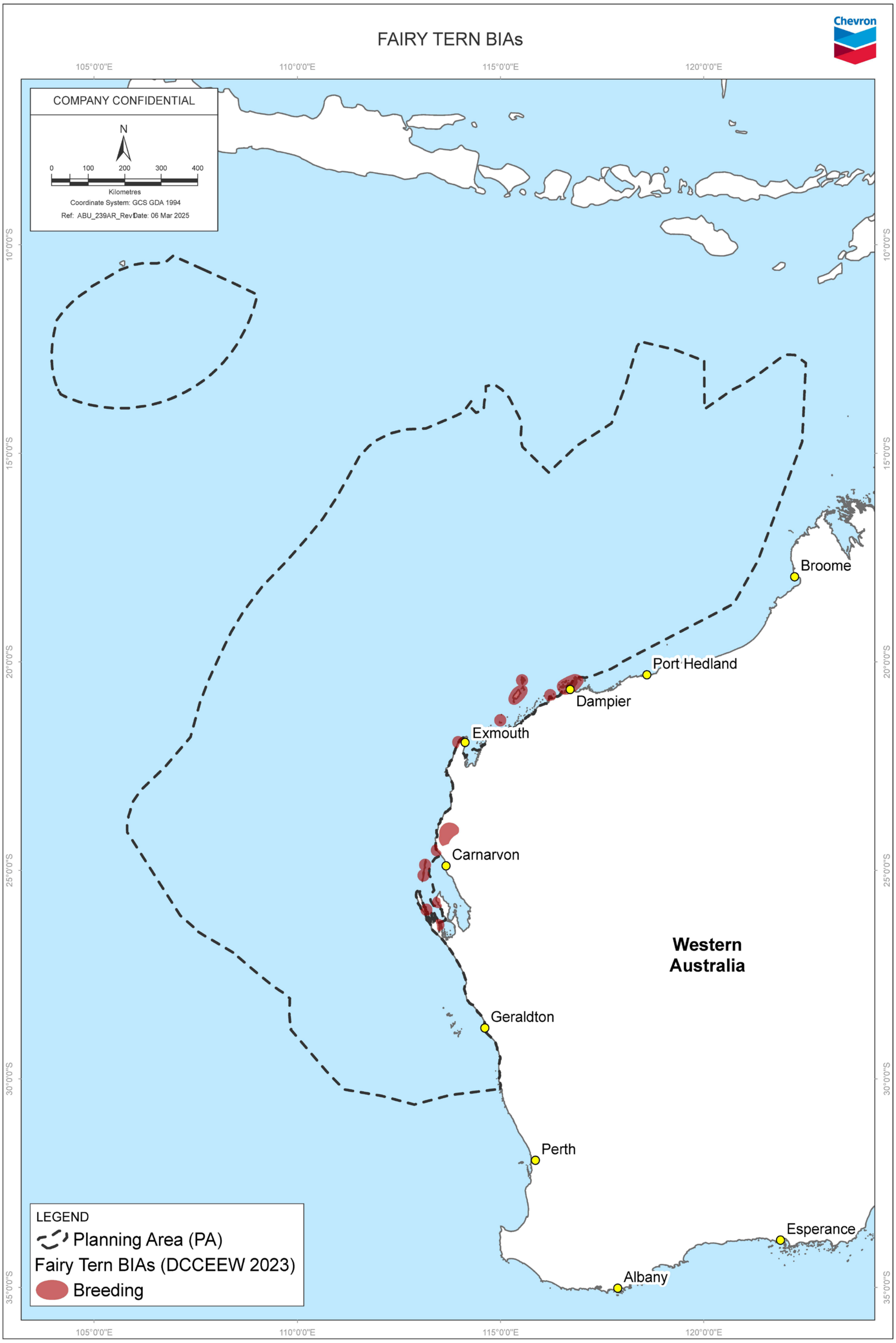

Figure 4-16: Biologically important areas for Australian fairy tern

4.3.4.25 Fork-tailed swift

The fork-tailed swift (*Apus pacificus*) is a migratory bird and a non-breeding visitor to all states and territories of Australia. In WA, it is widespread in coastal and subcoastal areas between Augusta and Carnarvon, including nearshore and offshore islands (Ref. 515). They are also found along the coast from the south-west Pilbara to the north and east Kimberley regions near Wyndham. Inland sightings are sparse, with records from areas such as the Wheatbelt, Lake Annean, and Wittenoom, as well as parts of the Gascoyne, Pilbara, and Kimberley regions (Ref. 515).

Fork-tailed swifts forage at heights ranging from 1 to 300 m above the ground, typically in flocks of 10 to 1,000 birds, feeding primarily on flying insects (Ref. 515; Ref. 516). They migrate seasonally, arriving in Australia around October, with rare early arrivals in September. Birds are commonly sighted in WA arriving from Indonesia between October and November (Ref. 515). In Broome, peak numbers occur in February, while in the Kimberley, Pilbara, and Eucla regions, they are present from September to late April. Most birds leave south-east WA by mid-April and depart from north and north-west WA by the end of April (Ref. 515).

During the breeding season, fork-tailed swifts nest in small colonies, often on cliff ledges or under building eaves, constructing nests from saliva and plant material (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.26 Great frigatebird

The great frigatebird (*Fregata minor*) is primarily found in tropical and subtropical regions. In WA, it inhabits coastal areas, islands, lagoons, and coral reefs, including the Rowley Shoals and Montebello Islands (Ref. 516). This species prefers open ocean and coastal waters for foraging, feeding mainly on fish, squid, and chicks (Ref. 408; Ref. 517), which it catches by soaring and diving. It also exhibits kleptoparasitism, stealing food from other seabirds (Ref. 517).

Major breeding populations are located in tropical waters of the Pacific and Indian Oceans. The great frigatebird breeds on small, remote tropical and subtropical islands, often in mangroves, bushes, or occasionally on bare ground (Ref. 479). Within the NWMR, it breeds in small numbers on Ashmore Reef. Although pelagic, breeding birds typically forage within 100–200 km of their colony during the early stages of the breeding season (Ref. 519).

Highly social, great frigatebirds are often seen in large flocks and are renowned for their exceptional flying abilities (Ref. 518).

Breeding and foraging BIAs have been identified (Figure 4-17, Table 4-18) for this species in northern Australia. In WA, breeding areas have been identified around Kimberley and Ashmore Reef, overlapping the northern part of the PA, particularly the Kimberley section.

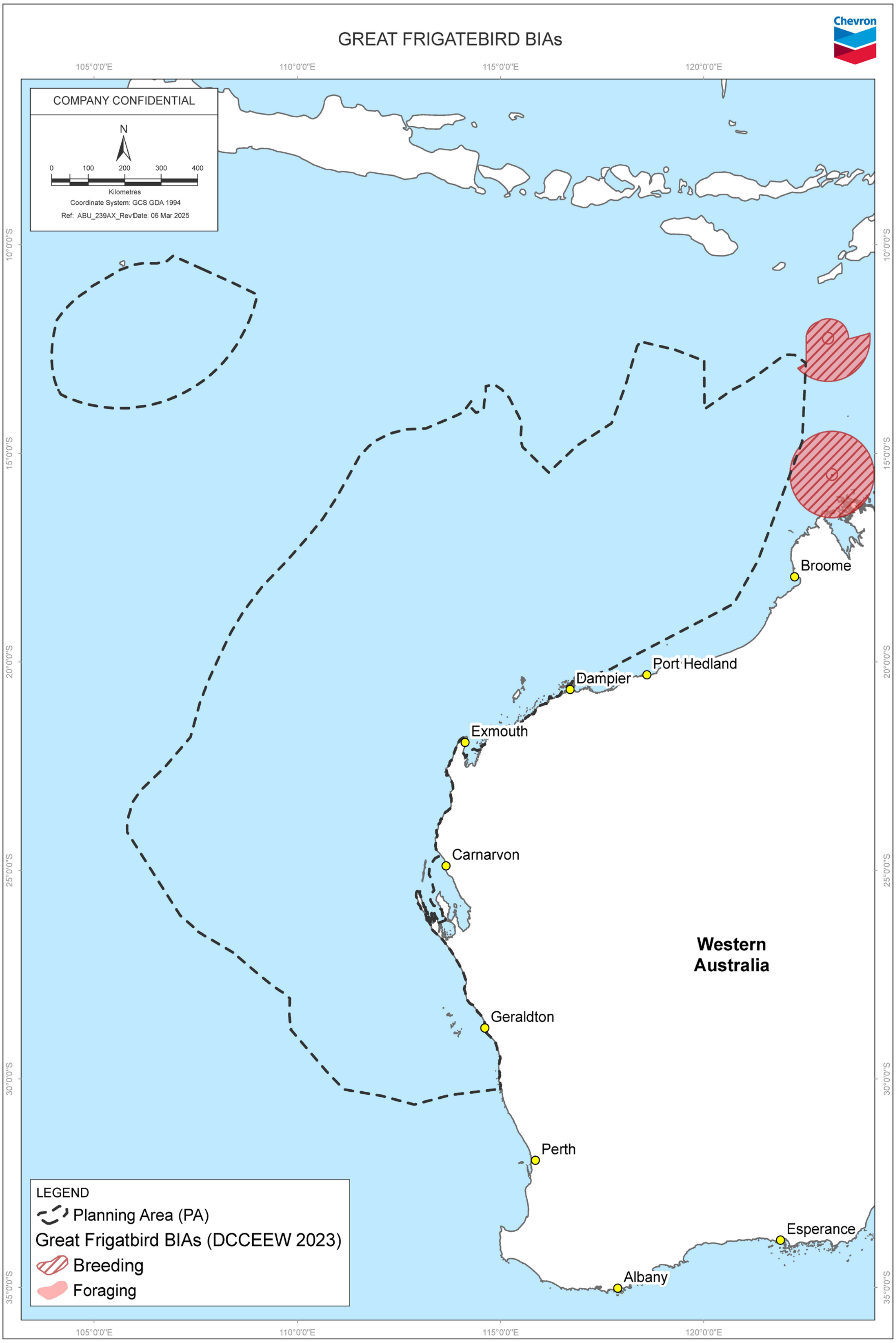

Figure 4-17: Biologically important areas for great frigatebird

4.3.4.27 Great knot

The Great Knot (*Calidris tenuirostris*) is a medium-sized migratory shorebird confined to the East Asian–Australasian Flyway, visiting Australia during its non-breeding season (Ref. 519). The largest populations in Australia are found in northern regions, including the Pilbara and Kimberley coasts of WA (Ref. 425), Birds typically arrive in late August to early September, with juveniles and many males arriving later, around October-November (Ref. 520). Most individuals remain near their arrival sites throughout the non-breeding season, with a few making single-flight movements to southern Australia (Ref. 425). They leave Australia via the northern coast in March-April (Ref. 500).

During migration, the species can fly non-stop for distances up to 5,000 km, relying on stored fat for energy (Ref. 519) and flocks can number in the thousands, aiding in locating food and providing safety in numbers (Ref. 500).

The great knot forages by probing mud or sand with its long, slender bill, extracting invertebrates. It predominantly inhabits coastal mudflats, tidal flats, salt marshes, and estuarine environments, which provide nutrient-rich sediments and abundant prey such as molluscs, crustaceans, and worms (Ref. 425; Ref. 500). The species often roosts and feeds in large flocks during low tide (Ref. 452).

Great knots breed in the montane tundra of the subarctic at elevations of 300-1,600 m, with egg-laying occurring from late May to late June (Ref. 425; Ref. 453).

The *Conservation Advice for great knot* (Ref. 425) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.28 Greater crested tern

The greater crested tern (*Thalassarche bergii*) is a large seabird found across coastal regions of the Southern Hemisphere, including WA (Ref. 521). It is commonly observed year-round in estuaries and along the coast, where it dives into the water to catch fish (Ref. 522). In WA, the species has been recorded at the Abrolhos and Montebello Islands (Ref. 516).

The diet of the greater crested tern primarily consists of small fish, crustaceans, and occasionally molluscs, which it catches with remarkable agility and speed by diving from the air (Ref. 441; Ref. 522). his highly social species often forms large colonies and typically forages within 3 km of its breeding colony (Ref. 453). After hatching, the chicks are precocial, leaving the nest soon after birth but relying on their parents for food for several weeks.

No BIAs have been identified for this species in Australia.

4.3.4.29 Greater sand plover

The greater sand plover (*Charadrius leschenaultii*) is a medium-sized shorebird that breeds in western China, Mongolia, and southern Russia (Ref. 519). During the non-breeding season, this species visits Ashmore Reef in internationally significant numbers between December and February (Ref. 446). Its distribution extends from North West Cape to Roebuck Bay, WA, with occasional records along the southern WA coast (Ref. 426).

The greater sand plover is one of the earliest migratory waders to return to north-western Australia, typically arriving in late July, with some individuals departing in October and November (Ref. 523; Ref. 524).

Feeding usually occurs in sheltered coastal areas, including sandy, shelly, or muddy habitats, as well as intertidal mudflats, sandbanks, saltmarshes, estuaries, coral reefs, rocky islands, tidal lagoons, and coastal dunes (Ref. 450). The species primarily feeds on invertebrates such as molluscs, crustaceans, and insects, which it forages by probing the sand or mud, particularly during low tide when feeding grounds are exposed (Ref. 441).

The *Conservation Advice for greater sand plover* (Ref. 426) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.30 Grey plover

The Grey Plover (*Pluvialis squatarola*) is a migratory shorebird found in coastal regions of Australia during the non-breeding season. Approximately 38% of the species' Australian population occurs in WA (Ref. 450), with Ashmore Reef supporting >1% of the flyway population (Ref. 446; Ref. 525). They typically visit Ashmore Reef during the non-breeding period between December and February (Ref. 446).

Migrating grey plovers arrive in northern Australia between August and October (Ref. 526) and usually depart between February and April (Ref. 500; Ref. 526). Some individuals in south-western Australia leave in April, moving northwards along the east coast (Ref. 500; Ref. 527). Unusually, nearly all grey plovers in Australia are females (Ref. 528; Ref. 529). This species can travel thousands of kilometres, often in non-stop flights, relying on stored fat as their primary energy source (Ref. 452).

Grey plovers prey on a variety of invertebrates, including molluscs, worms, and crustaceans (Ref. 529). They occasionally consume insects such as grasshoppers and beetles or earthworms when inland (Ref. 453; Ref. 530). Foraging is characterized by stop-start running, pecking, and probing, mostly in mud or soft, wet sand on intertidal flats, saltmarshes, sandflats, and beaches of oceanic coastlines, bays, and estuaries (Ref. 453; Ref. 530).

Roosting occurs in sandy areas such as unvegetated sandbanks, sand-spits along sheltered beaches, or other protected environments like estuaries and lagoons. Grey plovers are also observed in small numbers on mangrove mudflats (Ref. 427).

The *Conservation Advice for grey plover* (Ref. 427) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.31 Grey-tailed tattler

The grey-tailed tattler (*Tringa brevipes*) is a migratory wader that spends its non-breeding season in Australia, primarily along the northern coasts (Ref. 452). In WA, it has been recorded along the south coast near the Eyre Bird Observatory, Point Malcolm, Rossiter Bay, Shark Lake Nature Reserve, and surrounding swampland. It is also found in the southwest between Augusta and Cervantes, and is widespread from the Houtman Abrolhos to the Kimberley division. Inland sightings include Lake Argyle, as well as islands off the coast (Ref. 452).

The species typically arrives in Australia in August, though some individuals appear as early as July, while others remain on breeding grounds until September or October (Ref. 533). Adults first reach northern Australia from late August to early September, with first-year birds arriving approximately four weeks later. Most grey-tailed tattlers leave Australia by early to mid-April to return to their breeding grounds (Ref. 533).

Grey-tailed tattlers inhabit sheltered coastal areas with reefs, rock platforms, and intertidal mudflats. They are also found in rocky, coral, or stony intertidal zones, as well as islets exposed at low tide (Ref. 533). The species forages in shallow water, often on hard intertidal substrates like rock pools, reefs, and coral rubble, as well as on exposed mudflats, sandflats, and areas near mangroves or seagrass. It is typically seen in small groups but can form larger aggregations at productive feeding sites, particularly during migration (Ref. 452).

The diet of the grey-tailed tattler consists primarily of polychaetes, molluscs, crustaceans, insects, and occasionally fish (Ref. 533). For roosting, it prefers mangrove branches, dense shrubs, snags, or driftwood. In areas without mangroves, it roosts on rocks, which are sometimes partially submerged (Ref. 533).

While generally non-territorial in Australia, the grey-tailed tattler may exhibit aggressive behaviour toward other shorebirds during feeding or roosting when resources are limited (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.32 Indian yellow-nosed albatross

The Indian yellow-nosed albatross (*Thalassarche carteri*) is a small albatross species that visits Australian waters during its non-breeding season. Its primary breeding grounds are located on island groups of France and South Africa (Ref. 406). The species is an annual breeder when successful (Ref. 406).

Tracking studies and at-sea records indicate that the Indian yellow-nosed albatross disperses from its breeding colonies primarily within the higher latitudes of the Indian Ocean, ranging from southern Africa to south-west Australia. In WA, it is commonly observed in offshore waters (Ref. 534).

The species is most abundant in waters off southern WA and SA between March and May. Immature birds typically return south between September and October, moving northward along the coast and favouring inshore waters during this time (Ref. 441; Ref. 535).

Indian yellow-nosed albatrosses inhabit open ocean environments, favouring waters with surface temperatures of 10°C to 23°C, and are most abundant in the warmer parts of the subtropical zone. They concentrate over productive waters of continental shelves, particularly at coastal upwellings and current boundaries during both breeding and non-breeding seasons (Ref. 536; Ref. 537; Ref. 538).

The species uses dynamic soaring, a specialised foraging technique that allows it to cover vast areas with minimal energy expenditure (Ref. 441). Its diet primarily consists of cephalopods and fish, and it is known to scavenge from fishing vessels when opportunities arise (Ref. 534).

Foraging BIAs for this species are located in southwestern Australia (around Augusta) and the South-east Marine Region, including Macquarie Island. These BIAs are outside the PA.

4.3.4.33 Lesser crested tern

The lesser crested tern (*Thalasseus bengalensis* formerly known as *Sterna bengalensis*), inhabits tropical and subtropical sandy and coral coasts and estuaries. It breeds on low-lying offshore islands, coral flats, sandbanks, and flat sandy beaches, and forages in the surf and over offshore waters (Ref. 452).

Since 1996, this species has nested regularly at the Lowendal Islands, where up to 200 pairs nest among larger colonies of crested terns (Ref. 519). Additional nesting sites within state waters adjacent to the NWMR include Sterna Island in the Kimberley, Bedout Island in the Pilbara, and potentially the Montebello Islands (Ref. 519). Breeding records also exist for Ashmore Reef, various Kimberley islands (including Low Rocks and Adele Island), and islands extending south to Shark Bay (Ref. 519; Ref. 439).

During the breeding season, lesser crested terns prefer to nest in colonies on bare sand or shingle, where they are protected from terrestrial predators. Outside the breeding season, they roost on coastal rocks and sandbars (Ref. 500).

The species feeds by plunging or dipping from the air to catch prey in shallow waters, primarily targeting pelagic fish and shrimps (Ref. 408; Ref. 453). Lesser crested terns are highly social, particularly during the breeding season, when they form colonies that often include other seabird species (Ref. 452).

Breeding BIAs for this species have been identified (Figure 4-18, Table 4-18) In the north-west coast of WA extending along the coast to the NT. These BIAs overlap the PA.

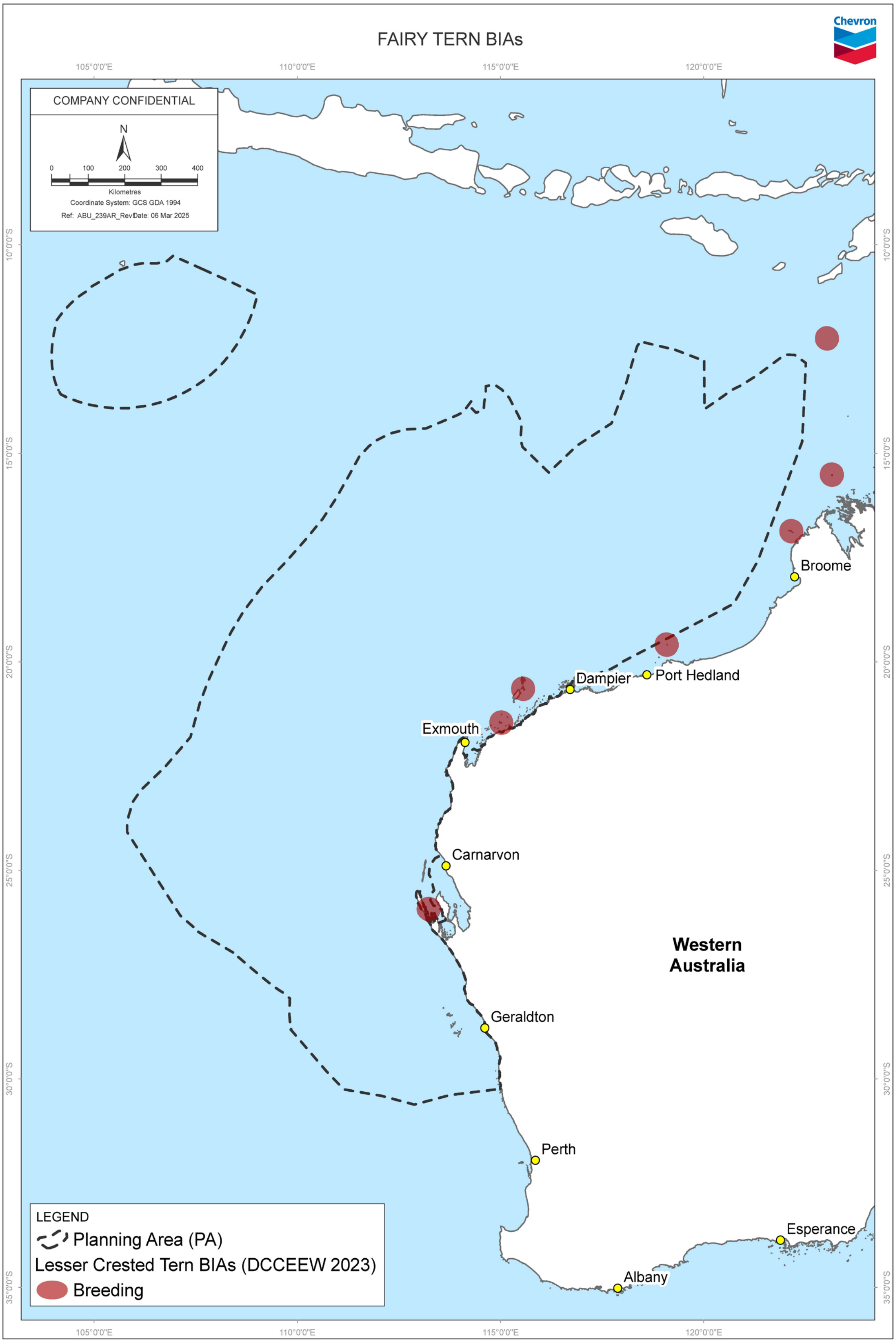

Figure 4-18: Biologically important areas for lesser crested tern

4.3.4.34 Lesser frigatebird

The lesser frigatebird (*Fregata ariel)* is the most widely distributed of the frigatebirds, inhabiting tropical waters across the Indian, western, and central Pacific Oceans (Ref. 408). In Australia, it is commonly observed in tropical or warmer coastal waters, particularly in WA, the NT, Queensland and northern NSW (Ref. 519).

Breeding colonies of lesser frigatebirds are known on Adele, Bedout, and West Lacapede Islands (Ref. 441), as well as Ashmore Reef and Cartier Island (Ref. 539). Historically, the species also bred on Swan Island in the Kimberley, although this colony no longer exists (Ref. 539).

Tracking studies have revealed that non-breeding individuals roosting at Ashmore Reef and Adele Island exhibit extensive distributions, ranging from Australian coastal waters to the South China, Java, and Sulu Seas, and the Gulf of Thailand (Ref. 540). During the wet season, Australian waters serve as optimal habitat for non-breeding individuals (Ref. 540).

The lesser frigatebird breeds on remote tropical and subtropical islands, often in mangroves, bushes, or even on bare ground. Outside the breeding season, the species is largely sedentary, with immature and non-breeding birds dispersing across tropical seas, particularly in the Indian and Pacific Oceans (Ref. 479).

Foraging occurs by snatching prey from surface waters or capturing prey as it breaks the surface. The species also practices kleptoparasitism, harassing other seabirds until they regurgitate their food. Their diet primarily includes flying fish and squid, but also extends to seabird eggs and chicks, carrion, and fish scraps (del Hoyo et al. 1992).

Breeding and foraging BIAs have been identified (Figure 4-19, Table 4-18) for this species in northern Australia. In WA, breeding BIAs have been defined along the Kimberley and Pilbara coasts (from Port Hedland to the NT border) and at Ashmore Reef. These breeding BIAs overlap with the Kimberly and Pilbara sections of the PA.

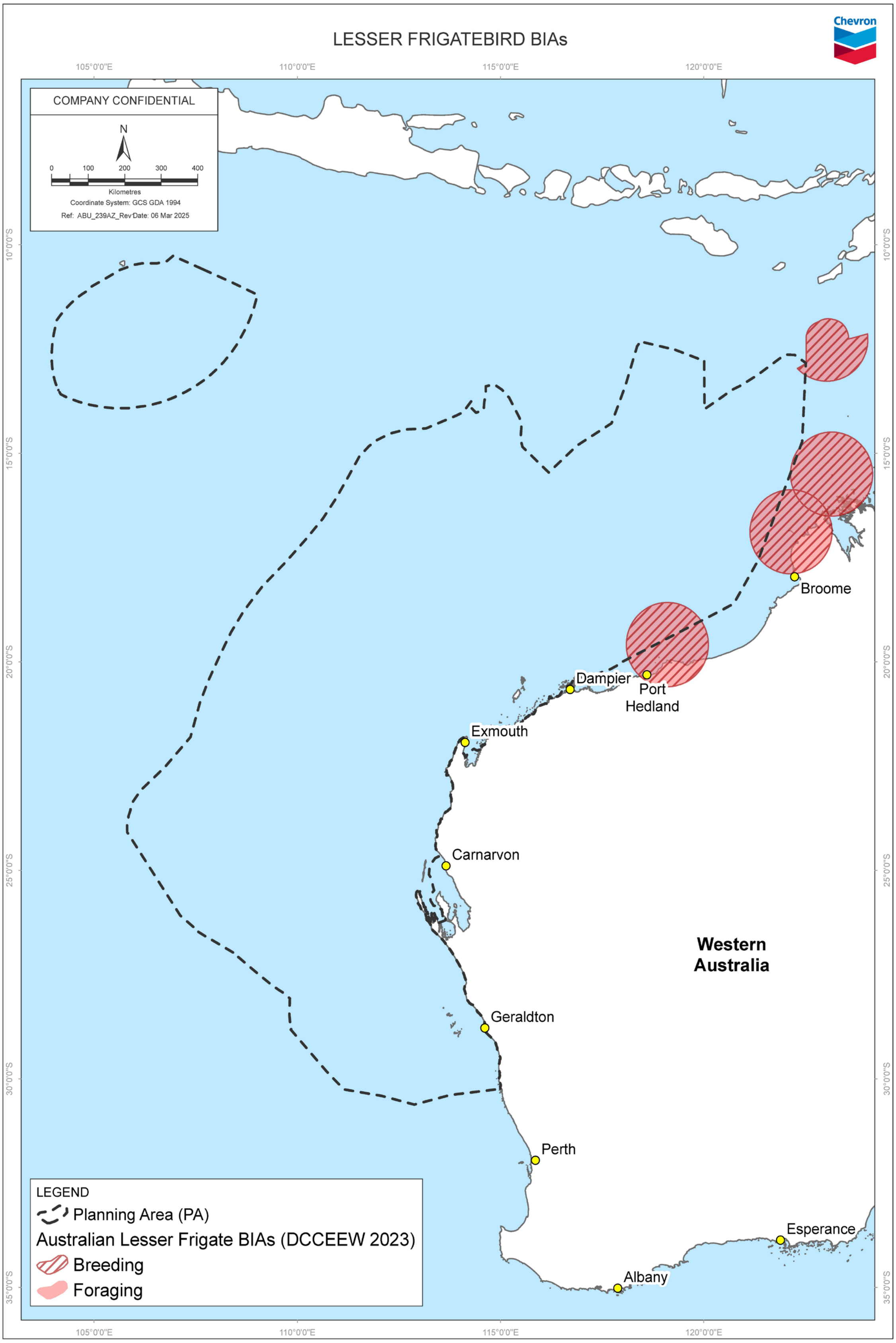

Figure 4-19: Biologically important areas for Lesser frigatebird

4.3.4.35 Lesser sand plover

The lesser sand plover (*Charadrius mongolus*) is a migratory shorebird that spends the non-breeding season in Australia during the Austral summer (September to April or May). Maximum numbers are typically observed at most sites by December, remaining fairly constant until late February (Ref. 428). In Australia, the species is widespread in coastal regions and recorded in all states, primarily occurring in northern and eastern areas (Ref. 428). Off WA, it has also been observed on Lord Howe Island, Norfolk Island, and Christmas Island (Ref. 441).

During the non-breeding season, the lesser sand plover is almost exclusively coastal, favouring sandy beaches, mudflats in bays and estuaries, sandflats, and coastal dunes (Ref. 453). It occasionally frequents mangrove mudflats in Australia (Ref. 541). The species is highly mobile, moving between foraging and roosting sites in response to tidal changes and food availability (Ref. 500).

The lesser sand plover often feeds alongside other shorebird species, especially the greater sand plover, though the two typically roost separately (Ref. 441). It is primarily diurnal but may forage on moonlit nights (Ref. 453; Ref. 541). During the breeding season, its diet consists mainly of beetles, weevils, fly larvae, stalk worms, and crabs (Ref. 453). In the non-breeding season, the diet expands to include insects, crustaceans (especially crabs and amphipods), molluscs (especially bivalves), and polychaete worms (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.36 Little curlew

The little curlew (*Numenius minutus*) is a small migratory wader that spends its non-breeding season in northern Australia, from Port Hedland in WA to the Queensland coast (Ref. 542). It has also been recorded on Lord Howe Island, Cocos-Keeling Island, and Christmas Island (Ref. 452). The species is typically present in Australia between September and April, with few records during the winter months (Ref. 462). In the Broome and Darwin regions, numbers gradually increase until late October before decreasing during November and December as individuals disperse southward or inland (Ref. 542).

The little curlew primarily inhabits short, dry grasslands and sedgelands, including dry floodplains and blacksoil plains with scattered shallow freshwater pools or seasonally inundated areas. It also uses open woodlands with grassy or burnt understories, dry saltmarshes, coastal swamps, and estuaries. Other habitats include mudflats, sandflats on sheltered coasts, mown lawns, gardens, recreational areas, ovals, racecourses, and road or airstrip verges (Ref. 452).

Foraging typically occurs in relatively short grass (~20 cm tall), as the birds avoid dense, tall grasses (Ref. 452). The little curlew primarily feeds on insects but also consumes seeds and berries (Ref. 452). During the non-breeding season, it is highly gregarious, often forming dense flocks of several hundred to thousands on coastal and inland grasslands or blacksoil plains near freshwater swamps, pools, or flooded ground (Ref. 542).

No BIAs have been identified for this species in Australia.

4.3.4.37 Little shearwater

The little shearwater (*Puffinus assimilis*) is a small seabird that inhabits subantarctic, subtropical, and occasionally tropical waters (Ref. 408). In Australia, it occurs in coastal waters of southeastern and southwestern regions, particularly during its breeding season, which extends from June to December (Ref. 408). These birds primarily nest in burrows on offshore islands and coastal cliffs, including areas such as Bass Strait and islands off the coasts of NSW, SA, and WA (Ref. 452). During the non-breeding season, little shearwaters are pelagic, ranging widely across the southern Indian and Pacific Oceans, feeding in offshore waters (Ref. 543).

The species breeds colonially, typically under forest cover or in tussocks. At sea, little shearwaters are usually solitary or found in small groups. They forage by plunge-diving or surface-seizing, feeding on cephalopods, crustaceans, and small fish (Ref. 408; Ref. 452).

During the breeding season, little shearwaters are primarily nocturnal, coming ashore at night to avoid diurnal predators such as gulls and large seabirds (Ref. 543). They are highly social during this period, nesting in dense colonies and often returning to the same burrows each year.

Foraging and breeding BIAs have been identified (Figure 4-20, Table 4-18) in the SWMR of WA, as well as around Lord Howe Island and Norfolk Island off Australia's east coast. The foraging BIAs overlap with the West Coast and Ningaloo sections of the PA.

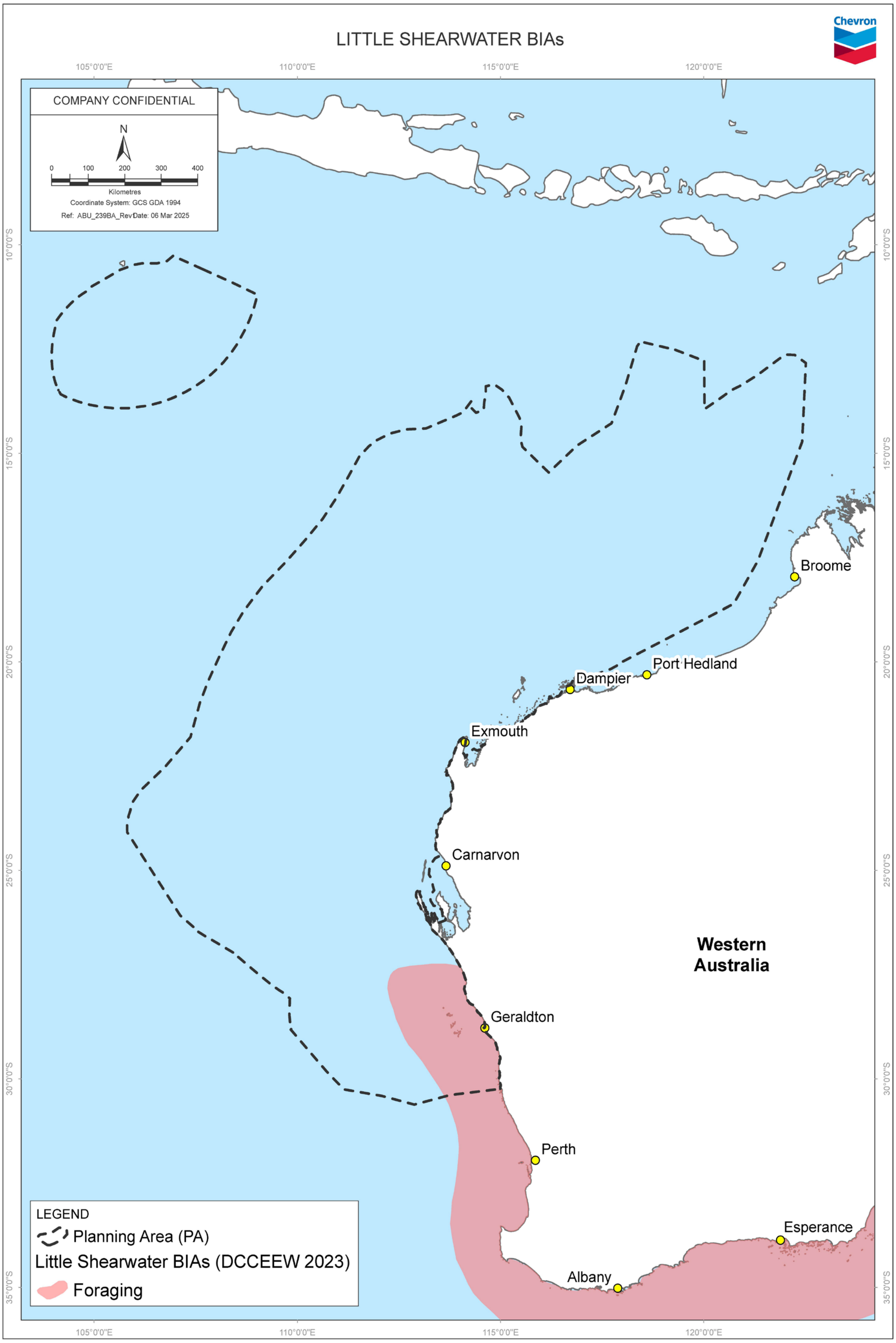

Figure 4-20: Biologically important areas for little shearwater

4.3.4.38 Little tern

The little tern (*Sternula albifrons*) is the smallest tern in the Australian region (Ref. 408). This species breeds across much of Europe, parts of Africa and Asia, and regions of Australasia (Ref. 408).

The western Pacific subspecies (*Sternula albifrons sinensis*) is one of three subspecies of *Sternula albifrons*. In Australia, there are three subpopulations of *S. a. sinensis*, two of which occur in the NWMR (Ref. 519):

- a northern Australian breeding subpopulation that nests around Broome and extends into the North Marine Region, spanning the Gulf of Carpentaria to the east coast of Cape York Peninsula
- an east Asian breeding subpopulation, some of which migrate to the northern Australian coast, ranging from Shark Bay to southeastern Queensland during the austral summer.

The northern Australian breeding subpopulation nests along shorelines and sand spits, similar to the fairy tern (*Sternula nereis,* refer to Section 4.3.4.24). Many nearshore islands with undisturbed sheltered beaches in the Kimberley likely support breeding pairs during September and October (Ref. 539).

Little terns typically forage close to breeding colonies in shallow waters of estuaries, coastal lagoons, and lakes (Ref. 452). Their diet consists primarily of small fish (<10 cm), supplemented by crustaceans, insects, worms, and molluscs (Ref. 452).

During the breeding season, little terns are colonial nesters, forming small-sized colonies on sandy beaches or saltmarshes. Their nests are simple ground depressions, sometimes lined with shells or small stones (Ref. 453).

Breeding and resting BIAs for this species have been identified (Figure 4-21, Table 4-18) in WA, along the Kimberley, Pilbara, and Gascoyne coasts and islands, including Ashmore Reef. The breeding BIAs overlap the Kimberley section and a small portion of the Pilbara section of the PA.

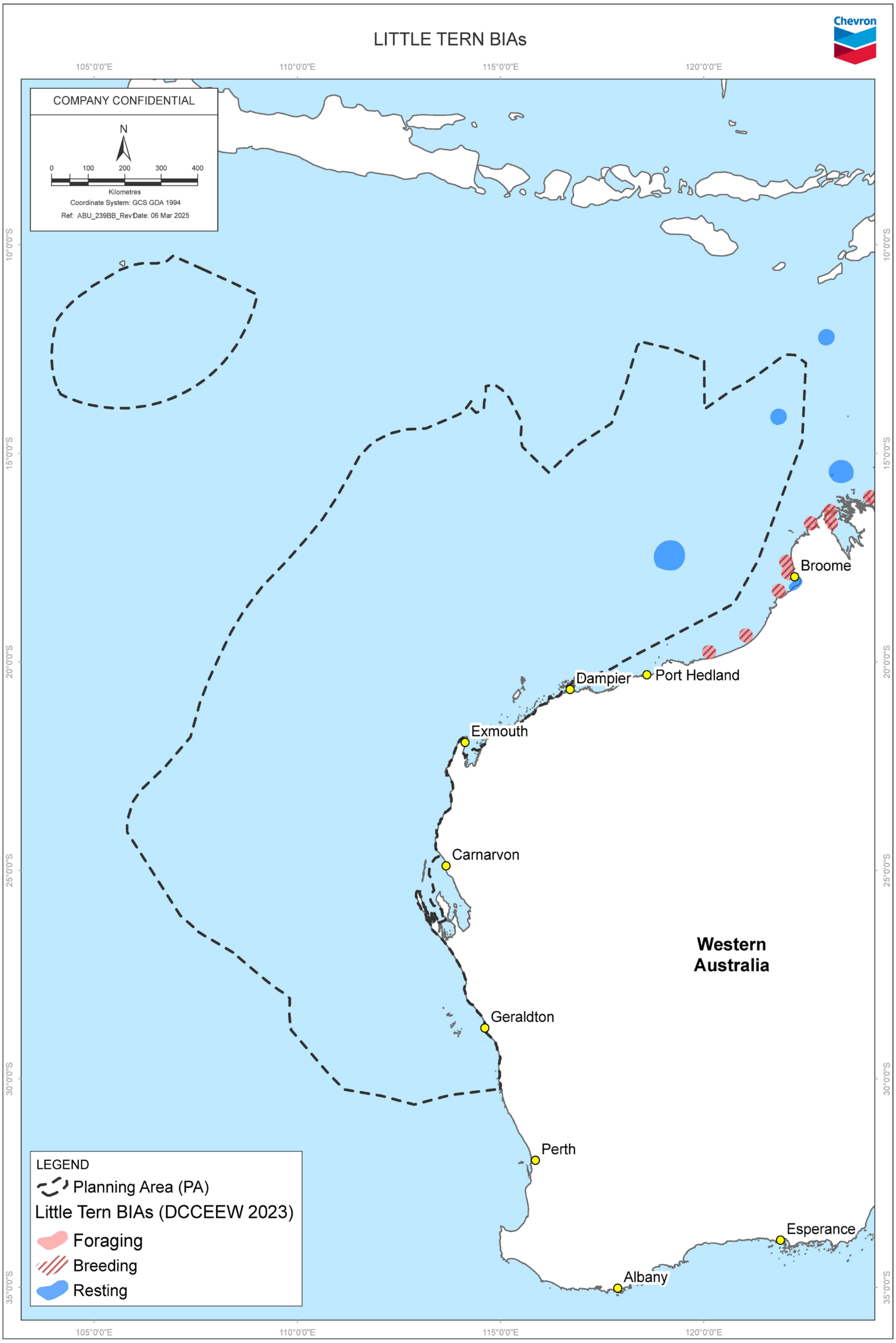

Figure 4-21: Biologically important areas for little tern

4.3.4.39 Long-toed stint

The long-toed stint (*Calidris subminuta*) is a small sandpiper that breeds in Siberia and migrates to Australia primarily during the southern hemisphere summer (Ref. 544). In WA, the species is predominantly found along the coast, with occasional inland records. Notable locations include the Gascoyne Region (e.g. Lake Wooleen, Meeberrie Station, and McNeill Claypan) and widespread areas in the Pilbara and Kimberley regions, from Karratha to Wyndham-Kununurra (Ref. 544).

The species arrives on the north coast, occupying freshwater wetlands in the west Kimberley and Pilbara regions. During summer, it disperses mainly between the Pilbara and South Australian coast, with a few individuals moving farther east (Ref. 544). Most of the population departs south-west Australia in February–March, returning to the Kimberley from March to May before continuing their migration to breeding grounds in Siberia (Ref. 544).

In Australia, the long-toed stint inhabits a variety of terrestrial wetlands, favoring shallow freshwater or brackish environments. It is often found along muddy shorelines or areas with short grass, weeds, sedges, and aquatic vegetation. The species is also common on the muddy fringes of drying ephemeral lakes and swamps and may frequent permanent wetlands like reservoirs and artificial lakes (Ref. 452). Although uncommon, it has been observed at tidal estuaries, saline lakes, salt ponds, and bore swamps (Ref. 452). These habitats provide abundant food sources, including molluscs, crustaceans, and insects (Ref. 545).

The long-toed stint typically forages on wet mud or shallow water, often among short vegetation or on floating weeds and algae. It uses a crouched or hunched posture while feeding (Ref. 452). Roosting sites include sparse vegetation at wetland edges, damp mud near shallow water, or small depressions in the mud. They are mostly active during the day, particularly at low tide. In the evenings, they rest in groups, often on islands or mudflats (Ref. 500).

No BIAs have been identified for this species in Australia.

4.3.4.40 Marsh sandpiper

The marsh sandpiper (*Tringa stagnatilis*) occurs throughout southern Africa, the Nile River valley, and the Red Sea coast, breeding from eastern Europe to eastern Siberia (Ref. 546). In WA, they are mainly found around the coast (Ref. 546).

Birds arrive in Australia from September, moving southward across the continent between September and December (Ref. 500). During the Australian summer, some dispersive movements have been observed (Ref. 452). The marsh sandpiper begins its migration northward to breeding grounds in March–April (Ref. 546).

This species inhabits permanent or ephemeral wetlands of varying salinity, including swamps, lagoons, billabongs, saltpans, saltmarshes, estuaries, and inundated floodplains. It is also commonly found at sewage farms and saltworks (Ref. 546). Less frequently, it is recorded at reservoirs, waterholes, soaks, bore-drain swamps, and flooded inland lakes. In northern Australia, the species shows a preference for intertidal mudflats (Ref. 452).

The marsh sandpiper typically forages in shallow water along the edges of wetlands, probing wet mud or feeding among marshy vegetation. It roosts or loafs on tidal mudflats, low saltmarshes, and around inland swamps (Ref. 452).

A carnivorous species, the marsh sandpiper primarily consumes insects, molluscs, and, internationally, crustaceans. Plant material has been found in stomach contents, though it may be ingested incidentally (Ref. 452). Feeding occurs singly or in groups, and the species has been observed following ducks, egrets, and other waders, taking advantage of prey disturbed by these birds (Ref. 547).

No BIAs have been identified for this species in Australia.

4.3.4.41 Masked booby

The masked booby (*Sula dactylatra*) is a large seabird found in tropical and subtropical waters. While not migratory, individuals may range widely from their breeding islands in search of food (Ref. 548).

In Australia, masked boobies are primarily found from the Dampier Archipelago in WA, along the entire north coast and east coast, extending south to Brisbane (Ref. 549). Individuals have also been recorded in Barrow Island (Ref. 441). The breeding population on Lord Howe Island represents the most southerly breeding colony in the world Ref. 549).

This species typically roosts on the ground beside their nests during the breeding season, though some breeding birds roost on beaches near colonies. Non-breeding adults and juveniles also roost on the ground near colonies, forming small groups (Ref. 549). Outside the breeding season, individuals may roost on other islands or the sea surface. After foraging, masked boobies often rest on beaches or sandbanks, occasionally in mixed-species flocks (Ref. 441).

Masked boobies are usually solitary or found in small, loose colonies on breeding islands, where they engage in complex courtship displays. The breeding season is year-round (Ref. 519) but varies by locality, with colonies forming on rocky offshore islands. Nests are typically built on cliff ledges, though other sites are also used (Ref. 479).

This species is well-adapted to life over the ocean. At sea, masked boobies are generally found over pelagic waters, preferring deeper areas compared to other booby species. Their diet consists primarily of large shoaling fish, especially flying fish, but also includes large squid (Ref. 408).

Breeding and foraging BIAs have been identified for this species along the east coast of Australia, from northern Queensland southward, encompassing the offshore islands of the Great Barrier Reef, Norfolk Island, and Lord Howe Island. These BIAs are outside the PA.

4.3.4.42 Northern giant petrel

The northern giant petrel (*Macronectes halli*) is a large seabird that breeds in the sub-Antarctic and visits areas off the Australian mainland primarily during the winter months (May–October) (Ref. 550). In WA, immature and some adult birds are commonly observed in offshore and inshore waters around Fremantle during this period (Ref. 551).

At Macquarie Island, the only known breeding site in Australia, most breeding birds forage within 100 km of the island (Ref. 552). During the breeding cycle, individuals from Macquarie Island often forage southward to the Antarctic ice edge or eastward toward South America (Ref. 552).

Northern giant petrels are diurnal feeders at sea and are known to scavenge on land both during the day and at night (Ref. 553). Females exhibit more pelagic habits and feed extensively on marine resources during breeding periods, while males tend to scavenge more nearshore or on land (Ref. 554).

The breeding population at Macquarie Island is likely critical for the long-term persistence of northern giant petrels within Australian jurisdiction (Ref. 406). Foraging BIAs for this species have been identified along the east coast of Australia.

No BIAs have been identified for this species in the PA.

4.3.4.43 Northern Siberian bar-tailed godwit

The northern Siberian bar-tailed godwit (*Limosa lapponica menzbieri*), also known as the Yakutian bar-tailed godwit, is a long-distance migratory wader that breeds in northern Siberia and migrates to north-western Australia for the non-breeding season (Ref. 450). In WA, the species is widespread along the coast, from Eyre to Derby (Ref. 452).

Bar-tailed godwits typically forage near the water's edge or in shallow water within tidal estuaries and harbors (Ref. 452). They are found on exposed sandy or muddy substrates on intertidal flats, banks, and beaches (Ref. 429). Their diet mainly consists of invertebrates such as worms, molluscs, crustaceans, and occasionally plant material, which they probe from the mud using their long, straight bill (Ref. 452). They roost in supratidal areas during higher tides, often in very large aggregations Ref. 556)

Known for their extraordinary migration, bar-tailed godwits travel over 11,000 km non-stop between Siberia and Australia (Ref. 555). During this journey, they rely on large fat reserves to sustain them. Outside the breeding season, they are highly social, frequently seen in large flocks in areas with abundant food (Ref. 452). Though they typically feed during the day, they may also forage by moonlight (Ref. 452).

The *Conservation Advice for Yakutian bar-tailed Godwit* (Ref. 429) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.44 Oriental plover

The oriental plover (*Charadrius veredus*) is a medium-sized migratory shorebird that breeds in Central Asia and migrates to Australia (Ref. 559). In Australia, most records are along the north-western coast between Exmouth Gulf and Derby, with a few scattered sightings elsewhere. Two major staging areas are near Broome, where the majority of birds pass through during their arrival and departure (Ref. 559). Oriental plovers typically arrive in north-western Australia from early to mid-September, with numbers peaking in October and November (Ref. 470; Ref. 500; Ref. 560; Ref. 561). They usually leave between February and April, with most departing by the end of March (Ref. 470; Ref. 560).

Initially, this species is found in coastal habitats, such as estuarine mudflats, sandbanks, sandy or rocky beaches, nearby reefs, and near-coastal grasslands (Ref. 562; Ref. 563; Ref. 564). Later, they disperse inland to flat, open, semi-arid, or arid grasslands with short, sparse grass interspersed including dry paddocks, playing fields, lawns, cattle camps, and recently burned areas (Ref. 565; Ref. 566). Such environments provide a reliable source of invertebrates, including insects, small crustaceans, and other prey.

The Oriental Plover is well-adapted to ground foraging, often seen on mudflats and saltflats. It uses its sharp bill and keen eyesight to pick food from the surface (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.45 Osprey

The osprey (*Pandion haliaetus,* also known as *Pandion cristatus*) is a coastal raptor commonly found in northern Australia. Ospreys inhabit littoral and coastal regions, as well as terrestrial wetlands, across tropical and temperate Australia, including offshore islands (Ref. 408). Tin WA, locations include the North-Western and South-Western coasts, particularly areas such as Shark Bay, Exmouth, and the Swan River. Inland, they are also found near large freshwater lakes and wetlands with abundant fish population (Ref. 570).

They tend to stay year-round if food resources remain consistent (Ref. 462). They require extensive areas of open fresh, brackish or saline water for foraging (Ref. 470). Their preferred habitats include inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs, and large lakes or waterholes (Ref. 470).

In Australia, ospreys breed between April and February (Ref. 408). B Breeding seasons vary with latitude, commencing progressively later in southern regions compared to northern areas (Ref. 470).

Ospreys are generally solitary, except during the breeding season. Outside the nesting period, they are typically seen alone but may gather in small groups in areas with abundant food, such as fish-rich rivers or lakes (Ref. 452. Ref. 462).

No BIAs have been identified for this species in Australia.

4.3.4.46 Pacific golden plover

Pacific golden plovers (*Pluvialis fulva*) are medium-sized shorebirds that breed in the Arctic regions of Siberia and Alaska before migrating to Australia for the southern hemisphere summer (Ref. 519). In the NWMR, they are present at Ashmore Reef during the southern spring and summer, between September and March (Ref. 446).

In Australia, the Pacific golden plover is commonly found along the northern and eastern coasts, particularly in habitats such as mudflats, estuaries, and tidal flat margins (Ref. 519). They roost near their foraging areas, which include sandy beaches, spits, rocky points, islets, and exposed reefs. Occasionally, they may also roost among or beneath vegetation, such as mangroves, low saltmarsh, or beach-cast seaweed (Ref. 470; Ref. 571).

These highly social birds typically form small to medium-sized flocks, especially during the non-breeding season. They forage both during the day and at night, using gleaning and probing techniques to feed on invertebrates. Their diet is sourced from moist mud or sand on mudflats, saltmarshes, wave-wash zones, tide wrack on beaches, and even pastureland (Ref. 470).

No BIAs have been identified for this species in Australia.

4.3.4.47 Pacific gull

The Pacific gull (*Larus pacificus*) is a large seabird native to Australia (Ref. 408). The subspecies *georgii* is found along the coasts of south-western WA and western SA, with its range recently expanding northwards along the WA coast (Ref. 572).

This species prefers coastal environments, including rocky shorelines, sandy beaches, and estuaries, which provide abundant food sources (Ref. 452). Its diet is diverse, comprising fish, squid, intertidal molluscs, echinoderms, crabs, fish offal, carrion, and refuse (Ref. 408).

Pacific gulls breed between September and January, either solitarily or in small, open colonies. Most nest sites are protected due to their inaccessibility, and the species has adapted well to urbanised environments, taking advantage of new food sources (Ref. 453; Ref. 573; Ref. 574).

Foraging BIAs have been identified (Figure 4-22, Figure 4-22) along Australia's southern coastline, stretching from Adelaide, SA, to Kalbarri, WA. These BIAs overlap with the southern section of the PA, specifically the West Coast section.

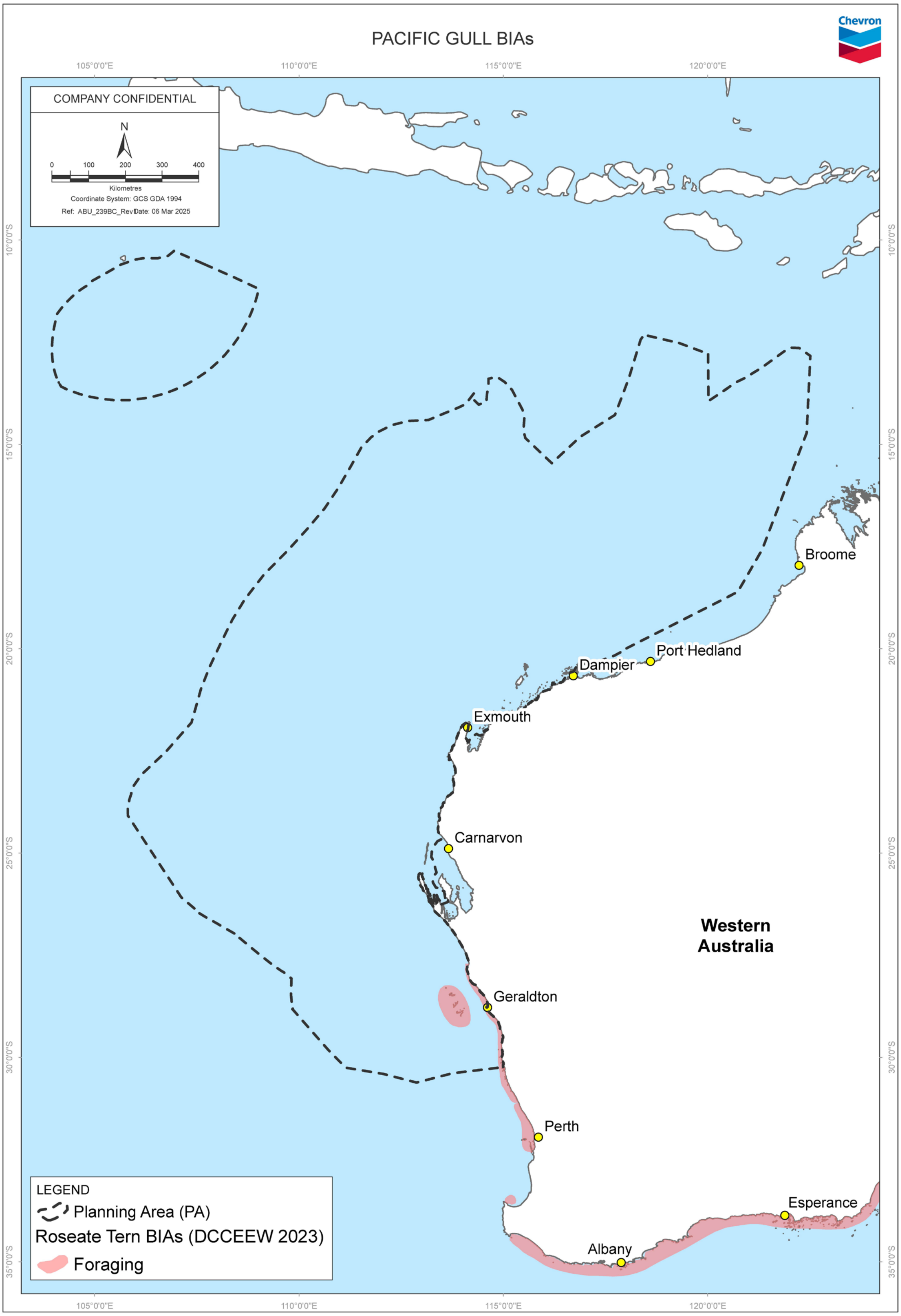

Figure 4-22: Biologically important areas for Pacific gull

4.3.4.48 Pectoral sandpiper

The pectoral sandpiper (*Calidris melanotos*) is a small to medium-sized shorebird that breeds in northern Russia and North America, migrating to non-breeding areas in Australia (Ref. 575). In WA, the species is rarely recorded, with observations at locations such as the Nullarbor Plain, Reid, Stokes Inlet, Grassmere Lake, Warden Lake, Dalyup and Yellilup Swamp, Swan River, Benger Swamp, Guraga Lake, Wittecarra, Harding River, coastal Gascoyne, the Pilbara, and the Kimberley (Ref. 452).

Migration is primarily driven by the availability of food resources and changes in day length, with birds typically leaving their breeding grounds in late summer and returning in spring (Ref. 576).

During the breeding season, the pectoral sandpiper builds its nest on the ground, often in shallow depressions lined with grasses, moss, and plant material (Ref. 576). In Australasia, it favours shallow freshwater to saline wetlands, typically in coastal or near-coastal areas, though it is occasionally found farther inland. Preferred habitats include wetlands with open, fringing mudflats and low emergent vegetation, such as grass or samphire (Ref. 575).

The species forages in shallow water or soft mud at wetland edges, feeding on a diverse diet that includes algae, seeds, crustaceans, arachnids, and insects (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.49 Pin-tailed snipe

The pin-tailed snipe (*Gallinago stenura*) is a migratory wader species that breeds in Russia and northeast Asia, migrating to Australia during the non-breeding season (Ref. 577). In WA, the species has been recorded in the Pilbara, including areas such as Port Hedland, Myaree Pool, Maitland River, and near Karratha. Its distribution in the Pilbara is believed to range from Pardoo (Banningarra Spring) to the lower Maitland River and Shay Gap (Ref. 577). Additionally, the pin-tailed snipe has been reported on the Cocos (Keeling) Islands and Christmas Island (Ref. 452).

The species typically arrives in Australia, particularly in the Pilbara, from late September to the end of March, with occasional sightings in southwestern WA in late March. There are no winter records of the species in Australia (Ref. 452).

In Australia, the Pin-tailed Snipe inhabits freshwater wetlands, including shallow lakes, ponds, mudflats, and marshes. These environments often feature dense vegetation such as reeds and grasses, which provide feeding grounds and sheltered roosting sites (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.50 Red knot

The red knot (*Calidris canutus*) is a medium-sized migratory shorebird with a worldwide distribution. It breeds in various Arctic regions and migrates to non-breeding areas, including the Australian coast (Ref. 578). In WA, it is occasionally observed in the south, particularly around Peron Peninsula and Carnarvon, and is widespread along the coast from Ningaloo and Barrow Island to the south-west Kimberley Division. Large numbers are consistently recorded at 80 Mile Beach and Roebuck Bay, which are significant strongholds for the species (Ref. 578).

Most red knots arrive on the north-west coast and the Gulf of Carpentaria from late August (Ref. 432). They reach south-west and southern Australia from September onward (Ref. 452) and depart north-west Australia between late March and late April, often migrating directly to China (Ref. 578).

In Australia, red knots inhabit intertidal mudflats, sandflats, and sandy beaches along sheltered coasts, estuaries, bays, inlets, lagoons, and harbours (Ref. 432). They are active both diurnally and nocturnally, with feeding activity regulated by tidal movements. Individuals often feed along the receding tide and are highly gregarious, frequently forming large flocks and mixing with other small shorebirds while feeding and roosting (Ref. 452).

The red knot's diet in non-breeding areas consists primarily of intertidal invertebrates, including bivalve and gastropod molluscs, crustaceans, annelid worms, and insects. Occasionally, they may consume fish and seeds (Ref. 453; Ref. 579).

The *Conservation Advice for red knot* (Ref. 432) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.51 Red-footed booby

The red-footed booby (*Sula sula*) is a seabird found in tropical and subtropical regions, including northern Australia (Ref. 408; Ref. 580). Within the NWMR, it breeds on Ashmore and Cartier Islands (Ref. 539). However, there are no records of this species from the WA mainland coasts (Ref. 441).

While the species is known to migrate, the specifics of its migratory patterns in Australian populations remain unclear. Most adults appear to leave colonies after breeding, but some individuals return more frequently than others (Ref. 581). The red-footed booby has a year-round breeding season, typically laying a single egg per clutch (Ref. 408).

The species is highly dependent on areas of high marine productivity, often associated with underwater slopes adjacent to breeding islands, which provide rich feeding grounds (Ref. 441). Red-footed boobies feed on fish and squid, capturing their prey by diving from considerable heights, a characteristic behaviour of the booby family (Ref. 580). Birds are known to follow boats, sometimes for hundreds of kilometres, as part of their feeding behaviour (Ref. 408; Ref. 441).

Breeding and foraging BIAs were identified (Figure 4-23, Table 4-18) for the red-footed booby have been identified off the northern coast of WA and the north-eastern coast of Queensland. In WA, breeding BIAs are identified around Ashmore Reef and Adele Island, both located within the northern section of the PA, specifically in the Kimberley region.

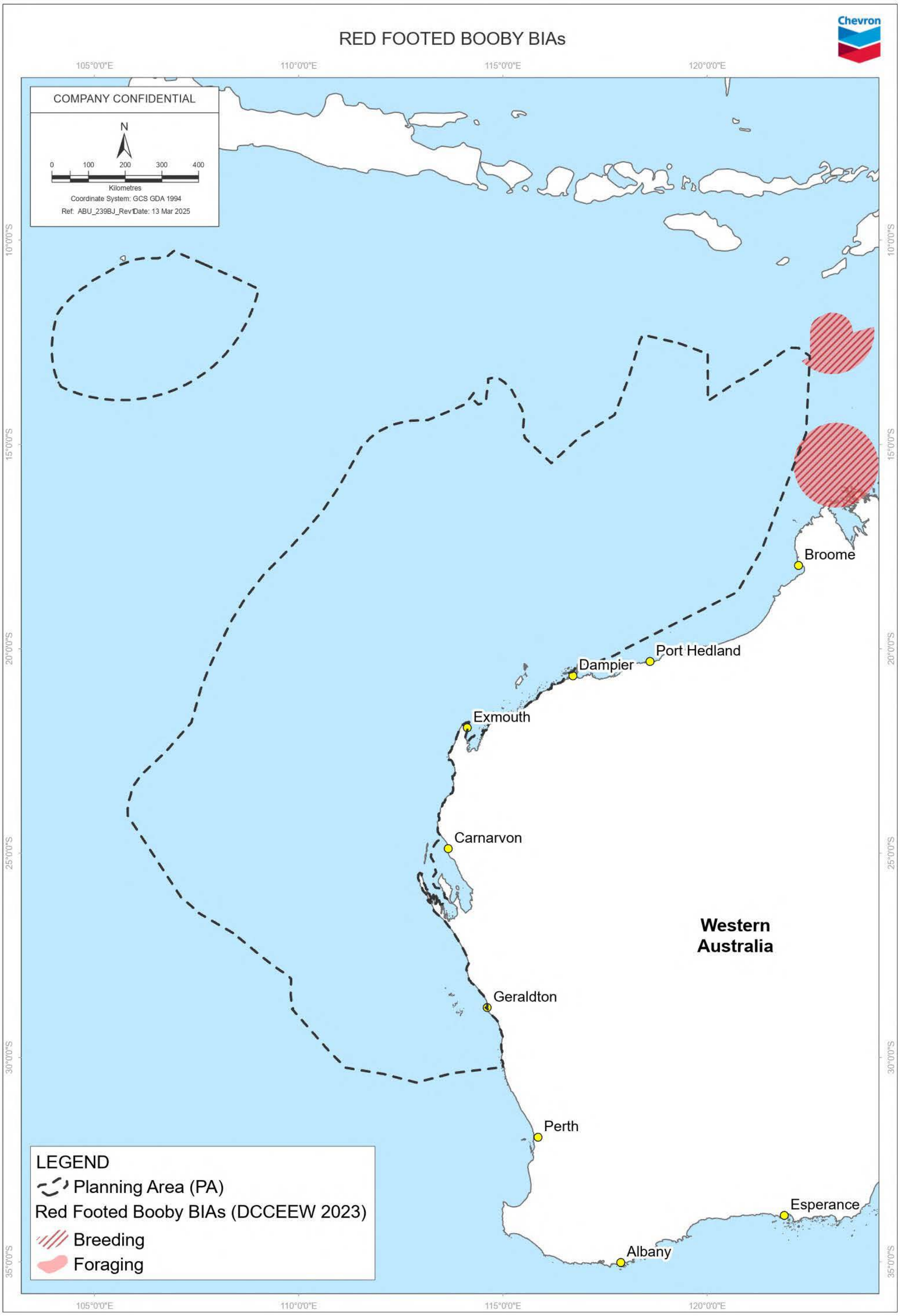

Figure 4-23: Biologically important areas for red-footed booby

4.3.4.52 Red-necked phalarope

The red-necked phalarope (*Phalaropus lobatus*) is a migratory shorebird that breeds in the Arctic and subarctic regions of North America, Europe, and Russia (Ref. 582). In WA, this species is regularly observed at the Port Hedland Saltworks and Rottnest Island (Ref. 582). Red-necked phalaropes are commonly sighted in Australia from mid-October to early April (Ref. 452).

During the non-breeding period, the red-necked phalarope primarily occurs at sea. In Australia, it is recorded at inland and coastal lakes or swamps, including highly saline waters and artificial wetlands such as saltfields (Ref. 452). It feeds on abundant invertebrates, including brine flies and aquatic larvae, in these habitats (Ref. 583).

Although primarily solitary outside the breeding season, red-necked phalaropes are often seen in flocks in Australia, particularly during migration, when large groups gather at suitable feeding sites (Ref. 583).

No BIAs have been identified for this species in Australia.

4.3.4.53 Red-necked stint

The red-necked stint (*Calidris ruficollis*) is a small migratory shorebird, with over 80% of its global population visiting Australia during the non-breeding period (Ref. 519). The northwest of Australia plays a critical role during their southward migration, with birds flying from the northwest to the southeast of the continent (Ref. 519). In the NWMR, nationally significant numbers are recorded at Ashmore Reef during the southern spring and summer, between September and March (Ref. 446). Red-necked stints typically arrive in Australia from August, sometimes as early as July, with most arriving by early September. They depart between late February and April, though a few may remain until May (Ref. 452).

During migration, the species relies on shallow, nutrient-rich waters with abundant food sources. Important migration sites for the red-necked stint are located entirely within Australia (Ref. 584).

This species commonly inhabits coastal and inland wetlands, including intertidal mudflats, estuaries, saline lakes, and flooded plains (Ref. 441). Red-necked stints often travel and feed in dense flocks, consuming invertebrates such as crustaceans, molluscs, and insects (Ref. 583; Ref. 584). They also glean food from vegetation in saltmarshes and water surfaces (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.54 Red-tailed tropicbird

The red-tailed tropicbird (*Phaethon rubricauda*) is a medium-sized seabird found in the Indo-Pacific Ocean (Ref. 408). This species typically inhabits offshore islands, such as those in the Coral Sea, including the Great Barrier Reef, and parts of the northern coastline (Ref. 441). Of the four recognized subspecies, two occur in Australian territory. The subspecies *Phaethon rubricauda westralis*, commonly known as the Indian Ocean red-tailed tropicbird, is found in WA (Ref. 433).

At sea, the red-tailed tropicbird is solitary, flying above the waves with steady, mechanical wing-beats interspersed with horizontal glides (Ref. 519). It breeds in tropical and subtropical zones on volcanic islands, coastal cliffs, slopes, cays, and atolls. Nests are located in rugged terrain, under dense tree canopies, or on coral atolls (Ref. 441; Ref. 519; Ref. 586). Birds generally return to the same breeding sites for successive attempts, unless the sites have been overgrown (Ref. 587) or destroyed (Ref. 588).

The red-tailed tropicbird captures most of its food by deep plunging into the water. Its diet primarily consists of fish and cephalopods, and it often feeds opportunistically near schools of fish or marine predators (Ref. 518). While the movements of adults and juveniles away from breeding sites are not well understood, they appear to disperse widely (Ref. 519).

Breeding and foraging BIAs have been identified for this species have been identified as buffer zones around islands off Queensland and NSW. These BIAs do not overlap the PA.

The *Conservation Advice for Indian Ocean red-tailed tropicbird* (Ref. 433) identifies all known and potential breeding habitats as habitats critical to the survival of the subspecies. This includes Christmas Island, the Cocos (Keeling) Islands, Bedwell Island, Rowley Shoals, and the islands of Ashmore Reef, as well as Rottnest Island. However, no critical habitats for this subspecies have been identified within the PA. No BIAs have been identified for this subspecies (Indian Ocean red-tailed tropicbird) in Australia.

4.3.4.55 Roseate tern

The roseate tern (*Sterna* d*ougalli*i) is a seabird known for its striking plumage and migratory behaviour. The roseate tern occurs in coastal and marine areas in subtropical and tropical seas. The species inhabits rocky and sandy beaches, coral reefs, sand cays and offshore islands (Ref. 452). The roseate tern is a migratory species, though the movement patterns are not well known. Birds are known to usually move away from breeding colonies following breeding, but their non-breeding range is not well defined (Ref. 452).

Behaviours used to define biologically important areas for seabirds in Commonwealth marine areas include breeding with a foraging buffer, and roosting (Ref. 408). Bird species may forage in the waters surrounding the islands during nesting seasons.

Breeding in WA occurs in two distinct periods (Ref. 441):

- at some sites (including Montebello Islands), breeding occurs during both late spring-summer and late autumn-winter
- at other sites (typically further south, including around Cervantes), breeding occurs only during autumn-winter.

Roseate terns breed in the Pilbara region from March to July and October (Ref. 589).

Different islands can be chosen for the breeding colony from year to year. As roseate terns do not forage widely from their breeding colonies, suitable nesting islands may be chosen because of nearby aggregations of their pelagic fish prey (Ref. 590).

Breeding, foraging and resting BIAs have been identified (Figure 4-24, Table 4-18) for this species in WA and the NT. In the NWMR, breeding populations of roseate terns have been recorded at Ashmore Reef, Napier Broome Bay, the Bonaparte Archipelago, Lacepede Island, Bedout Island, the Dampier Archipelago, Lowendal Island, Frazer Island, Koks Island, Mary Anne Island, and Meade Island (Ref. 519). Foraging and breeding BIAs overlap with the PA.

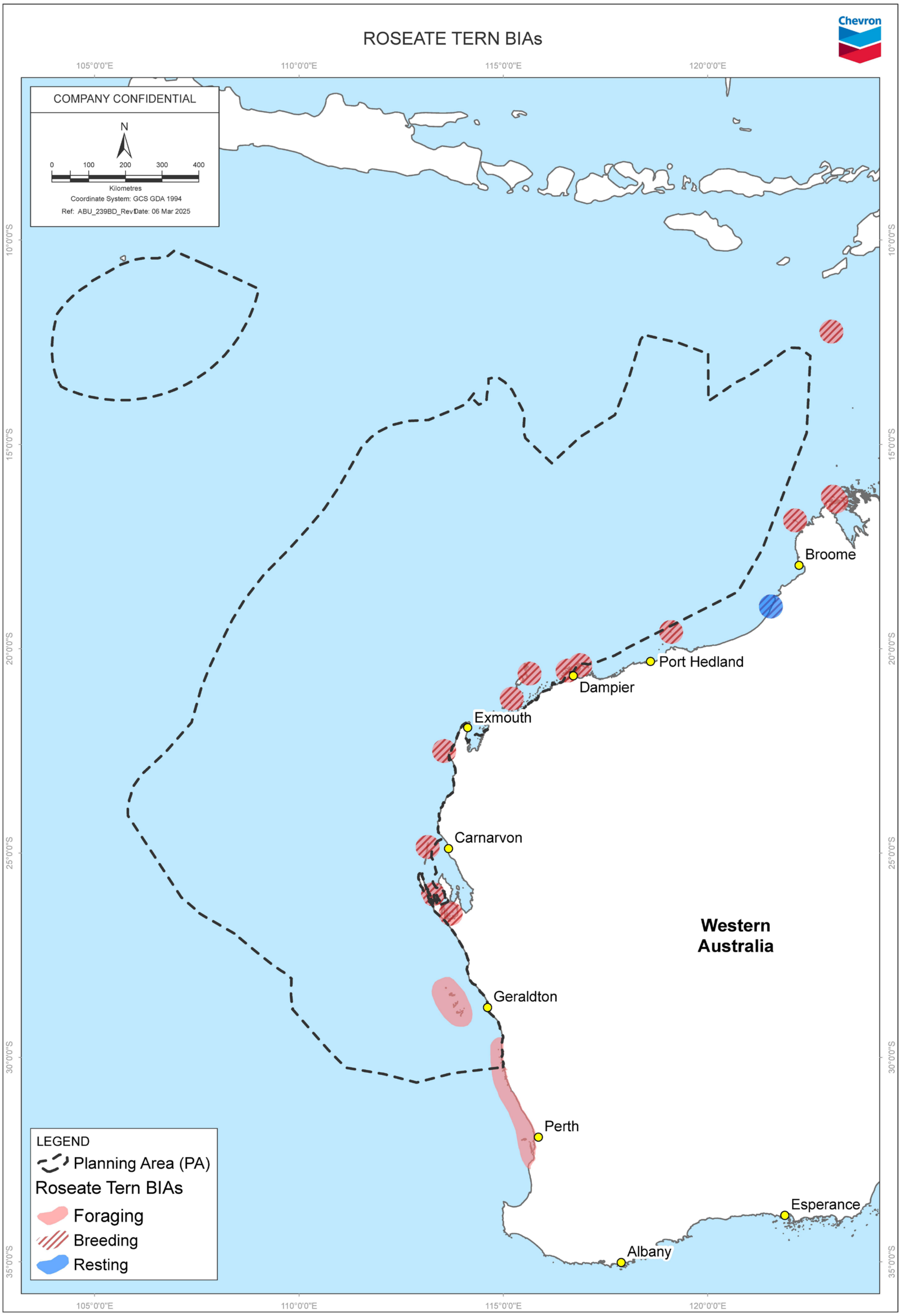

Figure 4-24: Biologically important areas for roseate tern

4.3.4.56 Ruddy turnstone

The ruddy turnstone (*Arenaria interpres*) is a migratory shorebird that breeds in the high Arctic tundra in Siberia and Alaska (Ref. 454) and visits Australia during its southward migration. Ruddy turnstones arrive in northwestern Australia, although this region appears to be less extensively used during their southward migration compared to their northward journey (Ref. 519). They are present in internationally significant numbers in the NWMR at Ashmore Reef between August and May (Ref. 446). In WA, the species is also found at Eighty Mile Beach, Roebuck Bay, Barrow Island, and the Lacepede Islands (Ref. 446).

Ruddy turnstones arrive in northern and southern WA from August onwards, with movements into and through Australia continuing until at least October. They depart southern sites from mid-March. The absence of inland records during March and April suggests that some birds may fly directly over northern Australia during migration (Ref. 452).

In Australia, the ruddy turnstone prefers coastal environments, including rocky shores, sandy beaches, mudflats, and estuaries, although there are occasional records of inland populations (Ref. 452). It is known for its distinctive foraging behaviour, using its robust bill to flip over stones, shells, and debris to uncover hidden prey such as small crabs, insects, and molluscs (Ref. 441).

The ruddy turnstone is social, particularly outside the breeding season, often forming large flocks during migration or at abundant food sources (Ref. 583). In Australia, these flocks are frequently observed foraging together on tidal flats or rocky shorelines (Ref. 452). During the breeding season, however, the species is solitary, nesting on the open tundra in the Arctic.

Ruddy turnstones typically roost on beaches above the tideline, among rocks, shells, beach-cast seaweed, or other debris. They have also been observed roosting on rocky islets with grassy tussocks and on mudflats and sandflats (Ref. 452).

No BIAs have been identified for this species in Australia.

4.3.4.57 Sanderling

The sanderling (*Calidris alba*) is a small migratory shorebird that travels from its Arctic breeding grounds to the coastal regions of Australia during the non-breeding season (Ref. 441). On their southward migration, sanderlings arrive in Australia through the northwest; however, this area is less extensively used compared to their northward migration (Ref. 446). In WA, they are more frequently recorded along the south and southwest coasts, extending northward to southern Shark Bay. Records become more sporadic further north, in the Gascoyne and Pilbara regions, and the Kimberley Division (Ref. 591). Internationally significant numbers have also been observed at Ashmore Reef between December and February (Ref. 446).

Sanderlings typically arrive in Australia during September, with most occurrences in northwestern regions, and depart between March and May (Ref. 452).

This species prefers coastal habitats such as sandy beaches exposed to open sea swells, as well as exposed sandbars, spits, and shingle banks. They forage primarily in the wave-wash zone and among rotting seaweed (Ref. 591). These environments provide ideal feeding grounds, where sanderlings consume small invertebrates, including crustaceans, molluscs, and other marine organisms

(Ref. 441). They occasionally feed on medusae, fish, and larger molluscs and crustaceans as carrion (Ref. 591).

Sanderlings are known for their distinctive behaviour of running swiftly along the shoreline, pausing briefly to peck at the sand for food before darting forward again. This behaviour enables them to efficiently exploit exposed prey, particularly during low tide when invertebrates are more accessible (Ref. 583).

No BIAs have been identified for this species in Australia.

4.3.4.58 Sharp-tailed sandpiper

The sharp-tailed sandpiper (*Calidris acuminata*) is a small migratory shorebird that breeds in northern Siberia and visits all Australian states during the non-breeding season (Ref. 433). Approximately 91% of the East Asian – Australasian population occurs in Australia and New Zealand (Ref. 446). In WA, scattered records exist along the northwest and west coasts, including Henty River and Port Davey (Ref. 433). Inland, the species is widespread, ranging from Cape Arid to Carnarvon, across the coastal and sub-coastal plains of the Pilbara region, and throughout the Kimberley Division (Ref. 452).

Small numbers of sharp-tailed sandpipers arrive in north-west Australia by mid-August, with larger numbers arriving in early September. They depart the non-breeding grounds in Australia by April, being one of the earliest shorebirds to leave (Ref. 452).

The species is predominantly found in southeastern Australia but is widespread in both inland and coastal locations. Sharp-tailed sandpipers occur in both freshwater and saline habitats, including wetlands and intertidal mudflats (Ref. 452; Ref. 592).

During the non-breeding season in Australia, sharp-tailed sandpipers forage along the edges of wetlands and intertidal mudflats, typically on bare wet mud, sand, or in shallow water (Ref. 452). Roosting occurs on rocky and sandy beaches, as well as in freshwater and inland saltwater habitats (Ref. 452). Highly gregarious, the species often forms large flocks, particularly during migration and feeding. Sharp-tailed sandpipers exhibit varied foraging techniques, such as rapid running and probing in the mud, which enable efficient prey capture (Ref. 593). Their diet consists of seeds, worms, molluscs, crustaceans, and insects (Ref. 452).

The *Conservation Advice for sharp-tailed sandpiper* (Ref. 433) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.59 Shy albatross

The shy albatross (*Thalassarche cauta*) is a large seabird endemic to Australia, breeding exclusively on three Tasmanian islands: Albatross Island, Mewstone, and Pedra Branca (Ref. 406). Unlike many other albatross species, shy albatrosses are less oceanic, typically found over the continental shelf and frequently venturing close to shore along the coasts of Tasmania and southern Australia (Ref. 594; Ref. 595; Ref. 596).

Shy albatrosses are annual breeders when successful, with birds present at the colonies year-round. Females lay a single egg predominantly in September

(Ref. 406). During the breeding season, adults forage near their colonies, usually within 300 km in continental shelf waters (Ref. 595)

These birds typically forage singly or in flocks of ~20 individuals (Ref. 535). They also aggregate behind fishing vessels, where they outcompete smaller Procellariiformes and most species except the great albatrosses (Ref. 597). Shy albatrosses capture prey from surface schools using flight feeding, surface feeding, and surface diving, with most diving activity occurring during daylight hours. Their diet primarily consists of fish and cephalopods, with smaller amounts of tunicates and crustaceans (Ref. 535; Ref. 595; Ref. 598).

The *National Recovery Plan for albatrosses and petrels* (Ref. 406) identifies the Tasmanian islands of Albatross Island, the Mewstone and Pedra Branca as critical habitat for they shy albatross under the EPBC Act. Breeding and foraging BIAs have also been identified along the southeastern coast of Australia. However, the critical habitat and BIAs do not overlap the PA.

4.3.4.60 Soft-plumaged petrel

The soft-plumaged petrel (*Pterodroma mollis*) is a medium-sized seabird found over temperate and subantarctic waters in the South Atlantic, Southern Indian, and Western South Pacific Oceans (Ref. 599). The species is a regular and relatively common visitor to southern Australian seas (Ref. 599). In WA, beachcast individuals have been found in the southwest between June and September, though sightings have been recorded throughout most months (Ref. 441).

Primarily a pelagic species, the soft-plumaged petrel is typically found far from land. In Australia, it breeds at two sites: Maatsuyker Island off Tasmania and Macquarie Island, nesting in burrows or rock crevices (Ref. 599). Its movements during the non-breeding season remain poorly documented (Ref. 599). The bird is often observed in small groups, flying swiftly near the water's surface (Ref. 435).

The diet of the soft-plumaged petrel mainly consists of cephalopods, along with fish and crustaceans. It frequently forages by following fishing boats or scavenging in areas with upwelling currents that bring prey to the surface. The species feeds on the wing by dipping to the water’s surface to capture prey and occasionally dives from the surface (Ref. 600).

Breeding and foraging BIAs have been identified (Figure 4-25, Table 4-18) for the soft-plumaged petrel in southwestern WA, from Geraldton to Albany, as well as south of Tasmania. Foraging BIAs overlap the southern section of the PA, particularly within the West Coast section.

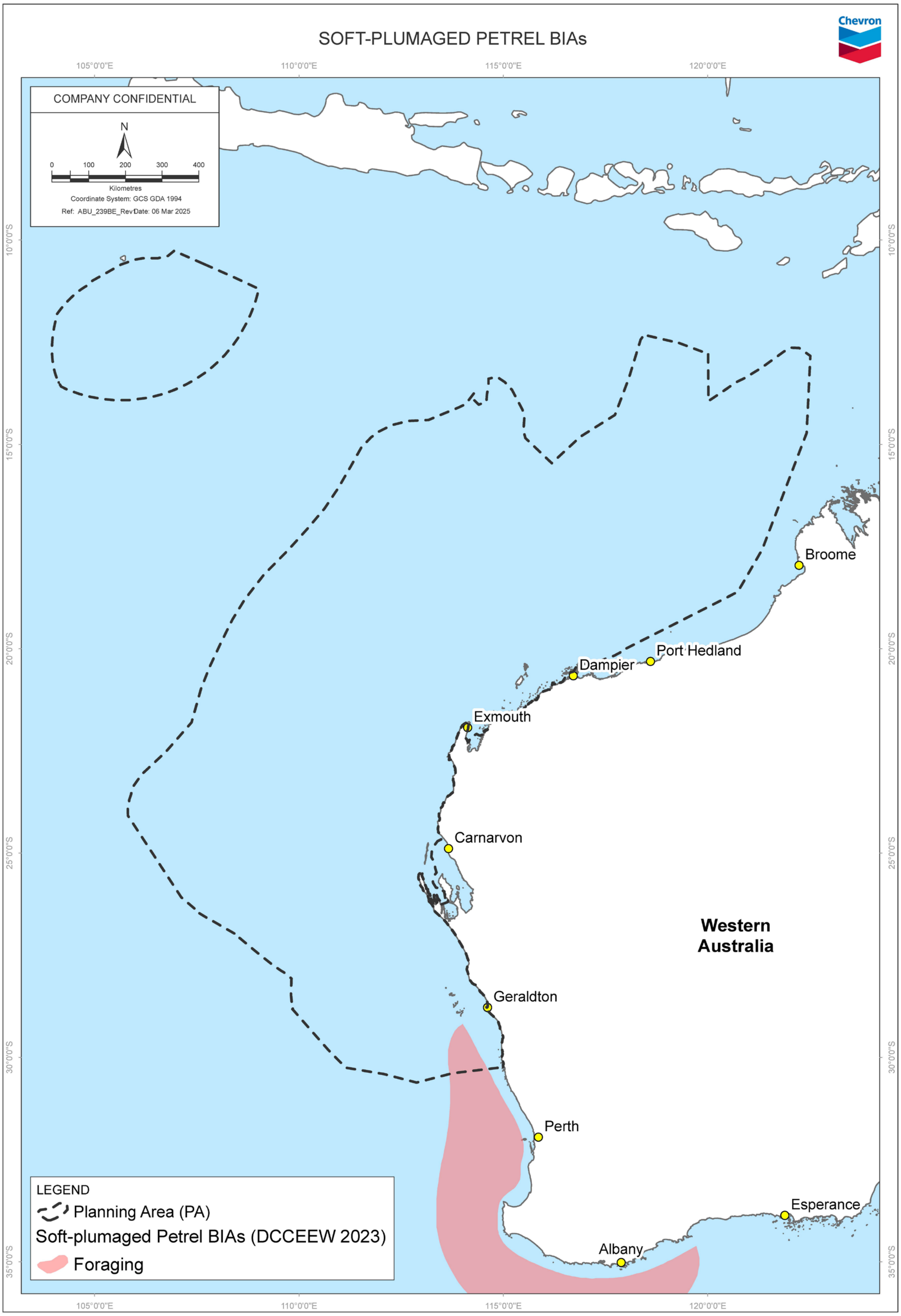

Figure 4-25: Biologically important areas for soft plumage petrel

4.3.4.61 Sooty albatross

The sooty albatross (*Phoebetria fusca*) is a seabird primarily inhabiting the Indian Ocean and surrounding waters, with breeding grounds located in territories belonging to France, South Africa, and the United Kingdom (Ref. 406). While Australia is within the foraging range of the sooty albatross, it is considered a rare visitor to Australian waters (Ref. 406).

This marine and pelagic species is most commonly found south of 35°S during the summer, frequenting subtropical and subantarctic waters, particularly near the Subtropical Convergence (Ref. 602; Ref. 603). Its range extends south of the Antarctic Convergence in the southwestern Indian Ocean, though it is rarely observed beyond this region (Ref. 603). In late autumn and winter, the species predominantly occupies the Subtropical Zone (Ref. 602; Ref. 604). Immature birds remain within the Subtropical Zone year-round.

The sooty albatross is solitary and monogamous (Ref. 601). It occurs widely over pelagic waters during both breeding and non-breeding seasons, foraging across dispersed food sources (Ref. 603). Its diet primarily consists of cephalopods, fish, crustaceans, siphonophores, and occasionally penguin carrion, which it captures while flying over the sea (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.62 Sooty tern

The sooty tern (*Onychoprion fuscatus*) is a medium-sized tropical seabird commonly found in tropical and subtropical regions. It is absent from areas influenced by cold ocean currents and generally avoids islands inhabited by terrestrial predators (Ref. 453). Large populations are present in WA (Ref. 606), Queensland (Ref. 607), and the Coral Sea Marine Park. A 2019 survey of the Ashmore Reef Marine Park (Ref. 608) identified sooty terns as the most abundant bird species at Ashmore.

The species breeds on flat, open, oceanic or barrier islands composed of sand, coral, or rock, which may be sparsely or heavily vegetated. These islands are typically situated in productive tropical and subtropical offshore waters rich in plankton, fish, and squid (Ref. 453; Ref. 605). Their diet predominantly consists of fish and squid, though it occasionally consumes crustaceans, insects, and offal (Ref. 453; Ref. 605). During breeding, it relies heavily on prey driven to the surface by predatory fish, such as tuna (Ref. 452).

Sooty terns are highly adapted to life at sea, exhibiting impressive foraging behaviour. They often hunt in groups, using their speed and agility to capture prey effectively (Ref. 441).

Breeding and foraging BIAs have been identified (Figure 4-26, Table 4-18) for this species in offshore waters along WA, from Augusta to Carnarvon, and around islands off the east coast, from Norfolk Island to offshore Cairns. Breeding BIAs overlap the PA, particularly in the Western Coast section.

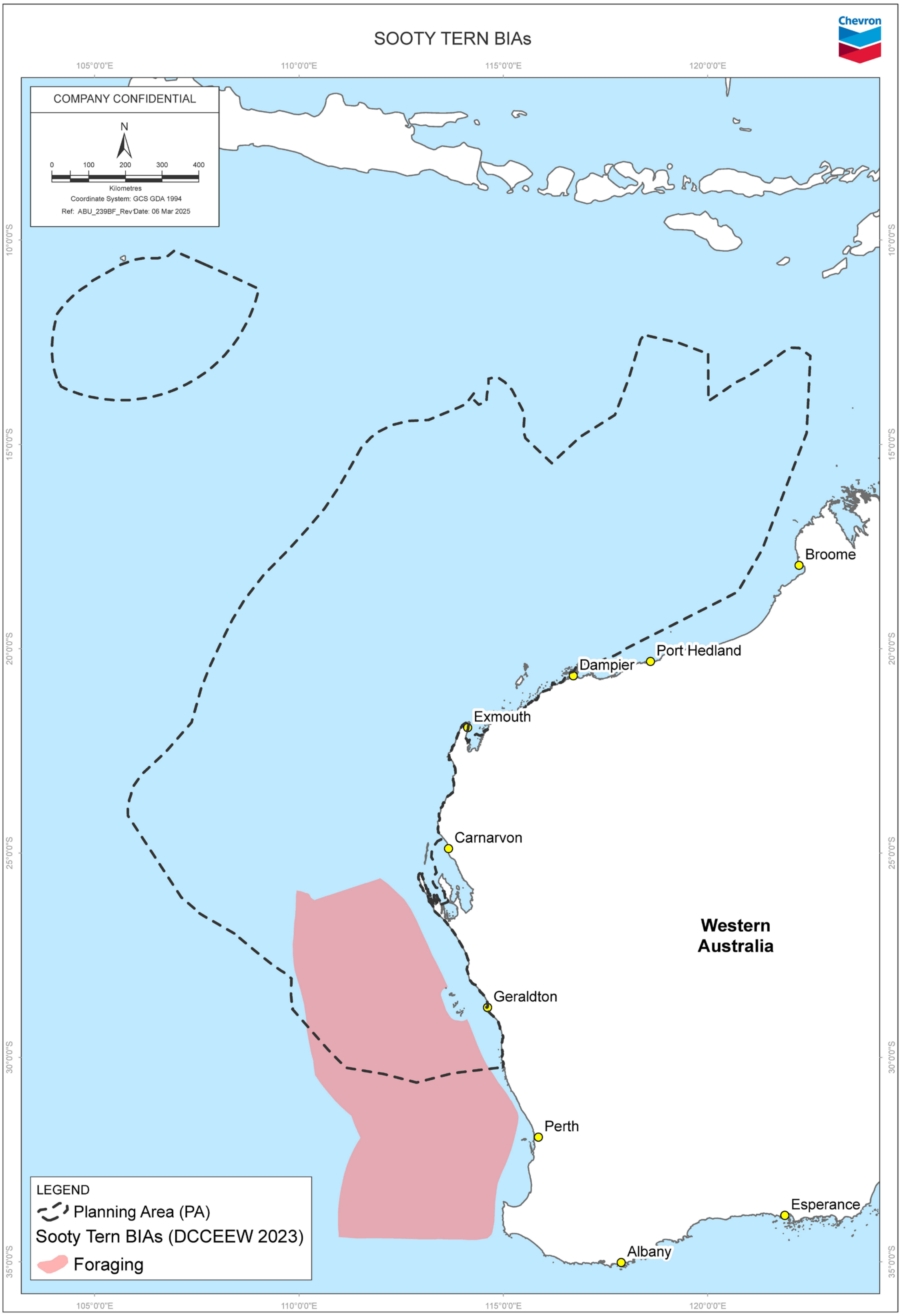

Figure 4-26: Biologically important areas for sooty tern

4.3.4.63 Southern giant-petrel

The southern giant-petrel (*Macronectes giganteus*) is the largest petrel, with a widespread distribution across the Southern Ocean. In Australia, it breeds exclusively in the Australian Antarctic Territory, Heard Island, McDonald Islands, and Macquarie Island (Ref. 406). While the majority of the population breeds annually, a significant proportion (20–40%) does not breed in a given year (Ref. 406).

The species is an opportunistic scavenger. During the breeding season, southern giant petrels primarily prey on cephalopods and fish at sea. On land, they prey on penguin chicks and scavenge seal and penguin carrion (Ref. 553; Ref. 609). Their hunting methods at sea include surface seizing, surface filtering, surface diving, and surface plunging (Ref. 609).

All breeding populations of the southern giant petrel within Australia's jurisdiction are likely to be important for the long-term persistence of the species within Australia (Ref. 406). Foraging BIAs have been identified for this species in the shelf region of NSW coast. These BIAs do not overlap the PA.

4.3.4.64 Southern royal albatross

The southern royal albatross (*Diomedea epomophora*) is a large seabird predominantly found in the subantarctic regions of the Southern Ocean, with primary breeding colonies in New Zealand. Australia lies within the foraging range of this species (Ref. 406).

The southern royal albatross inhabits cold, nutrient-rich waters of the Southern Ocean. It breeds on remote, windswept islands, nesting on flat, grassy plateaus or ridges that are free from predators (Ref. 610). During non-breeding periods, the species ranges widely across the Southern Ocean, including southern subantarctic Australia and the Australian Antarctic Territory (Ref. 406).

Its large wings are adapted for dynamic soaring, an energy-efficient method of flight that allows it to cover vast distances while foraging for squid, fish, and krill (Ref. 441). The southern royal albatross is an efficient forager, capable of traveling thousands of kilometres during its long migrations in search of food (Ref. 610).

No BIAs have been identified for this species in Australia.

4.3.4.65 Streaked shearwater

The streaked shearwater (*Calonectris leucomelas*) is a large shearwater native to the western Pacific. It breeds on coastal and offshore islands in Japan, Russia, China, and the Korean Peninsula (Ref. 408). The species undergoes trans-equatorial migration, traveling south during the northern winter to the coasts of Australia. It is commonly observed between October and March, with occasional records from August to May (Ref. 441).

Streaked shearwaters are typically found over continental shelves and around islands, where they feed on abundant marine resources such as small fish, squid, and other marine organisms. Their primary foraging method is surface-seizing, capturing prey from the water's surface while in flight (Ref. 408; Ref. 441).

During the breeding season, these birds nest on remote islands (Ref. 611). They exhibit strong site fidelity, returning to the same colonies each year. Highly social, streaked shearwaters are often observed in large flocks, particularly while foraging or migrating (Ref. 612).

No BIAs have been identified for this species in Australia.

4.3.4.66 Swinhoe’s snipe

The Swinhoe’s snipe (*Gallinago megala*) is a migratory wader species that occasionally migrates through or winters in Australia. Primarily breeding in Siberia, this snipe migrates to northern coastal regions of Australia during the non-breeding season (Ref. 613). In WA, it has been recorded in the Pilbara, Kimberley region, Mount Goldsworthy, Mount Blaize, and areas around the Mitchell Plateau (Ref. 441). The species is observed in northern Australia, particularly the Kimberley region, from October to April, and may also occur in the Pilbara from October to March (Ref. 613).

During the non-breeding season, Swinhoe’s snipe typically inhabits coastal wetlands, mudflats, and estuarine environments (Ref. 613). It prefers habitats with soft, muddy substrates rich in invertebrate prey such as insects, worms, and small crustaceans (Ref. 441).

The species is known for its long migratory flights, typically undertaken at night, covering vast distances across the Asian continent to reach Australian wetlands. Swinhoe’s snipe is generally solitary or found in small groups, exhibiting swift, direct flight patterns. Unlike many other wader species, it is less frequently observed in large flocks and is known for its elusive behaviour when feeding (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.67 Terek sandpiper

The terek sandpiper (*Xenus cinereus*) is a medium-sized migratory shorebird primarily found along the northwest and east coasts of Australia during the non-breeding season (Ref. 446). It breeds from eastern Europe to eastern Russia, with less than half of the flyway population migrating as far south as Australia (Ref. 519). In WA, the species is widespread in the Pilbara and Kimberley regions, from Dampier to Wyndham, with occasional records around Shark Bay (Ref. 614). Nationally significant numbers of terek sandpipers have been observed at Ashmore Reef (Ref. 446; Ref. 525).

The species arrives around Cairns and Darwin in August, and in northern and north-western Australia beginning of September (Ref. 500). Departure starts in late April (Ref. 436).

Terek sandpipers primarily forage on soft, wet intertidal mudflats or in sheltered estuaries, embayments, harbors, and lagoons. They are also recorded on islets, mudbanks, sandbanks, spits, and near mangroves. While typically foraging in open areas, they may occasionally wade into shallow water (Ref. 470). Their diet includes crabs (Ref. 519), crustaceans, insects, seeds, molluscs, and arachnids (Ref. 441).

The species exhibits swift movements and abrupt changes of direction and is usually seen singly or in small flocks. It can also form communal roosts, sometimes numbering in the hundreds, often among other waders. When roosting, terek sandpipers commonly perch on mangroves, partially submerged posts, or breakwaters, frequently alongside grey-tailed tattlers (Ref. 470).

The *Conservation Advice for terek sandpiper* (Ref. 436) defines habitats critical to the survival of the species as those essential for foraging, breeding, roosting, dispersal, maintaining genetic diversity, and long-term species recovery. However, no critical habitat for the species has been identified within the PA, and no BIAs have been identified for this species in Australia.

4.3.4.68 Wandering albatross

The wandering albatross (*Diomedea exulans*) is a large seabird primarily found in the Southern Ocean, with its distribution extending into Australian waters. While it breeds in subantarctic and Antarctic regions, including Macquarie Island, it is commonly observed in the southern and southeastern oceans of Australia (Ref. 406; Ref. 441).

Wandering albatrosses mostly feed during daylight (Ref. 609; Ref. 615). They often gather in large groups at abundant food sources, such as behind fishing vessels, where they are aggressive scavengers, outcompeting other seabirds for discards and baited hooks (Ref. 597; Ref. 603). Their feeding methods include surface seizing, surface diving up to one meter, and occasional shallow plunging (Ref. 609; Ref. 616). Their diet consists mainly of fish and cephalopods, with smaller amounts of crustaceans, jellyfish, and scavenged prey such as penguins (Ref. 617; Ref. 618; Ref. 619).

Foraging areas vary due to sexual and age-related segregation. During non-breeding years, individuals often maintain a preferred home range 1,500–8,500 km from breeding islands, with females tending to forage in warmer waters than males (Ref. 620). The species demonstrates efficient energy acquisition relative to effort, with the lowest flight costs recorded among seabirds.

Macquarie Island is listed as critical habitat for the Wandering Albatross under the EPBC Act (Ref. 406). Foraging BIAs have been identified in the shelf region off the NSW coast, encompassing the EEZ from the Victorian border to Adelaide, SA. These critical habitats and BIAs do not overlap the PA.

4.3.4.69 Wedge-tailed shearwater

Wedge-tailed shearwaters (*Ardenna pacifica*) are a pelagic, migratory visitor to WA; estimates indicate more than one million shearwaters migrate to the Pilbara islands each year (Ref. 589); out of an estimated global population of five million (Ref. 519). Wedge-tailed shearwaters typically begin arriving at their WA colonies around August each year and will excavate burrows on vegetated islands for nesting; peak egg laying typically occurs during November; and they will typically leave nests in early-April to early-May and travel north to the Indian Ocean (Ref. 441; Ref. 621). Migration from the colony is very synchronous, but the return is less so (Ref. 621). Once adults cease returning to feed their young, the young (fledgling) wedge-tailed shearwaters fledge and depart nests (Ref. 622; Ref. 423).

Known breeding locations in the NWMR include Forestier Island (Sable Island), Bedout Island, Dampier Archipelago, Passage Island, Lowendal Island, islands off Barrow Island (Mushroom, Double and Boodie islands), islands in the Onslow area (including Airlie, Bessieres, Serrurier, North and South Muiron and Locker islands), islands in Freycinet Estuary, and south Shark Bay (Slope, Friday, Lefebre, Charlie, Freycinet, Double and Baudin islands) (Ref. 519).

Baseline monitoring (pre-construction of the Gorgon Gas Development) recorded ~20–50 wedge-tailed shearwater nesting burrows on North Double Island and ~300 on South Double Island (Ref. 455; Ref. 624). CAPL (Ref. 253; Ref. 455) provided an estimate of 500 burrows over a 2 ha portion of the north-eastern corner of South Double Island, supporting 5,000–10,000 pairs of wedge-tailed shearwaters.

This species forages relatively close to breeding islands and its diet consists of squid, fish, and crustaceans (Ref. 519). However, more recent studies have indicated bimodal foraging. A study on foraging behaviour of the wedge-tailed shearwaters during the 2018 nesting season on the Muiron Islands showed a bimodal foraging strategy that incorporated both short (<4 days) and long (>7 day) trips (Ref. 621). The foraging trips of the wedge-tailed shearwaters from the Muiron Islands were recorded over a large area, extending from the Cape Range Canyon to the Indonesian Archipelago; and a consistent pattern of foraging near seamounts was observed (Ref. 621). It is noted that this same area is part of the foraging extent used by the wedge-tailed shearwaters from both Pelsaert and Houtman Abrolhos islands) (Ref. 621; Ref. 425). The use of a bimodal foraging strategy suggests that prey availability close to the colony (i.e. areas that would be utilised on short trips) are inadequate for the large numbers of breeding shearwaters (Ref. 621).

Breeding and foraging BIAs have been identified (Figure 4-27, Table 4-18) for this species in WA, Victoria, NSW and Queensland. In the NWS, only breeding BIAs has been identified, which overlap with the PA.

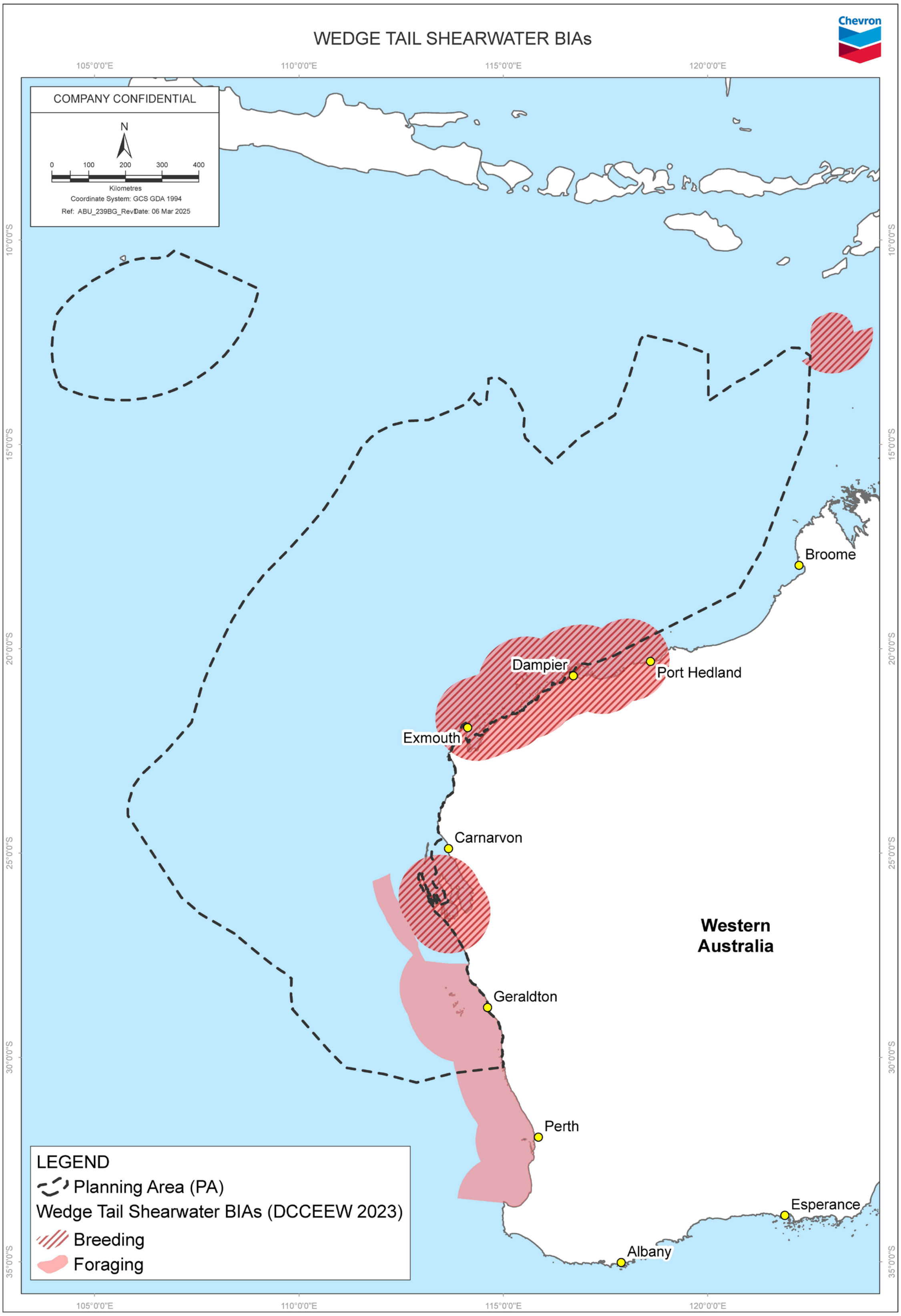

Figure 4-27: Biologically important areas for wedge-tailed shearwater

4.3.4.70 Whimbrel

The whimbrel (*Numenius phaeopus*) is a migratory wader that travels from its Arctic breeding grounds to Australia during the non-breeding season (Ref. 519). It is commonly found along Australia's northern coasts. In WA, it is widespread from Carnarvon to the northeast Kimberley Division. The species is occasionally observed along the south coast and in the southwest, including Shark Bay (Ref. 626).

In WA, Whimbrels migrate south through Roebuck Bay from August to September (Ref. 500). They begin their northward migration in February, with most leaving Roebuck Bay between mid- and late April (Ref. 626). Whimbrels are present in nationally significant numbers at Ashmore Reef during the southern spring and summer, between September and March (Ref. 446).

Whimbrels primarily inhabit intertidal mudflats along sheltered coasts, but they are also found in harbours, lagoons, estuaries, and river deltas, often in areas with mangroves or open, unvegetated mudflats (Ref. 626). These habitats provide abundant food sources, including molluscs, worms, and crustaceans (Ref. 441). The species forages on intertidal mudflats, muddy estuary banks, and coastal lagoons and often roosts in mangroves or other elevated structures during high tide (Ref. 626).

Whimbrels are social birds, typically observed in small groups or loose flocks during the non-breeding season, particularly in areas with plentiful food (Ref. 441).

No BIAs have been identified for this species in Australia.

4.3.4.71 White-capped albatross

The white-capped albatross (*Thalassarche steadi)* is a medium-sized seabird endemic to New Zealand, with a foraging range that extends into Australian waters (Ref. 406). It is observed in Australian southern oceans, particularly around Tasmania and the southern coasts of Victoria and NSW, during the non-breeding season (Ref. 441).

This species inhabits pelagic zones, far from the coastline, where it forages in the open ocean (Ref. 441). Its diet primarily consists of squid, fish, and krill, which it captures while gliding over the ocean or diving from the air (Ref. 441; Ref. 627).

The white-capped albatross is solitary and monogamous, typically forming long-term pair bonds with a single mate (Ref. 441). During the non-breeding season, it is migratory, traveling vast distances across the Southern Ocean in search of food. It is usually observed alone or in small groups while foraging but may gather in areas with abundant food resources (Ref. 441).

Foraging BIAs have been identified for the species along the NSW shelf. These BIAs do not overlap the PA.

4.3.4.72 White-faced storm petrel

The white-faced storm petrel (*Pelagodroma marina*) is a medium-sized petrel commonly found over inshore and oceanic waters around southern Australia (Ref. 408). This species has an extensive range, breeding on remote islands in the North and South Atlantic Ocean, as well as along the coasts of southern Australia and New Zealand (Ref. 408).

During the breeding season (September to March), the species nests in burrows on remote, rocky islands in subantarctic and temperate regions, such as

Macquarie Island and other islands off southern Australia, where it is sheltered from predators (Ref. 408; Ref. 628). Females typically lay a single egg per breeding season (Ref. 408; Ref. 628).

The white-faced storm petrel feeds primarily on planktonic crustaceans, krill, small fish, and zooplankton (Ref. 408). It forages while in flight, using a pattering and dipping technique to snatch prey from the water (Ref. 408; Ref. 629), and occasionally follows cetaceans to access disturbed prey. The species rarely follows ship (Ref. 408).

The white-faced storm petrel is migratory, moving from temperate breeding areas to tropical and subtropical waters during the non-breeding season (Ref. 408).

Breeding and foraging BIAs have been identified (Figure 4-28, Table 4-18) in southern Australia. Foraging BIAs overlap the south section of the PA, particularly the West Coast section.

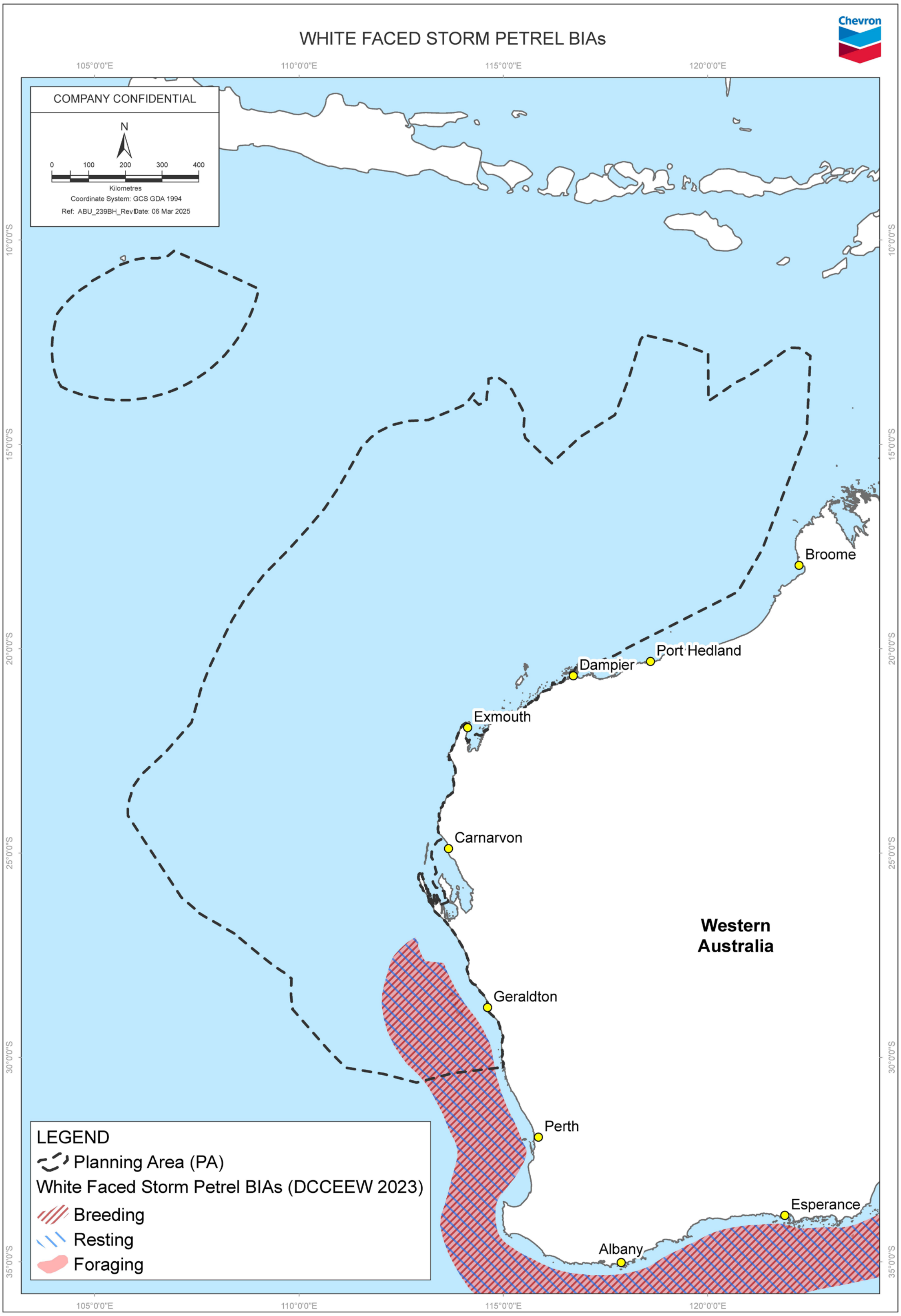

Figure 4-28: Biologically important areas for white-faced storm petrel

4.3.4.73 White-tailed tropicbird

The white-tailed tropicbird (*Phaethon lepturus*) is a pantropical seabird widely distributed across tropical and subtropical regions. It is primarily found off the northern coast of WA, with occasional sightings in the Coral Sea and along the east coast (Ref. 408; Ref. 630). The subspecies *P. l. lepturus* is present in the NWMR but is limited in both numbers and distribution (Ref. 519).

Tropicbirds are predominantly pelagic, rarely coming to shore except to breed (Ref. 519). Their nests are located on islands and atolls, utilising a variety of habitats, including closed-canopy rainforests, bare sandy ground, and rugged rocky terrain (Ref. 408).

White-tailed tropicbirds are solitary foragers, primarily feeding on flying fish and cephalopods (Ref. 441). They forage at the ocean's surface, occasionally diving shallowly, and rest on the water between foraging bouts (Ref. 631). Their foraging range is extensive, with some individuals travelling up to 1,600 km from their breeding colonies, such as those on Christmas Island (Ref. 630).

Breeding BIAs have been identified (Figure 4-29, Table 4-18) in waters off the northwest coast of WA, particularly near Port Hedland and Derby, within the Pilbara and Kimberley sections of the PA.

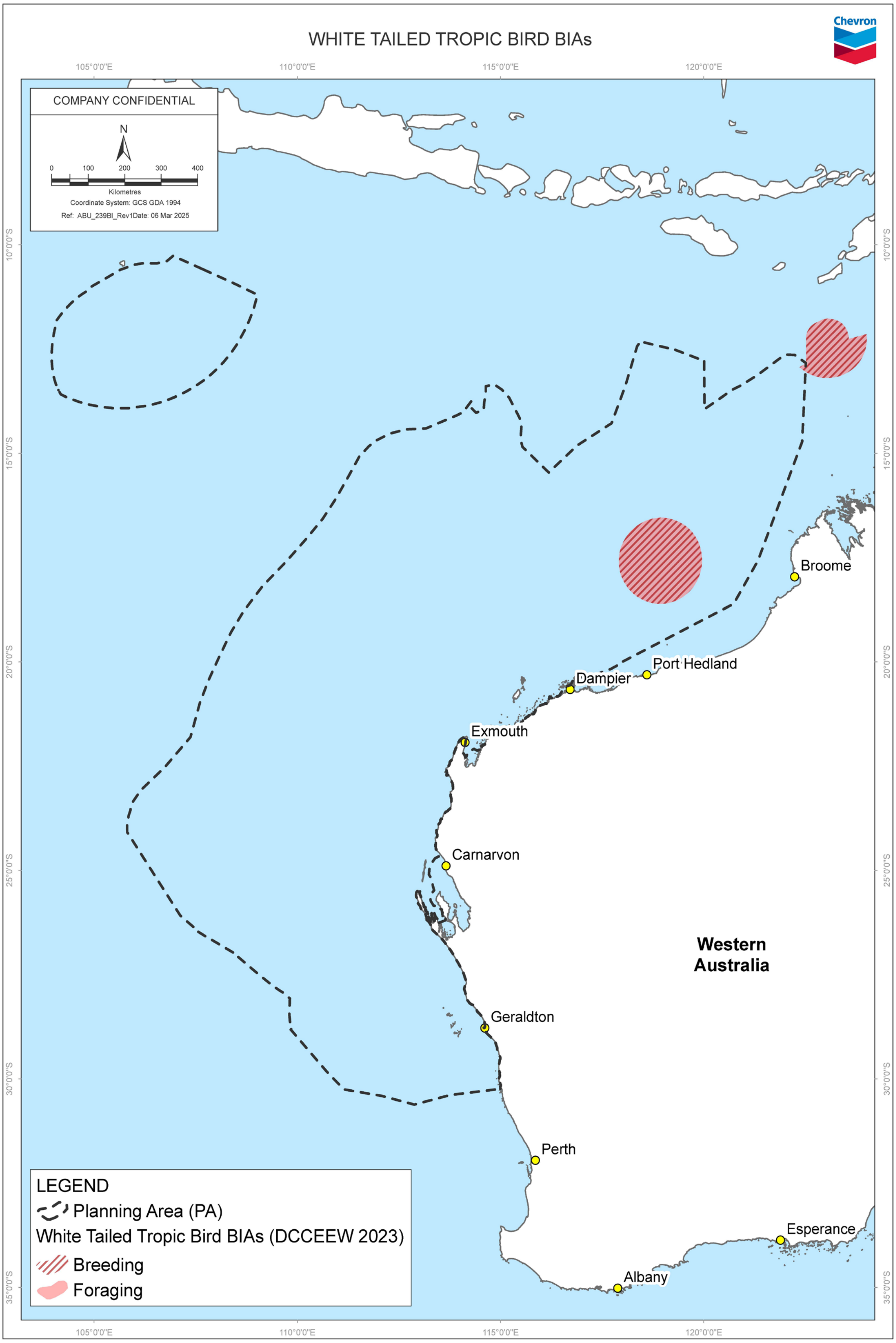

Figure 4-29: Biologically important areas for white-tailed tropicbird

4.3.4.74 Wood sandpiper

The wood sandpiper (*Tringa glareola*) is a migratory shorebird that breeds across Eurasia and visits Australia, typically between August and departures in March or April (Ref. 452).

This species inhabits well-vegetated, shallow freshwater wetlands such as swamps, billabongs, lakes, pools, and waterholes. These wetlands are often characterised by emergent aquatic plants or grasses and fringed with taller vegetation, such as dense stands of rushes or reeds, shrubs, or live and dead trees (Ref. 639). In WA, the wood sandpiper is often concentrated at specific sites within wetlands, frequently occurring within a few meters of one another (Ref. 452).

The Wood Sandpiper forages along the moist or dry mud margins of wetlands, including shores, areas with open scattered aquatic vegetation, and shallow clear water (Ref. 452). Its diet in Australia primarily consists of insects and molluscs, reflecting its carnivorous feeding habits (Ref. 452).

Typically observed singly, in pairs, or in small flocks, the Wood Sandpiper occasionally gathers in flocks of hundreds. It freely associates with other wader species and often feeds in scattered groups (Ref. 639). In Australia, it is most commonly seen in small to medium-sized groups in suitable feeding areas (Ref. 640).

No BIAs have been identified for this species in Australia.

4.3.5 Summary of marine fauna seasonal sensitivities

Table 4-20 presents periods of the year coinciding with key biologically important behaviours for EPBC Act listed threatened and/or migratory species that may potentially be in the Pilbara Section, where CAPL's activities are primarily concentrated.

Table 4-20: Seasonal presence of marine fauna with biologically important behaviours within the Pilbara section of the PA

Activity / Species	January	February	March	April	May	June	July	August	September	October	November	December
Marine mammals												
Dugong breeding, foraging and nursing[1]												
Humpback whale migration[2]												
Humpback whale resting[3]												
Pygmy blue whale northern migration[4]												
Pygmy blue whale southern migration[4]												
Southern right whale migration[5]												
Southern right whale reproduction[6]												
Reptiles												

Activity / Species	January	February	March	April	May	June	July	August	September	October	November	December
Flatback turtle nesting and internesting[7]												
Green turtle nesting and internesting[8]												
Hawksbill turtle nesting and internesting[9]												
Loggerhead turtle internesting[10]												
Fishes, including sharks and rays												
Whale shark migration and foraging[11]												
Southern bluefin tuna spawning[12]												
Seabirds and shorebirds												
Australian fairy tern breeding[13]												
Brown booby breeding[14]												
Lesser crested tern breeding[15]												
Lesser frigatebird breeding[16]												
Little tern nesting[17]												
Roseate tern breeding[18]												
Wedge-tailed shearwater migration[19]												
Wedge-tailed shearwater breeding[20]												
White-tailed tropicbird breeding[21]												

	Species may be present and display biologically important behaviour in the region
	Predicted peak period

1. Dugong breeding, foraging and nursing occurs along the Ningaloo coast year-round (Ref. 33).
2. Humpback whale migration along WA coast typically occurs between May and November (Ref. 80; Ref. 81). Predicted peak migration periods for the Montebello Islands region are late-July (northern) and early-September (southern) (Ref. 79).
3. Humpback whale females and calves are known to stop and rest in Exmouth Gulf and Shark Bay. Peak densities of lactating females were observed in late September to early October around Exmouth Gulf (Ref. 79).
4. Pygmy blue whales migrate north along the WA coast between February and August (Ref. 88; Ref. 92), with predicted highest densities in the Montebello Island region during May and June (Ref. 93). Pygmy blue whales migrate south between November and January (Ref. 88; Ref. 92), with predicted highest densities in the Montebello Island region during November and December (Ref. 93).
5.Souther right whale migration in WA, spans 3 nm from Exmouth to Augusta with migration occurring from April to October (Ref. 33).
6. From May to October, Southern right whales inhabit calving and nursing grounds, with peak calving occurring in late July and August (Ref. 41).
7.Seasonal presence within nesting and internesting habitat critical to the survival of flatback turtles in the Pilbara (including Barrow and Montebello islands) is predicted to occur between

Activity / Species	January	February	March	April	May	June	July	August	September	October	November	December
October and March (Ref. 198), with peak nesting activity on Barrow Island predicted between November and January (Ref. 241). 8. Seasonal presence within nesting and internesting habitat critical to the survival of green turtles in the NWS (including Barrow and Montebello islands) is predicted to occur between November and March (Ref. 198), with peak nesting activity on Barrow Island predicted between December and February (Ref. 241). 9. Seasonal presence within nesting and internesting habitat critical to the survival of hawksbill turtles in WA (including Montebello and Lowendal islands) is predicted to occur between October and February Ref. 198), with peak nesting activity on Barrow Island predicted in October (Ref. 241). 10. Seasonal presence within internesting habitat critical to the survival of loggerhead turtles in WA (including Muiron Islands) is predicted to occur between November and May (Ref. 198). 11.Whale shark migration occurs mainly between July to November along the 200 m isobath (Ref. 304). A foraging BIA for Whale Sharks is associated with the area around this isobath. 12. Two peaks spawning periods have been observed in southern bluefin tuna spawning ground: September–October and February–March (Ref. 696; Ref. 697). 13. The Pilbara and upper Gascoyne sedentary population of Australian Fairy Terns nests from late-July to late-September (Ref. 412). 14. Brown booby breeding around Bedout Island occurs from February to October, with a peak in March to May (Ref. 33). 15. Lesser crested terns breed in the Pilbara region from March to June (Ref. 33). 16. Breeding colonies of lesser frigatebirds are known on Adele, Bedout, and West Lacapede Islands (Ref. 441), as well as Ashmore Reef and Cartier Island (Ref. 539). Breeding occurs from March to September (Ref. 33). 17. The breeding subpopulation of little terns nest along nearshore islands in the Kimberley likely supporting breeding pairs during September and October (Ref. 539). 18. Roseate terns breed in the Pilbara region from March to July and October (Ref. 589). 19. Wedge-tailed shearwaters typically begin arriving at their WA colonies around August; and then leave nests in early-April to early May (Ref. 441; Ref. 621). Once adults cease returning to feed their young, the young (fledging) wedge-tailed shearwaters fledge and depart nests (Ref. 622; Ref. 423). 20. Wedge-tailed shearwaters breed in the Pilbara region from November to April (Ref. 306); peak egg laying typically occurs during November (Ref. 441; Ref. 621). 21. White-tailed tropicbirds breed on Ashmore Reef and Rowley Shoals from May to October (Ref. 33).												

4.4 Marine environmental quality

The term ‘environmental quality’ refers to the level of contaminants, or changes to the physical or chemical properties relative to a natural state (Ref. 643).

4.4.1 Meteorology

Northwest WA is characterised by an arid, subtropical climate. During summer (September to March), average temperatures range from 23°C to 32°C, while winter (May to July) mean temperatures range from 19°C to 25°C (Ref. 644). April and August are transitional months, with weather conditions varying between summer and winter regimes (Ref. 645). The region experiences relatively low rainfall overall, though heavy downpours can occur during tropical cyclones and depressions. Average temperatures in the north SWMR are lower than those in northwest WA (Ref. 644).

Wind patterns in northwest WA are influenced by the monsoonal climate, characterised by the summer monsoon (December to April) and winter monsoon (June to October) (Ref. 646). In winter, the higher latitudinal position of the anticyclonic belt results in strong offshore trade winds over the Pilbara. During summer, as the belt shifts to its southernmost latitude, monsoonal wind systems move into the area, combining with regular prevailing south-southwesterly winds and sea breezes to influence the weather (Ref. 647).

The cyclone season in northwest WA typically occurs between November and April, predominantly affecting the region between Broome and Exmouth (Ref. 648). On average, two cyclones per year cross the Pilbara coast, bringing intense winds that can reach up to 300 km/h (Ref. 647).

Christmas Island, part of Australia's IOT, has a tropical climate with temperatures ranging from 21°C to 32°C. Humidity is around 80–90% and south-east trade winds provide pleasant weather for most of the year. However, during the wet season between November and April, it is common for some storm activity to occur producing a swell in seas around the Island. The average rainfall is ~2,000 mm per annum (Ref. 649).

4.4.2 Oceanography

Waters in north-west WA, including Christmas Island, are tropical year-round, with sea surface temperature in open shelf waters reaching ~26°C in summer, and dropping to ~22°C in winter. Nearshore temperatures of north-west WA fluctuate through a higher temperature range from ~17°C in winter to ~31°C in summer (Ref. 650). Tropical surface waters are also present in the northern section of the SWMR, aligning with the temperature and salinity characteristics of the Leeuwin Current (Ref. 651).

The major surface currents influencing WA flow towards the poles and include the Indonesian Throughflow, the Leeuwin Current, the South Equatorial Current, and the Eastern Gyral Current. The Ningaloo Current, the Holloway Current, the Shark Bay Outflow, and the Capes Current are seasonal surface currents in the region. Below these surface currents are several subsurface currents, the most important of which are the Leeuwin Undercurrent and the West Australian Current. These subsurface currents flow towards the equator in the opposite direction to surface currents (Ref. 3). Water circulation in WA is strongly influenced by the southward-flowing Indonesian Throughflow, whose strength varies seasonally with the northwest monsoon (Ref. 3).

The NWMR is notable for large internal waves, with amplitudes up to 75 m, which facilitate the mixing of surface waters with nutrient-rich deeper waters. This mixing is critical for biological productivity in the region. Key sites of internal wave activity include the Exmouth Plateau and the slope adjacent to the NWS (Ref. 3). In the SWMR, wave energy is also high, particularly on the continental shelf throughout the region (Ref. 5).

North-west WA experiences some of the largest tides along a coastline adjacent to an open ocean in the world. Tidal amplitudes increase from south to north, corresponding to the widening continental shelf (Ref. 3). Nearshore waters exhibit larger and stronger tidal movements than offshore waters. Tides in the region are broadly categorised as semidiurnal (i.e. two high tides and two low tides per day) with a spring/neap cycle (Ref. 3). In the SWMR, tidal flows are generally small (2–5 cm/s) over the adjacent shelves, but stronger tidal currents (~50 cm/s) occur in the gulfs (Ref. 651).

4.4.3 Water quality

The NWS is characterised by a relatively clear water column; however, these waters sometimes have naturally higher levels of turbidity as a result of local current, tidal or wave-induced resuspension of fine sediments and seasonal fluvial inputs (Ref. 652; Ref. 653). In the waters off the east coast of Barrow Island, turbidity and concentrations of suspended sediments were generally low (<5 mg/L) and indicative of clear water environments (Ref. 653).

The nearshore waters on the east coast of Barrow Island are generally oligotrophic, with temporal fluctuations in nutrients (Ref. 653; Ref. 654). Nutrient concentrations were generally below the Australian and New Zealand Governments (ANZG) default trigger values (nutrient enrichment) for tropical Australia, with occasional fluctuations of ammonia, nitrite+nitrate, and orthophosphate well above guideline values (Ref. 653; Ref. 654). Pre-construction water quality sampling off the east coast of Barrow Island showed that concentrations of metals were typically consistently below the ANZG guideline trigger values for 99% species protection (Ref. 653).

Close to the Australian mainland, in the waters surrounding the Dampier Archipelago, Wenziker et al. (Ref. 655) estimated natural background concentrations for various potential contaminants. These contaminants included heavy metals (e.g. cadmium, chromium, copper, lead, mercury, and zinc) and organic chemicals (e.g. polycyclic aromatic hydrocarbons, total petroleum hydrocarbons). The survey identified low background concentrations of both metals and organic chemicals, with localised elevations of some contaminants (metals) near the coastal industrial centres and ports (e.g. Dampier).

With the exception of select constituents, such as relatively high natural levels of cadmium, the concentrations of metals were low by world standards. Wenziker et al. (Ref. 655) recommended that guideline water quality trigger values from the ANZG for Fresh and Marine Water Quality (Ref. 656) are suitable for use in the NWS.

Salinity in the waters of north-west WA varies spatially and temporally, ranging from 34.4 to 36.3 g/L in offshore areas around the NWS (Ref. 655). Salinity for the SWMR and Christmas Island also fall within these ranges (Ref.29; Ref. 659).

The SWMR has clear waters and low turbidity, the region's waters are typically oligotrophic which fluctuate in nutrient concentrations due to seasonal changes and natural processes or local runoff (Ref. 7; Ref. 657). Overall, the water quality supports a healthy marine ecosystem, though local variations can occur near infrastructure, ports and anthropogenic activities (Ref. 7). Similar characteristics are expected from Christmas Island (Ref. 657; Ref. 658).

4.4.4 Sediments quality

Sediment quality sampling during 2014 and 2015 off the east coast of Barrow Island showed that except for nickel in one reference site sample, total metal concentrations of all sediment samples were below respective laboratory Limit of Reporting (LoR) and/or Interim Sediment Quality Guideline (ISQG)-Low trigger values (Ref. 653). Sediment tributyltin concentrations were all below the laboratory LoR and the ISQG-Low trigger value, except for one sample in each of the 2014 and 2015 surveys (Ref. 653). Total petroleum hydrocarbons and Total polycylic aromatic hydrocarbon (PAH) concentrations were all below the LoR in 2014 and at very low concentrations in 2015 samples (with a much lower LoR). Once normalised for (very low) organic carbon content, six samples from 2015 were above ISQG-Low concentrations for benzo(a)pyrene, but well below the ISQG-High concentrations (Ref. 653).

Closer to the Australian mainland, from Exmouth to the Dampier Archipelago, the Department of Environment and Conservation (Ref. 660) estimated background concentrations for various potential contaminants. Background sediment quality was found to be high, with concentrations of most metals and metalloids at similar levels or lower than those observed in other studies conducted in northern Australia. However, total arsenic concentrations were relatively high (median of 36 mg/kg for one site off Onslow) and exceeded the recommended sediment quality guideline at some essentially unimpacted locations sampled across the region. These elevations are considered natural and likely related to the region's geology.

The report (Ref. 660) did not detect organic chemicals in any of the samples. However, compliance with the recommended sediment quality guidelines could not be determined for eight of the analysed chemicals (acenaphthene, anthracene, dibenzo(ah)anthracene, fluorene, lindane, chlordane, dieldrin and endrin) due to laboratory LoR limitations.

In the SWMR, metal and hydrocarbon concentrations are typically low to moderate levels with some localised hotspots near urban, industrial and agricultural areas (Ref. 12). The remoteness of Christmas Island and its limited industrial activity contribute to the low concentration of metals and hydrocarbons in its waters (Ref. 658).

4.4.5 Air quality

Vessel traffic and existing offshore infrastructure are the main sources of pollutants in the PA. Closer to the coast, localised and temporary reductions in air quality may occur in areas with high vessel traffic or as a result of dust storms and bushfires.

As part of the Ambient Air Quality Monitoring Program on Barrow Island, there were no recorded exceedances for nitrogen dioxide (NO_2), ozone), sulfur dioxide (SO_2), carbon monoxide, hydrogen sulfide (H_2S), or aromatic hydrocarbons (benzene, toluene, ethylbenzene and xylene) against the relevant National Environmental Protection Measure (NEPM) standards (Ref. 661). There have been elevations of PM_{10} levels around facilities on Barrow Island, however these are likely associated with vehicle traffic and regional weather events (Ref. 661).

In the northern sector of the SWMR there has been elevations of PM_{10} air quality index between 30-35 μg/m^3. This is typically in the moderate range and not hazardous for the general public (Ref. 662). Christmas Island has an average annual air quality index of 20 μg/m^3 indicating less polluted air (Ref. 663).

4.5 People and communities

People and communities, and specifically their social, economic, and cultural features, are included in the definition of environment within the OPGGS(E)R. People and communities have been identified and described to the extent that they are directly affected, or are affected by, the existing physical and biological environments.

The NWMR and SWMR support a range of economic, social, and cultural activities. At present, industries within these regions include petroleum exploration and production, commercial and recreational fishing, tourism, ports and shipping (Ref. 3; Ref. 5). These uses of the NWMR and SWMR make an important economic and social contribution to settlements along the coast (Ref. 3). Industry activities present with the PA are identified in Section 5.6.

As outlined in Section 1.1, this document describes the 'offshore area' where CAPL’s activities may interact with the environment, typically extending up to the high-water mark.

Given that CAPL’s activities are primarily concentrated in the Pilbara region, additional details are provided below for that area. If further descriptions are required in a project-specific EP, CAPL will assess their significance and include detailed information in the EP as necessary.

4.5.1 Land use

The Montebello Islands are designated as a State Conservation Park (International Union for Conservation of Nature II (IUCN II)) (Section 6.3), and are surrounded by the State Montebello Islands Marine and Conservation Parks (Section 6.2) and the Commonwealth Montebello Marine Park (IUCN VI) (Section 6.1). The Conservation Park is gazetted to the HWM. Given the natural values of the islands and surrounding waters, recreational activities may occur. Shore-based fishing, beach walks, picnics and wildlife viewing are types of activities that may occur (Ref. 664). Camping is permitted on some of the islands (with some restrictions during turtle nesting season) (Ref. 664).

Barrow, Double, Middle, and Boodie islands are designated as State Nature Reserves (IUCN IA) (Section 6.3), and are surrounded by the Barrow Island Marine Park (IUCN IA) and Barrow Island Marine Management Area (IUCN VI) (Section 6.2). The Nature Reserves are gazetted to the low water mark (LWM). Access to Barrow, Double, Middle, and Boodie Islands is not encouraged due to numerous natural and man-made hazards, including the operation of an oilfield and the Gorgon Gas Project (Ref. 664). Camping is not permitted on any of these islands (Ref. 664).

The Pilbara Inshore Islands are a group of over 170 islands, islets, rocks and cays that lie between the bottom of Exmouth Gulf and the Regnard Islands near Cape Preston (Ref. 664). Some of the islands are classified as Nature Reserves (IUCN IA) (Section 6.3). The islands are gazetted to both the LWM and HWM. The Pilbara Inshore Islands Nature Reserves are known as important breeding and resting places for migratory and resident shorebirds, seabirds and marine turtles (Ref. 664). Shore-based fishing, beach walks and wildlife viewing are types of activities that may occur in the Pilbara Inshore Islands Nature Reserves (Ref. 664). Camping is only permitted on certain islands and may require a permit (Ref. 664).

The Bundegi Coastal Park is a 5(1)(h) Reserve (IUCN II) (Section 6.3), protected under WA jurisdiction, and forms part of the Ningaloo Coast World Heritage Area (Section. 7.1). The terrestrial protected area is gazetted to the HWM. Given the natural values of the parks and surrounding waters, recreational activities may occur. Walk trails, wildlife viewing, camping, beachcombing, swimming, snorkelling, beach fishing are types of activities that may occur (Ref. 665).

The Dampier Archipelago comprises 42 islands and islets off the coasts of Dampier and Point Samson (Ref. 664; Ref. 666). 25 of these islands are nature reserves protected under WA jurisdiction (Ref. 664). The islands are known as nesting sites for marine turtles, breeding grounds for land, sea, and shorebirds, and a popular destination for marine fauna viewing (Ref. 666). Alongside the Burrup Peninsula, the islands host one of the densest and most diverse collections of rock art globally, as well as other Aboriginal heritage features such as shell middens, stone arrangements, and artefact scatters (Ref. 664). Camping is permitted on selected islands for up to five consecutive nights, up to 100 m inland from the HWM in areas zoned for recreation.

Recreational activities along the Pilbara coastline include fishing, diving, snorkelling, and boating (Ref. 666; Ref. 667). The beaches near Onslow and surrounding areas are also known for sunset beach walks (Ref. 667).

Native Title determinations extend into the PA (Section 7.3.2). The determination areas contain places of special significance, such as spiritual and ceremonial sites and natural resources (Ref. 668).

4.5.2 Heritage

Heritage includes places, values, traditions, events and experiences that capture where we have come from, where we are now and gives context to where we are headed as a community (Ref. 669).

Where known heritage sites and/or artefacts are formally protected under specific heritage legislation, these are described within Section 7. The following sections summarise other known heritage values identified within the PA, with a focus on the NWMR, where the majority of the PA lies.

4.5.2.1 First nations cultural activities

The land adjacent to the NWMR has been inhabited by First Nations people for at least 50,000 years, and they continue to use the NWMR and adjacent coastal resources, and have an ongoing connection to these areas (Ref. 3).

Evidence from offshore waters near Murujunga (Burrup Peninsula) and on Barrow Island are indicative of the historical and ongoing connection of First Nations people to the NWMR.

Australia's first confirmed First Nations underwater archaeological sites were identified in 2020 in waters offshore from Murujuga (Burrup Peninsula) during the Deep History of Sea Country Project (Ref. 670). These findings confirmed an understanding that First Nations people would have lived on lands that are now submerged in water from rising seas after the last glacial maximum (LGM)[11]. At the LGM sea level was ~125 m below present (Ref. 672); this coincides with the ancient coastline at 125 m depth KEF (refer to Section 4.6.1 for a description of this KEF).

Recent studies at Murujuga have demonstrated that archaeological material remains on the seabed, predating inundation by rising seas (Ref. 670; Ref. 673). Previous geomorphological work (which was based on the analysis of available 3D seismic data) on the mid to outer shelf regions proximal to Barrow Island, demonstrated the presence of a highly complex and geomorphically mature coastal landscape preserved at depths of 70–75 m below sea level, including coastal barrier dunes, lagoonal systems, tidal flats, and estuarine channels. (Ref. 672). Such feature preservation has significant geoheritage value (Ref. 672).

Archaeological deposits from Boodie Cave on Barrow Island, reveal some of the oldest evidence for First Nations occupation of Australia, as well as illustrating the early use of marine resources (Ref. 674). First occupation on Barrow Island has been dated as occurring between 51.1 and 46.2 ka, overlapping with earliest

[11] The period of the LGM in Australia is described as 24 to 18 ka (Ref. 671).

dates for occupation of Australia (Ref. 674). There is evidence of marine resources (e.g. shellfish, fish) being incorporated into dietary assemblages by 42.5 ka on Barrow Island; which continued through all periods of occupation, despite fluctuating sea levels and associated extensions of the coastal plain (Ref. 674). The caves on Barrow Island (including Boodie Cave), and others on nearby Montebello Islands, were abandoned by 6.8 ka when rising sea levels reached their present levels, and the islands had become increasingly distant from the mainland coast (Ref. 674). Despite the isolation of Barrow Island from the mainland for most of the Holocene, Thalanyji knowledge holders refer to historic use of the island from both colonial-era fishing activities and indentured labour in the pearling grounds (Ref. 675).

First Nations people have a culture that relates to a connectedness of land and sea in a holistic way (Ref. 676). The term ‘Country’ refers to more than just a geographical area, and includes values, places, resources, stories, and cultural obligations associated with that geographical area (Ref. 677). For First Nations peoples the term ‘Country’ includes both land and sea and the coastal areas that are connected with the traditional Country of a group or clan. Both Country and Sea Country, contain evidence of the ancient events by which all geographic features, animals, plants and people were created (Ref. 676). For example, Thalanyji knowledge holders reference Sea Country “between the islands of the shelf”, and “see the artifacts as an important manifestation of their ancestral use of, and connection to, the now-drowned coastal plain” (Ref. 675).

Cultural heritage is not only comprised of tangible values; it also includes intangible values. Tangible values are those with a physical nature (such as artefacts and engravings); while intangible values are those that do not have a physical component (such as songlines and dances). Songlines are a feature of First Nations culture, linking people, places, and practices (Ref. 678). Certain songlines are referred to as ‘Dreaming pathways’ because of the tracks forged by Creator Spirits during the Dreaming; these Dreaming songlines have specific ancestral stories attached to them (Ref. 679). Nunn and Reid (Ref. 680) discuss how First Nations oral traditions have documented sea level rise over the last 7,000 years. Kearney et al. (Ref. 681) also discusses how seabed mapping near Murujuga (Burrup Peninsula) identified two submerged waterholes that were identified by local senior elders as belonging to the Kangaroo songline. A song line from the mainland to Barrow Island has been referenced during studies involving Thalanyji knowledge holders (Ref. 675) and also identified by representatives of Mardathoonera Cultural Heritage Pty Ltd (MCH) during consultation (Table 4-21).

The cultural, customary, and spiritual significance of species and the ecological communities they form are diverse and varied for First Nations people and their stewardship of Country (Ref. 41). For example, some First Nations people have a strong connection to whales, which has significance as totemic ancestors to some groups (Ref. 41). The arrival of whales along Australia's coast marked the arrival of the "elders of the sea", which follows a songline that traces the journeys of ancestral spirits as they created the land, animals, and lore (Ref. 41).

First Nations people in northwest WA continue to rely on coastal and marine environments and resources of the region for their cultural identity, health and wellbeing, and their domestic and commercial economies (Ref. 677). Their commitment to their sea country is demonstrated through their native title claims and their many initiatives to regain their role as managers of the cultural and natural values of northwest WA (Ref. 677).

First Nations peoples of northwest WA engage in a diverse range of marine resource use activities, including hunting, egg collecting, fishing and gathering shellfish. Activities also continue on lands and waters where they have a ceremonial and spiritual connections (Ref. 677).

Consultation with First Nations groups and individuals has identified that Sea Country is of importance to their people (Table 4-21). These values include coastal areas, offshore islands, marine fauna, and traditional stories (e.g. it is believed that the Dreamtime serpent which created the rivers and inland springs is now in its resting place off the Pilbara coast; and as such, if the sea is protected, then the serpent is also being protected). It is acknowledged that First Nations people who are the custodians of this knowledge have the rights to decide how it is shared and used.

Underwater cultural heritage (UCH), including First Nations UCH, as protected under the UCH Act is discussed in Section 7.2.

Table 4-21: Cultural values or features identified through consultation

Source	Cultural value or feature
Baiyungu Aboriginal Corporation (BAC)	• the Baiyungu coastal area, Sea Country, and adjacent islands are highly valuable to the Baiyungu people • no specific areas have been identified through consultation however BAC has noted the cultural importance of Sea Country and the need to ensure it is protected.
Buurabalayji Thalanyji Aboriginal Corporation (BTAC)	• the Thalanyji people have a deep connection to Sea Country north of Onslow, extending out into the islands off the coast of the Pilbara including: – Montebello Islands – Barrow Island – Mackerel Islands – Direction Island – Airlie Island – Weld Island – North and South Islands – Ashburton Island – Twin Islands – any island or atoll proximate to the above islands – a general radius of 150 km from Onslow.
Kariyarra Aboriginal Corporation (KAC)	• KAC has noted that flatback turtles are culturally significant • KAC has also identified the importance of protecting marine fauna.
Malgana Aboriginal Corporation	• Malgana Aboriginal Corporation identified Shark Bay seagrass as culturally significant.
Mardathoonera Cultural Heritage Pty Ltd (MCH)	• identified a connection with Barrow Island and surrounding waters; specific values described include: – the creation story starts on Barrow Island – Barrow Island is a place that connects saltwater and freshwater together – Barrow Island is connected to Murujuga; both are considered by MCH as women’s places – Biggada Creek is significant and connected to the Fortescue River; and that the rock formations in the creek are protectors – women’s sites and ancestor spirits are present on Barrow Island

Source	Cultural value or feature
	• identified that Barrow Island was a hill in ancient times and is a sister hill to two hills on the mainland, and old people would walk across before the sea levels rose and the island drifted; because of this, there will be artefacts and stories underwater • identified cultural importance of traditional stories, songlines ocean, and marine fauna – the sea is the source of energy for all life, it holds the codes that are encrypted in each person's body, the songlines, and is the lifeforce for the world – the places where the saltwater from the sea and the freshwater from the land connect are where the biggest energy lines are, and that connection is a force of creation relevant to a Dreaming story – songlines extend out from the land, through the sea, and around the globe – songlines connect places, people, and animals to each other, creating migratory patterns for animals and telling animals of the right time to birth and eat – freshwater that flows underneath the seabed carries the songlines – there is a large energy line that exists off the coast of Murujuga and runs through the area that CAPL operates in – there are songlines that go through Barrow Island and offshore and connect Barrow Island to the mainland; this includes a whale songline – Mardathoonera people are connected to songlines—if the songlines are disrupted, their widdart (heart) is disconnected, like the whales, their feet get lost and they don't know where to go anymore. • Country owns people and we are all connected by energy – different frequencies connect all beings on earth and everything on earth is connected – if you protect country, it will protect you – women hold the energy connected to water.
Murujuga Aboriginal Corporation (MAC)	• no specific areas have been identified through consultation however MAC has noted the cultural importance of Sea Country and the need to ensure it is protected.
Nganhurra Thanardi Garrbu Aboriginal Corporation (NTGAC)	• no specific areas have been identified through consultation however NTGAC has noted the cultural importance of Sea Country and the need to ensure it is protected • in addition CAPL understands the Ningaloo Coast is culturally significant to the groups NTGAC represents.
Ngarluma Aboriginal Corporation (NAC)	• NAC has noted that offshore islands are culturally significant.
Ngarluma Yindjibarndi Foundation Ltd (NYFL)	• the people from the land speak for and care about the marine animals, even if they are far out to sea • identified that marine fauna, specifically whales, dugongs, and turtles are species of importance • the nature of many traditional narratives have origins and connection to the seascape, and that impacts to the seascape can have cultural repercussions • presence and importance of intangible values, such as Barrimirndi (the serpent), which is an important part of dreaming for Ngarluma and Yindyibarndi people

Source	Cultural value or feature
	• identified the interconnectedness of the cultural landscape, whereby Traditional Owners from the western Pilbara are held to account by other Nyambali (cultural bosses) when proponents impact land and sea • cultural responsibilities transcend Native Title and other boundaries.
Robe River Kuruma Aboriginal Corporation (RRKAC)	• the area within their Kuruma Mardathoonera native title claim, Jajiwurra (Robe River) and the waters extending seaward from the river mouth • ecological integrity of Jajiwurra.
Wirrawandi Aboriginal Corporation (WAC)	• the coastal area, Sea Country, and adjacent islands are highly valuable to the Yaburara and Mardathoonera people • identified a connection to Barrow Island.
Yinggarda Aboriginal Corporation (YAC)	• Bernier Island, Dorre Island and associated Sea Country have been identified as significant to the Yinggarda people.
Yamatji Marlpa Aboriginal Corporation (YMAC)	• no specific areas have been identified through consultation; however, YMAC has noted the cultural importance of Sea Country and the need to ensure it is protected.

4.5.2.2 European heritage

Early European exploration of the NWMR and adjacent coast occurred in the 1600s; however, it was concluded at the time that resources and conditions were not appropriate for settlement (Ref. 677). British colonisation did not begin in the Pilbara until 1860s, with pastoralism the first major industry, followed by small ports and service centres (Ref. 677). The pearling industry began in the late-1800s, and remains a significant contributor to the economy of northwest WA (Ref. 677).

Similarly, small fishing fleets were common from the 1860s onwards, and the commercial fishing industry also remains a significant economic input for northwest WA, particularly from prawn and demersal finfish fisheries (Ref. 3). Petroleum discovery and development commenced from the 1950s, with both onshore and offshore discoveries (Ref. 3).

The marine and coastal industries that still exist and operate within the PA are further described in Section 5.6.

4.6 Commonwealth marine area

The Commonwealth marine area is a MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R. The PA is within Commonwealth waters off WA that are part of the NWMR and SWMR.

The NWMR comprises the Commonwealth waters and seabed from the WA— NT border south to Kalbarri (Ref. 3). The NWMR is characterised by shallow-water tropical marine ecosystems with high species richness. Most of the region’s species are tropical and are also found in other parts of the Indian and western Pacific oceans (Ref. 3).The region is a tropical carbonate margin that comprises an extensive area of shelf, slope, and abyssal plain/deep ocean floor, as well as complex areas of bathymetry such as plateau, terraces and major canyons (Ref. 9). The region experiences a tropical monsoonal climate towards the northern extent of the region, transitioning to tropical arid and subtropical arid within the central and southern areas of the region (Ref. 3).

The SWMR comprises Commonwealth waters from the eastern end of Kangaroo Island in SA to Shark Bay in WA (Ref. 5). Particular hotspots for biodiversity are the Houtman Abrolhos Islands, the overlap between tropical and temperate fauna along the west coast, the Recherche Archipelago and the soft sediment ecosystems in the Great Australian Bight (Ref. 5). The low-nutrient environment of the SWMR results in clear waters and high levels of light penetration, giving rise to a continental shelf characterised by high diversity of seagrass and algal species and benthic communities (Ref. 5).

Conservation values of the Commonwealth marine area include:

- protected species and/or their habitat (Section 4.3)
- protected places including Australian Marine Parks (Section 6.1) and heritage places (Section 7)
- KEFs (Section 4.6.1).

4.6.1 Key ecological features

KEFs are elements of the Commonwealth marine environment that are considered to be of regional importance for a region's biodiversity or its ecosystem function and integrity. KEFs are not MNES and have no legal status in their own right; however, they are considered as components of the Commonwealth marine area.

KEFs meet one or more of these criteria (Ref. 3; Ref. 5):

- a species, group of species, or a community with a regionally important ecological role (e.g. a predator, or prey that affects a large biomass or number of other marine species)
- a species, group of species, or a community that is nationally or regionally important for biodiversity
- an area or habitat that is nationally or regionally important for:
  - enhanced or high productivity (such as predictable upwellings—an upwelling occurs when cold nutrient-rich waters from the bottom of the ocean rise to the surface)
  - aggregations of marine life (such as feeding, resting, breeding or nursery areas)
  - biodiversity and endemism (species that only occur in a specific area)
- a unique sea floor feature, with known or presumed ecological properties of regional significance.

KEFs have been identified by the Australian Government based on advice from scientists about the ecological processes and characteristics of the area.

The presence of KEFs within the PA, and a description of the KEFs values, are shown in Table 4-22 and Figure 4-30.

Table 4-22: Presence of KEFs

KEF	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Ancient coastline at 125 m depth contour	—	—	✓	✓	—
Parts of the ancient coastline, particularly where it exists as a rocky escarpment, are thought to provide biologically important habitats in areas otherwise dominated by soft sediments. The topographic complexity of these escarpments may also facilitate vertical mixing of the water column, providing relatively nutrient-rich local environments (Ref. 3). The ancient submerged coastline provides areas of hard substrate and therefore may provide sites for higher diversity and enhanced species richness relative to surrounding areas of predominantly soft sediment. Little is known about fauna associated with the hard substrate of the escarpment but it is likely to include sponges, corals, crinoids, molluscs, echinoderms and other benthic invertebrates representative of hard substrate fauna in the North West Shelf bioregion (Ref. 3). **Values:** Unique sea floor feature with ecological properties of regional significance (Ref. 3).					
Ancient coastline at 90-120 m depth	✓	—	—	—	—
A prominent escarpment occurs close to the middle of the continental shelf off the Great Australian Bight at a depth of 90–120 m. Experts suggest that, in places, this ancient coastline may support some demersal fish species travelling across the continental shelf to the upper continental slope—thereby supporting ecological connectivity. Benthic biodiversity and productivity occur where the ancient coastline forms a prominent escarpment, such as in the western Great Australian Bight, where the sea floor is dominated by sponge communities of significant biodiversity and structural complexity (Ref. 5). Large sponges up to one metre across—which is remarkable for any discrete colonial animal—have been recorded from this area; the large individuals at these depths are likely to be many decades old (Ref. 5). **Values:** Relatively high productivity and aggregations of marine life, and high levels of biodiversity and endemism (Ref. 5).					
Canyons linking the Argo Abyssal Plain with the Scott Plateau	—	—	—	✓	—
The canyons linking the Argo Abyssal Plain and Scott Plateau are important features likely to be associated with aggregations of marine life (Ref. 3). The Bowers and Oats canyons are major canyons on the slope between the Argo Abyssal Plain and Scott Plateau. The canyons cut deeply into the south-west margin of the Scott Plateau at a depth of ~2,000–3,000 m, and act as conduits for transport of sediments to depths of more than 5,500 m on the Argo Abyssal Plain (Ref. 683). Benthic communities at these depths are likely to be dependent on particulate matter falling from the pelagic zone to the sea floor. The ocean above the canyons may be an area of moderately enhanced productivity, attracting aggregations of fish and higher-order consumers such as large predatory fish, sharks, toothed whales and dolphins. Whaling records from the 19th century suggest that sperm whales aggregated over Scott Plateau for reasons that remain unclear (Ref. 3). **Values:** High productivity and aggregations of marine life (Ref. 3).					
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	—	✓	✓	—	—
The canyons are associated with upwelling as they channel deep water from the Cuvier Abyssal Plain up onto the slope. This nutrient-rich water interacts with the Leeuwin Current at the canyon heads. Aggregations of whale sharks, manta rays, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area (Ref. 3). The canyons on the slope of the Cuvier Abyssal Plain and Cape Range Peninsula are connected to the Commonwealth waters adjacent to Ningaloo Reef and may also have					

KEF	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
connections to Exmouth Plateau. The narrow shelf width (~10 km) near the canyons facilitates nutrient upwelling. Thus the canyons probably play a part in the enhanced productivity of the Ningaloo Reef system. (Ref. 3). The canyons are also repositories for organic and inorganic particulate matter from the shelf and serve as conduits for its transfer from the surface and shelf to greater depths. The hard substrates of canyons provide habitat for deepwater snapper and other species (Ref. 11). **Values:** Unique seafloor features with ecological properties of regional significance (Ref. 3).					
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	✓	—	—	—	—
The Houtman Abrolhos Islands and surrounding reefs support a unique mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. The Houtman Abrolhos Islands are the largest seabird breeding station in the eastern Indian Ocean. They support more than one million pairs of breeding seabirds. (Ref. 5). The islands represent the southern limit in WA of many widespread Indo-Pacific tropical fish. The high biodiversity of the islands is attributed to the mix of temperate and tropical species, resulting from the southward transport of species by the Leeuwin Current over thousands of years. Many of the islands' biodiversity features rely on the benthic and pelagic ecosystems in deeper, offshore waters—most notably, seabirds and rock lobster (Ref. 5). **Values:** High levels of biodiversity and endemism (Ref. 5).					
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	✓	—	—	—	—
The chain of inshore lagoons that extends from south of Mandurah to Kalbarri is considered important for benthic productivity and recruitment for a range of marine species. The lagoons are formed by distinct ridges of limestone reef with extensive beds of macroalgae (principally *Ecklonia spp*.) and extend to a depth of 30 m. Although macroalgae and seagrass appear to be the primary source of production, scientists suggest that groundwater enrichment may supplement the supply of nutrients to the inshore lagoon (Ref. 5). These lagoons are important for benthic productivity, including macroalgae and seagrass communities, and breeding and nursery aggregations for many temperate and tropical marine species. They are important areas for the recruitment of commercially and recreationally important fishery species. Extensive schools of migratory fish visit the area annually, including herring, garfish, tailor and Australian salmon. Seagrass meadows occur in more sheltered areas and in the inter-reef lagoons along exposed sections of the coast (Ref. 5). **Values:** High productivity and aggregations of marine life (Ref. 5).					
Commonwealth waters adjacent to Ningaloo Reef	—	✓	✓	—	—
The Commonwealth waters adjacent to Ningaloo reef include Ningaloo Marine Park (Commonwealth waters) and encompass an area of 2,435 km^2. This feature lies adjacent to the Ningaloo Reef state water margin at the 3 nm limit. Ningaloo Reef is globally significant as the only extensive coral reef in the world that fringes the west coast of a continent. Upwellings associated with canyons on the adjacent slope and interactions between the Ningaloo and Leeuwin currents are thought to support the rich aggregations of large marine species present at Ningaloo Reef (Ref. 3). Aggregations of whale sharks, manta rays, humpback whales, sea snakes, sharks, large predatory fish and seabirds are known to occur in this area (Ref. 3).					

KEF	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Detrital input from phytoplankton production in surface waters and from higher-trophic consumers cycles back to the deeper waters of the shelf and slope (Ref. 11). Deepwater biodiversity includes fish, molluscs, sponges, soft corals and gorgonians. Some of these sponge and filter-feeding communities appear to be significantly different to those of the Dampier Archipelago and Abrolhos Islands, indicating that the Commonwealth waters of Ningaloo Marine Park have some particular areas of potentially high and unique sponge biodiversity (Ref. 684). **Values:** High productivity and aggregations of marine life (Ref. 3).					
Continental Slope Demersal Fish Communities	—	✓	✓	✓	—
The diversity of demersal fish assemblages on the continental slope in the Timor Province, the Northwest Transition and the Northwest Province is high compared to elsewhere along the continental slope (Ref. 3). The continental slope between North West Cape and the Montebello Trough has more than 500 fish species, 76 of which are endemic, which makes it the most diverse slope bioregion in Australia (Ref. 685). The demersal fish species occupy two distinct demersal community types associated with the upper slope (water depth of 225–500 m) and the mid slope (750–1,000 m) (Ref. 3). Bacteria and fauna present on the continental slope are the basis of the food web for demersal fish and higher-order consumers in this system (Ref. 3). **Values:** High levels of endemism (Ref. 3).					
Exmouth Plateau	—	—	✓	—	—
The Exmouth Plateau is a regionally and nationally unique deep-sea plateau in tropical waters. The plateau is a very large topographic obstacle that may modify the flow of deep waters, generating internal tides and may contribute to upwelling of deeper water nutrients closer to the surface, thus serving an important ecological role (Ref. 3). The topography of the plateau (with valleys and channels), in addition to potentially constituting a range of benthic environments, may provide conduits for the movement of sediment and other material from the plateau surface through the deeper slope to the abyss (Ref. 3). The Exmouth Plateau is generally an area of low habitat heterogeneity; however, it is likely to be an important area of biodiversity as it provides an extended area offshore for communities adapted to depths of around 1,000 m. Sediments on the plateau suggest that biological communities include scavengers, benthic filter feeders and epifauna. Fauna in the pelagic waters above the plateau are likely to include small pelagic species and nekton (Ref. 11). **Values:** Unique seafloor feature with ecological properties of regional significance (Ref. 3).					
Glomar Shoals	—	—	✓	—	—
The Glomar Shoals are a submerged littoral feature at depths of 33–77 m (Ref. 683). The shoals consist of a high percentage of marine-derived sediments with high carbonate content and gravels of weathered coralline algae and shells (Ref. 686). The area's higher concentrations of coarse material in comparison to surrounding areas are indicative of a high-energy environment subject to strong sea-floor currents (Ref. 683). Cyclones are also frequent in this area of the north-west and stimulate periodic bursts of productivity as a result of increased vertical mixing (Ref. 3). it is known to be an important area for a number of commercial and recreational fish species such as rankin cod, brown-striped snapper, red emperor, crimson snapper, bream and yellow-spotted triggerfish (Ref. 687). These species have recorded high catch rates associated with the Glomar Shoals, indicating that the shoals are likely to be an area of high productivity. **Values:** High productivity and aggregations of marine life (Ref. 3).					
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	—	—	✓	✓	—

KEF	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
The KEF encompasses Mermaid Reef Marine National Nature Reserve as well as waters from 3 nm out to 6 nm surrounding Clerke and Imperieuse reefs (Ref. 3). The reefs of the Rowley Shoals (including Mermaid Reef) are areas of enhanced productivity and high species richness. Enhanced productivity that contributes to this species richness is thought to be facilitated by the breaking of internal waves in the waters surrounding the reefs, causing mixing and re-suspension of nutrients from water depths of 500–700 m into the photic zone. The steep changes in slope around the reef also attract a range of migratory pelagic species such as dolphins, tuna, billfish and sharks (Ref. 3). The reefs provide a distinctive biophysical environment in the region as there are few offshore reefs in the north-west. The reefs may play a role in supplying coral and fish larvae to reefs further south via the southward flowing Indonesian Throughflow. Both coral communities and fish assemblages differ from similar habitats in eastern Australia (Ref. 688). **Values:** High productivity and aggregations of marine life (Ref. 3).					
Perth Canyon and adjacent shelf break, and other west coast canyons	✓	—	—	—	—
The Perth Canyon is prominent among the west coast canyons because of its size and ecological importance; however, the sheer abundance of canyons spread over a broad latitudinal range makes this feature important as a whole. The west coast canyons are believed to be associated with small, periodic upwellings that locally enhance productivity and attract aggregations of marine life (Ref. 5). The Perth Canyon is the largest known undersea canyon in Australian waters. Deep ocean currents rise to the surface, creating a nutrient-rich cold water habitat attracting feeding aggregations of deep-diving mammals, such as pygmy blue whales and large predatory fish that feed on aggregations of small fish, krill and squid (Ref. 5). **Values:** High biological productivity and aggregations of marine life, and unique seafloor features with ecological properties of regional significance (Ref. 5).					
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	—	—	—	✓	—
Seringapatam Reef and the Commonwealth waters in the Scott Reef complex are regionally important in supporting the diverse aggregations of marine life, high primary productivity and high species richness associated with the reefs themselves. As two of the few offshore reefs in the north-west, they provide an important biophysical environment in the region (Ref. 3). The coral communities at Scott and Seringapatam reefs play a key role in maintaining the species richness and subsequent aggregations of marine life identified as conservation values for this key ecological feature. Scott Reef is a particularly biologically diverse system and includes >300 species of reef-building corals, ~400 mollusc species, 118 crustacean species, 117 echinoderm species and around 720 fish species (Ref. 689). Scott and Seringapatam reefs and the waters surrounding them attract aggregations of marine life including humpback whales and other cetacean species, whale sharks and sea snakes (Ref. 689; Ref. 690; Ref. 691). **Values:** High productivity and aggregations of marine life (Ref. 3).					
Wallaby Saddle	—	✓	—	—	—
The Wallaby Saddle may be an area of enhanced productivity. Historical whaling records provide evidence of sperm whale aggregations in the area of the Wallaby Saddle, possibly due to the enhanced productivity of the area and aggregations of baitfish (Ref. 3). It is a unique habitat that neither occurs anywhere else nearby (within hundreds of kilometres) nor with as large an area (Ref. 683). The Wallaby Saddle covers 7,880 km^2 of sea floor					

<table>
<tr><th rowspan="2">KEF</th><th colspan="5">Section</th></tr>
<tr><th>West Coast</th><th>Ningaloo</th><th>Pilbara</th><th>Kimberley</th><th>Christmas Island</th></tr>
<tr><td colspan="6">(Ref. 692) in water depths of 4,000–4,700 m (Ref. 683) and is located within the Indian Ocean water mass (Ref. 3).
Values:
High productivity and aggregations of marine life (Ref. 3).</td></tr>
<tr><td>Western demersal slope and associated fish communities</td><td>✓</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="6">The western demersal slope provides important habitat for demersal fish communities, with a high level of diversity and endemism. A diverse assemblage of demersal fish species below a depth of 400 m is dominated by relatively small benthic species such as grenadiers, dogfish and cucumber fish. Unlike other slope fish communities in Australia, many of these species display unique physical adaptations to feed on the sea floor (such as a mouth position adapted to bottom feeding), and many do not appear to migrate vertically in their daily feeding habits (Ref. 5).
Values:
Species groups that are nationally or regionally important to biodiversity (Ref. 5).</td></tr>
<tr><td>Western rock lobster</td><td>✓</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td colspan="6">This species is the dominant large benthic invertebrate in the region. The lobster plays an important trophic role in many of the inshore ecosystems of the SWMR. Western rock lobsters are an important part of the food web on the inner shelf, particularly as juveniles (Ref. 5).
Western rock lobsters are also particularly vulnerable to predation during seasonal moults in November–December and to a lesser extent during April–May (Ref. 5).
Values:
A species that plays a regionally important ecological role (Ref. 5).</td></tr>
</table>

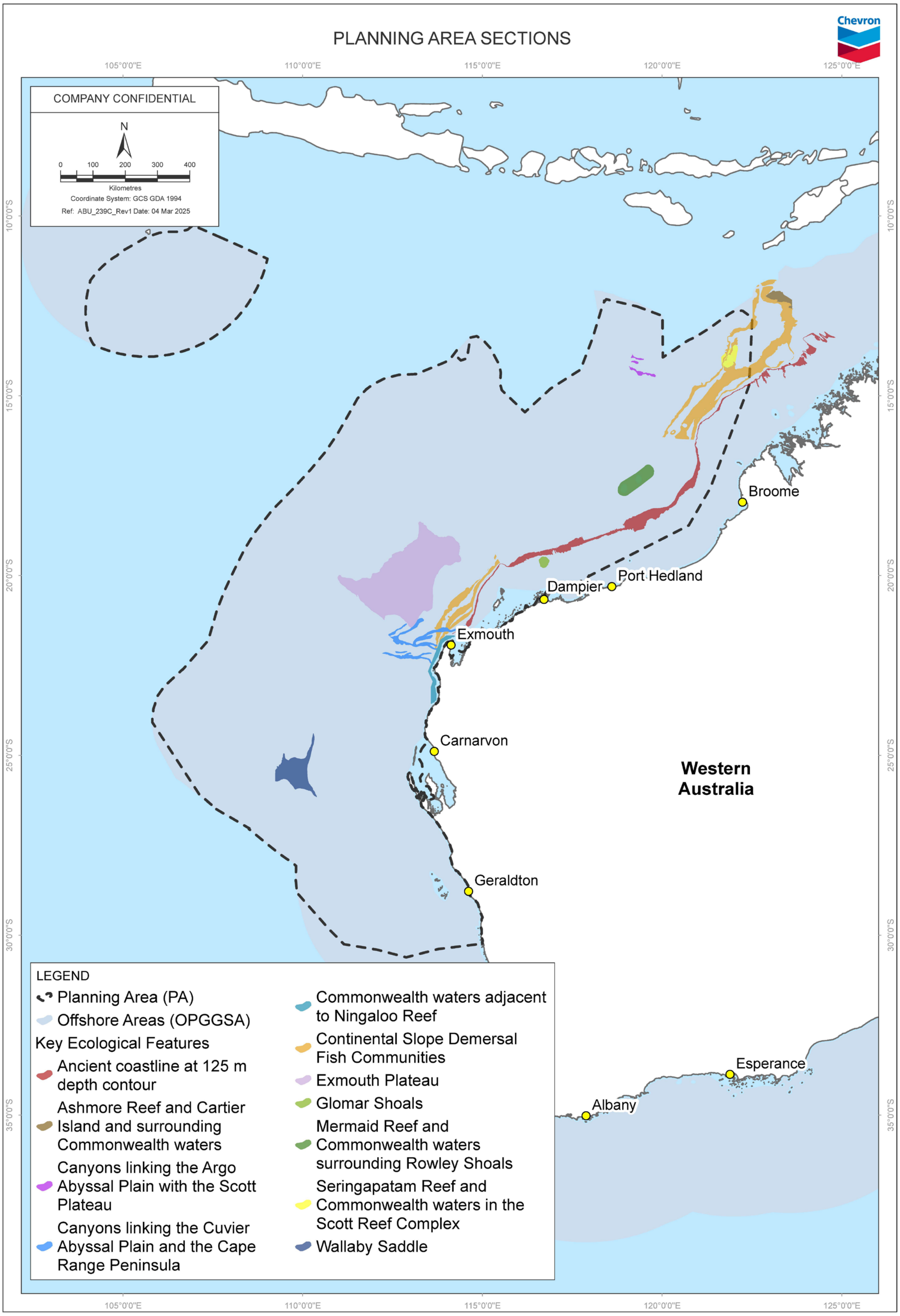

Figure 4-30: KEFs within the vicinity of the PA

4.7 Commonwealth land area

Commonwealth land[12] is a relevant value and sensitivity under the OPGGS(E)R. Based on spatial review and searches of the EPBC Act protected matters database (appendix a) presence of Commonwealth land within the PA was identified, except in the Kimberley section. Specific details are not provided in this document. However, if Commonwealth land is identified within an Operational Area described in a project-specific EP, CAPL will assess its significance and include detailed information in that EP, if necessary.

[12] Commonwealth land includes land owned or leased by the Commonwealth or a Commonwealth agency, land in the Jervis Bay Territory, land in the Christmas Island, Ashmore and Cartier Islands, Coral Sea Islands, Cocos (Keeling) Islands, Australian Antarctic territory and Heard and McDonald Islands external territories, and any other area of land that is included in a Commonwealth reserve.

5 natural and physical resources

Natural and physical resources are described as substances occurring in nature which can be exploited for economic gain, and may include such resources as fishing stocks, petroleum reservoirs, or values of the Commonwealth marine area.

Marine and coastal industries have been developed based on natural and physical resources, and where these industries may overlap with the PA they have been identified and described in the following sections.

5.1 Commercial fisheries

5.1.1 Commonwealth-managed fisheries

The Commonwealth-managed commercial fisheries with fishery management areas that intersect the PA, and that have fishing effort recorded during 2018–2023 (Ref. 693) are listed in Table 5-1. Further descriptions are provided in the following subsections.

The southern bluefin tuna fishery primarily operates within the Great Australian Bight and southeastern Australian waters; however, known spawning grounds overlap with parts of the PA, particularly in the Pilbara, Kimberley, and Christmas Island sections.

5.1.1.1 Southern bluefin tuna fishery

A known spawning ground for southern bluefin tuna occurs in the Indian Ocean between Java and northern WA (Ref. 694; Ref. 695). The indicative spawning ground for the southern bluefin tuna (based on geospatial data provided by Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES), and as shown in annual Commonwealth fishery status reports) extends into the PA. Two peaks have been observed in southern bluefin tuna spawning activity: September–October and February–March (Ref. 696; Ref. 697). Spawning typically occurs near the water surface. The fish then regularly dive into deeper waters to thermoregulate as they are cold-water fish and cannot tolerate warm waters for extended periods (Ref. 696). Individual fish probably stay in the spawning area for one month or so (Ref. 696; Ref. 698). The larvae drift passively before becoming entrained in the southwards flowing South Java and Leeuwin Currents and carried down the coast of WA (Ref. 696). One to two-year old juveniles then head east to the Great Australian Bight, or west to the waters off South Africa (Ref. 697).

Table 5-1: Presence of recent (2018–2023) fishing effort recorded within Commonwealth-managed commercial fisheries

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
North-west slope trawl fishery	—	—	✓	✓	—	**Area** Between the 200 m isobath and the outer boundary of the Australian Fishing Zone. **Fishing methods** Bottom (or demersal) trawl methods to target deep-water prawn and scamp. **Key species** The primary species is Australian scampi, with smaller quantities of velvet scampi (*M. velutinus*) and Boschma's scampi (*M. boschmai*). The fishery also interacts with a number of other scampi species often grouped together and reported as mixed scampi (*Metanephrops spp.* and *Nephropsis spp.*). A quantity of prawns is also harvested each season, and squids are becoming an increasingly significant component of the catch. **Fishing efforts** Increased from 196 days, 3,950 trawl-hours and seven fishing permits in 2021–22 season to 218 days, 4,349 trawl hours and seven fishing permits in 2022-23 season. **Fishing mortality** Scampi stock are classified as not overfished and not subject to overfishing.
Western deepwater trawl fishery	✓	✓	✓	—	—	**Area** Waters seaward of a line approximating the 200 m isobath, in habitats ranging from temperate–subtropical in the south to tropical in the north. **Fishing methods** Demersal trawl methods, catching >50 species. **Key species** The primary species are dominated by six commercial finfish species or species groups: orange roughy (*Hoplostethus atlanticus*), oreos (*Oreosomatidae*), boarfish (*Pentacerotidae*), eteline snapper (*Lutjanidae: Etelinae*), apsiline snapper (*Lutjanidae: Apsilinae*) and sea bream (*Lethrinidae*). Between 2000 and 2005, deepwater bugs emerged as the most important target species.

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Fishing efforts No catch or effort was recorded in 2022–23. The total catch in the WDTF for 2021–22 was 12 t, with a catch effort of 7 days and 76 trawl-hours. Ruby snapper compromised 40% of the catch in 2021–22 and 31% in 2020–21. **Fishing mortality** Deepwater bugs and ruby snapper stock are classified as not subject to overfishing.
Western tuna and billfish fishery	✓	✓	—	—	—	**Area** Australia's Exclusive Economic Zone and high seas of the Indian Ocean. **Fishing methods** Pelagic longline, with low levels of minor-line fishing methods to target five species. **Key species** Bigeye tuna (*Thunnus obesus*), yellowfin tuna (*T. albacares*) and swordfish (*Xiphias gladius*). Striped marlin (*Kajikia audax*) is a minor component of the catch and albacore (*T. alalunga*), a non-quota species, can approach levels similar to yellowfin tuna catch in some years. In recent years, fishing effort has concentrated off south-west WA, with occasional activity off SA. **Fishing efforts** Increased from 223,713 hooks, 15 minor lines, and 93 boats in 2022 season to 236,020 hooks, 17 minor lines, and 93 boats in 2023 season). A total of four vessels operated in 2023 season. **Fishing mortality** Three of the key target species (bigeye tuna, yellowfin tuna and striped marlin) are classified as subject to overfishing, while swordfish and albacore are classified as not subject to overfishing.

^Source: Ref. 694.

5.1.2 State-managed fisheries

The State-managed commercial fisheries with fishery management areas that intersect the PA, and that have fishing effort recorded over a 10-year period (2014–2023) (Ref. 699) are listed in Table 5-2. Further descriptions are provided in the following subsections.

Table 5-2: Presence of fishing effort recorded over the 2014–2023 period within State-managed commercial fisheries

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
Abrolhos Islands and mid-west trawl managed fishery	✓	—	—	—	—	**Area** The fishery operates around the Abrolhos Islands, extending from 27º51’S to 29º03’S. **Fishing methods** Otter trawls. **Key species** The target species is the saucer scallop, *Ylistrum balloti* (formerly *Amusium balloti).* **Fishing efforts** The fishery was environmentally limited and did not open. It is managed using a constant escapement approach outlined in the Harvest Strategy. **Active licences/vessels** Up to five active vessels were recorded between 2017 and 2023 in the PA, with none recorded in 2022 (Ref. 699).
Broome prawn managed fishery	—	—	✓	✓	—	**Area** The fishery operates within the 200 m isobath, spanning waters from near Derby to north of Port Hedland. It is part of the northern prawn managed fishery. **Fishing methods** Low opening, otter prawn trawl system. **Key species** The target species are western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), and blue endeavour prawns (*Metapenaeus endeavouri*). **Fishing efforts** No fishing efforts were recorded in 2022. **Active licences/vessels** Up to three active vessels were recorded between 2015 and 2023 in the PA, with none recorded in 2022 (Ref. 699).
Christmas Island line fishery*	—	—	—	—	✓	**Area** The fishery operates within the waters around Christmas Island, extending from the territorial sea baseline to the outer limit of the EEZ.

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Fishing methods Handline methods. **Key species** The target species are pelagic fish, mainly wahoo (*Acanthocybium solandri*) and yellowfin tuna (*Thunnus albacares*). In addition, target of deepwater species, primarily deepwater snappers may also occur. **Fishing efforts** In 2014, two out of the three licences were active. There is no information available regarding total catch for the 2022 or 2023 seasons. The fishery is managed primarily through input controls, including limited entry and gear restrictions. It also incorporates output controls, such as catch limits on both demersal and pelagic species. **Active licences/vessels** Up to three active vessels were recorded between 2014 and 2022, with none recorded in 2023 (Ref. 699).
Exmouth Gulf prawn managed fishery	—	—	✓	—	—	**Area** The fishery operates within Exmouth Gulf, with its upper limit defined as east of Muiron Island and west of Serrurier Island. **Fishing methods** Low-opening, otter prawn trawl systems. **Key species** The target species are western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), blue endeavour prawns (*Metapenaeus endeavouri*), and banana prawns (*Penaeus merguiensis*). **Fishing efforts** The total catch in 2022 was 898 t. Brown tiger prawns are the primary species retained, with significant landings of western king and blue endeavour prawns also reported. It is managed through input controls, including limited entry, gear controls (maximum headrope units), seasonal and spatial openings and closures, and monthly moon closures. **Active licences/vessels** Six vessels operated during the 2022 season.

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Up to seven active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Gascoyne demersal scalefish managed fishery	✓	✓	—	—	—	**Area** The fishery extends from 114°50’E to 27°00’S (from Exmouth to Denham). **Fishing methods** Mechanised handlines (line fishing). **Key species** The fishery targets include >60 demersal species inhabiting marine waters deeper than 20 m in the Gascoyne Coast Bioregion. The target species are pink snapper (*Chrysophrys auratus*), and goldband snapper (*Pristipomoides multidens).* **Fishing efforts** In 2021/22, the landed commercial pink snapper catch was 42 t, within the revised total allowable commercial catch (51 t). The landed goldband snapper catch was 83 t, also within the allowable catch limit (100–120 t). **Active licences/vessels** 10 vessels operated during the 2021/22 season. Up to seven active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Mackerel managed fishery	✓	✓	✓	✓	—	**Area** The mackerel managed fishery extends from Augusta to the WA/NT border. There are three managed fishing areas: Area 1: Kimberley (121°E to the WA/NT border); Area 2: Pilbara (114°E to 121°E) and Area 3: Gascoyne / West Coast (34°S to 114° E). **Fishing methods** Surface and midwater troll fishing methods. **Key species** The fishery targets are Spanish mackerel (*Scomberomorus commerson*), Grey mackerel (*S. semifasciatus*) and Samson fish (*Seriola hippos*). **Fishing efforts** The 2022 catch is below the target commercial catch range for Spanish mackerel in the MMF (246–430 t). In the Kimberley area, the 2022 catch of 137 t is within the catch range (110–225 t), while the catches of 56 t in the Pilbara and 16 t in the Gascoyne /

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						West Coast are below the respective tolerance ranges of 80–126 t and 56–79 t. Activity primarily occurs from May to November. **Active licences/vessels** 13 boats fished in the 2022 season. Up to five active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Marine aquarium fish managed fishery	✓	✓	✓	✓	—	**Area** The fishery operates in all State waters between the NT border and the SA border. **Fishing methods** SCUBA or surface-supplied air (hookah) from small vessels, usually in teams of two or three people. **Key species** Fish catches were dominated by species such as the Spotted Blenny (*Istiblennius meleagris*), Stripey (*Microcanthus strigatus*), Scribbled Angelfish (*Chaetodontoplus duboulayi*), Vachell's Glassfish (*Ambassis vachellii*), Margined Coralfish (*Chelmon marginalis*), Black-axil Chromis (*Chromis atripectoralis*), blue and yellow Wrasse (*Anampses lennardi*), with nearly 250 other fish taxa also reported. **Fishing efforts** In 2022, the total catch for the fishery was 98,694 fish and invertebrates, 17.83 t of coral, live rock, and living sand, and 39 litres of marine plants and live feed. The fishery is typically more active in waters south of Broome, with higher effort levels around the Capes region, Perth, Geraldton, Exmouth, Dampier, and Broome. Recent effort has also been observed in waters from Broome northwards to the NT border. **Active licences/vessels** 11 out of the 12 licences were active during the 2022 season. Up to six active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Nickol Bay prawn managed fishery	—	—	✓	—	—	**Area** The fishery operates from Karratha (116º45'E) to north of Port Hedland (120º00'E). **Fishing methods** Low-opening and high-opening otter prawn trawl systems (the latter specifically for targeting banana prawns, *Penaeus merguiensis*). **Key species**

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						The target species are western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), blue endeavour prawns (*Metapenaeus endeavouri*) and banana prawns (*Penaeus merguiensis*). **Fishing efforts** In 2022, total of landings of penaeids were 51 t, dominated by banana prawns (42 t), with minor landings of brown tiger (7 t), blue endeavour (2 t), and western king prawns (<1 t). It is managed using input controls, including limited entry, gear controls (maximum headrope units), and seasonal and area openings and closures. **Active licences/vessels** Up to eight active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Northern demersal scalefish managed fishery	—	—	✓	✓	—	**Area** The fishery extends from north of Port Hedland (120°00'E) to the WA/NT border and is divided into two managed fishing areas. Area 1: Inshore Area (between the HWM and a line ~30 m isobath) and Area 2: Offshore Area (between a line ~30 m isobath and the EEZ). **Fishing methods** Area 1: line fishing only. Area 2: handline, dropline, and fish traps. Since 2002, it has primarily operated as a trap-based fishery, employing gear time access and spatial zones as the primary management measures. **Key species** The main species landed by this fishery in the Kimberley subregion are goldband snapper and red emperor. **Fishing efforts** The total catch in 2022 was 1,458 t, following the highest recorded catch of 1,544 t in 2021, with the majority of the catch coming from Area 2. The reported 2022 catch for the jobfish group (*Pristipomoides spp.*) was 552 t, with goldband snapper accounting for ~91% of the jobfish catch. **Active licences/vessels** Eight vessels fished in the 2022 fishing season. Up to six active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
Octopus interim managed fishery	✓	—	—	—	—	**Area** The fishery extends from Shark Bay to the WA/SA border and is divided into three managed fishing zones: Zone 1: from 26°30'S to 30°30'S; Zone 2: from 30°30'S to 34°24'S and Zone 3: from 34°24'S to the WA/SA border. **Fishing methods** Baited octopus traps, which combine active trapping (trigger or sliding door traps with trigger mechanisms) and passive trapping (shelter traps) via open-ended traps. Unbaited shelter pots are also used. **Key species** The main species is Western Australian Rock Octopus (*Octopus djinda*). **Fishing efforts** In 2022, the total commercial octopus catch was 744 t live weight, a 53% increase compared to the 2021 catch of 487 t. **Active licences/vessels** 27 commercial vessels fished in the 2022 fishing season. Up to five active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Onslow prawn managed fishery	—	—	✓	—	—	**Area** The fishery operates from Karratha (116º45'E) to north of Onslow (115º26'E). **Fishing methods** Low-opening otter prawn trawl systems. **Key species** The target species include western king prawns (*Penaeus latisulcatus*), brown tiger prawns (*Penaeus esculentus*), and blue endeavour prawns (*Metapenaeus endeavouri*). **Fishing efforts** Due to data confidentiality, catch reporting and maps of fishing activity are not disclose; however, one boat fished in the 2022 season, as such, the fishery recorded relatively low effort and catch. The fishery is managed using input controls, including limited entry, gear controls (maximum headrope units), and seasonal and area openings and closures. **Active licences/vessels**

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Less than three active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Pilbara crab managed fishery	—	—	✓	—	—	**Area** The fishery extends from north of Port Hedland (120°00'E) to Onslow (115°06.5'E). **Fishing methods** Hourglass traps, primarily within inshore waters around Nickol Bay. **Key species** Blue swimmer crab (*Portunus armatus*). **Fishing efforts** In 2022, the total catch of the blue swimmer crab was 11.2 t, accounting for ~2% of the state's catch. **Active licences/vessels** Less than three active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Pilbara fish trawl (interim) managed fishery	—	—	✓	—	—	**Area** The fishery extends from north of Port Hedland (120º00'E) to Exmouth and is divided into Zone 1 and Zone 2 (the latter subdivided into six areas). This fishery is restricted to less than ~2% of the NWS. Zone 1 is closed to fish trawling, while Area 3 and the waters inside the 50 m isobath are permanently closed to fish trawling. Additionally, no fish trawling has occurred in Area 6 since 1998. The fishery is managed under a combination of limited entry, effort allocations (time), gear limits, and spatial zones, including extensive trawl closures. It is part of the Pilbara Demersal Scalefish Fishery. **Fishing methods** Demersal trawl. The fishery operates with standard stern trawling gear (single net with extension sweeps). **Key species** The primary target species are bluespotted emperor, red emperor, and rankin cod. **Fishing efforts** In 2022, the total catch was 1,784 t, representing 72% of the total commercial catch of demersal scalefish in the Pilbara.

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Active licences/vessels Four commercial vessels participated in the 2022 season. Up to five active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Pilbara line fishery (condition)	—	—	✓	—	—	**Area** The fishery is part of the Pilbara Demersal Scalefish Fishery. Boat licences are permitted to operate anywhere within ‘Pilbara waters’, bounded by a line commencing at the intersection of 21°56′S latitude and the HWM on the western side of the North West Cape on the mainland of WA; west along the parallel to the intersection of 21°56′S latitude and the boundary of the AFZ, and north to longitude 120°E. **Fishing methods** Demersal long line methods. **Key species** The target species are bluespotted emperor (*Lethrinus punctulatus*), red emperor (*Lutjanus sebae*) and rankin cod (*Epinephelus multinotatus*), as well as some deeper offshore species such as ruby snapper and eight-bar grouper. **Fishing efforts** In 2022, the total catch was 104 t, representing 4% of the total commercial catch of demersal scalefish in the Pilbara. The fishery operates on an exemption basis which restricts vessels to operating within a nominated 5-month block period each year (typically May- September). **Active licences/vessels** Six commercial vessels participated in the 2022 season. Up to six active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Pilbara trap managed fishery	—	—	✓	—	—	**Area** The fishery, which is part of the Pilbara Demersal Scalefish Fishery, covers the area from Exmouth northwards and eastwards to the 120°S line of longitude, and offshore as far as the 200 m isobath. **Fishing methods** Trap methods. **Key species**

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						The main species targeted by the Pilbara Trap Managed Fishery are bluespotted emperor (*Lethrinus punctulatus*), red emperor (*Lutjanus sebae*) and rankin cod (*Epinephelus multinotatus*). **Fishing efforts** In 2022, the total catch was 597 t, representing 24% of the total commercial catch of demersal scalefish in the Pilbara. It is managed through area closures and effort allocations **Active licences/vessels** Three commercial vessels participated in the 2022 season. Up to three active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Shark Bay beach seine and mesh net managed fishery	—	✓	—	—	—	**Area** The fishery covers Shark Bay's inner gulf. **Fishing methods** Beach seine netting. **Key species** The primary target species are whiting (mostly yellowfin whiting, *Sillago schomburgkii*), sea mullet (*Mugil cephalus*), tailor (*Pomatomus saltatrix*) and western yellowfin bream (*Acanthopagrus morrisoni*). **Fishing efforts** In 2022, the total commercial catch was 131 t, of which 70-90% is mostly yellowfin whiting. **Active licences/vessels** Five commercial vessels participated in the 2022 season, with a total of 510 boat days. Up to seven active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Shark Bay crab managed fishery	—	✓	—	—	—	**Area** The fishery extends from Shark Bay gulf to south of Coral Bay. **Fishing methods** Trap and trawl methods. **Key species**

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						The primary target species is the blue swimmer crab (*Portunus armatus*). **Fishing efforts** The 2021/22 catch landings of 401 t was significantly lower than the 600 t total allowable commercial catch. **Active licences/vessels** Up to 22 active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Shark Bay prawn managed fishery	—	✓	—	—	—	**Area** he fishery extends from the Shark Bay Gulf (26°30′S) to south of Coral Bay (23°34′S). **Fishing methods** Low-opening otter prawn trawl systems within inner Shark Bay. **Key species** The primary target species are western king prawns (*Penaeus latisulcatus*), brown tiger prawns (P*enaeus esculentus*), and lesser quantities of blue endeavour (*Metapenaeus endeavouri*) and coral prawns (*Metapenaeopsis sp*.). **Fishing efforts** In 2022, the total commercial catch was 831 t. A combination of low recruitment for both king and tiger prawns, along with management restrictions to protect spawning stocks, led to the lowest recorded catches. Management restrictions are based on input controls, including limited entry, gear restrictions (e.g. maximum headrope units), and seasonal and spatial openings and closures to ensure fishing effort maintains a sufficient spawning biomass of prawns. **Active licences/vessels** 18 commercial vessels participated in the 2022 season. Up to 18 active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
Shark Bay scallop managed fishery	—	✓	—	—	—	**Area** The fishery extends from the Shark Bay Gulf (26°30′S) to south of Coral Bay (23°34′S). **Fishing methods** Otter trawls methods. **Key species** The target species is Saucer scallops, *Ylistrum balloti* (formerly *Amusium balloti*).

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						Fishing efforts Total scallop landings in WA in 2022 were 65.3 t meat weight (326 t whole weight). Of this, 35.5 t meat weight (177.3 t whole weight) was harvested from the Shark Bay fishery, which was 99% of the total quota of 36 t. Only 0.9% of the fishery area, as per the management plan, or 2.2% of the inner Shark Bay area (around Denham), was fished in 2022. It is typically WA's most valuable scallop fishery, comprising boats licensed exclusively for scallops and boats that also fish for prawns. The fishery is managed using a constant escapement approach outlined in the Harvest Strategy. **Active licences/vessels** Up to 24 active vessels were recorded between 2015 and 2023 in the PA (Ref. 699).
Specimen shell managed fishery	✓	✓	✓	—	—	**Area** The fishery operates along the entire WA coastline, with activity concentrated in areas near population centres such as Broome, Exmouth, Shark Bay, Geraldton, Perth, Mandurah, the Capes area, Albany, and Esperance. **Fishing methods** The primary ones being hand collection by small groups of divers operating from small boats in shallow coastal waters, wading along coastal beaches below the HWM, or, in some cases, using remotely operated underwater vehicles. The fishery focuses on the collection of individual shells for display, collection, cataloguing, classification, and sale. **Key species** About 200 species of specimen shells are collected annually, with efforts concentrated on mollusc families popular among shell collectors, such as cowries, cones, murexes, and volutes. **Fishing efforts** In 2022, a total of 5,074 specimen shells, representing 200 species, were collected, with an average catch rate of ~13 shells per day. The fishery is managed through input controls, including limited entry, gear restrictions, and permanent closed areas. Operational limitations such as depth, time, and tide are also in place. **Active licences/vessels** There are 30 licences issued for this fishery, with a maximum of four divers allowed in the water per licence at any given time, and collection is permitted by hand only. In

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						2022, 16 licences were active, and an exemption was granted for the trial use of remotely operated underwater vehicles, limited to one per licence. Up to six active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
West Coast deep sea crustacean managed fishery	✓	✓	✓	—	—	**Area** The fishery extends from Augusta to the WA/NT border, with closed areas below the 150 m isobath. **Fishing methods** Pot fishery that uses baited pots operated in a long-line formation in shelf-edge water (150-1,200 m) of the West Coast and Gascoyne Bioregions. **Key species** The primary target species are crystal (snow) (*Chaceon albus*), champagne (spiny) (*Hypothalassia acerba*), and giant (*Pseudocarcinus gigas*) crabs. **Fishing efforts** In 2022, the total commercial catch consisted of 123.2 t crystal crab, 10 t champagne crab, 0.1 giant crab and <0.1 king crab. **Active licences/vessels** Seven licence holders operated in the fishery, with five vessels active during the 2022 season. Up to four active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
West Coast demersal gillnet and demersal longline (interim) managed fishery	✓	✓	—	—	—	**Area** The fishery operates between Shark Bay (26°S) and Bunbury (33°S). The fishery is part of the Temperate Demersal Gillnet and Demersal Longline Fisheries **Fishing methods** Demersal gillnets and demersal longline (the latter is not widely used). **Key species** The primary target species are gummy (*Mustelus antarcticus*), dusky (*Carcharhinus obscurus*), whiskery (*Furgaleus macki*), and sandbar (*C. plumbeus*) shark. **Fishing efforts** In the 2021-22 season, the total catch of sharks and rays was 924 t, consisting of 411 t of gummy shark, 193 t of dusky shark, 39 t of sandbar shark, and 156 t of whiskery

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						shark. This catch was consistent with previous years and remained within acceptable catch ranges. **Active licences/vessels** Five commercial vessels fished in the 2022 season. Up to four active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
West Coast demersal scalefish (interim) managed fishery	✓	✓	—	—	—	**Area** The fishery extends from Augusta (115°30'E) to waters around Shark Bay (26°30'S) and is divided into four managed fishing areas: Kalbarri, Metropolitan, Mid-West, and South-West Areas. **Fishing methods** Involves boat-based commercial, charter, and recreational line fishers. **Key species** The fishery targets over 100 species in both inshore (20-250 m deep) and offshore (>250 m) demersal habitats of the West Coast Bioregion. **Fishing efforts** In 2022, the total commercial catch was 240 t, distributed as follows: Kalbarri: 80 t, Mid-West: 93 t, and South-West: 68 t. **Active licences/vessels** A total of 30 commercial vessels participated in the 2022 season. Up to nine active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
West Coast rock lobster managed fishery	✓	✓	—	—	—	**Area** The fishery operates along the west coast of WA, extending from Shark Bay to Cape Leeuwin. **Fishing methods** Baited pots and hand collection. **Key species** The primary target species is the western rock lobster (*Panulirus cygnus*) with additional bycatch including octopus, champagne crabs, and baldchin grouper. **Fishing efforts**

Fishery	Section					Description^
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
						In 2022, the total commercial catch was 6,342 t, with catch rates remaining near record-high levels. The fishery is managed under a Harvest Strategy and Control system. **Active licences/vessels** Up to 42 active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).
West Australian sea cucumber fishery	—	✓	✓	—	—	**Area** Fishing predominantly occurs in the northern half of the state, from Exmouth Gulf to the NT border. **Fishing methods** Primarily employs diving as its method of catch, with a smaller amount harvested through wading. **Key species** The primary target species are sandfish (*Holothuria scabra*), and redfish (*Actinopyga echinites*). **Fishing efforts** In 2022, a total of 56.5 t of sea cucumber was harvested, comprising 45.2 t of sandfish, 10.8 t of deepwater redfish, and 0.5 t of black teatfish. Access to the fishery is managed under an exemption and is subject to input controls, including limited entry, a maximum number of divers, spatial closures, and gear restrictions. **Active licences/vessels** Two commercial vessels fished in 2022. Less than three active vessels were recorded between 2014 and 2023 in the PA (Ref. 699).

**Source: Ref. 699.*

^Source: Ref. 700.

5.1.3 Pearling and aquaculture

Pearling and aquaculture operations in the northwest are typically restricted to inland and shallow coastal waters, primarily within State waters. Table 5-3 listed the presence of these industries within the PA.

In WA, aquaculture is predominantly focused on pearl production from the oyster species *Pinctada maxima*. A significant number of pearl oysters for seeding are sourced from wild stocks and supplemented by hatchery-produced oysters, with major hatcheries operating in Broome and the Dampier Peninsula (Ref. 700). The Pearl Oyster Managed Fishery is the world's only remaining significant wild stock fishery for pearl oysters. It operates as a quota-based dive fishery in shallow coastal waters (Ref. 700). The fishery is currently managed under the *Pearling Act 1990*.

In 2022, the total catch was 756,531 shells, with six vessels participating in the fishery. Most vessels operate between March and August each year (Ref. 700).

Further aquaculture in the NWMR primarily focuses on barramundi farming within the Kimberley region (Ref. 700).

Table 5-3: Presence of pearling and aquaculture sites

Activity	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Aquaculture site					
Application^	✓	✓	✓	—	—
Licensed^	✓	✓	✓	—	—
Pearling					
Pearl farm lease*	—	—	✓	—	—
Pearl holding site*	—	—	✓	—	—

^In the Pilbara Section, applications were identified around the Dampier Archipelago and Exmouth Gulf, while licensed sites were located around the Dampier Archipelago, Onslow, and Exmouth Gulf.

*In the Pilbara Section, farm leases were identified around Exmouth Gulf, the Montebello Islands, the Dampier Archipelago, and Karratha, while holding sites were located around Exmouth Gulf, Onslow, and Port Hedland.

5.2 Recreational fisheries

Recreational fishing is one of the most popular activities in WA with an estimated third of the population fishing recreationally (Ref. 702). The WA Department of Primary Industries and Regional Development (DPIRD) conducts state-wide recreational fishing surveys every two to three years, with the first survey completed in 2011 (Ref. 703). The survey collects information from more than 3,000 recreational fishers who record their catches in logbooks over a 12-month period with DPIRD also conducting interviews throughout the State and monitoring the number of boat launches and retrievals using cameras at various boat ramps.

The 2020–2021 survey report (Ref. 704) revealed that most boat-based recreational fishing effort occurred in nearshore habitats (62%), followed by inshore demersal habitats (25%). Line fishing accounted for the majority of boat-based effort (59%), with pots contributing 35%. Fishing activity peaked during summer (38%), followed by autumn (24%) and spring (23%). Effort was lowest from June to August 2021. Fishing effort in December 2020 (20%) was higher than previous years, with increased activity in potting and nearshore habitats.

In the North Coast, where the majority of the Pilbara Section is located, fishing efforts align with state-wide trends. Most boat-based recreational fishing effort was concentrated in nearshore habitats (46%), followed by inshore demersal areas (32%). Line fishing was the predominant method (87%). Effort was highest in winter (42%), followed by spring (25%) and autumn (22%) (Ref. 704).

In the Gascoyne Coast, where the other part of the Pilbara Section is located, fishing effort was concentrated in nearshore (54%) and inshore demersal (39%) habitats. Most fishing effort was attributed to line fishing (91%), with the majority of effort occurring in autumn (36%), followed by winter (32%) and spring (24%) (Ref. 704).

Tour operator fishing efforts recorded over a 10-year period (2014–2023) (Ref. 699) identified the following:

- up to 14 active vessels were recorded between 2014 and 2023 in the West Coast Section
- up to four active vessels were recorded between 2014 and 2023 in the Ningaloo Section
- up to nine active vessels were recorded between 2014 and 2023 in the Pilbara Section
- up to five active vessels were recorded between 2014 and 2023 in the Kimberley Section
- no fishing efforts were recorded in the Christmas Island Section.

5.3 Traditional fisheries

Customary fishing applies to persons who have a traditional connection with the area being fished, and is fishing for personal, domestic, ceremonial, educational or non-commercial needs (Ref. 706). A Customary Fishing Policy has been incorporated into the *Fish Resources Management Act 1994* (WA), which allows for customary fishing by applicable persons to occur within a sustainable fisheries management framework. Customary fishing does not apply to other species of marine fauna (e.g. crocodile, turtle, or dugong).

Under amendments made in 2012 to the *Conservation and Land Management Act 1984* (WA) Aboriginal people can undertake customary activities which includes hunting (except in marine sanctuary zones or marine nature reserves) for dugong, turtle, or crocodiles in WA.

As described in Section 4.5.2.1, ongoing use of marine and coastal resources, including customary fishing, is expected to occur in NWMR and adjacent coastal waters. However, it is expected that much of this activity will occur within shallow coastal waters.

A Memorandum of Understanding (MoU) permits traditional Indonesian fishers to operate within Australian waters using only traditional fishing methods. It is managed through a bilateral agreement between the Australian and Indonesian governments. The MoU area is located within the Australian Fishing Zone and the continental shelf, adjacent to Ashmore Reef, Cartier Island, Scott Reef, Seringapatam Reef, and Browse Island (Ref. 707). Restrictions were later introduced around Ashmore Reef and Cartier Island following their designation as Nature Reserves under the Commonwealth's National Parks and Wildlife *Conservation Act 1975* in 1983 and 2000, respectively.

The northern section of the PA, Kimberley Section, overlaps with the MoU area.

5.4 Commercial shipping

AMSA collects vessel traffic data from a variety of sources, including satellite shipborne automated identification system data, across Australia's Search and Rescue region. This data has been used to develop Figure 5-1, which shows vessel traffic within the vicinity of the PA.

Shipping fairways are designed to direct shipping traffic away from offshore infrastructure. While their use is not mandatory, it is strongly recommended. As a result, commercial vessels transiting the NWS are expected to remain within these fairways. Shipping fairways are primarily identified in the Pilbara Section, with minor overlaps in the Kimberley and Ningaloo Sections (Figure 5-1).

Vessel traffic within the Pilbara Section is most likely to consist of offshore support vessels servicing existing petroleum activities.

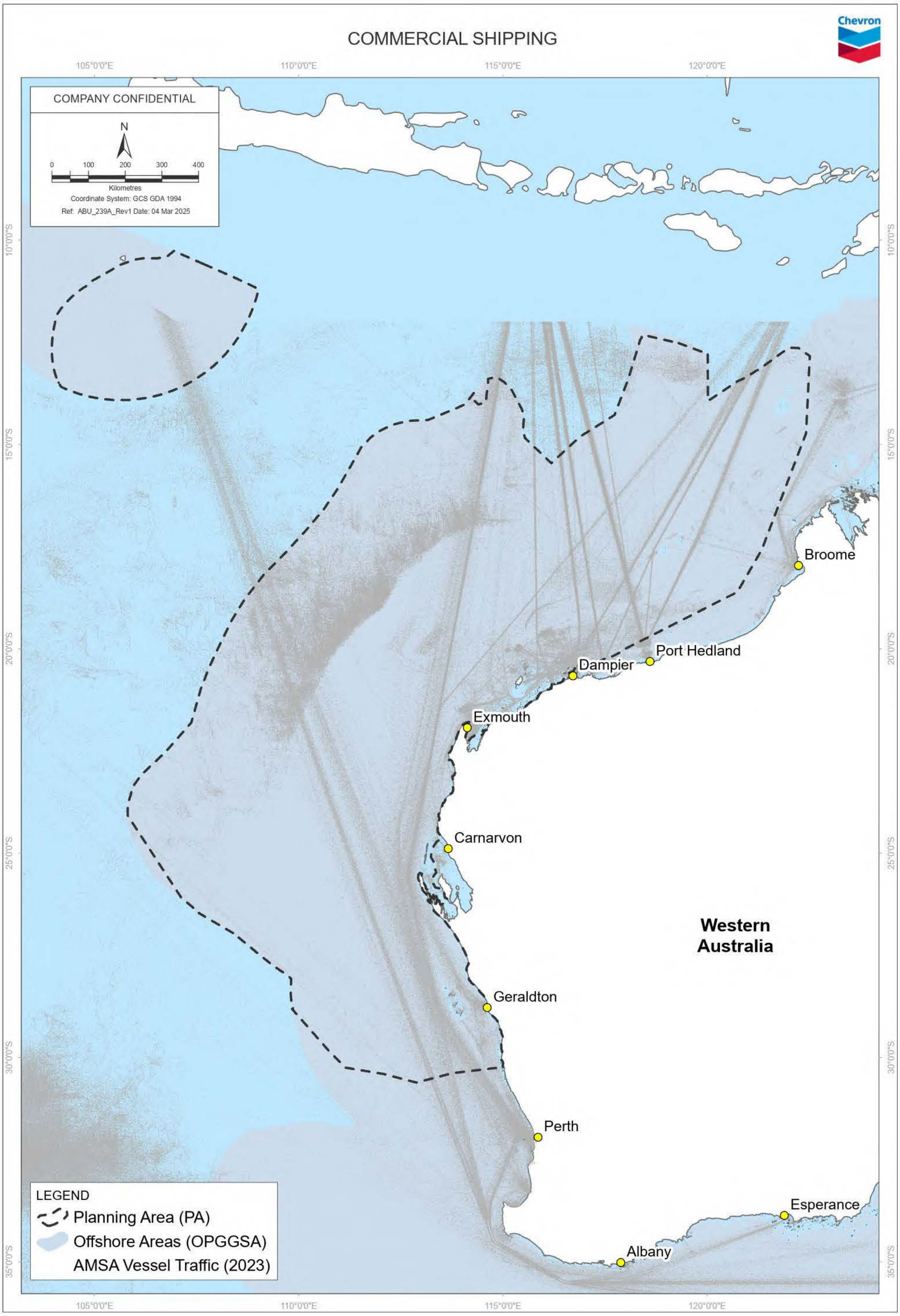

Figure 5-1: Vessel traffic and shipping fairways within the vicinity of the PA

5.5 Tourism and recreation

Tourism is an important industry for WA, directly employing 66,700 people and indirectly employing a further 44,000 (Ref. 707). Charter fishing, diving, snorkelling, wildlife watching, and cruising are some of the commercial tourism activities in and adjacent to the WA coastline (Ref. 3; Ref. 700). With the exception of offshore fishing (Section 5.2), most marine tourism and recreational activities occur in the shallower State waters (Ref. 3).

Within the NWMR, the Gascoyne, Pilbara and Kimberley regions are popular visitor destinations for both Australian and international tourists.

In the Gascoyne Region, marine nature-based tourism is primarily concentrated around the Ningaloo Coast World Heritage Area (Section 7.1). Activities undertaken include recreational fishing, snorkelling and scuba diving, wildlife watching and encounters (including whale sharks, manta rays, humpback whales and turtles) (Ref. 709). Other popular activities include beach access, surfing, and paddling sports.

In the Pilbara Region, recreational activities tends to be concentrated in State waters adjacent to population centres. Charter vessels may also frequent the waters surrounding the Montebello Islands (Ref. 710).

In the Kimberley Region, marine tourism includes charter fishing, diving, snorkeling, and wildlife watching (whales, turtles, and dolphins), along with sightseeing cruises. Luxury cruises are becoming increasingly popular, taking tourists along the coastline and to remote coral atolls for fishing and diving. Primary dive locations include the Rowley Shoals, Scott Reef, Seringapatam Reef, Ashmore Reef, and Cartier Island (Ref. 700).

In the SWMR, beach-going is one of the most popular leisure activities for tourists. Other popular marine-based activities include surfing, fishing, SCUBA diving, snorkelling, windsurfing, whale watching, and marine wildlife experiences (Ref. 700). Charter fishing may occur in both State and Commonwealth waters.

On Christmas Island, recreational activities include SCUBA diving, snorkelling with turtles and dolphins, kite surfing, beach-going, free diving, and fishing (Ref. 705).

5.6 Other marine and coastal industries

Several other marine and coastal industries may be present within the PA (Table 5-4). There were no offshore renewable energy facilities or declared offshore wind areas, or salt mines identified within the PA.

Table 5-4: Presence of industries

Industry	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Defence	✓	✓	✓	✓	—
Onshore facilities	—	—	✓	—	—
Petroleum exploration and production	✓	✓	✓	✓	✓
Ports	✓	—	✓	—	—
Submarine cable	✓	✓	✓	✓	✓

5.6.1 Defence

The Royal Australian Air Force have two bases located in the northwest of WA: Learmonth Base near Exmouth, and Curtin Base near Derby. A designated maritime firing practice and exercise area is associated with these bases (Ref. 711). Military exercise areas are designated over the waters and airspace of northwest WA and may be activated following the required notifications.

Some areas may contain Unexploded Ordnance (UXO) as a result of past military activities. These include offshore sites where ammunition and explosives have been dumped or areas used as live bombing or firing ranges. Defence maintains a record of sites confirmed or reasonably suspected to be affected by UXO (Ref. 712). Known or suspected UXO sites may be present within the PA, particularly near designated firing practice areas.

5.6.2 Onshore facilities

Only one onshore industry with coastal interference, the Karratha Gas Plant, was identified within the PA. Located on the Burrup Peninsula near the Port of Dampier and the City of Karratha, the Karratha Gas Plant is a major producer of liquefied natural gas, natural gas, liquefied petroleum gas, condensate, and crude oil (Ref. 713). Operations at this plant rely on production from offshore fields. Offshore production facilities include the North Rankin Complex, Goodwyn A and Angel platforms, and the Okha floating production, storage, and offloading vessel (Ref. 713).

The onshore gas plant consists of five liquefied natural gas processing plants—referred to as “trains”—a domestic gas plant supplying WA, liquefied petroleum gas production units, and storage and loading facilities for liquefied natural gas, liquefied petroleum gas, and condensate (Ref. 713).

5.6.3 Petroleum exploration and production

Petroleum exploration and production occur along the WA coast within all sections of the PA, except for the Christmas Island Section. Petroleum wells extend throughout the PA, with the majority concentrated in the Pilbara Section. Most petroleum activities take place in the NWMR.

There are seven sedimentary petroleum basins in the NWMR: the Northern and Southern Carnarvon basins, Perth, Browse, Roebuck, Offshore Canning and Bonaparte basins (Ref. 4). Of these, the Northern Carnarvon Basin is one of the most heavily explored and developed petroleum basins in Australia. The Northern Carnarvon, Browse and Bonaparte basins together comprise most of Australia’s natural gas reserves (Ref. 4; Ref. 700). The Carnarvon Basin supports >95% of WA’s oil and gas production, accounts for ~63% of Australia’s total production of crude oil, condensate, and natural gas, and it is the most heavily explored (Ref. 4).

In addition to existing facilities, there are proposed developments in the region, including plans to extract gas and condensate from multiple fields.

5.6.4 Ports

The *Port Authorities Act 1999* (WA) governs Western Australia's port authorities, covering their functions, responsibilities, concept of operations and related matters. The *Shipping and Pilotage Act 1967* (WA) governs shipping and pilotage within ports, boat harbours, and mooring control areas across the state. The

Barrow Island Port (also known as Varanus Island Port) is a declared port under this Act.

Six ports (Ashburton, Dampier, Port Hedland, Bala Balla, Barrow and Varanus) were identified within the Pilbara section, while one port, Geraldton, was identified in the West Coast section.

5.6.5 Submarine cables

Submarine telecommunications cables are underwater infrastructure linking Australia with other countries; the submarine communications cables carry the bulk of Australia's international voice and data traffic. Several known submarine cables intersect with the PA. Under Part 2 of the *Telecommunications Act 1997* (Cth), the Australian Communications and Media Authority can declare protection zones covering the cables to prohibit and/or restrict activities that may damage them. The protection zones are generally the area within 1.85 km (1 nm) either side of the cable and include both the waters and seabed within the area. No protection zone has been declared for the submarine cables identified within the PA.

6 qualities and characteristics of locations, places and areas

The qualities and characteristics of the protected places present within the PA are described in the following sections.

6.1 Australian marine parks

Marine parks help conserve marine habitats and the marine species that live within and rely on these habitats. Marine parks also provide places for people to watch wildlife, dive, and go boating, snorkelling, or fishing (Ref. 714). The PA overlaps several AMP in the Indian Ocean Territories (IOT), North-west and South-west Marine Parks.

The *North-west Marine Parks Network Management Plan* (Ref. 715) and *South-west Marine Parks Network Management Plan* (Ref. 716) defines the following types of values for the Marine Parks in the North-west and South-west Networks:

- natural values—habitats, species and ecological communities, and the processes that support their connectivity, productivity and function
- cultural values—living and cultural heritage recognising Indigenous beliefs, practices and obligations for Country, places of cultural significance and cultural heritage sites
- heritage values—non-Indigenous heritage that has aesthetic, historic, scientific or social significance
- socioeconomic values—the benefits of marine parks for people, businesses and/or the economy.

The types of values identified in the report on the proposal to prepare draft IOT management plans (Ref. 717) applicable for Christmas Island are summarised as:

- natural values—areas of biological importance for threatened species, marine turtles, in particular hawksbill and green sea turtles, resident and migratory seabirds, the ecological linkage of the Christmas Island National Park and the Christmas Island Marine Park for seabirds and the red crab migration, coral reefs and the diverse assemblage of species they support, land crabs on Christmas Island and natural assets that occur outside of the marine parks
- cultural values— the marine environment's contribution to local community identity, culture, and lifestyle, the continuity of traditional fishing practices in the marine parks, sites of importance within the Christmas Island Marine Park and their contribution to the island's history
- social and economic values— the attraction of scuba divers, snorkelers and other tourists to the marine park's natural values and the flow on benefits this has to the wider community and local economy, fishing and access to resources local employment opportunities recreational activities that occur within the marine parks, the importance of supporting social and economic values through streamlined processes for appropriate commercial access to the marine parks.

The objectives of the *North-west Marine Parks Network Management Plan* (Ref. 715) and *South-west Marine Parks Network Management Plan* (Ref. 716) are to provide for:

- the protection and conservation of biodiversity and other natural, cultural and heritage values of marine parks in the North-west Network
- ecologically sustainable use and enjoyment of the natural resources within marine parks in the North Network, where this is consistent with objective (a).

No objectives were identified in the report on the proposal to prepare draft IOT management plans (Ref. 717).

Australian Marine Parks (AMPs) occur within Commonwealth waters that start at the outer edge of state and territory waters and extend to the outer boundary of Australia's EEZ, 200 nautical miles (~370 km) from the shore (Ref. 715; Ref. 716). AMPs have been proclaimed under the EPBC Act in 2007 and 2013. The presence of AMPs within the PA, and a summary of values, is described in Table 6-1 (Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4).

Table 6-1: Presence of AMPs

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Abrolhos (SWMR)^					
Habitat Protection Zone (IUCN IV)	✓	✓	—	—	—
Multiple Use Zone (IUCN VI)	✓	✓	—	—	—
National Park Zone (IUCN II)	✓	✓	—	—	—
Special Purpose Zone (IUCN VI)	✓	✓	—	—	—
The Abrolhos Marine Park is located adjacent to the WA Houtman Abrolhos Islands, covering a large offshore area extending from the WA state water boundary to the edge of Australia's EEZ. The northernmost part of the shelf component of the Marine Park, north of Kalbarri, is adjacent to the Shark Bay World Heritage Area. The Marine Park covers an area of 88,060 km² and a water depth range between <15 m and 6,000 m. **Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Province—characterised by a narrow continental slope incised by many submarine canyons and the most extensive area of continental rise in any of Australia's marine regions. A significant feature within the area are several eddies that form off the Leeuwin Current at predictable locations, including west of the Houtman Abrolhos Islands • Central Western Shelf Province—a predominantly flat, sandy and low nutrient area, in water depths between 50 and 100 m. Significant seafloor features of this area include a deep hole and associated area of banks and shoals offshore of Kalbarri. The area is a transitional zone between tropical and temperate species • Central Western Transition—a deep ocean area characterised by large areas of continental slope, a range of significant seafloor features including the Wallaby Saddle, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species • South-west Shelf Transition—a narrow continental shelf that is noted for its physical complexity. The Leeuwin Current has a significant influence on the biodiversity of this nearshore area as it pushes subtropical water southward along the area's western edge. The area contains a diversity of tropical and temperate marine life including a large number of endemic fauna species. The marine park includes seven KEFs characterised by aggregation of marine life, transport nutrients and plankton communities and high species diversity and endemism. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include foraging and breeding habitat for seabirds, foraging habitat for Australian sea lions and white sharks, and a migratory pathway for humpback and pygmy blue whales. The Marine Park is					

<table>
<tr><th rowspan="2">AMP</th><th colspan="5">Section</th></tr>
<tr><th>West Coast</th><th>Ningaloo</th><th>Pilbara</th><th>Kimberley</th><th>Christmas Island</th></tr>
<tr><td colspan="6">adjacent to the northernmost Australian sea lion breeding colony in Australia on the Houtman Abrolhos Islands.
Cultural values
Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years.
The Nanda and Naaguja People have responsibilities for sea country in the Marine Park. Traditional owners have strong stories that connect ocean and land. Artefacts from ancestors are abundant on islands in the adjacent state marine park.
The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region.
Heritage values
No international heritage listings apply to the Marine Park at the commencement of this plan, however, the Marine Park is adjacent to the WA Shark Bay World Heritage Property, listed as an area of outstanding universal value under the World Heritage Convention in 1991, meeting world heritage listing criteria vii, viii, ix, and x.
No Commonwealth or national heritage listings apply to the Marine Park at the commencement of this plan; however the Marine Park is adjacent to the WA Shark Bay National Heritage Place.
Historic shipwrecks
The Marine Park contains 11 known shipwrecks listed under the Historic Shipwrecks Act 1976.
The Zuytdorp (wrecked in 1712) historic shipwreck protected zone lies in state waters adjacent to the northernmost part of the shelf component of the Marine Park, north of Kalbarri. The HMAS Sydney II and HSK Kormoran Shipwreck Sites (1941) lie at 2,500 m depth about 75 km east of the northern part of the Marine Park. This site is on the National Heritage List and a historic shipwreck protected zone. The Batavia (wrecked on the adjacent Abrolhos Islands in 1629) Shipwreck Site and Survivor Camps Area are on the National Heritage List.
Social and economic values
Tourism, commercial fishing, mining, recreation including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.</td></tr>
<tr><td colspan="6">Argo-Rowley Terrace (NWMR)*</td></tr>
<tr><td>Multiple Use Zone (IUCN VI)</td><td>—</td><td>—</td><td>✓</td><td>✓</td><td>—</td></tr>
<tr><td>National Park Zone (IUCN II)</td><td>—</td><td>—</td><td>—</td><td>✓</td><td>—</td></tr>
<tr><td>Special Purpose Zone (IUCN VI)</td><td>—</td><td>—</td><td>—</td><td>✓</td><td>—</td></tr>
<tr><td colspan="6">The Argo–Rowley Terrace Marine Park is located ~270 km north-west of Broome, WA, and extends to the limit of Australia’s EEZ. The Marine Park is adjacent to the Mermaid Reef Marine Park and the WA Rowley Shoals Marine Park.
The Marine Park covers an area of 146,003 km^2 and water depths between 220 m and 6,000 m.
Natural values
The Marine Park includes examples of ecosystems representative of:
• Northwest Transition—an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Key topographic features include Mermaid, Clerke and Imperieuse Reefs which collectively are a biodiversity hotspot
• Timor Province—an area dominated by warm, nutrient-poor waters. Canyons are an important feature in this area of the Marine Park and are generally associated with high productivity and aggregations of marine life.
The marine park includes two KEFs characterised by y seasonal and sporadic upwelling, nutrient rich water and aggregations of marine life and high species richness. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include resting and breeding habitat for seabirds and a migratory pathway for the pygmy blue whale.</td></tr>
</table>

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Cultural values Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan there is limited information about the cultural significance of this Marine Park. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan. *Historic shipwrecks* The Marine Park contains two known shipwrecks listed under the *Historic Shipwrecks Act 1976*: Alfred (wrecked in 1908) and Pelsart (wrecked in 1908). **Social and economic values** Commercial fishing and mining are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Carnarvon Canyon (NWMR)*					
Habitat Protection Zone (IUCN IV)	—	✓	—	—	—
The Carnarvon Canyon Marine Park is located ~300 km north-west of Carnarvon. It covers an area of 6,177 km² and a water depth range of 1,500–6,000 m. **Natural values** The Marine Park includes examples of ecosystems representative of the Central Western Transition—a bioregion characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species. It includes the Carnarvon Canyon, a single-channel canyon covering the entire depth range of the Marine Park. Ecosystems of the Marine Park are influenced by tropical and temperate currents, deep-water environments and proximity to the continental slope and shelf. The soft-bottom environment at the base of the Carnarvon Canyon is likely to support species that are typical of the deep seafloor (e.g. holothurians, polychaetes and sea-pens). The Marine Park supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. There is limited information about species' use of this Marine Park. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan. **Social and economic values** Commercial fishing is an important activity in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Christmas Island (IOT)#					
Habitat Protection Zone (IUCN IV)	—	—	—	—	✓
National Park Zone (IUCN II)	—	—	—	—	✓
Christmas Island rises sharply from the deep surrounding tropical waters of the Indian Ocean to a height of 361 m. In 2022, the Christmas Island Marine Park was established by the Australian Government under EPBC Act. **Social and economic importance** Christmas Island Marine Park was co-designed with the local community as the marine environment is important for many social, cultural and economic reasons. The park's clear and					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
warm topical waters are valued by the community for commercial, recreational and subsistence fishing and other activities like boating, diving and snorkelling. It is also an attraction for many visitors which helps to support and promote the local tourism industry. Additionally, the unique marine environment of Christmas Island means there is potential for increasing scientific study and educational activities in the area.					
Dampier (NWMR)*					
Habitat Protection Zone (IUCN IV)	—	—	✓	—	—
Multiple Use Zone (IUCN VI)	—	—	✓	—	—
National Park Zone (IUCN II)	—	—	✓	—	—
The Dampier Marine Park is located ~10 km north-east of Cape Lambert and 40 km from Dampier extending from the WA state water boundary. The Marine Park covers an area of 1,252 km² and a water depth range between <15 m and 70 m. **Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. The Marine Park supports a range of species including those listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and foraging habitat for seabirds, internesting habitat for marine turtles and a migratory pathway for humpback whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Ngarluma, Yindjibarndi, Yaburara, and Mardudhunera people have responsibilities for sea country in the Marine Park. The native title holders for these people are represented by the Ngarluma Aboriginal Corporation and Yindjibarndi Aboriginal Corporation. These Prescribed Body Corporates represent traditional owners with native title over coastal area adjacent to the Marine Park are the points of contact for their respective areas of responsibility for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Pilbara and Yamatji regions. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is ~10 km north of the Dampier Archipelago (including Burrup Peninsula) national heritage listing, which has significant Indigenous heritage values including rock art sites. **Social and economic values** Port activities, commercial fishing and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Eighty Mile Beach (NWMR)*					
Multiple Use Zone (IUCN VI)	—	—	✓	—	—
The Eighty Mile Beach Marine Park is located ~74 km north-east of Port Hedland, adjacent to the WA Eighty Mile Beach Marine Park. The Marine Park covers an area of 10,785 km² and a water depth ranges between <15 m and 70 m. **Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding, foraging and resting habitat for seabirds, internesting and nesting habitat for marine turtles, foraging, nursing and pupping habitat for sawfish and a migratory pathway for humpback whales. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The sea country of the Nyangumarta, Karajarri and Ngarla people extends into Eighty Mile Beach Marine Park. Sea country is culturally significant and important to their identity. They have an unbroken, deep spiritual connection to their sea country, with traditional practices continuing today. Staple foods of living cultural value for the Nyangumarta, Karajarri and Ngarla people include saltwater fish, turtles, dugong, crabs and oysters. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities. The native title holders for the Nyangumarta, Karajarri and Ngarla people are represented by the Karajarri Aboriginal Corporation, Nyangumarta Karajarri Aboriginal Corporation, Nyangumarta Warrarn Aboriginal Corporation, and Wanparta Aboriginal Corporation. These Prescribed Body Corporates represent traditional owners with native title over coastal area adjacent to the Marine Park and are the points of contact for their respective areas of responsibility for sea country in the Marine Park. The Kimberley Land Council and the Yamatji Marlpa Aboriginal Corporation are the Native Title Representative Bodies for Kimberley and Pilbara regions. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan. *Historic shipwrecks* The Marine Park contains three known shipwrecks listed under the *Historic Shipwrecks Act 1976*: Lorna Doone (wrecked in 1923), Nellie (wrecked in 1908), and Tifera (wrecked in 1923). **Social and economic values** Tourism, commercial fishing, pearling and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Gascoyne (NWMR)*					
Habitat Protection Zone (IUCN IV)	—	✓	✓	—	—
Multiple Use Zone (IUCN VI)	—	✓	✓	—	—
National Park Zone (IUCN II)	—	✓	✓	—	—
The Gascoyne Marine Park is located ~20 km off the west coast of the Cape Range Peninsula, adjacent to the Ningaloo Reef Marine Park and the WA Ningaloo Marine Park, and extends to the limit of Australia's EEZ. The Marine Park covers an area of 81,766 km² and water depths between 15 m and 6,000 m. **Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Shelf Transition—continental shelf with water depths up to 100 m, and a significant transition zone between tropical and temperate species					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island

- Central Western Transition—characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species
- Northwest Province—an area of continental slope comprising diverse and endemic fish communities.

The marine park includes four KEFs characterised by seasonal and sporadic upwelling, nutrient rich water and aggregations of marine life and high diversity of demersal fish assemblages. The Marine Park supports a range of species including species listed as threatened, migratory, marine, or cetacean under the EPBC Act. BIAs within the Marine Park include breeding habitat for seabirds; internesting habitat for marine turtles; a migratory pathway for Humpback Whales; and foraging habitat and migratory pathway for Pygmy Blue Whales.

Cultural values

Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Gnulli people have responsibilities for sea country in the Marine Park.

The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region.

Heritage values

World heritage

The Ningaloo Coast was listed as an area of outstanding universal value under the World Heritage Convention in 2011, meeting world heritage listing criteria vii and x. The Ningaloo Coast World Heritage Property is adjacent to the Marine Park.

Commonwealth heritage

The Ningaloo Marine Area (Commonwealth waters) was established on the Commonwealth Heritage List in 2004, meeting the Commonwealth heritage listing criteria A, B and C. The Ningaloo Marine Area is adjacent to the Marine Park.

National heritage

The Ningaloo Coast was established on the National Heritage List in 2010, meeting the national heritage listing criteria A, B, C, D, and F and is adjacent to the Marine Park.

Historic shipwrecks

The Marine Park contains more than five known shipwrecks listed under the *Historic Shipwrecks Act 1976.*

Social and economic values

Commercial fishing, mining and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.

Kimberley (NWMR)*					
Habitat Protection Zone (IUCN IV)	—	—	—	✓	—
Multiple Use Zone (IUCN VI)	—	—	—	✓	—
National Park Zone (IUCN II)	—	—	—	✓	—

The Kimberley Marine Park is located ~100 km north of Broome, extending from the WA state water boundary north from the Lacepede Islands to the Holothuria Banks offshore from Cape Bougainville. The Marine Park is adjacent to the WA Lalanggarram/Camden Sound Marine Park and the North Kimberley Marine Park. The Marine Park covers an area of 74,469 km² and water depths from <15 m to 800 m.

Natural values

The Marine Park includes examples of ecosystems representative of:

- Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and an ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island

- Northwest Shelf Transition—straddles the North-west and North Marine Regions and in the Northwest includes shelf break, continental slope, and the majority of the Argo Abyssal Plain and is subject to a high incidence of cyclones. Benthic biological communities in the deeper parts of the bioregion have not been extensively studied, although high levels of species diversity and endemism occur among demersal fish communities on the continental slope
- Timor Province—water depths (of the bioregion) ranging from about 200 m near the shelf break to 5,920 m over the Argo Abyssal Plain. The reefs and islands of the bioregion are regarded as biodiversity hotspots. Endemism in demersal fish communities of the continental slope is high; two distinct communities have been identified on the upper and mid slopes.

The marine park includes three KEFs characterised by strong tides, cyclonic storms, long-period swells and internal tides seasonal and endemic demersal fish. The Marine Park supports a range of species, including protected species listed as threatened, migratory, marine or cetacean under the EPBC Act. BIAs within the Marine Park include breeding and foraging habitat for seabirds, internesting and nesting habitat for marine turtles, breeding, calving and foraging habitat for inshore dolphins, calving, migratory pathway and nursing habitat for humpback whales, migratory pathway for pygmy blue whales, foraging habitat for dugong and foraging habitat for whale sharks.

Cultural values

Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years.

The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people's sea country extends into the Kimberley Marine Park. The Wunambal Gaambera people's country includes daagu (deep waters), with about 3,400 km^2 of their sea country located in the Marine Park. The Wunambal Gaambera, Dambimangari, Mayala, Bardi Jawi and the Nyul Nyul people have an unbroken connection to their sea country, having deep spiritual connection through Wunggurr (creator snakes) that still live in the sea. Staple foods of living cultural value include saltwater fish, turtles, dugong, crabs and oysters. Access to sea country by families is important for cultural traditions, livelihoods and future socio-economic development opportunities.

The national heritage listing for the West Kimberley recognises the following key cultural heritage values:

- Wanjina Wunggurr Cultural Tradition which incorporates many sea country cultural sites
- log-raft maritime tradition, which involved using tides and currents to access warrurru (reefs) far offshore to fish
- interactions with Makassan traders around sea foods over hundreds of years
- important pearl resources that were used in traditional trade through the wunan and in contemporary commercial agreements.

The Wunambal Gaambera, Dambimangari and Bardi Jawi people consider that these values extend into the Kimberley Marine Park. The Wanjina Wunggurr is law of the Wunambal Gaambera and Dambimangari people and it is recognised that all of the sea country, land, plants and animals were put there by Wanjina Wunggurr. Under Wanjina Wunggurr law, the Wunambal Gaambera and Dambimangari people have a responsibility to manage country, to maintain the health of the country and all living things. The Wunambal Gaambera, Bardi Jawi, Mayala and the Nyul Nyul people have had native title determined over parts of their sea country included in this Park. The native title holders for these people are represented by the Wunambal Gaambera Aboriginal Corporation, Bardi and Jawi Niimidiman Aboriginal Corporation and the Kimberley Land Council. These representative bodies are the points of contact for their respective areas of sea country for the Marine Park.

The Kimberley Land Council is the Native Title Representative Body for Kimberley region.

Heritage values

No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the national heritage place of The West Kimberley.

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Historic shipwrecks The Marine Park contains >40 known shipwrecks listed under the *Historic Shipwrecks Act 1976*. **Social and economic values** Tourism, commercial fishing, mining, recreation, including fishing, and traditional use are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Mermaid Reef (NWMR)*					
National Park Zone (IUCN II)	—	—	—	✓	—
The Mermaid Reef Marine Park is located ~280 km north-west of Broome, adjacent to the Argo–Rowley Terrace Marine Park and ~13 km from the WA Rowley Shoals Marine Park. The Marine Park covers an area of 540 km² and water depths from <15 m to 500 m. **Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Transition—an area of shelf break, continental slope, and the majority of the Argo Abyssal Plain. Together with Clerke Reef and Imperieuse Reef, Mermaid Reef is a biodiversity hotspot and key topographic feature of the Argo Abyssal Plain. A key ecological feature of the Marine Park is the Mermaid Reef and Commonwealth waters surrounding Rowley Shoals—an area of enhanced productivity and high species richness thought to be facilitated by internal wave action generated by internal tides in the lagoon. Ecosystems of the Marine Park are associated with emergent reef flat, deep reef flat, lagoon, and submerged sand habitats. The Marine Park supports a range of species, including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds and a migratory pathway for the pygmy blue whale. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. **Heritage values** No international or national listings apply to the Marine Park at commencement of this plan. *Commonwealth heritage* Mermaid Reef–Rowley Shoals was established on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B, C and D. *Historic shipwrecks* The Marine Park contains one known shipwreck listed under the *Historic Shipwrecks Act 1976*: Lively (wrecked in 1810). **Social and economic values** Tourism, recreation, and scientific research are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Montebello (NWMR)*					
Multiple Use Zone (IUCN VI)	—	—	✓	—	—
The Montebello Marine Park is located offshore of Barrow Island and 80 km west of Dampier extending from the WA state water boundary, and is adjacent to the WA Barrow Island and Montebello Islands Marine Parks. The Marine Park covers an area of 3,413 km² and water depths from <15 m to 150 m. **Natural values** The Marine Park includes examples of ecosystems representative of the Northwest Shelf Province—a dynamic environment influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities,					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. A key ecological feature of the Marine Park is the ancient coastline at the 125 m depth contour where rocky escarpments are thought to provide biologically important habitat in areas otherwise dominated by soft sediments. The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds, internesting, foraging, mating, and nesting habitat for marine turtles, a migratory pathway for humpback whales and foraging habitat for whale sharks. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. At the commencement of this plan, there is limited information about the cultural significance of this Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Pilbara region. **Heritage values** No international, Commonwealth or national listings apply to the Marine Park at commencement of this plan, however the Marine Park is adjacent to the Western Australia Barrow Island and the Montebello– Barrow Island Marine Conservation Reserves which have been nominated for national heritage listing. *Historic shipwrecks* The Marine Park contains two known shipwrecks listed under the *Historic Shipwrecks Act 1976*: Trial (wrecked in 1622), the earliest known shipwreck in Australian waters and Tanami (unknown date). **Social and economic values** Tourism, commercial fishing, mining and recreation are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Ningaloo (NWMR)*					
National Park Zone (IUCN II)	—	✓	—	—	—
Recreational Use Zone (IUCN IV)	—	✓	✓	—	—
The Ningaloo Marine Park stretches ~300 km along the west coast of the Cape Range Peninsula, and is adjacent to the WA Ningaloo Marine Park and Gascoyne Marine Park. The Marine Park covers an area of 2,435 km² and a water depth range of 30 m to >500 m. **Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Shelf Transition—continental shelf of water depths up to 100 m, and a significant transition zone between tropical and temperate species • Central Western Transition—characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species • Northwest Province—an area of continental slope comprising diverse and endemic fish communities • Northwest Shelf Province—a dynamic environment, influenced by strong tides, cyclonic storms, long-period swells and internal tides. The bioregion includes diverse benthic and pelagic fish communities, and ancient coastline thought to be an important seafloor feature and migratory pathway for humpback whales. The marine park includes four KEFs characterised by seasonal and sporadic upwelling, nutrient rich water and high diversity of demersal fish assemblages. Ecosystems represented in the Marine Park are influenced by interaction of the Leeuwin Current, Leeuwin Undercurrent and the Ningaloo Current.					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding and or foraging habitat for seabirds, internesting habitat for marine turtles, a migratory pathway for humpback whales, foraging habitat and migratory pathway for pygmy blue whales, breeding, calving, foraging and nursing habitat for dugong and foraging habitat for whale sharks. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Gnulli people have responsibilities for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region. **Heritage values** *World heritage* The Marine Park is within the Ningaloo Coast World Heritage Property, recognised for its outstanding universal heritage values, meeting world heritage listing criteria vii and x. In addition to the Marine Park, the world heritage area includes the WA Ningaloo Marine Park, the Murion Islands, the WA Cape Range National Park and other terrestrial areas. The area is valued for high terrestrial species endemism, marine species diversity and abundance, and the interconnectedness of large-scale marine, coastal and terrestrial environments. The area connects the limestone karst system and fossil reefs of the ancient Cape Range to the nearshore reef system of Ningaloo Reef, to the continental slope and shelf in Commonwealth waters. *National heritage* The Ningaloo Coast overlaps the Marine Park and was established on the National Heritage List in 2010, meeting the national heritage listing criteria A, B, C, D, and F. *Commonwealth heritage* The Ningaloo Marine Area (Commonwealth waters) was established on the Commonwealth Heritage List in 2004, meeting Commonwealth heritage listing criteria A, B and C. The Ningaloo Marine Area overlaps the Marine Park. *Historic shipwrecks* The Marine Park contains more than 15 known shipwrecks listed under the *Historic Shipwrecks Act 1976.* **Social and economic values** Tourism and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					
Shark Bay (NWMR)*					
Multiple Use Zone (IUCN VI)	—	✓	—	—	—
The Shark Bay Marine Park is located ~60 km offshore of Carnarvon, adjacent to the Shark Bay world heritage property and national heritage place. The Marine Park covers an area of 7,443 km², extending from the WA state water boundary, and a water depth range between 15 m and 220 m. **Natural values** The Marine Park includes examples of ecosystems representative of: • Central Western Shelf—a predominantly flat, sandy and low-nutrient area, in water depths 50–100 m. The bioregion is a transitional zone between tropical and temperate species • Central Western Transition—characterised by large areas of continental slope, a range of topographic features such as terraces, rises and canyons, seasonal and sporadic upwelling, and benthic slope communities comprising tropical and temperate species. Ecosystems represented in the Marine Park are influenced by the Leeuwin, Ningaloo and Capes currents.					

AMP	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
The Marine Park supports a range of species including species listed as threatened, migratory, marine or cetacean under the EPBC Act. Biologically important areas within the Marine Park include breeding habitat for seabirds, internesting habitat for marine turtles, and a migratory pathway for humpback whales. The Marine Park and adjacent coastal areas are also important for shallow-water snapper. **Cultural values** Sea country is valued for Indigenous cultural identity, health and wellbeing. Across Australia, Indigenous people have been sustainably using and managing their sea country for tens of thousands of years. The Gnulli and Malgana people have responsibilities for sea country in the Marine Park. The Yamatji Marlpa Aboriginal Corporation is the Native Title Representative Body for the Yamatji region. **Heritage values** No international, Commonwealth or national heritage listings apply to the Marine Park at commencement of this plan, but the Marine Park is adjacent to the Shark Bay, WA World Heritage Property and Shark Bay, WA National Heritage Place. *Historic shipwrecks* The Marine Park contains ~20 known shipwrecks listed under the *Historic Shipwrecks Act 1976.* **Social and economic values** Tourism, commercial fishing, mining and recreation, including fishing, are important activities in the Marine Park. These activities contribute to the wellbeing of regional communities and the prosperity of the nation.					

** Source: Ref. 715*

^Source: Ref. 716

 # Source: Ref. 718

6.2 State Marine Protected Areas

State marine parks, management areas, and reserves are proclaimed under the *Conservation and Land Management Act 1984* (WA) (CALM Act), are located in State waters and are vested in the WA Conservation and Parks Commission.

The presence of marine parks, management areas within the PA and a summary of values, are shown in Table 6-2.

Fish Habitat Protection Areas (FHPAs) are areas of special protection and management in WA waters. They are established in areas identified as having a particular value for the protection of fish and their habitats, education and/or aquaculture and which is considered to require a higher level of protection than other parts of the marine environment (Ref. 719). They are set under section 115 of the *Fish Resources Management Act 1994* (WA) for the following purposes:

- the conservation and protection of fish, fish breeding areas, fish fossils or the aquatic ecosystem
- the culture and propagation of fish and experimental purposes related to that culture and propagation
- the management of fish and activities relating to the appreciation or observation of fish.

Under the Act, fish can include a range of organisms including finfish, crustaceans, molluscs, corals, seagrass and algae at all stages of their life cycles (Ref. 719). FHPAs may restrict non-fishing related activities, such as the use of anchors, if they are considered to be inconsistent with the purpose of the FHPA. Protection may also involve the management of human activities such as dredging, draining of wetlands, and fishing or diving near sensitive marine habitats (Ref. 719).

WA has six FHPAs, four of which are located within the PA (Table 6-2, Figure 6-1, Figure 6-2, Figure 6-3, Figure 6-4).

- Abrolhos Islands
- Kalbarri Blue Holes
- Miaboolya Beach
- Point Quobba

Table 6-2: Presence of state marine parks, management areas and reserves

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Abrolhos Islands FHPA					
Unassigned (IUCN IV)	✓	—	—	—	—
The Houtman Abrolhos is an archipelago of 210 islands, islets and rocks surrounded by coral reef located off the mid-west coast of WA (Ref. 720). The Abrolhos extend >100 km from north to south and consists of three main island groups: the Wallabi Group (including North Island), the Easter Group, and the Pelsaert (or Southern) Group (Ref. 720). The state waters surrounding the Abrolhos Islands are designated as a gazetted Fish Habitat Protection Area (FHPA), renowned for its exceptional marine biodiversity, cultural heritage, and recreational and fishing values (Ref. 720). The islands are home to several conservation-significant species, including seabirds, migratory shorebirds, and the Australian sea lion. More than 380 species of finfish have been documented in the FHPA, encompassing demersal (bottom-dwelling), pelagic (water-column), and nearshore species (Ref. 721). Turtles are also commonly observed in the surrounding waters, with resident green turtles foraging in and around the reefs (Ref. 722). The FHPA supports the southernmost coral reef system in the Indian Ocean and is among the world's highest-latitude coral reef systems (Ref. 721). Ten seagrass species have been recorded at the Abrolhos ranging from small, delicate species to larger, more robust types that grow in large meadows (Ref. 722). The predominant species of seagrasses occurring in the Abrolhos FHPA include Posidonia australis, *Amphibolis sp*. and *Halophila sp*. A single mangrove species, the grey mangrove (*Avicennia marina*), occurs at the Abrolhos. Extensive stretches of mangroves can be seen on Pelsaert Island, Wooded Island and Morley Island (Ref. 721).					
Barrow Island Marine Park and Marine Management Area					
Unassigned (IUCN IA, VI)	—	—	✓	—	—
Barrow Island and its surrounding waters are known to support marine biota typical of the Indo west Pacific flora and fauna; however, there is a significant degree of endemism in the region (Ref. 710). The Island is known as a breeding area for marine turtles (Ref. 724) and serves as a significant rookery for at least 15 seabird species (Ref. 710). Although macroalgae-dominated limestone reefs and subtidal reef platform/sand mosaics are the main marine habitat types, coral reefs, mangroves, and subtidal sand and soft-bottom habitats are also common (Ref. 710). The subtidal coral reef communities have a high diversity of invertebrates, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (Ref. 710).					
Great Sandy Island Nature Reserve					
Unassigned (IUCN IA)	—	—	✓	—	—

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
The Great Sandy Island is part of the Pilbara Islands. The Pilbara Islands are a group of over 170 islands, islets, rocks and cays that lie between the bottom of Exmouth Gulf and the Regnard Islands near Cape Preston (Ref. 725). These remote islands have immense natural, cultural, and heritage value and many of the islands are protected as nature reserves. The islands have high conservation value and provide a refuge for threatened and priority species, relatively free from threats like introduced predators, light or noise pollution, development, bushfires and other disturbances. They also support priority ecological communities, priority flora, and increasingly rare pristine vegetation types (Ref. 725).					
Hamelin Pool Marine Nature Reserve					
Unassigned (IUCN IA)	—	✓	—	—	—
Hamelin Pool, located 100 km south-east of Denham, is one of only two places in the world with living marine stromatolites, also known as 'living fossils.' It is part of the Shark Bay World Heritage Area (Ref. 726). Stromatolites thrive undisturbed in Hamelin Pool, where the sea water is twice as salty as usual, thanks to a natural bar across the bay's entrance (Ref. 726). Recreational activities such as boating, swimming, diving and snorkelling are not permitted over stromatolites, or within 300 m of the shore (Ref. 726)					
Kalbarri Blue Holes FHPA					
Unassigned (IUCN IV)	✓	—	—	—	—
Blue Holes Beach is a FHPA located south of Kalbarri. The Kalbarri Blue Holes FHPA includes part of a near-shore limestone reef system, which stretches intermittently from Red Bluff in the South to the Murchison River Mouth in the North (Ref. 727). A healthy and diverse reef community composed of both temperate and tropical species have been identified in this area. Small colonies of corals occurring within metres of the beach are highly accessible during periods of low swell (Ref. 727). Stormwater from the urban areas of Kalbarri discharges directly into the near-shore marine waters in the vicinity of the FHPA, which has the potential to affect local water quality (Ref. 727). To Aboriginal people, the highly accessible nature of this coastal reef system, which is in near proximity of the river mouth, is likely to have made it a significant site for hunting fish and gathering seafood (Ref. 727).					
Miaboolya BeachFHPA					
Unassigned (IUCN IV)	—	✓	—	—	—
Miaboolya Beach is16 km by road north of Carnarvon, part of the Gascoyne River delta, and home to a rich array of species and habitats (Ref. 728). It includes nearshore waters, mangroves, seasonal creeks and salt marshes up to the HWM from South Bejalong Hill, south to the Gascoyne River mouth (Ref. 728). The area is a habitat for an abundance of native fauna. These include juvenile finfish species and various crab species including mud crabs, blue swimmer and green mud crabs (Ref. 729). All these species are important to the Carnarvon region and are part of the ecological balance that exists within the Miaboolya Beach ecosystem (Ref. 729). The mangals found within Miaboolya Creek are of environmental importance. Resident and migratory populations of birds, marine turtles and dolphins also exist within the area and contribute to its environmental value (Ref. 729).					
Montebello Islands Marine Park and Conservation Park					
General Use Zone (IUCN II)	—	—	✓	—	—
Recreation Zone (IUCN II)	—	—	✓	—	—
Sanctuary Zone (IUCN IA)	—	—	✓	—	—
Special Purpose Zone (Benthic Protection) (IUCN IV)	—	—	✓	—	—

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Special Purpose Zone (Pearling) (IUCN VI)	—	—	✓	—	—
Unassigned (IUCN II)	—	—	✓	—	—
The islands are located ~120 km west of the town of Dampier in WA and 8,000 years ago were once part of mainland Australia (Ref. 730). These waters and islands are important for threatened sea turtles as well as dolphins, dugongs and various species of seabird and shorebirds. The Island is known as a breeding area for marine turtles (Ref. 724) and serves as a significant rookery for at least 15 seabird species (Ref. 710). Although macroalgae-dominated limestone reefs and subtidal reef platform/sand mosaics are the main marine habitat types, coral reefs, mangroves, and subtidal sand and soft-bottom habitats are also common (Ref. 710). The subtidal coral reef communities have a high diversity of invertebrates, with at least 150 species of hard corals recorded from fringing and patch coral reef areas (Ref. 710).					
Muiron Islands Marine Management Area					
Conservation Area (IUCN IA)	—	—	✓	—	—
Marine Management Area (Unclassified) (IUCN VI)	—	—	✓	—	—
The Muiron Islands consist of the South Muiron and North Muiron islands which serve as important nesting sites for seabirds and green turtles (Ref. 731). These islands and surrounding waters are also within the Muiron Islands Marine Management Area and the Ningaloo Coast World Heritage property and National Heritage place (Section 7.1). The Muiron Islands Marine Management Area is recognised for its rich marine biodiversity, coral reefs, filter-feeding communities and macroalgal beds (Ref. 732).					
Ningaloo Marine Park					
General Use (IUCN II)	—	✓	✓	—	—
Recreation Area (IUCN II)	—	✓	✓	—	—
Sanctuary Zone (IUCN IA)	—	✓	✓	—	—
Special Purpose Zone (Benthic Protection) (IUCN IV)	—	✓	—	—	—
Special Purpose Zone (Shore Based Activities) (IUCN II)	—	✓	✓	—	—
Unassigned (IUCN II)	—	✓	—	—	—
Ningaloo Marine Park is World Heritage-listed and home to one of the largest fringing reefs in Australia, supporting hundreds of fish and coral species. The Ningaloo Reef stretches over 300 km and forms a discontinuous barrier enclosing a lagoon that varies in width from 200 m to over 7 km (Ref. 732). The reef is home to >300 species of coral and 500 species of fish, as well as iconic marine life such as whale sharks, orcas, humpback whales, dugongs, manta rays, turtles, and dolphins (Ref. 732). In 2004, surveys by the Australian Institute of Marine Science recorded extensive areas of filter-feeding communities in depths ranging from 20 to 200 m (Ref. 732). Shoreline intertidal reefs, a prominent feature along the Ningaloo Marine Park coastline, contribute significantly to the park's biological diversity. These reefs are shaped by tidal and wave action and support a variety of organisms resistant to desiccation (Ref. 732). Larger fish and marine animals feed on the reefs during high tide, while the abundance of invertebrates provides an essential food source for shorebirds. Macroalgal meadows, occupying ~2,200 ha of shallow limestone lagoonal platforms, are also present (Ref. 732). Additionally, three species of mangroves have been identified within the park. The white mangrove (*Avicennia marina*) is the dominant species, while the red mangrove (*Rhizophora stylosa*) and ribbed-orange fruit mangrove (*Bruguiera exaristata*) are less common (Ref. 732).					

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Point Quobba FHPA					
Unassigned (IUCN IV)	—	✓	—	—	—
Point Quobba is ~75 km north-west of Carnarvon in WA, and adjoins the popular 'Blowholes' natural tourist attraction. It sits between two distinctive landscapes: the 'Cliff Coast' and the 'Dune Coast' (Ref. 733). Known for its calm, coral-filled lagoon, Point Quobba boasts an abundance of fish, shells, and a white sandy beach. The marine habitat at Point Quobba serves as a transition zone between tropical and temperate climates, supporting a highly diverse range of species (Ref. 733).					
Rocky Island Nature Reserve					
Unassigned (IUCN IA)	—	—	✓	—	—
Rocky Island is part of the Pilbara Islands. The Pilbara Islands are a group of over 170 islands, islets, rocks and cays that lie between the bottom of Exmouth Gulf and the Regnard Islands near Cape Preston (Ref. 725). These remote islands have immense natural, cultural, and heritage value and many of the islands are protected as nature reserves. The islands have high conservation value and provide a refuge for threatened and priority species, relatively free from threats like introduced predators, light or noise pollution, development, bushfires and other disturbances. They also support priority ecological communities, priority flora, and increasingly rare pristine vegetation types (Ref. 725).					
Rowley Shoals Marine Park					
General Use (IUCN II)	—	—	✓	✓	—
Recreation Zone (IUCN II)	—	—	✓	✓	—
Sanctuary Zone (IUCN IA)	—	—	—	✓	—
Unassigned (IUCN IV)	—	—	—	✓	—
Located ~300 km north-north-west of Broome, the Rowley Shoals consist of three oceanic reef systems: Mermaid Reef, Clerke Reef, and Imperieuse Reef, positioned ~30-40 km apart. The Rowley Shoals Marine Park includes Clerke and Imperieuse Reefs, which lie within State waters (Ref. 734). The marine reef fauna of the Rowley Shoals is exceptionally rich and diverse, featuring species typical of the oceanic coral reef communities of the Indo-West Pacific. The faunal assemblages within the Rowley Shoals Marine Park are regionally significant, containing numerous species absent from the more turbid coastal environments of tropical WA (Ref. 734). The Shoals are regionally important due to their location in the headwaters of the Leeuwin Current, suggesting they serve as a vital source of invertebrate and finfish recruits to southern areas. They are also of international significance, acting as a global benchmark for Indo-West Pacific reefs due to their low exposure to human pressures (Ref. 734). The Park also features drop-off areas exceeding 50 m in depth, which support a variety of migratory pelagic species (Ref. 734).					
Scott Reef Nature Reserve					
Unassigned (IUCN IA)	—	—	—	✓	—
Scott Reef rises steeply from the depths near the edge of north-western Australia's continental shelf, isolated from the mainland and other reefs (Ref. 735). The reef consists of two separate reef formations: North Reef and South Reef. The coral communities at Scott reef play a key role in maintaining the species richness and subsequent aggregations of marine life. Scott Reef is a particularly biologically diverse system and includes >300 species of reef-building corals, ~400 mollusc species, 118 crustacean species, 117 echinoderm species and ~720 fish species (Ref. 689). The surrounding waters attract a remarkable diversity of marine life, including aggregations of humpback whales during their northerly migration, as well as Bryde's whales, pygmy blue					

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
whales, Antarctic minke whales, dwarf minke whales, minke whales, dwarf sperm whales, and spinner dolphins. Whale sharks and several species of sea snakes have also been recorded in the area (Ref. 689). Sandy Islet on South Scott Reef serves as a nesting site for green and hawksbill turtles during the summer months. These species also use the surrounding waters for internesting and foraging (Ref. 249).					
Sedimentary Deposits Reserve 5(1)(g) Reserve					
Unassigned (IUCN III)	—	✓	—	—	—
Sedimentary Deposits Reserve is a marine protected area located ~64 km east of WA. The reserve's surrounding waters are encompassed by the Shark Bay Marine Park. Further details about its characteristics are provided in the Shark Bay description below.					
Shark Bay Marine Park					
General Use (IUCN II)	—	✓	—	—	—
Recreation Zone (IUCN II)	—	✓	—	—	—
Sanctuary Zone (IUCN IA)	—	✓	—	—	—
Special Purpose Zone (Dugong Protection) (IUCN IV)	—	✓	—	—	—
Special Purpose Zone (Habitat Protection) (IUCN IV)	—	✓	—	—	—
Special Purpose Zone (Seagrass Protection) (IUCN IV)	—	✓	—	—	—
Special Purpose Zone (Wildlife Viewing and Protection) (IUCN IV)	—	✓	—	—	—
Shark Bay Marine Park, part of the Shark Bay World Heritage Area, is renowned for its rich and diverse marine life (Ref. 736). The park supports a unique mix of tropical and temperate fish species, along with an abundance of turtles, dugongs, sea snakes, sharks, and vibrant communities of seagrasses, corals, and sponges (Ref. 737) Humpback whales use the bay as a key staging post during their coastal migration. Green and loggerhead turtles are also found in the area, with Dirk Hartog Island serving as an important nesting site for loggerhead turtles in WA (Ref. 736). Shark Bay is also famous for the Monkey Mia bottlenose dolphins, and its wide sheltered bays provide habitats for a diverse and relatively unexplored array of molluscs, crustaceans, and other invertebrates (Ref. 736). The park encompasses over 4,000 km² of seagrass meadows, which are the foundation of Shark Bay's marine ecosystems. These meadows provide essential shelter and food for a wide range of species, including molluscs, crustaceans, fish, and sea snakes (Ref. 737). The Malgana name for Shark Bay is Gathaaguda. The majority of the Shark Bay Marine Park is Malgana Sea Country, with the north eastern section in Yinggarda Country (Ref. 737).					
Thevenard Island Nature Reserve					
Unassigned (IUCN IA)	—	—	✓	—	—
Thevenard Island is part of the Pilbara Islands. The Pilbara Islands are a group of over 170 islands, islets, rocks and cays that lie between the bottom of Exmouth Gulf and the Regnard Islands near Cape Preston (Ref. 725). These remote islands have immense natural, cultural, and heritage value and many of the islands are protected as nature reserves. The islands have high conservation value and provide a refuge for threatened and priority species, relatively free from threats like introduced predators, light or noise pollution, development, bushfires and other disturbances. They also support priority ecological communities, priority flora, and increasingly rare pristine vegetation types (Ref. 725).					

State marine protected areas	Section				
	West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Marine turtles use the island beaches in summer for nesting and resting, females often rest at the water line before moving back out to sea (Ref. 738).					

6.3 State terrestrial protected areas

Terrestrial protected areas, proclaimed under the CALM Act, are located on State lands and are vested in the WA Conservation and Parks Commission.

While CAPL's activities usually occur offshore and do not directly interface with the coast, the Hydrocarbon EMBAs associated with the EPs may intersect with coastal areas. Table 6-3 identifies the state terrestrial protected areas within the PA[13]. For project-specific EPs, CAPL will assess their significance and include detailed information in the EP, if required.

Table 6-3: Presence of State terrestrial protected areas

Lands protected areas	Zone Type (IUCN category)	Section				
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Airlie Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Barrow Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Bedout Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Bernier And Dorre Islands*	Nature Reserve (IUCN IV)	—	✓	—	—	—
Bessieres Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Boodie, Double Middle Islands*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Bundegi Coastal Park^	5(1)(h) Reserve (IUCN II)	—	—	✓	—	—
Burnside And Simpson Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Cape Range^	National Park (IUCN II)		✓			
Cape Range (South)^	National Park (IUCN II)	—	✓	—	—	—
Christmas Island*	National Park (IUCN II)	—	—	—	—	✓
Dirk Hartog Island*^	National Park (IUCN II)	—	✓	—	—	—

[13] Only state terrestrial protected areas with a coastal and/or marine interface have been identified.

Lands protected areas	Zone Type (IUCN category)	Section				
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Faure Island^	Private Nature Reserve (IUCN IV)	—	✓	—	—	—
Francois Peron^	National Park (IUCN II)	—	✓	—	—	—
Freycinet, Double Islands etc#	Nature Reserve (IUCN IA)	—	✓	—	—	—
Giralia	Gazettal in Progress	—	—	✓	—	—
Gnandaroo Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Hamelin Station^	Conservation Reserve (IUCN II)	—	✓	—	—	—
Houtman Abrolhos Islands^	National Park (IUCN II)	✓	—	—	—	—
Jarrkunpungu*	Nature Reserve (IUCN IA)	—	—	—	—	—
Jurabi Coastal Park^	5(1)(h) Reserve (IUCN II)	—	✓	✓	—	—
Kalbarri^	National Park (IUCN II)	✓	—	—	—	—
Koks Island*	Nature Reserve (IUCN IA)	—	✓	—	—	—
Lacepede Islands*	Nature Reserve (IUCN IA)	—	—	—	✓	—
Little Rocky Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Locker Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Lowendal Islands^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Monkey Mia Reserve*	5(1)(h) Reserve (IUCN II)	—	✓	—	—	—
Montebello Islands^	Conservation Park (IUCN II)	—	—	✓	—	—
Muiron Islands^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Murujuga^	National Park (IUCN II)	—	—	✓	—	—
Nanga Station	Gazettal in Progress	—	✓	—	—	—
North Sandy Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—

Lands protected areas	Zone Type (IUCN category)	Section				
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
North Turtle Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Nyingguulu (Ningaloo) Coastal Reserve^	5(1)(h) Reserve (IUCN II)	—	✓	—	—	—
One Tree Point^	Nature Reserve (IUCN IA)	—	✓	—	—	—
Round Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Serrurier Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Shell Beach^	Conservation Park (IUCN III)	—	✓	—	—	—
Tamala Pastoral Lease (Part)	Gazettal in Progress	—	✓	—	—	—
Tent Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Victor Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Unnamed WA36907^	5(1)(h) Reserve (IUCN II)	—	—	✓	—	—
Unnamed WA36910^	5(1)(h) Reserve (IUCN II)	—	—	✓	—	—
Unnamed WA36913^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Unnamed WA36915^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Unnamed WA37500#	5(1)(h) Reserve (IUCN II)	—	✓	—	—	—
Unnamed WA49144#	Conservation Park (IUCN II)	—	✓	—	—	—
Weld Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Whalebone Island^	Nature Reserve (IUCN IA)	—	—	✓	—	—
Whitmore, Roberts, Doole Islands And Sandalwood Landing*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Y Island*	Nature Reserve (IUCN IA)	—	—	✓	—	—
Yaringga	Gazettal in Progress	—	✓	—	—	—

Lands protected areas	Zone Type (IUCN category)	Section				
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
Zuytdorp^	Nature Reserve (IUCN IA)	—	✓	—	—	—

** Protected area is landward of LWM.*

^ Protected area is landward of HWM.

 # No information available.

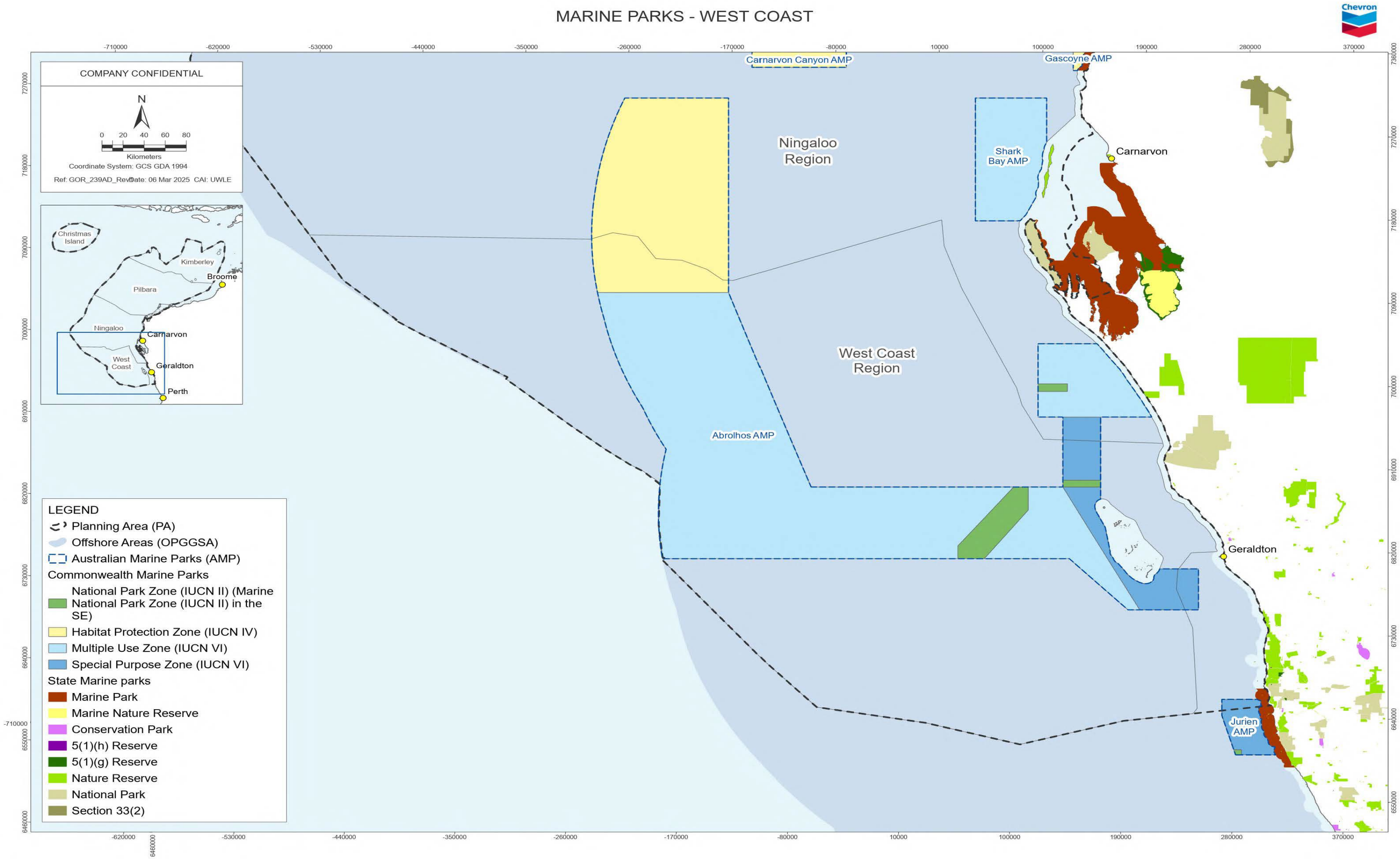

Figure 6-1: Commonwealth and state marine parks relevant to the PA, West Coast

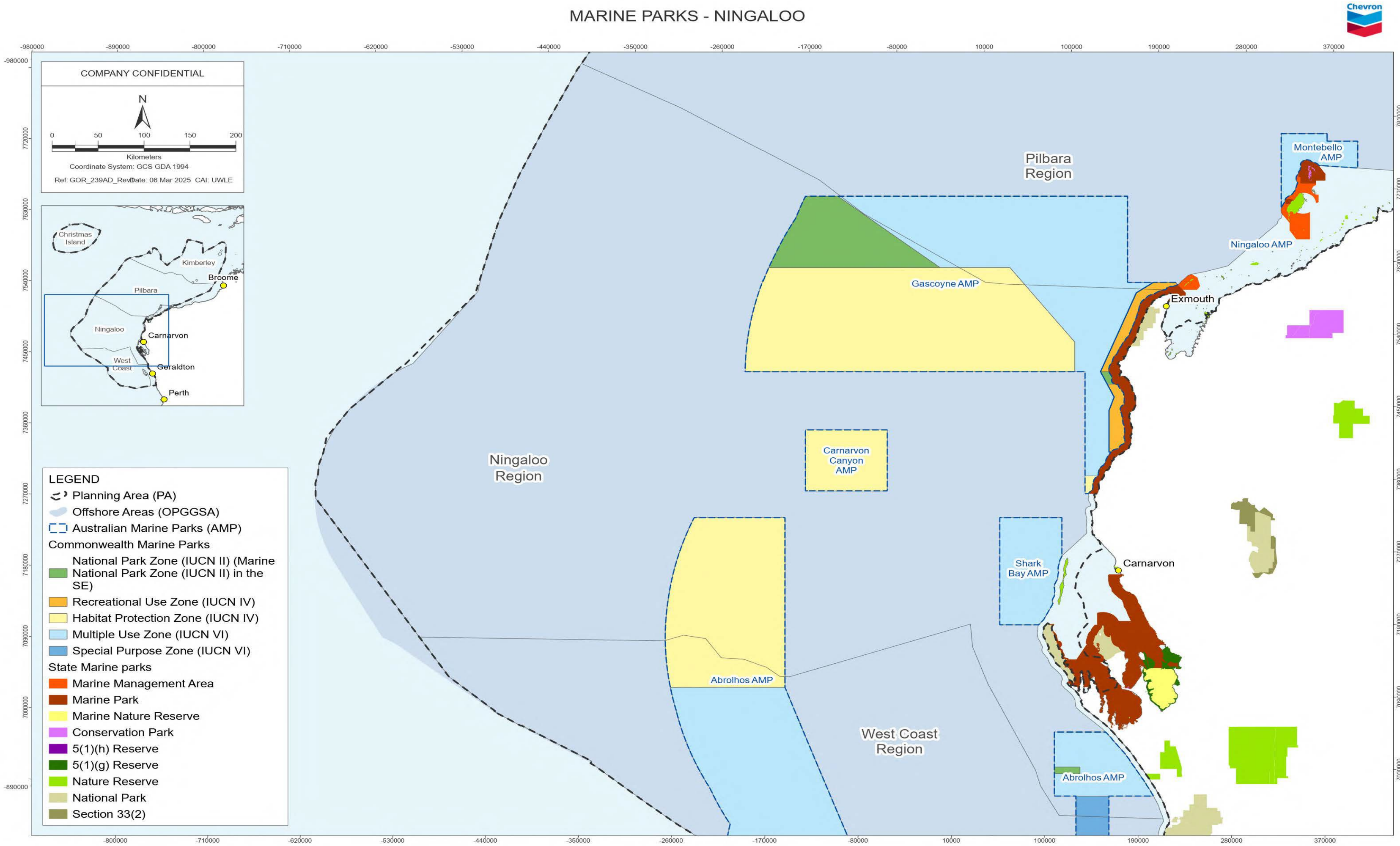

Figure 6-2: Commonwealth and state marine parks relevant to the PA, Ningaloo region

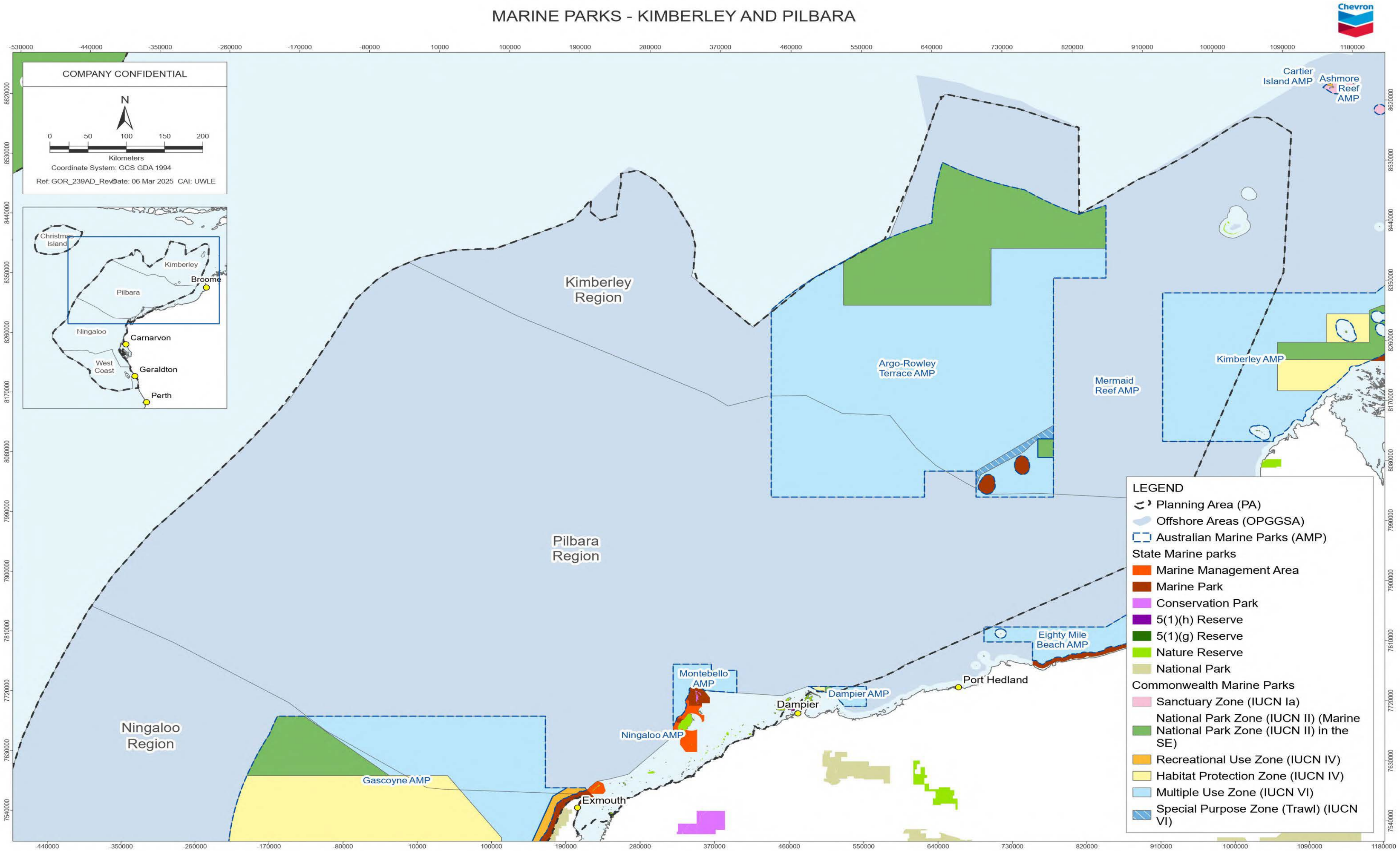

Figure 6-3: Commonwealth and state marine parks relevant to the PA, Kimberley Pilbara region

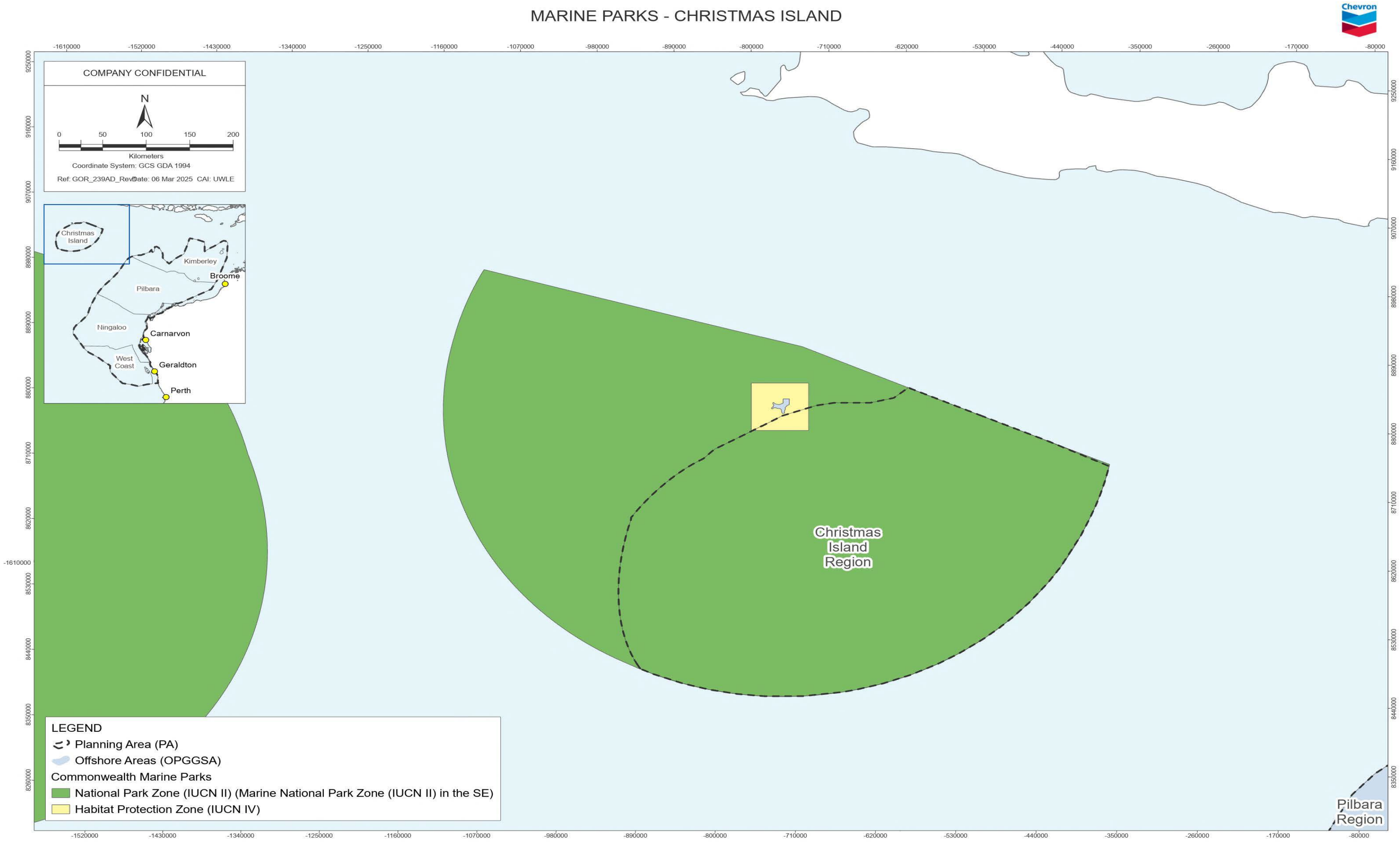

Figure 6-4: Commonwealth and state marine parks relevant to the PA, Christmas Island Region

7 heritage value and places

7.1 World Heritage properties, National and Commonwealth Heritage places

Listed World Heritage properties, and National Heritage places, are MNES under the EPBC Act, and a relevant value and sensitivity under the OPGGS(E)R.

Properties nominated for World Heritage listing are inscribed on the list only after they have been carefully assessed as representing the best examples of the world's cultural and natural heritage. At the time of writing this document, Australia has 20 properties on the World Heritage List (Ref. 739).

The National and Commonwealth Heritage Lists are Australia's list of natural, historic, and Indigenous places of outstanding significance to the nation. Both, the National and Commonwealth Heritage Lists spatial database (Ref. 740, Ref. 741) describes the place name, class (Indigenous, natural, historic), and status.

A review of the World Heritage Areas spatial database (Ref. 742), the Australia's World Heritage areas (Ref. 739), the National Heritage List spatial database (Ref. 740), the Commonwealth Heritage List spatial database (Ref. 741), searches of the online PMST (appendix a) identified the World, National and Commonwealth Heritage places that occur in the PA[14]. Table 7-1 summarises the values of these Heritage properties.

[14] Only listed World Heritage properties, National and Commonwealth Heritage places with a coastal and/or marine interface have been identified and described.

Table 7-1: World Heritage properties, National and Commonwealth Heritage places within the PA

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
World heritage property							
Shark Bay	N/A	—	✓	—	—	—	Located on the Indian Ocean coast at Australia's most westerly point, Shark Bay spans ~2.2 million hectares, with ~70% comprising marine waters. This area is renowned for its exceptional natural features, including the largest and richest seagrass beds in the world, a significant dugong population, and ancient stromatolites (dome-shaped colonies of algae considered some of the oldest life forms on Earth) (Ref. 743). Shark Bay also provide a refuge for several globally threatened species, including five species of endangered mammals (Ref. 743), found on Bernier and Dorre Islands (Ref. 743). Shark Bay is renowned for its marine fauna (Ref. 744): • a population of ~10,000 dugong and an abundance of dolphins, particularly at Monkey Mia • humpback whales, which use Shark Bay as a staging post during their WA coastal migration • green and loggerhead turtles near their southern limits, nesting on Dirk Hartog Island and Peron Peninsula beaches. Dirk Hartog Island is the most important nesting site for loggerhead turtles in WA • an important nursery ground for larval crustaceans, fishes, and jellyfish. ~25% of vascular plants (283 species) are at the limits of their range, with 51 species endemic to the region and some newly identified by science (Ref. 744). The area also supports a rich avifauna, with over 230 bird species (~35% of Australia’s total) recorded, and ~100 amphibian and reptile species, many at their range limits. Notable burrowing species include the Sandhill Frog, which thrives without surface water. Shark Bay is home to three endemic sand-swimming skinks and 10 of Australia's 30 dragon lizard species (Ref. 744).

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							Shark Bay contains Hamelin Pool, home to the world's most diverse and abundant stromatolite formations, which represent life forms from ~3.5 billion years ago (Ref. 744). Additionally, the area is one of the few marine regions dominated by carbonates unrelated to reef-building corals. This has fostered the development of the Wooramel Seagrass Bank, the largest seagrass meadow globally and the site with the highest recorded seagrass species diversity (Ref. 743).
The Ningaloo Coast	N/A	—	✓	✓	—	—	The Ningaloo Coast is located on WA's remote coast along the East Indian Ocean. The property holds a high level of terrestrial species endemism and high marine species diversity and abundance (Ref. 745). Whale sharks aggregate annually coinciding with mass coral spawning events and seasonal localised increases in productivity (Ref. 745). The integration of the Ningaloo Reef and Exmouth Peninsula karst system as a cohesive limestone structure is at the heart of the natural heritage significance of the Ningaloo Coast (Ref. 746). The marine portion of the World Heritage property contains a high diversity of habitats that includes lagoon, reef, open ocean, the continental slope, and the continental shelf (Ref. 745). Intertidal systems such as rocky shores, sandy beaches, estuaries, and mangroves are also present (Ref. 745). The most dominant marine habitat is the Ningaloo reef, which sustains both tropical and temperate marine fauna and flora, including marine reptiles and mammals (Ref. 745). The main terrestrial feature of the Ningaloo Coast is the extensive karst system and network of underground caves and water courses of the Cape Range (Ref. 745). The karst system includes hundreds of separate features such as caves, dolines, and subterranean water bodies and supports a rich diversity of highly specialised subterranean species. Above ground, the Cape Range Peninsula belongs to an arid ecoregion recognised for its high levels of species richness and endemism, particularly for birds and reptiles (Ref. 745).

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							In addition to the natural values of the Ningaloo Coast, Indigenous values are identified under the National Heritage listing (Ref. 746). Archaeological deposits in the rock shelters on Cape Range show First Nations people sophisticated knowledge of marine resources between 35,000 and 17,000 years ago. The rock shelters are considered to provide the best evidence in Australia for the use of marine resources during the Pleistocene (Ref. 746). The evidence for standardisation in size and manufacture of the shell beads found at Mandu Creek rock shelter, coupled with the fact they provide the earliest unequivocal evidence for the creation of personal ornaments in Australia, demonstrates a high degree of creative and technical achievement (Ref. 747).
National heritage place							
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	Historic	✓	—	—	—	—	On the night of June 4, 1629, the Batavia struck a coral reef and sank in the Houtman Abrolhos Islands, 65 km off the coast of WA (Ref. 748). The Batavia is the oldest known Verenigde Oost-Indische Compagnie shipwreck on the WA coast. Due to its relatively undisturbed condition, archaeological investigations of the wreck have uncovered a wide range of historically significant artifacts (Ref. 749). The wreck site on Morning Reef is well-preserved, with substantial structural remains still intact. Similarly, the ruins of the two stone huts on West Wallabi Island are in good condition, with their walls largely preserved. Although little evidence remains of the campsites on Beacon Island, archaeological studies of the gravesites have revealed that they are in excellent condition (Ref. 749).
Dampier Archipelago (including Burrup Peninsula)	Indigenous	—	—	✓	—	—	The Dampier Archipelago, including the Burrup Peninsula, lies on the Indian Ocean coast in the west Pilbara region of northern WA, ~1,550 km north of Perth (Ref. 750). The Archipelago consists of 42 islands, islets and rocks ranging in size from <2 ha to 3,29 ha covering a total area of ~400 km^2 (Ref. 750). Formed 6,000–8,000 years ago by rising sea levels that flooded ancient coastal plains, the Archipelago is underpinned by some of

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							the oldest rocks on Earth, dating back over 2.4 billion years to the Archaean period (Ref. 750). The region features diverse marine habitats, from wave-exposed, clear-water seaward areas with low sedimentation to sheltered coastal bays with turbid waters, as well as six species of mangroves (Ref. 750). Its warm tropical waters support abundant and highly diverse marine life, including rich coral species, bivalves, gastropods, crustaceans, worms, burrowing anemones, echinoderms, and brachiopods (Ref. 750). Additionally, the Dampier Archipelago is home to 650 species of shallow-water marine fish, including a rich reef assemblage (Ref. 750). The Dampier Archipelago (including the Burrup Peninsula) are renowned for their rock engravings, boasting one of Australia's densest concentrations. Some sites feature thousands, even tens of thousands, of images. These engravings include an exceptionally diverse range of schematised human figures, with some arranged in intricate scenes of national significance (Ref. 750). The area also contains a high density of stone arrangements. These include standing stones, stone pits, and circular stone formations. Standing stones range from solitary monoliths to extensive alignments of several hundred stones (Ref. 750). The Ngarda-Ngarli people of this region have traditional accounts of the formation of the Dampier Archipelago. For them, ancestral beings formed the landscape of the Dampier Archipelago in the Dreamtime and the spirits of these beings and other spirits such as Ngkurr, Bardi, and Gardi continue to live in the area (Ref. 750). They have left their mark in features like the Marntawarrura, or 'black hills,' said to be stained from the blood of the creative beings (Ref. 751).
Dirk Hartog Landing Site 1616 - Cape Inscription Area	Historic	—	✓	—	—	—	Cape Inscription is the site of the oldest known landings of Europeans on the WA coastline, and is associated with a series of landings and surveys by notable explorers over a 250-year period (Ref. 752). The first known European landing on the west coast of Australia was by Dirk Hartog of the Dutch East India Company's

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							ship the Eendracht at Cape Inscription on 25 October 1616 (Ref. 752). After leaving the island, Hartog sailed northwards charting the coastline of WA to 22° south. As a result, a known part of the coastline of WA appeared on world maps for the first time, replacing the mythical southern continent of 'Terra Australis Incognita' (Ref. 752).
HMAS Sydney II and HSK Kormoran Shipwreck Sites	Historic	✓	—	—	—	—	The naval battle fought between the Australian warship *HMAS Sydney II* and the German commerce raider *HSK Kormoran* off the WA coast during World War II (November 1941) was a defining event in Australia's cultural history (Ref. 753). HMAS Sydney II was Australia's most famous warship of the time and this battle has forever linked the stories of these warships to each other. The tragic loss of HMAS Sydney II and its entire crew of 645 following the battle with HSK Kormoran remains Australia's worst naval disaster (Ref. 753). The two areas that make up the place are located ~211 km off the coast of WA The shipwrecks of the HMAS Sydney II and HSK Kormoran are within the place and are located on the sea bed ~22 km apart. The place includes the surface of the seabed and includes both the water column above the seabed and the airspace above the sea (Ref. 753).
Shark Bay	Natural	—	✓	—	—	—	Refer to the summary in the World Heritage property section above.
The Ningaloo Coast	Natural	—	✓	✓	—	—	Refer to the summary in the World Heritage property section above.
The West Kimberley	Natural	—	—	—	✓	—	The National Heritage listing of the West Kimberley recognises the natural, historic, and Indigenous stories of the region that are of outstanding heritage value to the nation (Ref. 754). The listing also recognizes the important history of non-Indigenous exploration and settlement of the Kimberley. Many non-Indigenous people have forged their own close ties to the region and have learned to live in and understand this extraordinary place (Ref. 754). The Kimberley occupies more than 420,000 km^2 on the north-western margin of the Australian continent (Ref. 754). Its rocky

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							coastline edges the Indian Ocean, and off the coast lie thousands of islands, many fringed with coral. The Mitchell Plateau (Ngauwudu) rises to nearly 800 m above sea level at its centre, in places dropping into steep escarpments, and losing altitude as it approaches the sea. Further south, Yampi Peninsula lies in a transitional area between the high rainfall of tropical north Kimberley and the drier conditions characteristic of central WA. These different environments meet in a complex landscape of plains, dissected sandstone plateaus, and rugged mountains (Ref. 754). The central Kimberley, which includes the periphery of north Kimberley plateau country and the King Leopold Ranges, is very rugged; the physical structures here were formed by significant geological events, which folded rocks intensely, many thousands of millions of years ago. That such evidence of a distant past can today be seen so clearly in the landscape is due to the region's remarkable geological stability. This stability has also allowed the much more recent appearance of extensive limestone ranges, built from the remains of an extraordinary reef complex which, more than 300 million years ago, rivalled the Great Barrier Reef in size. The ranges have since eroded to form complex networks of caves and tunnels (Ref. 754). Dinosaur footprints and tracks are remarkable remnant of past life in the Kimberley; they are exposed in many places in the Broome sandstone, along the western length of Dampier Peninsula. This coastline is subject to one of the highest tidal ranges in the world, and many of the fossil footprints can only be seen for short periods during very low tides. Inland of Dampier Peninsula, south of the broad floodplains of the Fitzroy River, the distinctive red of the pindan country opens onto a vast expanse of desert (Ref. 754). Throughout the Kimberley, where water meets land—in estuaries, mangroves and mudflats, in moist vine thickets, along the banks of rivers and creeks, around waterholes or soaks—there is an abundance of plants and animals, some of which live only in the Kimberley, while others may have travelled from the far side of the world to nest or breed here (Ref. 754).

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							Aboriginal people believe that their traditional countries have been formed during an era of creation often described in English as 'the Dreaming' or 'the Dreamtime'. During the Dreaming both the natural and human world are formed coterminously by ancestral creator beings who are manifestations of powerful spiritual forces that permeate the cosmos (Ref. 754).
Commonwealth heritage place							
Christmas Island Natural Areas (External territories list)	Natural	—	—	—	—	✓	Christmas Island lies at the intersection of the Australian and Malaysian regions, hosting flora and fauna representative of both. Species on the island have adapted to its seasonal climate, phosphate-rich soils, and karst-dominated terrain (Ref. 755). The island is home to three notable endemic seabird species, seven endemic land birds, and serves as a habitat or stopover for migratory birds from regions like Japan and China. Additionally, the island is renowned for its marine biodiversity, which includes numerous fish, coral, mollusc, echinoderm, and decapod crustacean species (Ref. 755). The island's diverse land crab population plays a critical ecological role, substituting the scavenging functions typically performed by small mammals and ground birds. These crabs significantly influence the recruitment and distribution of rainforest plant species, contributing to the simple structure of the island's plateau rainforest. Fourteen land crab species are present, including the abundant and endemic red crab (Ref. 755). The blue crab, uniquely appearing in its blue form on the island, may represent an endemic subspecies pending further genetic analysis. Marine plankton feeders such as whale sharks and manta rays are observed in the surrounding waters, with whale sharks likely timing their visits to coincide with the seasonal red crab larval bloom (Ref. 755). Geologically, Christmas Island is an isolated volcanic seamount capped by discontinuous limestone formations. It rises from ocean depths of 4,500 m to an altitude of 357 m at Murray Hill. The limestone layer is characterized by karst features such as caves and sinkholes, with extensive systems following fault lines (Ref. 755).

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
HMAS Sydney II and HSK Kormoran Shipwreck Sites	Historic	✓	—	—	—	—	Refer to the summary in the National Heritage place section above.
Learmonth Air Weapons Range Facility	Natural	—	✓	—	—	—	The geomorphology of Cape Range, of which the Learmonth Range Facility is a part, is significant for documenting sea level and landform changes since the late Cenozoic (around 1.8 million years ago) (Ref. 756). A series of emergent reef complexes, representing multiple periods of coral reef development, are striking features of the western side of the Learmonth Range Facility and Cape Range. The ages of these reef terraces are crucial for understanding the timing of uplift events (Ref. 756). The coastal plain of Cape Range contains a network of subterranean waterways, including caverns and fissures in the limestone beneath the plain. Among these, Bundera Sinkhole, located within the Learmonth Range Facility, stands out as the only deep anchialine system known in Australia and the only continental anchialine system identified in the Southern Hemisphere (Ref. 756). Anchialine systems are cave networks with restricted surface exposure, subterranean connections to the sea, and a blend of marine and terrestrial influences (Ref. 756). The cave fauna of Cape Range, particularly at Bundera Sinkhole, is of exceptional biogeographical significance. Bundera Sinkhole hosts several species of aquatic stygofauna, many of which are endemic to the sinkhole or the Cape Range (Ref. 756). Many of these species share their closest affinities with the fauna of anchialine caves on both sides of the North Atlantic. This narrow cave is the only known habitat for a crustacean belonging to the class *Remipedia* (Ref. 756). Potential cultural values of National Estate significance, both Indigenous and non-Indigenous, may also be associated with this site. However, these values have not yet been identified,

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
							documented, or assessed by the Australian Heritage Commission (Ref. 756).
Mermaid Reef - Rowley Shoals	Natural	—	—	—	✓	—	Rowley Shoals consists of three large, emergent shelf-edge reefs located ~260 km f off the northwestern coast of mainland Australia on the edge of the broad continental shelf (Ref. 757). Mermaid Reef, one of the three reefs, is notable for its rare environmental conditions, including clear, deep oceanic water and large tidal ranges, characteristics unique to Rowley Shoals in WA (Ref. 757). The reefs provide habitats for diverse species, some of which have not been previously recorded in WA, including fish, molluscs, and echinoderms. They are regionally significant for their faunal diversity, particularly corals, molluscs, echinoderms, and fish (Ref. 757). Mermaid Reef, along with Clerke and Imperieuse Reefs, has biogeographical importance due to the presence of species at or near the limits of their geographic ranges, such as fish previously known only from Indonesian waters. It also acts as a genetic "stepping stone," facilitating the transfer of genetic material from the Indonesian archipelago to southern reefs (Ref. 757). Rowley Shoals is among the best examples of shelf-edge reefs in Australian waters, showcasing their structural and developmental characteristics. It has been the focus of significant biological research, including major collection expeditions by the Western Australian Museum (Ref. 757). Additionally, a shipwreck off the western edge of Mermaid Reef is believed to be that of the British whaling vessel, the Lively, which was lost in the early 1800s (Ref. 757).
Ningaloo Marine Area - Commonwealth Waters	Natural	—	✓	✓	—	—	Refer to the summary in the World Heritage property section above.

Heritage property/place	Class	Section					Brief overview of values
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island	
Scott Reef and Surrounds - Commonwealth Area	Natural	—	—	—	✓	—	Scott Reef is a large, emergent shelf atoll located on the edge of the broad continental shelf, ~300 km off the northwestern coast of Australia and ~23 km south-west of Seringapatam Reef (Ref. 758). The reef is regionally significant for its unique faunal composition, which includes species not found in coastal WA waters and demonstrates affinities with oceanic reef habitats of the Indo-West Pacific and Indonesian regions (Ref. 758). Its sedimentary sequence, extending back to the Triassic period, provides valuable insights into long-term geomorphological processes, reef formation, and past environments (Ref. 758). Scott Reef supports a highly diverse range of marine life, including 51 fish species, 14 mollusc species, six echinoderm species, and the seagrass *Thalassia hemprichii* (Ref. 758). The reef's isolation and size contribute to the evolution of genetically distinct subspecies and endemic species. Additionally, Scott Reef, along with Seringapatam Reef, are biogeographically significant for facilitating gene flow and coral spore movement to nearby reefs such as Ashmore Reef and Rowley Shoals. Its extensive habitat diversity makes it a biodiversity hotspot, particularly for fish (Ref. 758). The reef's environmental conditions, which are clear, deep oceanic water and large tidal ranges, are rare for shelf atolls. The sand cays within Scott Reef provide critical staging habitats for migrating animals and birds in the otherwise landless Timor Sea (Ref. 758). Of the 25 bird species identified, 17 are listed under the China-Australia and Japan-Australia Migratory Bird Agreements (Ref. 758).

7.2 Underwater cultural heritage

Australia's underwater cultural heritage is protected under the *Underwater Cultural Heritage Act 2018* (Cth) (UCH Act); this legislation protects shipwrecks, sunken aircraft and other types of underwater heritage, including First Nations UCH in Australian waters[15].

Under section 15 of the UCH Act, UCH is defined as "any trace of human existence that has a cultural, historical, or archaeological character, and is located under water". The UCH Act protects physical sites and artefacts; intangible heritage values with no physical component are not protected under the Act (Ref. 759).

A desktop analysis was undertaken to determine the presence of underwater cultural heritage within the PA using searches of the online Australasian Underwater Cultural Heritage Database (Ref. 760) for known underwater cultural heritage (shipwrecks, aircraft, relics, and other underwater cultural heritage) in Australian waters.

Table 7-2 summarises the known underwater cultural heritage. The PA includes ~360 shipwrecks, including historic ones. Given the large number, specific details are not provided in this document. However, if shipwrecks are identified within an Operational Area described in a project-specific EP, CAPL will assess their significance and include detailed information in that EP, if necessary.

Table 7-2: Summary of known underwater cultural heritage

UCH	Brief overview
Historic shipwrecks (>75 years old)	Around 260 shipwrecks have been identified and classified as follows: • ~50 historic shipwrecks in the West Coast section • ~110 historic shipwrecks in the Ningaloo section • ~50 historic shipwrecks in the Pilbara section • ~50 historic shipwrecks in the Kimberley section • only one historic shipwreck, Nissei Maru, in Christmas Island section
Shipwrecks (including historic shipwrecks)	Around 360 shipwrecks have been identified and classified as follows: • ~90 shipwrecks in the West Coast section • ~115 shipwrecks in the Ningaloo section • ~95 shipwrecks in the Pilbara section • ~60 shipwrecks in the Kimberley section • only one shipwreck, Nissei Maru, in Christmas Island section
Sunken aircraft	No known sunken aircraft was identified in the PA
In situ artefacts	Only one, Point Samson Unidentified, was identified off Karratha, in the Pilbara section

7.3 Aboriginal cultural heritage

The *Aboriginal Cultural Heritage Act 1972* (WA) recognises Aboriginal cultural heritage in the WA, including within State waters. A desktop search of heritage sites within the Department of Planning, Lands and Heritage (DPLH) spatial

[15] The UCH Act applies to all Australian waters, including both State waters (coastal waters) and Commonwealth waters (extending from coastal waters to the edge of continental shelf).

dataset (Ref. 761; HOLD) was undertaken to determine the presence of Aboriginal cultural heritage (ACH) in the PA with a potential coastal and/or marine interface. Table 7-3 summarises the results of the desktop search. . Given the large numberof ACH places identified in the search (~4,700), specific details are not provided in this document. However, if ACH are identified within an Operational Area described in a project-specific EP, CAPL will assess their significance and include detailed information in that EP, if necessary.

This is considered a conservative approach, as the heritage sites within the DPLH spatial dataset (Ref. 761) include a buffer around sites to protect privacy regarding the location. As such, the identified heritage sites may not be present within the PA. There may be other Aboriginal cultural heritage within the meaning of the *Aboriginal Cultural Heritage Act 1972* (WA) present in the PA even if not within the DPLH spatial dataset (Ref. 761)

Table 7-3: Summary of known Aboriginal Cultural Heritage

ACH	Brief overview
Register	Around 2,900 ACH register places have been identified and classified as follows: • 13 ACH register places have been identified in the West Coast section • 187 ACH register places have been identified in the Ningaloo section • 2,700 ACH register places have been identified in the Pilbara section • no ACH register places have been identified in the Kimberley section • no ACH register places have been identified in the Christmas Island section
Lodged	Around 1,800 lodged places have been identified and classified as follows: • three ACH lodged places have been identified in the West Coast section • 83 ACH lodged places have been identified in the Ningaloo section • 1,789 ACH lodged places have been identified in the Pilbara section • no ACH lodged places have been identified in the Kimberley section[16] • no ACH lodged places have been identified in the Christmas Island section

7.3.1 Indigenous Protected Areas

Indigenous Protected Areas (IPAs) are protected areas of land and sea Country managed by First Nations groups to achieve biodiversity conservation outcomes for the benefit of Australians, under voluntary agreements with the Australian Government (Ref. 762). As of October 2024, there are 87 dedicated IPAs (Ref. 762). The PA does not overlap with any IPAs.

7.3.2 Native Title

Native Title recognises the rights and interests of Aboriginal and Torres Strait Islander people in land and waters according to their traditional laws and customs, and is administered under the *Native Title Act 1993* (Cth).

Native Title areas relevant to the PA are detailed in Table 7-4 .

[16] Although the ACH Inquiry system has identified one ACH, it is located outside of the Kimberley section.

Table 7-4: Determined areas under the *Native Title Act 1993* (Cth)

Tribunal ID	Name	Section				
		West Coast	Ningaloo	Pilbara	Kimberley	Christmas Island
WCD2005/001	Ngarluma/Yindjibarndi	—	—	✓	—	—
WCD2007/003	Ngarla and Ngarla #2 (Determination Area A)	—	—	✓	—	—
WCD2008/003	Thalanyji	—	—	✓	—	—
WCD2015/007	Ngarluma People	—	—	✓	—	—
WCD2018/005	Bindunbur	—	—	—	✓	—
WCD2018/006	Yaburara & Mardudhunera People	—	—	✓	—	—
WCD2018/011	Nanda People and Nanda #2	—	✓	—	—	—
WCD2018/012	Malgana Part A	—	✓	—	—	—
WCD2018/015	Kariyarra	—	—	✓	—	—
WCD2019/014	Nanda People Part B, Malgana 2 and Malgana 3	✓	✓	—	—	—
WCD2019/016	Gnulli, Gnulli #2 and Gnulli #3 - Yinggarda, Baiyungu and Thalanyji People	—	✓	✓	—	—
WCD2020/001	Yamatji Nation	✓	—	—	—	—

7.3.2.1 WCD2005/001

The Native Title determination extends over the Dampier archipelago in the west of Pilbara. The Ngarluma and Yindjibarndi people received recognition as a Native Title holder over an area of 1,562 km^2. The determination area encompasses native title rights over parts of the claim area, including rights of access and to use resources (Ref. 763).

The relevant PBC is the Yindjibarndi Aboriginal Corporation.

7.3.2.2 WCD2007/003

The Native Title determination extends over Port Hedland in the Pilbara region. The Ngarluma and Yindjibarndi people received recognition as a Native Title holder over an area of 4,631 km^2. The determination area encompasses native title rights over parts of the claim area, including rights of access and camp on the land, to take certain traditional resources from the land, to engage in ritual and ceremony, and to care for, maintain and protect from physical harm particular sites and areas of significance (Ref. 764). The Ngarla People engage in Ngarla lore, culture and custom in their continued care and protection of country (Ref. 764).

The relevant PBC is the Wanparta Aboriginal Corporation RNTBC.

7.3.2.3 WCD2008/003

The Native Title determination extends around Onslow in the Pilbara region. The Thalanyji People received recognition as a Native Title holder over an area of 11,120 km^2. The majority of the area is comprised of thirteen pastoral leases. The remainder of the claim area consisted of primarily unallocated Crown land (Ref. 765).

The relevant PBC is the Burrabalayji Thalanyji Aboriginal Corporation.

7.3.2.4 WCD2018/005

The Native Title determination extends around Broome in the Kimberley region. The Nyul Nyul people alongside Nimanburr and Jabirr Jabirr people received recognition as Native Title holders. There are heritage places in the Native Title that have existing protections registered through Commonwealth and State legislative processes (Ref. 766).

The relevant PBCs are the Gogolanyngor Aboriginal Corporation, Nimanburr Aboriginal Corporation and Nyul Nyul PBC Aboriginal Corporation.

7.3.2.5 WCD2018/006

The Native Title determination extends over the Mardie coast area. The Yaburara and Mardudhunera people received recognition as a Native Title holder over an area of 5,683 km^2. The determination area encompasses several pastoral leases, mining tenements, roads, reserves and unallocated Crown land.

The Yaburara and Mardudhunera people have maintained a physical presence in their respective part of the determination area and have a continuing physical or spiritual involvement in that area (Ref. 767). The determination area contains places of special significance, such as cultural, spiritual, and ceremonial sites and natural resources.

The relevant PBC is the Wirrawandi Aboriginal Corporation (WAC).

7.3.2.6 WCD2018/011

The Native Title determination extends around Kalbarri in the Geraldton region. The Nanda people received recognition as a Native Title holder over an area of 17,350 km^2. There are also a number of waterways and tributaries that form part of the Murchison catchment area within the claim area that are significant to the Nanda People including Long Springs, Cement Slab, Bully Pool, Wilgie Mia Pool, and Syphon Pool (Ref. 768). The Determination Area also includes some highly significant natural heritage areas: the Kalbarri National Park, the Zuytdorp Nature Reserve, and the Toolonga Nature Reserve. Most of the freehold and leasehold tenure within the Determination Area exists in and around the town of Kalbarri (Ref. 768).

The relevant PBC is the Nanda Aboriginal Corporation RNTBC.

7.3.2.7 WCD2018/012

The Native Title determination extends around Shark Bay in the southern Gascoyne region. The Malgana people received recognition as a Native Title holder over an area of 28,800 km^2. The determination area encompasses native title rights over parts of the claim area, including rights of access and camp on the land, to take certain traditional resources from the land and water, and to engage in cultural activities (Ref. 769).

The relevant PBC is the Malgana Aboriginal Corporation Registered Native Title Body Corporate.

7.3.2.8 WCD2018/015

The Native Title determination extends around Port Hedland in the Pilbara region. The Kariyarra People received recognition as a Native Title holder over an area of 17,356 km^2.

The determination area encompasses native title rights over parts of the claim area, including rights of access and camp on the Non-Exclusive area, to take certain traditional resources, to engage in cultural activities and to participate in decision-making related to the use of the Non-Exclusive area (Ref. 770). The Kariyarra People also successfully developed an Indigenous Land Use Agreement in collaboration with the Western Australian Government and Yamatji Marlpa Aboriginal Corporation (Ref. 770).

The relevant PBC is the Kariyarra Aboriginal Corporation RNTBC.

7.3.2.9 WCD2019/014

The Native Title determination extends south of Shark Bay and west of Toolonga Nature Reserve. The Malgana people received recognition as Native Title holders.

The determination area encompasses native title rights over parts of the claim area, including rights of access and camp on the land, to take certain traditional resources from the land and water, and to engage in cultural activities (Ref. 668).

The relevant PBC is the Malgana Aboriginal Corporation Registered Native Title Body Corporate. Part of the determination area overlaps the same area of land where the Malgana People and Nanda People are recognised as native title holders (Ref. 668). In the shared area, the native title rights and interests are held by both the Malgana Aboriginal Corporation for the Malgana People, and the Nanda Aboriginal Corporation (RNTBC), for the Nanda People (Ref. 668).

7.3.2.10 WCD2019/016

The Native Title determination extends over the Ningaloo Coast region. The Yinggarda, Baiyungu, and Thalanyji people received recognition as a Native Title holder over an area of 71,354 m^2. The determination area encompasses several pastoral leases, mining tenements, roads, and reserves, as well as portions of the Kennedy Range and Cape Range national parks, Ningaloo Marine Park, Lake MacLeod, and waters in the Exmouth Gulf and Ningaloo Marine Park (Ref. 668). The Yinggarda, Baiyungu and Thalanyji people have each maintained a physical presence in their respective part of the determination area and have a continuing physical or spiritual involvement in that area (Ref. 668). The determination area contains places of special significance, such as cultural, spiritual, and ceremonial sites and natural resources (Ref. 668).

The relevant Prescribed Bodies Corporate (PBC) are the NTGAC (representing the Baiyungu and Thalanyji people) and the YAC.

7.3.2.11 WCD2020/001

The Native Title determination extends around Geraldton in the Midwest Region. The Yamatji Nation, which includes group of descendants of ancestors not included in the other underlying claims (Yamatji Marlpa Aboriginal Corporation) received recognition as a Native Title holder over an area of 48,000 km^2.

This determination provides recognition of the Yamatji Nation claim group's non-exclusive native title rights and interests over parts of the former Barnong, Menai Hills, and Kadji Kadji pastoral leases, land parcels adjacent to the Wanda Nature Reserve and within the Lucky Bay Reserve, as well as Aboriginal Lands Trust areas in Carnamah, Kadathini and Eneabba (Ref. 772).

The relevant PBC is the Bundi Yamatji Aboriginal Corporation.

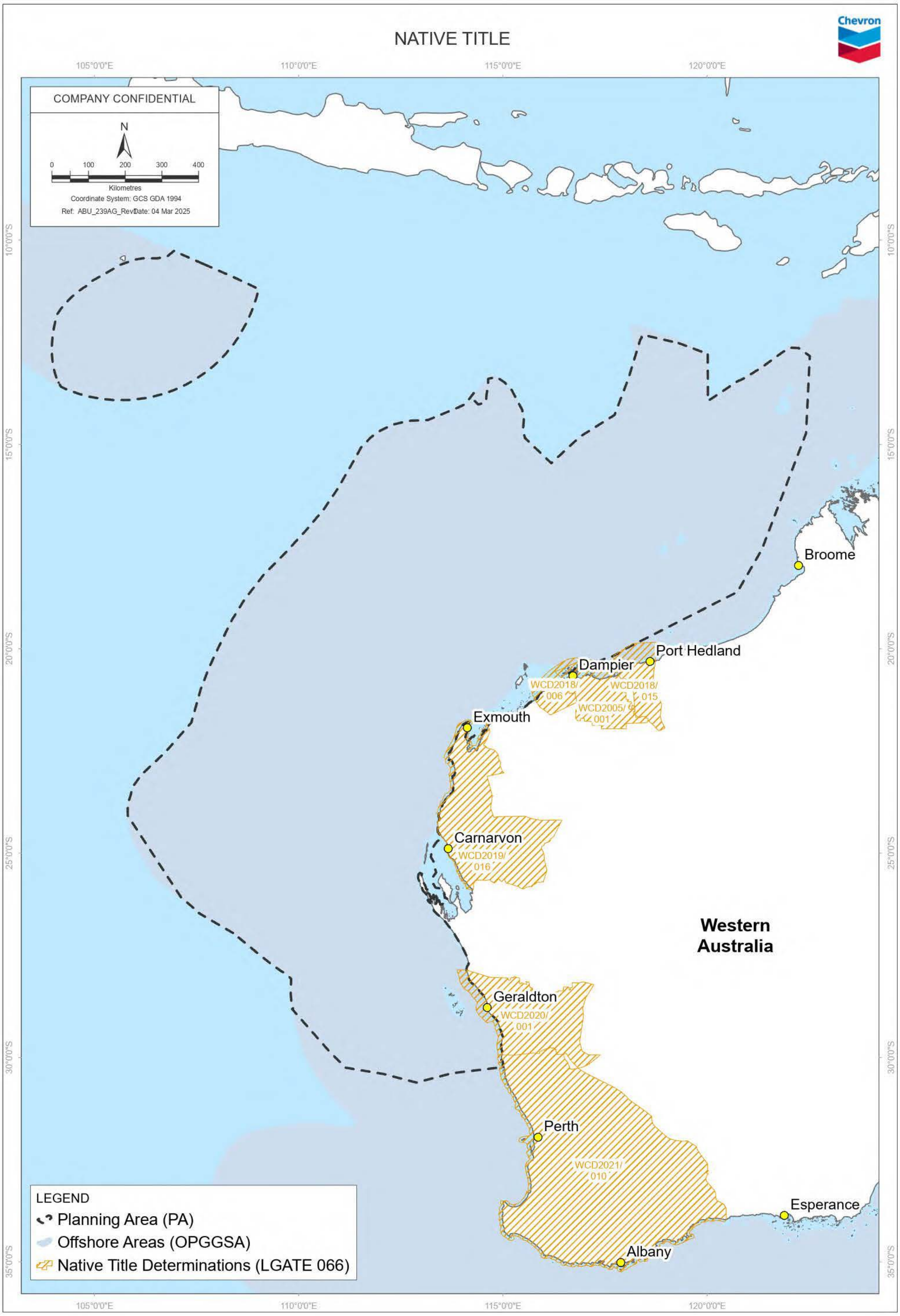

Figure 7-1: Native Title determinants relevant to the PA

8 acronyms and abbreviations

Table 8-1 defines the acronyms and abbreviations used in this document.

Table 8-1: Acronyms and abbreviations

Acronym / Abbreviation	Definition
ABARES	Australian Bureau of Agricultural and Resource Economics and Sciences
ACH	Aboriginal Cultural Heritage
AFZ	Australian Fishing Zone
AMPs	Australian Marine Parks
AMSA	Australian Maritime Safety Authority
AMSIS	Australian Marine Spatial Information System
ANZG	Australian and New Zealand Governments
BAC	Baiyungu Aboriginal Corporation
BIAs	Biologically Important Areas
BKO	Breeding known to occur within area
BTAC	Buurabalayji Thalanyji Aboriginal Corporation
CALM Act	*Conservation Land Management Act 1984*
CAPL	Chevron Australia Pty Ltd
CSIRO	Commonwealth Scientific and Industrial Research Organisation
Cth	Commonwealth (of Australia)
DAS	Distributed Acoustic Sensing
DCCEEW	Department of Climate Change, Energy, the Environment and Water
DPIRD	Department of Primary Industries and Regional Development
DPLH	Department of Planning, Lands and Heritage
EEZ	Exclusive Economic Zone
EMBA	Environment that may be affected
EP	Environment Plan
EPBC	*Environmental Protection and Biodiversity Act 1999*
ES	Ecological Sustainability
FBLO	Foraging, feeding or related behaviour likely to occur within area
FBKO	Foraging, feeding or related behaviour known to occur within area
FHPA	Fish Habitat Protection Areas
HCTS	Habitat of Critical to the Survival
HWM	High water mark
IBRA	Interim Biogeographic Regionalisation for Australia
IMCRA	Integrated Marine and Coastal Regionalisation of Australia
IOT	Indian Ocean Territories
IPAs	Indigenous Protected Areas

Acronym / Abbreviation	Definition
ISQG	Interim Sediment Quality Guidelines
IUCN	International Union for Conservation of Nature
ka	kiloannum
KAC	Kariyarra Aboriginal Corporation
KEF	Key ecological feature
LNG	Liquid natural gas
LoR	Limit of Reporting
LWM	Low water mark
MAC	Murujuga Aboriginal Corporation
MCH	Mardathoonera Cultural Heritage Pty Ltd
MMF	Mackerel Managed Fishery
MNES	Matters of National Environmental Significance
MoU	Memorandum of Understanding
MRKO	Migration route known to occur within area
NAC	Nanda Aboriginal Corporation (RNTBC)
NAC	Ngarluma Aboriginal Corporation
NEPM	National Environmental Protection Measure
NOPSEMA	National Offshore Petroleum Safety and Environmental Management Authority
NSW	New South Wales
NT	Northern Territory
NTGAC	Nganhurra Thanardi Garrbu Aboriginal Corporation
NWMR	North-West Marine Region
NWS	North West Shelf
NWSTF	North West Slope Trawl Fishery
NYFL	Ngarluma Yindjibarndi Foundation Ltd
OPGGS Act	*Offshore Petroleum and Greenhouse Gas Storage Act 2006*
OPGGS(E)R	Offshore Petroleum and Greenhouse Gas Storage (Environment) Regulations 2023
OSMP	Operational and Scientific Monitoring Program
PA	Planning Area
PAH	Polycyclic Aromatic Hydrocarbons
PBC	Prescribed Body Corporate
PM	Particulate matter
PMST	Protected Matters Search Tool
RRKAC	Robe River Kuruma Aboriginal Corporation
SA	South Australia
SKO	Species or species habitat known to occur within area

Acronym / Abbreviation	Definition
SLO	Species or species habitat likely to occur within area
SMO	Species or species habitat may occur within area
SWMR	South-West Marine Region
TAC	Total Allowable Catch
TEC	Threatened Ecological Communities
UCH	Underwater Cultural Heritage
UXO	Unexploded Ordnance
WA	Western Australia
WAC	Wirrawandi Aboriginal Corporation
WDTF	Western Deepwater Trawl Fishery
WTBF	Western Tuna and Billfish Fishery
YAC	Yinggarda Aboriginal Corporation
YMAC	Yamatji Marlpa Aboriginal Corporation

9 references

The following documentation is either directly referenced in this document or is a recommended source of background information.

Table 9-1: References

Ref No	Description	Document ID
1.	NOPSEMA. 2024. *Guidance note: Environment plan content requirement.* National Offshore Petroleum Safety and Environmental Management Authority.	N-04750-GN1344 A339814
2.	DCCEEW. N.d. Protected Matters Search Tool. Department of Climate Change, Energy, the Environment and Water Available from: https://pmst.environment.gov.au/#/map?lng=131.52832031250003&lat=-28.671310915880834&zoom=5&baseLayers=Imagery,ImageryLabels [Accessed: December 2024]	
3.	DSEWPC. 2012. *Marine bioregional plan for the North-west Marine Region, prepared under the Environment Protection and Biodiversity Conservation Act 1999*. Australian Government, Canberra, Australian Capital Territory.	
4.	DEWHA. 2008. *The North-west Marine Bioregional Plan – Bioregional Profile.* Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory.	
5.	DSEWPC. 2012. *Marine bioregional plan for the South-west Marine Region, prepared under the Environment Protection and Biodiversity Conservation Act 1999*. Australian Government, Canberra, Australian Capital Territory.	
6.	DEWHA. 2007. *A Characterisation of the Marine Environment of the North-west Marine Region.* A summary of an expert workshop convened in Perth, Western Australia, 5-6 September 2007.	
7.	DEWR. 2006. *A Characterisation of the Marine Environment of the South-west Marine Region.* A summary of an expert workshop convened in Perth, Western Australia, September 2006.	
8.	EPA. 2016. *Technical Guidance: Protection of Benthic Communities and Habitats.* Environmental Protection Authority, Government of Western Australia.	
9.	Harris, P., Heap, A., Passlow, V., Sbaffi, L., Fellows, M., Porter-Smith, R., Buchanan, C. and Daniell, J. 2005. *Geomorphic Features of the Continental Margin of Australia, Geoscience Australia: Record 2003/30*. 142pp.	
10.	Baker, Christina; Potter, Anna; Tran, Maggie; Heap, Andrew. 2008. *Sedimentology and Geomorphology of the North West Marine Region of Australia*. Geoscience Australia. Canberra	
11.	Brewer, D.; Vincent, L; Skewes, T; Rothlisberg, P. 2007. *Trophic systems of the North-west Marine Region.* CSIRO Marine and Atmospheric Research. Cleveland	
12.	Richardson, L., Mathews, E. and Heap, A. 2005. *Geomorphology and Sedimentology of the South Western Planning Area of Australia: review and synthesis of relevant literature in support of Regional Marine Planning.* Geoscience Australia, Record 2005/17. 124pp	
13.	CSIRO. 2015. *Marine Benthic Substrate Database – CAMRIS – Marsed – V.1.* CSIRO. Data Collection. Available from: https://data.csiro.au/collection/csiro:12843v1 [Accessed: January 2025].	

Ref No	Description	Document ID
14.	DEH. 2006. *A Guide to the Integrated Marine and Coastal Regionalisation of Australia – (IMCRA) Version 4.0*. Department of the Environment and Energy and Heritage, Australian Government.	
15.	DEWHA. 2008. *Profile. A Description of the Ecosystems, Conservation Values and Uses of the South-west Marine Region.* Department of the Environment, Water, Heritage and the Arts, Canberra, Australian Capital Territory.	
16.	Sharplies, C., Mount, R., Pedersen, R., Lacey, M., Newton, J., Jaskierniak, D., and Wallace, L. 2009. *The Australian Coastal Smartline Geomorphic and Stability Map Version 1*. Prepared by University of Tasmania, for Geoscience Australia and Department of Climate Change, Australian Government	
17.	Claire Butler, Vanessa Lucieer, Peter Walsh, Emma Flukes, Craig Johnson. 2017. Seamap Australia [Version 1.0] the development of a national benthic marine classification scheme for the Australian continental shelf. ISBN: 978-1-925646-61-0	
18.	DCCEEW. 2024. *Australia - Ecological Communities of National Environmental Significance Distributions - GDB (database)*. Department of Climate Change, Energy, the Environment and Water, Canberra, Australian Capital Territory. Available from: https://fed.dcceew.gov.au/datasets/3ce27fab85194f468bcfb106e5be15ee/about [Accessed: January 2025]	
19.	TSSC. 2013. *Subtropical and Temperate Coastal Saltmarsh Conservation Advice*. Threatened Species Scientific Committee	
20.	Saintilan N, Rogers K and Howe A. 2009. *Geomorphology and habitat dynamics. In: Australian Saltmarsh Ecology. (ed N Saintilan.)* CSIRO Publishing, Victoria.	
21.	Adam P. 2009. *Australian saltmarshes in global context. In: Australian Saltmarsh Ecology*. (ed.) N Saintilan. CSIRO Publishing, Victoria.	
22.	Fairweather P. 2011. *Saltmarshes. In: Scientific Working Group (2011)*. The vulnerability of coastal and marine habitats in South Australia. Marine Parks, Department of Environment, Water and Natural Resources South Australia.	
23.	Adam P. 1990. *Saltmarsh Ecology*. Cambridge University Press, Cambridge.	
24.	Saintilan N. 2009. *Biogeography of Australian saltmarsh plants.* Austral Ecology 34: 929–937	
25.	Saintilan N. 2009. *Distribution of Australian saltmarsh plants. In: Australian Saltmarsh Ecology. (ed. N Saintilan).* CSIRO Publishing, Victoria.	
26.	DCCEEW. 2022. *Australian Ramsar Wetlands - Internationally important wetlands*. Department of Climate Change, Energy, the Environment and Water, Canberra, Australian Capital Territory. Available from: https://www.dcceew.gov.au/water/wetlands/australian-wetlands-database/australian-ramsar-wetlands [Accessed: January 2025]	
27.	DCCEEW. 2024. *National dataset of Australia's Ramsar Wetlands (database)*. Department of Climate Change, Energy, the Environment and Water, Canberra, Australian Capital Territory. Available from: https://fed.dcceew.gov.au/datasets/erin::ramsar-wetlands-of-australia-1/about [Accessed: January 2025]	

Ref No	Description	Document ID
28.	RAMSAR the convention on Wetland. N.d. *Describing the Site*. Convention on Wetlands. Available from: https://www.ramsar.org/describing-site [Accessed: January 2025]	
29.	Director of National Parks. 2014. C*hristmas Island National Park - Management Plan 2014-2024.* Director of National Parks.	
30.	Hale, J. and Butcher, R., 2010. *Ecological Character Description for Hosnies Spring Ramsar Site.* Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.	
31.	DCCEEW. N.d. *Australian Wetlands Database*. Department of Climate Change, Energy, the Environment and Water, Canberra, Australian Capital Territory. Available from: https://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=40 [Accessed: January 2025]	
32.	Butcher, R., and Hale, J., 2010. E*cological Character Description for The Dales Ramsar Site.* Report to the Department of Sustainability, Environment, Water, Population and Communities, Canberra.	
33.	DCCEEW. 2024. *Biologically Important Areas for protected marine species (BIAs)*. Department of Climate Change, Energy, the Environment and Water, Canberra, Australian Capital Territory. Available from: https://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=40 [Accessed: January 2025]	
34.	Commonwealth of Australia (Geoscience Australia) 2023. *Australian Marine Spatial Information System (AMSIS),* Available at: https://geoscience-au.maps.arcgis.com/apps/Styler/index.html?appid=151f79f8a50c4da6bfbd13d59548e2db [Accessed January 2025]	
35.	DCCEEW no date. Find Environmental Data, Available at: https://fed.dcceew.gov.au/ [Accessed January 2025]	
36.	McCauley, R., Bannister, J., Burton, C., Jenner, C., Rennie, S. and Kent, C.S. 2004. *Western Australian Exercise Area – Blue Whale Project*. Final Summary Report.	
37.	Commonwealth of Australia. 2015. *Conservation Management Plan for the Blue Whale (2015-2025), A Recovery Plan under the Environment Protection and Biodiversity Conservation Act 1999*. Commonwealth of Australia	
38.	TSSC. 2015. *Conservation Advice Balaenoptera physalus fin whale.* Threatened Species Scientific Committee, Australian Government, Canberra, Australian Capital Territory.	
39.	TSSC. 2022. *Listing Advice Megaptera novaeangliae Humpback Whale.* Threatened Species Scientific Committee, Australian Government, Canberra, Australian Capital Territory.	
40.	TSSC. 2015. *Conservation Advice Balaenoptera borealis sei whale.* Threatened Species Scientific Committee, Australian Government, Canberra, Australian Capital Territory.	
41.	DCCEEW. 2024, *National Recovery Plan for the Southern Right Whale,* Department of Climate Change, Energy, the Environment and Water, Canberra	
42.	TSSC. 2020. *Conservation Advice Neophoca cinerea Australian Sea Lion.* Threatened Species Scientific Committee, Australian Government, Canberra, Australian Capital Territory.	

Ref No	Description	Document ID
43.	DSEWPC. 2013. Recovery Plan for the Australian Sea Lion (Neophoca cinerea). Department of Sustainability, Environment, Water, Population and Communities, Public Affairs	
44.	Bannister, J.L., C.M. Kemper & R.M. Warneke. 1996. T*he Action Plan for Australian Cetaceans*. Canberra: Australian Nature Conservation Agency. Available from: http://www.environment.gov.au/resource/action-plan-australian-cetaceans [Accessed: November 2024]	
45.	Thiele, D. & P.C. Gill. 1999. *Cetacean observations during a winter voyage into Antarctic sea ice south of Australia*. Antarctic Science. 11(1):48-53.	
46.	Best, P.B. 1985. *External characters of Southern Minke Whales and the existence of a diminutive form*.Scientific Reports of the Whales Research Institute, Tokyo. 36:1-33.	
47.	Zerbini, A.N., E.R. Secchi, S. Siciliano & P.C. Simões-Lopes. 1997. *A review of the occurrence and distribution of whales of the genus Balaenoptera along the Brazilian coast.* Reports of the International Whaling Commission. 47:407-417.	
48.	Perrin, W.F. & R.L. Brownell, Jr. 2002. *Minke Whales Balaenoptera acutorostrata and B. bonaerensis. In: Perrin W.F., Würsig B. & H.G.M. Thewissen, eds. Encyclopedia of Marine Mammals.* Page(s) 750-754. Academic Press.	
49.	DCCEEW 2024. *Balaenoptera bonaerensis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=67812 [Accessed: November 2024]	
50.	Ohsumi S, Masaki Y. & A. Kawamura. 1970. *Stock of the Antarctic minke whale.* Scientific Reports of the Whales Research Institute, Tokyo. 22:75-125.	
51.	Stewart, B.S. & S. Leatherwood. 1985. *Minke whale Balaenoptera acutorostrata Lacépède, 1804. In: Ridgway, S.H. & R. Harrison, eds. Handbook of Marine Mammals Vol 3: The Sirenians and Baleen Whales.* Page(s) 193-240. Academic Press, London.	
52.	Kato, H. 1982. *Some biological parameters for the Antarctic minke whale.* Report of the International Whaling Commission. 32:935-945.	
53.	Kasamatsu F. and S. Ohsumi. 1981. *Distribution pattern of minke whales in the Antarctic with special reference to the sex ratio in the catch.* Report of the International Whaling Commission. 31:345-348.	
54.	Masaki, Y. 1979. *Yearly changes of the biological parameters for the Antarctic minke whale.* Report of the International Whaling Commission. 29:407-20.	
55.	Filun D, Thomisch K, Boebel O, Brey T, Širović A, Spiesecke S, Van Opzeeland I. 2020. *Frozen verses: Antarctic minke whales (Balaenoptera bonaerensis) call predominantly during austral winter.* R Soc Open Sci. doi: 10.1098/rsos.192112.	
56.	Rice DW. 1998. *Marine mammals of the world: systematic and distribution.* Lawrence, Kansas: Society for Marine Mammalogy, Lawrence, K.S. (Society for Marine Mammalogy Special Publication Number 4).	

Ref No	Description	Document ID
57.	Committee on Taxonomy. 2024. *List of Marine Mammal Species and Subspecies.* The Society for Marine Mammology. Available from: https://marinemammalscience.org/science-and-publications/list-marine-mammal-species-subspecies/ [Accessed: November 2024].	
58.	Best, P.B., D.S. Butterworth & L.H. Rickett. 1984. *An assessment cruise for the South African inshore stock of Bryde's Whales (Balaenoptera edeni*). Report of the International Whaling Commission. 34:403-423.	
59.	DCCEEW 2024. *Balaenoptera edeni in Species Profile and Threats Database*. Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=35 [Accessed: November 2024]	
60.	NOAA Fisheries. 2023. Species Directory, Bryde’s Whale. National Oceanic and Atmospheric Administration. Available from: https://www.fisheries.noaa.gov/species/brydes-whale [Accessed: November 2024]	
61.	Pirotta, V., Cagnazzi, D., Dixon, B., Millar, S., Millar, J., Pickering, G., Peters, K. J. 2024. Bryde’s whale (Balaenoptera edeni) occurrence and foraging behaviour along the east coast of Australia. New Zealand Journal of Marine and Freshwater Research, 1–16. https://doi.org/10.1080/00288330.2024.2409681	
62.	Best, P.B. 1960. Further information on Bryde's whale (Balaenoptera edeni Anderson) from Saldanha Bay, South Africa. Norsk Hvalfangst-Tidende. 49:201-215.	
63.	Best, P.B. 1977. Two allopatric forms of Bryde's whale off South Africa. Report of the International Whaling Commission (Special Issue 1). Page(s) 10-38.	
64.	Kawamura, A. 1980. Food habits of the Bryde's whales taken in the South Pacific and Indian Oceans. Scientific Reports of the Whales Research Institute. 32:1-23.	
65.	Kato, H. 2002. *Bryde's Whales Balaenoptera edeni and B. brydei*. In: Perrin W.F., B. Wrsig & H.G.M. Thewissen, eds. Encyclopedia of Marine Mammals. Page(s) 171-177. Academic Press.	
66.	Paterson R, Van Dyck S. 1988. *Bryde’s whale in the coastal waters of eastern Australia.* Scientific Reports of the Whales Research Institute. 39:21–29.	
67.	McCauley R. 2011. *Woodside Kimberley Sea Noise Logger Program, Sept-2006 to June-2009: Whales, Fish and Man-made Noise*. Report prepared for Woodside.	
68.	TSSC. 2015. Conservation Advice, Balaenoptera physalus -fin whale. Threatened species scientific committee. Available from: https://www.environment.gov.au/biodiversity/threatened/species/pubs/37-conservation-advice-01102015.pdf [Accessed: November 2024]	
69.	Mackintosh, N.A. 1966. The distribution of southern blue and fin Whales. Norris K.S., ed. Whales, dolphins, and porpoises. Page(s) 125-144. Berkely: University of California Press.	
70.	Mackintosh, N.A. 1965. The stocks of whales. London: Fishing News (Books) Ltd	
71.	Watkins W.A., P. Tyack, K.E. Moore & J.E. Bird. 1987. The 20-Hz signals of finback whales (Balaenoptera physalus). Journal of Acoustical Society of America. 82:1901-1912.	

Ref No	Description	Document ID
72.	DCCEEW 2024. *Balaenoptera physalus* in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=37 [Accessed: January 2025]	
73.	Littaye, A., A. Gannier, S. Laran & J.P.F. Wilson. 2004. The relationship between summer aggregation of fin whales and satellite-derived environmental conditions in the northwestern Mediterranean Sea. Remote Sensing of Environment. 90(1):44-52	
74.	Gill, P.C. 2002. A blue whale (Balaenoptera musculus) feeding ground in a southern Australian coastal upwelling zone. Journal of Cetacean Research and Management. 4:179-184.	
75.	McCauley, R.D., C. Jenner, J.L. Bannister, D.H. Cato & A. Duncan. 2000. Blue whale calling in the Rottnest Trench, Western Australia, and low frequency sea noise. In: Paper presented at the Australian Acoustical Society Conference, Joondalup, Australia. unpublished.	
76.	Aulich, M. G., McCauley, R. D., Saunders, B. J., & Parsons, M. J. 2019. Fin whale (Balaenoptera physalus) migration in Australian waters using passive acoustic monitoring. Scientific Reports, 9(1), 1-12. https://doi.org/10.1038/s41598-019-45321-w	
77.	Aulich, M. G., McCauley, R. D., Miller, B. S., Samaran, F., Giorli, G., Saunders, B. J., & Erbe, C. 2022. Seasonal Distribution of the Fin Whale (Balaenoptera physalus) in Antarctic and Australian Waters Based on Passive Acoustics. Frontiers in Marine Science, 9, 864153. https://doi.org/10.3389/fmars.2022.864153	
78.	Rennie, S. Hanson, C.E., McCauley, R.D., Pattiaratchi, C. Burton, C., Bannister, J., Jenner,C., Jenner, M.N., 2009. Physical properties and processes in the Perth Canyon, Western Australia: Links to water column production and seasonal pygmy blue whale abundance. Journal of Marine Systems, Volume 77, Issues 1–2, Pages 21-44, ISSN 0924-7963, https://doi.org/10.1016/j.jmarsys.2008.11.008.	
79.	Jenner, K.C.S., Jenner, M.N. and McCabe, K.A. 2001. *Geographical and Temporal Movements of Humpback Whales in Western Australian Waters*. APPeA Journal. pp749–765.	
80.	DCCEEW 2024. Megaptera novaeangliae in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=38 [Accessed: January 2025]	
81.	TSSC. 2022. Listing Advice for Megaptera novaeangliae Humpback Whale). Threatened species scientific committee.	
82.	Irvine, L. G., Thums, M., Hanson, C. E., McMahon, C. R., & Hindell, M. A. 2018. Evidence for a widely expanded humpback whale calving range along the Western Australian coast. Marine Mammal Science, 34(2), 294-310	
83.	Browne, Ciara Edan, Christine Erbe, and Robert D. McCauley. 2024. Distribution and Seasonality of the Omura's Whale (Balaenoptera omurai) in Australia Based on Passive Acoustic Recordings. Animals 14, no. 20: 2944. https://doi.org/10.3390/ani14202944	
84.	Cerchio, S., Yamada, T. K., & Brownell, R. L. 2019. Global Distribution of Omura's Whales (Balaenoptera omurai) and Assessment of Range-	

Ref No	Description	Document ID
	Wide Threats. Frontiers in Marine Science, 6, 428450. https://doi.org/10.3389/fmars.2019.00067	
85.	Debens Henry A., McCorry Denise, Sidenko Evgenii, Erbe Christine, Collet Olivia, Pevzner Roman, Gurevich Boris. 2024. Whale detection and microseismic monitoring via DAS using submarine telecommunications cables – a case study from the NWS, Western Australia. Australian Energy Producers Journal 64, S481-S486.	
86.	Gavrilov A. N., McCauley R. D., Paskos G., and Alexey G. 2018. Southbound migration corridor of Pygmy Blue Whales off the northwest coast of Australia based on data from ocean bottom seismographs. The Journal of the Acoustical Society of America. https://doi.org/10.1121/1.5063452	
87.	Double, M.C. Jenner, K.C.S., Jenner, M-N., Ball, I., Laverick, S. and Gales, N., 2012. Satellite tracking of pygmy blue whales (Balaenoptera musculus brevicauda) off Western Australia. Final Report – May 2012. Australian Marine Mammal Centre.	
88.	Gales, N., Double, M. C., Robinson, S., Jenner, C., Jenner, M, King, E. & Paton, D. 2010. Satellite tracking of Australian humpback (Megaptera novaeangliae) and Pygmy Blue Whales (Balaenoptera musculus brevicauda). White paper presented to the Scientific Committee of the International Whaling Commission.	
89.	Branch, T. A., Matsuoka, K. and Miyashita, T. 2004. Evidence for increases in Antarctic blue whales based on Bayesian modelling. Marine Mammal Science 20(4): 726-754.	
90.	Double, M.C., Andrews-Goff, V., Jenner, K.C.S., Jenner, M-N., Laverick, S.M., Branch, T.A. and Gales, N., 2014. Migratory movements of pygmy blue whales (Balaenoptera musculus brevicauda) between Australia and Indonesia as revealed by satellite telemetry. PLOS one, April 2014 9(4).	
91.	Kahn, B., 2007. Blue whales of the Savu Sea, Indonesia. In: Biannual Marine Mammal Conference - Blue Whale Workshop. Cape Town, South Africa. 28 Nov - 3 Dec 2007.	
92.	McCauley, R.D. and K.C. Jenner. 2010. Migratory patterns and estimated population size of Pygmy Blue Whales (Balaenoptera musculus brevicauda) traversing the Western Australian coast based on passive acoustics. Paper SC/62/SH26 presented to the International Whaling Committee Scientific Committee.	
93.	Thums, M., Ferreira, L.C., Jenner, C., Jenner, M., Harris, D., Davenport, A., Andrews-Goff, V., Double, M., Moller, L., Attard, C.R.M., Bilgmann, K., Thomson, P.G., and McCauley, R. 2022, Pygmy blue whale movement, distribution and important areas in the Eastern Indian Ocean. Global Ecology and Conservation, 35 (2022). doi: https://doi.org/10.1016/j.gecco.2022.e02054	
94.	Ferreira, L.C., Jenner, C., Jenner, M. et al. 2024. *Predicting suitable habitats for foraging and migration in Eastern Indian Ocean pygmy blue whales from satellite tracking data*. Movement Ecology 12, 42. https://doi.org/10.1186/s40462-024-00481-x	
95.	Owen, K., Jenner, C.S., Jenner, MN.M.and Abdrews R. D. 2016. *A week in the life of a pygmy blue whale: migratory dive depth overlaps with large vessel drafts.* Anim Biotelemetry 4, 17 https://doi.org/10.1186/s40317-016-0109-4	
96.	Truong G and Rogers TL. 2023. La Niña conditions influence interannual call detections of pygmy blue whales in the eastern Indian	

Ref No	Description	Document ID
	Ocean. Frontiers. Marine Science. 9:850162. doi: 10.3389/fmars.2022.850162	
97.	Pendleton, D.E., Holmes, E.E., Redfern, J., Zhang, J., 2020. Using modelled prey to predict the distribution of a highly mobile marine mammal. *Divers. Distrib*. 26, 1612–1626.	
98.	Buchan, Susannah, Quiñones, Renato A. 2016. *First insights into the oceanographic characteristics of a blue whale feeding ground in northern Patagonia*, Chile. Marine Ecology Progress Series. 554. 10.3354/meps11762.	
99.	AIMS. 2019. *North West shoals to shore research program*. Australian Institute of Marine Science. Perth Office. Available from: https://www.aims.gov.au/sites/default/files/2019-11/AIMS%20NWSS%204pp%20newsletter%20December%2019_web.pdf [Accessed: January 2025].	
100.	Torres LG, Barlow DR, Chandler TE, Burnett JD. 2020. *Insight into the kinematics of blue whale surface foraging through drone observations and prey data*. PeerJ 8:e8906 https://doi.org/10.7717/peerj.8906	
101.	Jill R. Schoenherr. 1991. *Blue whales feeding on high concentrations of euphausiids around Monterey Submarine Canyon*. Canadian Journal of Zoology. 69(3): 583-594. https://doi.org/10.1139/z91-088	
102.	Thomas Doniol-Valcroze, Véronique Lesage, Janie Giard, Robert Michaud. 2011. *Optimal foraging theory predicts diving and feeding strategies of the largest marine predator*. Behavioral Ecology, Volume 22, Issue 4, Pages 880–888, https://doi.org/10.1093/beheco/arr038	
103.	Kemper, C.A. 2002. *Distribution of the pygmy right whale, Caperea marginata, in the Australasian region*. Marine Mammal Science. 18(1):99-111.	
104.	DCCEEW 2024. *Caperea marginata in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=39 [Accessed: January 2025]	
105.	Baker, A. 1985. *Pygmy right whale Caperea marginata (Gray, 1846)*. In: Ridgway, S H and R. Harrison, eds. Handbook of Marine Mammals Vol. 3: The Sirenians and Baleen Whales. Page(s) 345-354. Academic Press, London.	
106.	Ross, G.J.B., P.B. Best & B.G. Donnelly. 1975. N*ew records of the pygmy right whale (Caperea marginata) from South Africa, with comments on distribution, migration, appearance, and behaviour.* Journal of the Fisheries Research Board of Canada. 32(7):1005-1017.	
107.	Matsuoka K, F. Yoshihiro & L.A. Pastene. 1996. *A sighting of a large school of the pygmy right whale, Caperea marginata, in the southeast Indian Ocean.* Marine Mammal Science. 12(4):594-597.	
108.	Dedden, A. V., Kemper, C. M., Truong, G., McCurry, M. R., Van Ruth, P. D., & Rogers, T. L. 2023. *Stable isotopes infer the diet and habitat of the enigmatic pygmy right whale (Caperea marginata) off southern Australia*. Frontiers in Marine Science, 10, 1190623. https://doi.org/10.3389/fmars.2023.1190623	
109.	Kemper, CM, JF Middleton, and PD van Ruth. 2012. A*ssociation between Pygmy Right Whales (Caperea Marginata) and Areas of High Marine Productivity off Australia and New Zealand.* New Zealand Journal of Zoology 40 (2): 102–28 doi:10.1080/03014223.2012.707662	

Ref No	Description	Document ID
110.	Frainer, Guilherme, Elwen Simon. 2024. *Pygmy Right Whale Caperea marginata (Gray, 1846).* In book: Mammals of Middle and South America: Cetacea and Sirenia (pp.1-16). DOI:10.1007/978-3-031-23847-5_2-1	
111.	Sekiguchi K, P.B. Best & B.Z. Kaczmaruk. 1992. *New information on the feeding habits and baleen morphology of the pygmy right whale Caperea marginata.* Marine Mammal Science. 8(3):288-293.	
112.	DCCEEW 2024. Balaenoptera borealis in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=34 [Accessed: January 2025]	
113.	NOAA Fisheries. 2023. Species Directory, Sei Whale. National Oceanic and Atmospheric Administration. Available from: https://www.fisheries.noaa.gov/species/sei-whale [Accessed: November 2024]	
114.	Horwood, J. 2009. Sei whale Balaenoptera borealis. In: Perrin, W.F., B. Würsig & J.G.M. Thewissen, eds. Encyclopedia of marine mammals. Page(s) 1001-1003. Academic Press: Amsterdam.	
115.	Parker, D.A.A. 1978. Observations of Whales on Australian National Antarctic Research Expeditions (ANARE) Voyages between Australia and Antarctica. Australian Wildlife Research. 5:25-36	
116.	Thiele D, Chester E, Gill PC. 2000. Cetacean distribution off Eastern Antarctica at (80 - 150°E) during the austral summer of 1995/96.	
117.	Chatto R. & R.M. Warneke. 2000. Records of cetacean strandings in the Northern Territory of Australia. The Beagle, Records of the Museums and Art Galleries of the Northern Territory. 16:163-175.	
118.	Bannister JL. 2008. 'Great Whales' (CSIRO Publishing: Collingwood)	
119.	Miller, B.S., N. Kelly, M.C. Double, S.J. Childerhouse, S. Laverick & N. Gales. 2012. Cruise report on SORP 2012 blue whale voyages: development of acoustic methods. Paper SC/64/SH11 presented to the IWC Scientific Committee.	
120.	Gill, P.C., R. Pirzl, M.G. Morrice & K. Lawton. 2015. Cetacean diversity of the continental shelf and slope off southern Australia. The Journal of Wildlife Management.	
121.	Kenney RD. 2018. Right Whales: Eubalaena Glacialis, E. Japonica, and E. Australis, in B. Würsig, J. G. M. Thewissen and K. M. Kovacs. Encyclopedia of Marine Mammals (Third Edition). Academic Press. pp 817-822. https://doi.org/10.1016/B978-0-12-804327-1.00217-X.	
122.	Smith JN, Double M, Evans K & Kelly N. 2023. Relative Abundance of the 'Western' Population of Southern Right Whales (Eubalaena Australis) from an Aerial Survey Off Southern Australia: Final Report on 2022 Survey. Report to the National Environmental Science Program. Murdoch University (Lead organisation).	
123.	Charlton C, McCauley RD, Brownell Jr RL, Ward R, Bannister JL, Salgado Kent C & Burnell S. 2022. Southern Right Whale (Eubalaena Australis) Population Demographics at Major Calving Ground Head of Bight, South Australia, 1991–2016. Aquatic Conservation: Marine and Freshwater Ecosystems 32, 4, 671-686. DOI: https://doi.org/10.1002/aqc.3771.	
124.	Burnell SR & Bryden MM. 1997. Coastal Residence Periods and Reproductive Timing in Southern Right Whales, Eubalaena Australis.	

Ref No	Description	Document ID
	Journal of Zoology 241, 4, 613-621. DOI: https://doi.org/10.1111/j.1469-7998.1997.tb05736.x	
125.	Charlton C, Ward R, McCauley RD, Brownell Jr RL, Kent CS & Burnell S. 2019. Southern Right Whale (Eubalaena Australis), Seasonal Abundance and Distribution at Head of Bight, South Australia. Aquatic Conservation 29, 4, 576-588. DOI: https://doi.org/10.1002/aqc.3032.	
126.	Smith JN, Double M, Kelly N, Charlton C & Bannister J. 2022. Relative Abundance of the 'Western' Population of Southern Right Whales from an Aerial Survey Off Southern Australia: Final Report on 2021 Survey. Report to the National Environmental Science Program. Murdoch University (Lead organisation). https://www.nespmarinecoastal.edu.au/project-1-26-final-report-2/	
127.	Watson M, Stamation K & Charlton C. 2021. Calving Rates, Long-Range Movements and Site Fidelity of Southern Right Whales (Eubalaena Australis) in South-Eastern Australia. Journal of Cetacean Research Management 22, 1, 17-28. DOI: http://dx.doi.org/10.47536/jcrm.v22i1.210.	
128.	Townsend CH. 1935. The Distribution of Certain Whales as Shown by Logbook Records of American Whaleships. Zoologica 19, 1-50. https://www.biodiversitylibrary.org/page/51225956#page/125/mode/1up.	
129.	Bannister JL, Burnell SR, Burton C & Kato H. 1997. Right Whales Off Southern Australia: Direct Evidence for a Link between Onshore Breeding Grounds and Offshore Probable Feeding Grounds. Report of the International Whaling Commission.	
130.	Tormosov DD, Mikhaliev YA, Best PB, Zemsky VA, Sekiguchi K & Brownell RL. 1998. Soviet Catches of Southern Right Whales Eubalaena Australis, 1951-1971. Biological Data and Conservation Implications. Biological Conservation 86, 2, 185-197. DOI: https://doi.org/10.1016/S0006-3207(98)00008-1.	
131.	DCCEEW 2024. Physeter macrocephalus in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59 [Accessed: January 2025]	
132.	Whitehead, H. 2002. Sperm Whale. In: Perrin W.F., B. Würsig & J. Thewissen, eds. The Encyclopedia of Marine Mammals. Page(s) 62-72. San Diego: Academic Press.	
133.	CRRU. 2006. Sperm Whale (Physeter macrocephalus Linnaeus, 1758). Cetacean Research and Rescue Unit. Available from: https://crru.org.uk/education/species/sperm-whale [Accessed: November 2024]	
134.	Bearzin, A.A. 1972. The Sperm Whale. Pacific Scientific Research Institute of Fisheries and Oceanography, Moscow. (Translated from Russian 1971 version by the Israel Program for Scientific Translations, Jerusalem).	
135.	Clarke, M.R. 1977. Beaks, nets and numbers. Symposium of the Zoological Society. 38:89-126.	
136.	Clarke, M.R. 1980. Cephalopods in the diet of sperm whales of the Southern Hemisphere and their bearing on sperm whale biology. Discovery Reports. 37:324.	

Ref No	Description	Document ID
137.	Rice, D.W. 1989. Sperm whale Physeter macrocephalus. In: Ridgway, S.H. & R. Harrison, eds. Handbook of Marine Mammals Vol. 4: River Dolphins and the Larger Toothed Whales. Page(s) 177-233.	
138.	NOAA Fisheries. 2023. Species Directory, Sperm Whale. National Oceanic and Atmospheric Administration. Available from: https://www.fisheries.noaa.gov/species/sperm-whale [Accessed: January 2025]	
139.	Woodside. 2020. Scarborough – Offshore Project Proposal.	
140.	DCCEEW 2024. Sousa sahulensis in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=87942 [Accessed: January 2025]	
141.	Parra, G.J., & D. Cagnazzi. 2016. Conservation Status of the Australian Humpback Dolphin (Sousa sahulensis) Using the IUCN Red List Criteria. Advances in Marine Biology. 73:157-192.	
142.	Hunt TN, Bejder L, Allen SJ, Rankin RW, Hanf D & Parra GJ. 2017. Demographic characteristics of Australian humpback dolphins reveal important habitat toward the southwestern limit of their range. Endangered Species Research 32, 71-88. https://doi.org/10.3354/esr00784.	
143.	Hanf D. 2015. Species distribution modelling of western Pilbara coastal dolphins. Perth: Masters by Research thesis Murdoch University; 2015:118	
144.	Hanf DM, Hodgson AJ, Kobryn H, Bejder L & Smith JN. 2022. Dolphin distribution and habitat suitability in North Western Australia: Applications and Implications of a broad-scale, nontargeted dataset. Frontiers in Marine Science 8.	
145.	Raudino HC, Douglas CR & Waples KA. 2018. How many dolphins live near a coastal development? Regional Studies in Marine Science 19: 25-32.	
146.	Raudino, Holly & Hunt, Tim & Waples, Kelly. 2018. Records of Australian humpback dolphins (Sousa sahulensis) from an offshore island group in Western Australia. Marine Biodiversity Records. 11. 10.1186/s41200-018-0147-0.	
147.	DCCEEW. 2022. Conservation advice for Sousa sahulensis (Australian humpback dolphin). Department of Climate Change, Energy, the Environment and Water. Canberra	
148.	ALA. N.d. Sousa sahulensis Overview. Available from: https://bie.ala.org.au/species/https:/biodiversity.org.au/afd/taxa/a4b7f69c-4955-4dd8-ab08-214b7e3eb444 [Accessed: November 2024]	
149.	Parra, G.J., A.R. Preen, P.J. Corkeron, C. Azuma & H. Marsh. 2002. Distribution of Irrawaddy dolphins, Orcaella brevirostris, in Australian waters. Raffles Bulletin of Zoology. 10:141-154.	
150.	DCCEEW 2024. Orcaella heinsohni in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=81322 [Accessed: January 2025]	
151.	Parra, G. J., Schick, R., and Corkeron, P. J. 2006. Spatial distribution and environmental correlates of Australian snubfin and Indo-Pacific	

Ref No	Description	Document ID
	humpback dolphins. Ecography 29, 396–406. doi: 10.1111/j.2006.0906-7590.04411.	
152.	Parra, G. J. 2006. Resource partitioning in sympatric delphinids: space use and habitat preferences of Australian snubfin and Indo-Pacific humpback dolphins. J. Anim. Ecol. 75, 862–874. doi: 10.1111/j.1365-2656.2006.01104.	
153.	Bouchet, P. J., Thiele, D., Marley, S. A., Waples, K., Weisenberger, F., Rangers, B., et al. 2021. Regional assessment of the conservation status of snubfin dolphins (Orcaella heinsohni) in the Kimberley region, Western Australia. Front. Mar. Sci. 7:614852. doi: 10.3389/fmars.2020.614852	
154.	D'Cruz Alexandra , Salgado Kent Chandra , Waples Kelly , Brown Alexander M. , Marley Sarah A. , Thiele Deborah , Yawuru PBC , Raudino Holly C. 2022. Ranging Patterns and Site Fidelity of Snubfin Dolphins in Yawuru Nagulagun/Roebuck Bay, Western Australia. Frontiers in Marine Science. DOI 10.3389/fmars.2021.758435	
155.	Department of the Environment, Water, Heritage and the Arts. 2008. *The North Marine Bioregional Plan: Bioregional Profile: A Description of the Ecosystems*, Conservation Values and Uses of the North Marine Region. Canberra: DEWHA.	
156.	Kelly M. Robertson, Peter W. Arnold. 2009. Australian Snubfin Dolphin: Orcaella heinsohni. Encyclopedia of Marine Mammals (Second Edition), Academic Press, Pages 62-64, ISBN 9780123735539, https://doi.org/10.1016/B978-0-12-373553-9.00017-1.	
157.	Parra, G.J. 2005. Behavioural ecology of Irrawaddy, Orcaella brevirostris (Owen in Gray, 1866), and Indo-Pacific humpback dolphins, Sousa chinensis (Osbeck, 1765), in northeast Queensland, Australia: a comparative study. Ph.D. Thesis. Townsville: James Cook University.	
158.	Dolphin research Australia. N.d. Dolphin & Whale Species Fact Files: Australian snubfin dolphin Available from: https://www.dolphinresearchaustralia.org/learn-about-dolphin-whales/snubfin-dolphin/#toggle-id-2 [Accessed: November 2024]	
159.	DCCEEW 2024. Orcinus orca in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=46 [Accessed: January 2025]	
160.	Ling, J.K. 1991. Recent Sightings of Killer Whales, Orcinus orca (Cetacea: Delphinidae), in South Australia. Transactions of the Royal Society of South Australia. 115:95-98.	
161.	Morrice, M.G. & J. Van den Hoff. 1999. Preliminary investigations of killer whales (Orcinus orca) from inshore waters around sub-Antarctic Macquarie Island. Poster presentation for the 13th Biennial Conference on Marine Mammals, Hawaii. Page(s) 7.	
162.	Whale watch Western Australia. N.d. Bremer Bay Orca Tours. Available from: https://whalewatchwesternaustralia.com/species/orca/ [Accessed: January 2025]	
163.	Culik, B. 2002. Orcinus Orca. Review of small Cetaceans: Distribution, Behaviour, Migration and Threats. Compiled for the Convention on Migratory species (CMS). Bonn, Germany: UNEP and the Secretariat of CMS. www.cms.int/reports/small-cetaceans/.	
164.	Pitman, R. L., Totterdell, J. A., Fearnbach, H., Ballance, L. T., Durban, J. W., & Kemps, H. 2015. Whale killers: Prevalence and ecological	

Ref No	Description	Document ID
	implications of killer whale predation on humpback whale calves off Western Australia. Marine Mammal Science, 31(2), 629-657. https://doi.org/10.1111/mms.12182	
165.	Convention on the Conservation of Migratory Species of Wild Animals. 2016. Proposal for inclusion of species on the appendices of the convention on the conservation of migratory species of wild animals.	
166.	Haughey, R., Hunt, T. N., Hanf, D., Passadore, C., Baring, R., & Parra, G. J. 2021. Distribution and Habitat Preferences of Indo-Pacific Bottlenose Dolphins (Tursiops aduncus) Inhabiting Coastal Waters With Mixed Levels of Protection. Frontiers in Marine Science, 8, 617518. https://doi.org/10.3389/fmars.2021.617518	
167.	Strahan, R. 1983. The Australian Museum Complete Book of Australian Mammals. London, United Kingdom: Angus and Robertson.	
168.	Campbell, R.A., N.J. Gales, G.M. Lento & C.S. Baker. 2008. I*slands in the sea: extreme female natal site fidelity in the Australian sea lion, Neophoca cinerea*. Biology Letters. 23:139-142.	
169.	Campbell, R.A. 2003. *Demography and genetic population structure of the Australian sea lion (Neophoca cinerea).* Ph.D. Thesis. Department of Zoology, University of Western Australia.	
170.	Gales, N.J., A.J. Cheal, G.J. Pobar & P. Williamson. 1992. *Breeding biology and movements of Australian sea-lions, Neophoca cinerea, off the west coast of Western Australia*. Wildlife Research. 19:405-416.	
171.	Gales, N.J., P.D. Shaughnessy & T.E. Dennis. 1994. *Distribution, abundance and breeding cycle of the Australian sea lion Neophoca cinerea (Mammalia: Pinnipedia).* Journal of Zoology, London. 234:353-370.	
172.	Campbell, R. 2005. *Historical distribution and abundance of the Australian sea lion (Neophoca cinerea) on the west coast of Western Australia.* Fisheries Research Report no. 148. Department of Fisheries, Western Australia.	
173.	Dennis, T.E. & P.D. Shaughnessy. 1996. *Status of the Australian sea lion, Neophoca cinerea, in the Great Australian Bight*. Wildlife Research. 23:741-754.	
174.	Dennis, T.E. & P.D. Shaughnessy. 1999. *Seal survey in the Great Australian Bight region of Western Australia*. Wildlife Research. 26:383-388.	
175.	DCCEEW 2024. *Neophoca cinerea* in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=22 [Accessed: January 2025]	
176.	Goldsworthy, S.D., B. Page, P.D. Shaughnessy & A. Linnae. 2010. *Mitigating Seal Interactions in the SRLF and the Gillnet Sector SESSF in South Australia*. FRDC Project Number: 2007/041. Final Report to the Fisheries Research and Development Corporation.	
177.	Gales, N.J. & Cheal, A.J. 1992. *Estimating diet composition of the Australian sea-lion (Neophoca cinerea) from scat analysis: an unreliable technique*. Wildlife Research. 19:447-456.	
178.	Fragnito K. 2013. *Feeding behaviour and habitat utilisation of adult female Australian sea lions (Neophoca cinerea) using animal-borne video cameras*. BSc Honours thesis, The University of Adelaide, South Australia.	
179.	Peters KJ, Ophelkeller K, Bott NJ, Deagle BE, Jarman SN & Goldsworthy SD. 2015. *Fine-scale diet of the Australian sea lion (Neophoca cinerea) using DNA-based analysis of faeces*. Marine Ecology 36, 347–367.	

Ref No	Description	Document ID
180.	Berry TE, Osterrieder SK, Murray DC, Coghlan ML, Richardson AJ, Grealy AK & Bunce M. 2017. D*NA metabarcoding for diet analysis and biodiversity: A case study using the endangered Australian sea lion (Neophoca cinerea).* Ecology and Evolution 7, 5435–5453.	
181.	Costa DP, Gales NJ. 2003. *Energetics of a benthic diver: seasonal foraging ecology of the Australian Sea Lion, Neophoca cinerea.* Ecological Monographs 73, 27–43.	
182.	Lowther, A.D., R.G. Harcourt & S.D. Goldsworthy. 2013. *Regional variation in trophic ecology of adult female Australian sea lions inferred from stable isotopes in whiskers.* Wildlife Research. 40:303-311.	
183.	DCCEEW 2024. Dugongs Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.dcceew.gov.au/environment/marine/marine-species/dugongs [Accessed: January 2025]	
184.	Marsh, H., H. Penrose, C. Eros & J. Hugues. 2002. Dugong Status Report and Action Plans for Countries and Territories. Early Warning Assessment Reports. United Nations Environment Programme, Nairobi.	
185.	Brown, A.M., L. Bejder, K.H. Pollock & S.J. Allen. 2014. Abundance of coastal dolphins in Roebuck Bay, Western Australia: Updated results from 2013 and 2014 sampling periods. Report to WWF-Australia. Murdoch University Cetacean Research Unit, Murdoch University, Western Australia.	
186.	DCCEEW 2024. Dugong dugon in Species Profile and Threats Database Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=28 [Accessed: January 2025]	
187.	Hodgson, A.J., H. Marsh, N. Gales, D.K. Holley & I. Lawler. 2008. Dugong population trends across two decades in Shark Bay, Ningaloo Reef and Exmouth Gulf. Denham, Western Australia: Western Australia Department of Environment and Conservation.	
188.	Marsh, H., A. Grech & R. Hagihara. 2011. Aerial survey of Torres Strait to evaluate the efficacy of an enforced and possibly extended Dugong Sanctuary as one of the tools for managing the dugong fishery. Report to the Australian Marine Mammal Centre and the Torres Strait Regional Authority.	
189.	Lee Long, W.J., L.J. McKenzie & R.J. Coles. 1997. Deepwater seagrasses in northeastern Australia - How deep, how meaningful?. In: Kuo, J., R.C. Phillips, D.I. Walker & H. Kirkman, eds. Seagrass Biology: Proceedings of an International Workshop, Rottnest Island, Western Australia, 25-29 January 1996. Page(s) 41-50. University of Western Australia, Perth.	
190.	Sheppard, J., A.R. Preen, H. Marsh, I.R. Lawler, S. Whiting & R.E. Jones. 2006. Movement heterogeneity of dugongs, Dugong dugon (Muller) over large spatial scales. Journal of Experimental Marine Biology and Ecology. 334:64-83.	
191.	Preen, A., Marsh, H., Lawler, I., Prince, R. and Shepherd, R. 1997. Distribution and abundance of dugongs, turtles, dolphins and other megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia. Wildlife Research 24: 185–208.	
192.	Preen, A.R. 1989. Observations of mating behaviour in Dugongs (Dugong dugon). Marine Mammal Science. 5:382.	

Ref No	Description	Document ID
193.	Holley, D.K. 2006. Movement patterns and habitat usage of Shark Bay dugongs. Available from: http://ro.ecu.edu.au/theses/70.	
194.	Shark Bay world heritage. N.d. Dugong Fact sheet. Available from: https://www.sharkbay.org/publications/fact-sheets-guides/dugong/ [Accessed: November 2024]	
195.	DCCEEW. 2024. *Conservation advice for Aipysurus fuscus (dusky sea snake).* Department of Climate Change, Energy, the Environment and Water. Canberra	
196.	TSSC. 2010. *Approved Conservation Advice for Aipysurus foliosquama (Leaf-scaled Sea Snake).* Threatened Species Scientific Committee.	
197.	TSSC. 2010. *Approved Conservation Advice for Aipysurus apraefrontalis (Short-nosed Sea Snake).* Threatened Species Scientific Committee.	
198.	Commonwealth of Australia. 2017. Recovery Plan for Marine Turtles in Australia. Commonwealth of Australia.	
199.	TSSC. 2008. *Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle).* Threatened Species Scientific Committee.	
200.	Webb, G.J.W. & H. Messel. 1978. *Movement and dispersal patterns of Crocodylus porosus in some rivers of Arnhem Land, northern Australia*. Australian Wildlife Research. 5:263-283.	
201.	Webb, G.J.W., G.C. Sack, R. Buckworth & S.C. Manolis. 1983. *An Examination of Crocodylus porosus Nests in Two Northern Australia Freshwater Swamps, with an Analysis of Embryo Mortality.* Australian Wildlife Research. 10:571-605.	
202.	Miller, J.D. 1993. *Crocodiles in Queensland: A Brief Overview. In: Crocodiles,* Proceedings of the 2nd Regional Meeting of the Crocodile Specialist Group. 272-289. Gland, IUCN.	
203.	Taplin, L.E. 1987*. The management of crocodiles in Queensland, Australia. In: Webb, G. J. W., S. C. Manolis & P. J. Whitehead, eds. Wildlife Management: Crocodiles and Alligators.* Page(s) 129-140. Sydney, Surrey Beatty & Sons.	
204.	Burbidge, A.A. 1987. *The management of crocodiles in Western Australia. In: Webb, G. J. W., S. C. Manolis & P. J. Whitehead, eds. Wildlife Management: Crocodiles and Alligators.* Page(s) 125-127. Sydney: Surrey Beatty & Sons.	
205.	McNamara, K.J. & G.J. Wyre. 1993. *The conservation, management and farming of crocodiles in Western Australia. In: Crocodiles, Proceedings of the 2nd Regional Meeting of the Crocodile Specialist Group.* 435-450. Gland, IUCN.	
206.	DCCEEW 2024. *Crocodylus porosus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1774 [Accessed: January 2025]	
207.	Webb, G.J.W., Manolis, S.C. and Brien, M.L. 2010. *Saltwater Crocodile Crocodylus porosus.* Pp. 99-113 in Crocodiles. Status Survey and Conservation Action Plan. Third Edition, ed. by S.C. Manolis and C. Stevenson. Crocodile Specialist Group: Darwin.	
208.	DEC. 2009. *Management Plan for the Commercial Harvest and Farming of Crocodiles in Western Australia* Department of Environment and Conservation, 1 January 2009-31 December 2013.	

Ref No	Description	Document ID
209.	Grigg, G. & C. Gans. 1993. *Morphology and physiology of the Crocodylia. In: Glasby, C. J., G. J. B. Ross & P. L. Beesley, eds. Fauna of Australia. Volume 2A, Amphibia and Reptilia*. Page(s) 326-343. Canberra: Australian Government Publishing Service	
210.	Webb, G. & C. Manolis. 1989. *Crocodiles of Australia*. Page(s) 160. Sydney, Reed.	
211.	Guinea ML. 2013. *Surveys of the Sea Snakes and Sea Turtles on Reefs of the Sahul Shelf*. Monitoring program for the Montara Well release Timor Sea by Charles Darwin University, Darwin.	
212.	Udyawer, V., Somaweera, R., Nitschke, C., D'Anastasi, B., Sanders, K., Webber, B. L., Hourston, M., & Heupel, M. R. 2020. Prioritising search effort to locate previously unknown populations of endangered marine reptiles. Global Ecology and Conservation, 22, e01013. https://doi.org/10.1016/j.gecco.2020.e01013	
213.	Speed CW, Wilson NG, Somaweera R, Udyawer V, Meekan MG, Whisson G & Miller K. 2022. *Video surveys of sea snakes in the mesophotic zone shed light on trends in populations*. Frontiers in Marine Science 9, 921542.	
214.	Somaweera R, Udyawer V, Guinea ML et al. 2021. P*inpointing drivers of extirpation in sea snakes: A synthesis of evidence from Ashmore Reef*. Frontiers in Marine Science 8, 658756	
215.	Heyward A, Jones R, Meeuwig J et al. 2012. *Monitoring Study S5 Banks & Shoals: Montara 2011 Offshore Banks Assessment Survey*. Report prepared by the Australian Institute of Marine Science for PTTEP Australasia (Ashmore Cartier) Pty. Ltd.	
216.	DSSEG. 2023 *Dusky sea snake expert group. Agreed outcomes from a half-day expert workshop held online on 13 December 2023.* Attendees included Associate Professor Kate Sanders, Dr Vinay Udyawer, Dr Amber Gillett, Blanche d'Anastasi, and James Nankivell.	
217.	d'Anastasi BR, Hobbs JP, Simpfendorfer C & van Herwerden L. 2023. *Habitat and behavioural associations of the Aipysurus group of sea snakes in Western Australia*. In BR d'Anastasi (ed) Big Brown Sea Snakes: A Taxonomic, Population-Genetic and Natural History Study of Australia's Iconic and Threatened Aipysurus Sea Snake Fauna. Unpublished PhD Thesis, James Cook University, Townsville.	
218.	Chetty N, Du A, Hodgson WC, Winkel K & Fry B. 2004 The in vitro neuromuscular activity of Indo-Pacific sea-snake venoms: efficacy of two commercially available antivenoms. Toxicon 44, 193–200.	
219.	Guinea, M.L. & S.D. Whiting. 2005. *Insights into the distribution and abundance of sea snakes at Ashmore Reef.* The Beagle (Supplement 1). Page(s) 199-206.	
220.	McCosker JE. 1975. F*eeding behaviour of Indo-Australian Hydrophiidae*. Pages 217–232 in WA Dunson (ed) The Biology of Sea Snakes. University Park Press, Baltimore.	
221.	Voris, H.K.& H.H. Voris. 1983. *Feeding strategies in marine snakes: an analysis of evolutionary, morphological, behavioural and ecological relationships*. American Zoologist. 23(2):411-425.	
222.	Guinea, M.L. 1993. *Reptilia, Aves and Mammalia. In: in Russell, B.C. & J.R. Hanley, eds. Survey of Marine Biological and Heritage Resources of Cartier and Hibernia Reefs, Timor Sea.* Page(s) 74 - 83. Darwin: Northern Territory Museum of Arts and Sciences.	

Ref No	Description	Document ID
223.	Sanders, K., Crowe-Riddell, J.M., Courtney, T. & Rasmussen, A.R. 2021. *Aipysurus foliosquama.* The IUCN Red List of Threatened Species 2021: e.T176714A83765016. https://dx.doi.org/10.2305/IUCN.UK.20212.RLTS.T176714A83765016.en	
224.	Sanders, K.L., Schroeder, T., Guinea, M.L. and Rasmussen, A.R. 2015. *Molecules and morphology reveal overlooked populations of two presumed extinct Australian sea snakes (aipysurus: hydrophiinae).* PLoS ONE 10(2): e0115679. DOI: 10.1371/journal.pone.0115679	
225.	D'Anastasi, B., van Herwerden, L., Hobbs, J., Simpfendorfer, C. and Lukoschek, V. 2016. *New range and habitat records for threatened Australian sea snakes raise challenges for conservation.* Biological Conservation 194: 66-70.	
226.	Udyawer, V., D'Anastasi, B., MacAuley, R. and Heupel, M.R. 2016. *Exploring the status of Western Australia's sea snakes*. Final Report to the National Environmental Science Program and the Department of Environment Marine Biodiversity Hub Project A8.	
227.	Ehmann, H. 1992. *Reptiles. In: Strahan, R., ed. Encyclopedia of Australian Animals.* Sydney: Angus & Robertson.	
228.	McCosker, J.E. 1975. *Feeding behaviour of Indo-Australian Hydrophiidae. In: Dunson, W. A., ed. The Biology of Sea Snakes*. Page(s) 217-232. Baltimore: University Park Press.	
229.	Liu, Y., Chen, Y.H., Lillywhite, H.B., Tu M.C. *Habitat selection by sea kraits (Laticauda spp.) at coastal sites of Orchid Island, Taiwan* Integr. Comp. Biol., 52 (2012), pp. 274-280	
230.	DCCEEW 2024. *Aipysurus foliosquama in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1118 [Accessed: January 2025]	
231.	Voris, H.K. 1972. *The role of sea snakes (Hydrophiidae) in the trophic structure of coastal oceanic communities.* Journal of the Marine Biological Association of India. 14(2):429-442.	
232.	DCCEEW 2024. *Aipysurus apraefrontalis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1115 [Accessed: January 2025]	
233.	DCCEEW. 2023. *Short-nosed Sea Snake*. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/environment/biodiversity/threatened/action-plan/priority-reptiles/short-nosed-sea-snake [Accessed: November 2024]	
234.	Minton, S.A. & H. Heatwole. 1975. *Sea snakes from three reefs of the Sahul Shelf. In: Dunson, W. A., ed. The Biology of Sea Snakes*. Page(s) 141-144. Baltimore: University Park Press.	
235.	Lukoschek, V., M. Beger, D. Ceccarelli, Z. Richards & M. Pratchett. 2013. *Enigmatic declines of Australia's sea snakes from a biodiversity hotspot.* Biological Conservation. 166:191-202.	
236.	Guinea, M.L. 2007. *Survey March 16 - April 2 2007: Sea snakes of Ashmore Reef, Hibernia Reef and Cartier Island with comments on*	

Ref No	Description	Document ID
	Scott Reef. Final Report to the Department of the Environment and Water Resources, Canberra. Darwin: Charles Darwin University.	
237.	AIMS 2021. *"Thought to be lost forever": locally extinct sea snake re-discovered during deep-sea expedition.* Australian Institute of Marine Science. Available from: https://www.aims.gov.au/information-centre/news-and-stories/thought-be-lost-forever-locally-extinct-sea-snake-re-discovered-during-deep-sea-expedition [Accessed: November 2024]	
238.	Cogger, H.G. 2000. *Reptiles and Amphibians of Australia* - 6th edition. Sydney, NSW: Reed New Holland.	
239.	McCosker, J.E. 1975. *Feeding behaviour of Indo-Australian Hydrophiidae*. In: Dunson, W. A., ed. The Biology of Sea Snakes. Page(s) 217-232. Baltimore: University Park Press.	
240.	Voris, H.K. 1972. *The role of sea snakes (Hydrophiidae) in the trophic structure of coastal oceanic communities*. Journal of the Marine Biological Association of India. 14(2):429-442.	
241.	CAPL. 2018. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Long-term Marine Turtle Management Plan.* Chevron Australia, Perth, Western Australia.	145
242.	Pendoley, K.L. 2005. *Sea turtles and the environmental management of industrial activities in north-west Western Australia*. Ph.D. Thesis. PhD Thesis, Murdoch University: Perth.	132
243.	Pendoley, K., Bell, C., McCracken, R., Ball, K., Sherborne, J., Oates, J., Becker, P., Vitenbergs, A. and Whittock, P. 2014. *Reproductive biology of the Flatback Turtle Natator depressus in Western Australia*. Endangered Species Research, 23: 115–123.	133
244.	Pendoley Environmental. 2010. *Barrow Island Marine Turtle Track Census Monitoring 2004/05–2009/2010.* Unpublished report for Chevron Australia, Perth, Western Australia.	134
245.	Whittock, P., Pendoley, K., Hamann, M., 2014. *Inter-nesting distribution of Flatback Turtles Natator depressus and industrial development in Western Australia.* Endangered Species Research 26, 25–38. doi:10.3354/esr00628`	135
246.	Whittock, P. A., K. L. Pendoley, and M. Hamann. 2016. *Using habitat suitability models in an industrial setting: the case for internesting flatback turtles.* Ecosphere 7(11):e01551. 10.1002/ecs2.1551	136
247.	Thums, M., Waayers, D., Huang, Z., Pattiaratchi, C., Bernus, J. and Meekan, M., 2017. *Environmental predictors of foraging and transit behaviour of Flatback Turtles Natator depressus*. Endangered Species Research, 32: 333-349.	
248.	Dobbs, K. 2007. *Marine turtle and dugong habitats in the Great Barrier Reef Marine Park used to implement biophysical operational principles for the Representative Areas Program*. Great Barrier Reer Marine Parks Authority, Australian Government.	138
249.	Guinea, M., Sperling J.B., and Whiting S.D. 2006. *Flatback sea turtle inter-nesting habitat in Fog Bay Northern Territory, Australia*. In Proceedings of the 23rd Annual Sea Turtle Symposium on Sea Turtle Biology and Conservation 2003 Kuala Lumpur. 2006. Kuala Lumpur, Malaysia.	
250.	Pendoley Environmental. 2010. *Proposed Outer Harbour Development Port Hedland: Satellite Tracking of Flatback Turtles from Cemetery*	140

Ref No	Description	Document ID
	Beach 2009/2010 - Internesting Habitat. Report prepared by Pendoley Environmental Pty Ltd for SKM/BHP Billiton Iron Ore.	
251.	Seminoff JA, Allen CD, Balazs GH, Dutton PH, Eguchi T, Haas HL, Hargrove SA, MP J, Klemm DL, Lauritsen AM, MacPherson SL, Opay P, Possardt EE, Pultz SL, Seney EE, Van Houtan RS and Waples RS. 2015.*Status Review of the Green Turtle (Chelonia mydas) under the U.S.* Endangered Species Act. NOAANMFS-SWFSc-539. pp 571	
252.	Bjorndal, K.A. 1997. *Foraging Ecology and Nutrition in Sea Turtles.* In: P.L. Lutz and J.A. Musick (eds) The Biology of Sea Turtles, Vol. 1: 199–231. CRC Press, Boca Raton, Florida.	142
253.	Chevron Australia. 2005. *Draft Gorgon Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Gorgon Development.* Chevron Australia, Perth, Western Australia	
254.	DCCEEW 2024. *Eretmochelys imbricata in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1766 [Accessed: January 2025]	144 146abajo
255.	Chevron Australia. 2015. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Five-year Environmental Performance Report (August 2010– August 2015).* Chevron Australia, Perth, Western Australia	G1-NTREPX0007517
256.	Marquez, R. 1990. *FAO Species Catalogue; Sea Turtles of the World. An annotated and illustrated catalogue of the sea turtle species known to date.* FAO Fisheries Synopsis. 125 (11):pp 81. Rome: Food and Agriculture Organisation of United Nations.	147
257.	Benson, S.R., T. Eguchi, D.G. Foley, K.A. Forney, H. Bailey, C. Hitipeuw, B.P. Samber, R.F. Tapilatu, V. Rei, P. Ramohia, J. Pita & P.H. Dutton. 2011. *Large-scale movements and high-use areas of western Pacific leatherback turtles, Dermochelys coriacea*. Ecosphere. 2(7):art84.	148
258.	Limpus, C.J. & N. MacLachlin. 1979. *Observations on the leatherback turtle, Dermochelys coriacea (L.), in Australia.* Australian Wildlife Research. 6:105-116.	
259.	Limpus, C.J. & N. MacLachlin. 1994. *The conservation status of the Leatherback Turtle, Dermochelys coriacea, in Australia. In: James, R, ed. Proceedings of the Australian Marine Turtle Conservation Workshop*, Gold Coast 14-17 November 1990. Page(s) 63-67. Queensland Department of Environment and Heritage. Canberra: ANCA.	150
260.	Hazel, J. Hamann, M., Bell, I., Groom R. 2024. *Occurrence of leatherback turtles around Australia.* Endang Species Res 54:83-91. https://doi.org/10.3354/esr01331	
261.	Swaminathan A, Namboothri N, Shanker K. 2019. *Tracking leatherback turtles from Little Andaman Island.* Indian Ocean Turtle Newsl 29:8–10	152
262.	Limpus CJ. 2009. *A Biological Review of Australian Marine Turtles*. Brisbane, Queensland. Queensland Government Environmental Protection Agency. pp 324	165
263.	Martinez AL. 2000. *Dermochelys coriacea. In: IUCN 2007. 2007 IUCN Red List of Threatened Species.*	154
264.	DCCEEW 2024. *Dermochelys coriacea in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and	155

Ref No	Description	Document ID
	Water, Canberra. Available from: https://www.environment.gov.au/biodiversity/threatened/species/pubs/1768-listing-advice.pdf [Accessed: January 2025]	
265.	Limpus, C.J., A. Fleay & M. Guinea. 1984. *Sea turtles of the Capricornia section, Great Barrier Reef.* Royal Society Queensland Symposium. Page(s) 61-78.	156
266.	Hamann, M., C. Limpus, G. Hughes, J. Mortimer & N. Pilcher. 2006. *Assessment of the conservation status of the leatherback turtle in the Indian Ocean and South East Asia.* Bangkok: IOSEA Marine Turtle MoU Secretariat.	
267.	Pritchard P. 1982. *Nesting of Leatherback Turtle Dermochelys coriacea in Pacific Mexico, With a New Estimate of the World Population Status*. Copeia 4: 741-747.	158
268.	Limpus, CJ and McLachlan NC. 1990. *The Conservation Status of the Leatherback Turtle, Dermochelys coriacea, in Australia. In: James, R, ed. Proceedings of the Australian Marine Turtle Conservation Workshop*, Gold Coast 14-17 November 1990. Pages 68-72. Qld Dept Env. & Heritage. Canberra, ANCA.	
269.	Bone, C. 1998. *'Preliminary investigation into leatherback turtle, Dermochelys coriacea (L.) distribution, abundance and interactions with fisheries in Tasmanian waters*. Unpublished Report.'. Tasmanian Parks and Wildlife Service.	160
270.	Green, R.H. 1971. *Sea turtles around Tasmania*. Records Queen Victoria Museum. 38:1-4.	
271.	Avens L and Snover ML. 2013. *Age and age estimation in sea turtles.* In The Biology of Sea Turtles. Volume III, Wyneken J, Lohmann KJ and Musick JA, Eds. CRC Press, Boca Raton. pp 97-133.	162
272.	Plotkin, PT, MK Wicksten, and AF Amos. 1993. *Feeding ecology of the loggerhead sea turtle Caretta caretta in the northwestern Gulf of Mexico.* Marine Biology 115(1):1.	
273.	Cogger, HG, EE Cameron, RA Sadlier, and P Eggler. 1993. *The Action Plan for Australian Reptiles.* Canberra, ACT: Australian Nature Conservation Agency	164
274.	Baldwin, R., G. Hughes & R. Prince. 2003. *Loggerhead turtles in the Indian Ocean*. In: Bolten, A. & B. Witherington, eds. Loggerhead sea turtles. Washington: Smithsonian Books	
275.	DCCEEW 2024. *Caretta caretta in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=%201763 [Accessed: January 2025]	
276.	DCCEEW 2024. *Lepidochelys olivacea in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1767 [Accessed: January 2025]	
277.	Fitzsimmons NN and Limpus C. 2014. *Marine turtle genetic stocks of the Indo-Pacific: Identifying boundaries and knowledge gaps*. Indian Ocean Turtle Newsletter 20: 2-18	
278.	Jensen, Michael & Limpus, Colin & Whiting, Scott & Guinea, Michael & Prince, Robert & Dethmers, Kiki & Adnyana, Windia & Kennett, Rod & FitzSimmons, Nancy. 2013. Defining olive ridley turtle Lepidochelys	

Ref No	Description	Document ID
	olivacea management units in Australia and assessing the potential impact of mortality in ghost nets. Endangered Species Research. 21. 241-253. 10.3354/esr00521.	
279.	Robins, J.B. 2002. A *scientific basis for a comprehensive approach to managing sea turtle by-catch: The Queensland East Coast as a case study.* Ph.D. Thesis. James Cook University.	
280.	Robins, J.B. 1995. *Estimated catch and mortality of sea turtles from the East Coast Otter Trawl Fishery of Queensland, Australia.* Biological Conservation. 74:157-167.	
281.	Chatto, R., & B. Baker. 2008. *The distribution and status of marine turtle nesting in the Northern Territory-Technical Report 77/2008*. Parks and Wildlife Service, Department of Natural Resources, Environment, The Arts and Sport. Northern Territory Government.	
282.	Abreu-Grobois, A. & P. Plotkin. 2008. *Lepidochelys olivacea. IUCN 2008.* 2008 IUCN Red List of Threatened Species. .	
283.	Waayers D, Mau R, Mueller A, Smith J and Pet-Soede L. 2015. *A review of the spatial distribution of marine turtle nesting and foraging areas in Western Australia*. In Proceedings of the Second Australian and Second Western Australian Marine Turtle Symposia, Perth 25-27 August 2014. 2015. Science Division, Department of Parks and Wildlife. pp 83-86.	
284.	Whiting SD, Long J, Hadden K and Lauder A. 2005. *Identifying the Links Between Nesting and Foraging Grounds for the Olive Ridley (Lepidochelys olivacea) Sea Turtles in Northern Australia*. Final report to the Department of Environment and Water Resources. pp 35.	
285.	Whiting, Scott & Long, J. & Coyne, Michael. 2007. Migration routes and foraging behaviour of olive ridley turtles Lepidochelys olivacea in northern Australia. Endangered Species Research. 3. 1-9. 10.3354/esr003001.	
286.	Musick, J.A. & C.J. Limpus. 1997. *Habitat utilisation and migration in juvenile sea turtles.* In: Lutz, P., & J. A.Musick, eds. The Biology of Sea Turtles. Page(s) 137-163. Boca Raton, Florida: CRC Press Inc.	
287.	Conway, S. 1994. *Diets and feeding biology of adult olive ridley (Lepidochelys olivacea) and loggerhead (Caretta caretta) sea turtles in Fog Bay, Northern Territory*. Hons. Thesis. Darwin: Northern Territory University.	
288.	Hughes, G. 1974. *The sea turtles of south east Africa.* 1. status, morphology and distributions. Invest. Rep. Oceanogr. Res. Inst. S. Afr. 35:1-144.	
289.	Bray, D.J. 2021, *Seahorses, pipefishes, SYNGNATHIDAE* in Fishes of Australia. Available from: https://fishesofaustralia.net.au/home/family/34 [Accessed: January 2025].	
290.	Dawson, C.E. 1985. *Indo-Pacific pipefishes (Red Sea to the Americas)*. Gulf Coast Research Laboratory, Ocean Springs, Mississippi, USA.	
291.	Lourie, S.A., Vincent, A.C.J. and Hall, H.J. 1999. *Seahorses: an identification guide to the world's species and their conservation.* Project Seahorse, London, UK.	
292.	Lourie, S.A., Foster, S.J., Cooper, E.W.T. and Vincent, A.C.J. 2004. *A guide to the identification of seahorses.* Project Seahorse and TRAFFIC North America, University of British Columbia and World Wildlife Fund.	
293.	DSEWPC. 2012. *Species group report card – bony fishes Supporting the marine bioregional plan for the North-west Marine Region*. Department of Sustainability, Environment, Water, Population and Communities, Public Affair	
294.	Timothy D. O'Hara. 2023. *Proposed offshore Key Ecological Features and Biologically Important Areas of Australia's Indian Ocean Territories.* Museums Victoria V3.02, March 2023	
295.	Commonwealth of Australia .2015. *Sawfish and River Sharks Multispecies Recovery Plan,* Commonwealth of Australia.	

Ref No	Description	Document ID
296.	TSSC. 2009. *Approved Conservation Advice for Pristis clavata (Dwarf Sawfish).* Threatened Species Scientific Committee	
297.	TSSC. 2014. *Approved Conservation Advice for Pristis pristis (largetooth sawfish).* Threatened Species Scientific Committee	
298.	TSSC. N.d. *Approved Conservation Advice for Green Sawfish.* Threatened Species Scientific Committee	
299.	Commonwealth of Australia. 2014. *Recovery Plan for the Grey Nurse Shark (Carcharias taurus).* Commonwealth of Australia	
300.	TSSC. 2013. *Listing Advice for Centrophorus zeehaani (southern dogfish).* Threatened Species Scientific Committee	
301.	TSSC. 2014. *Approved Conservation Advice for Glyphis garricki (northern river shark).* Threatened Species Scientific Committee	
302.	TSSC. 2024. *Listing Advice for Sphyrna lewini (scalloped hammerhead).* Threatened Species Scientific Committee	
303.	TSSC. 2014. *Listing Advice Isurus oxyrinchus shortfin mako.* Threatened Species Scientific Committee	
304.	TSSC. 2015. *Conservation Advice Rhincodon typus whale shark.* Threatened Species Scientific Committee	
305.	DSEWPC. 2013. *Recovery Plan for the White Shark (Carcharodon carcharias).* Department of Sustainability, Environment, Water, Population and Communities, Public Affairs	
306.	Last, P.R. & J.D. Stevens. 1994. *Sharks and Rays of Australia.* Melbourne, Victoria: CSIRO.	
307.	Grant, M.I., Charles, R., Fordham, S., Harry, A.V., Lear, K.O., Morgan, D.L., Phillips, N.M., Simeon, B., Wakhida, Y. & Wueringer, B.E. 2022. *Pristis clavata.* The IUCN Red List of Threatened Species 2022: e.T39390A68641215.	
308.	Thorburn, D.C., D.L. Morgan, A.J. Rowland & H.S. Gill. 2007. *Freshwater sawfish Pristis microdon Latham, 1794 (Chondrichthyes: Pristidae) in the Kimberley region of Western Australia*. Zootaxa. 1471:27-41.	
309.	Peverell, S. 2007. *Dwarf Sawfish Pristis clavata.* Marine Education Society of Australasia website.	
310.	Peverell, S. 2005. *Distribution of Sawfishes (Pristidae) in the Queensland Gulf of Carpentaria, Australia - with notes on sawfish ecology.* Environmental Biology of Fishes. 73:391-402.	
311.	Thorburn, D.C., D.L. Morgan, A.J. Rowland, H.S. Gill & E. Paling 2007. *Life history notes of the critically endangered dwarf sawfish, Pristis clavata, Garman 1906 from the Kimberley region of Western Australia.* In: Environmental Biology of Fishes.	
312.	Stevens,J.D., R.B. McAuley, C.A. Simpfendorfer & R.D. Pillans. 2008. *Spatial distribution and habitat utilisation of sawfish (Pristis spp) in relation to fishing in northern Australia.* A report to the Department of the Environment, Water, Heritage and the Arts. CSIRO and Western Australia Department of Fisheries.	
313.	DCCEEW 2024. *Pristis clavatai in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?showprofile=Y&taxon_id=68447 [Accessed: January 2025]	

Ref No	Description	Document ID
314.	DEPWS. 2023. Threatened Species of the Northern Territory, Dwarf Sawfish Pristis clavata. Department of Environment, Parks and Water Security. Available from: https://nt.gov.au/__data/assets/pdf_file/0003/1328133/dwarf-sawfish.pdf [Accessed: January 2025]	
315.	DCCEEW 2024. *Pristis pristis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=60756 [Accessed: January 2025]	
316.	Whitty, J.M., D.L. Morgan, D.C. Thorburn, T. Fazeldean & S.C. Peverell. 2008. *Tracking the movements of Freshwater Sawfish (Pristis microdon) and Northern River Sharks (Glyphis sp. C) in the Fitzroy River.* Whitty, J.M., N.M. Phillips, D.L. Morgan, J.A. Chaplin, D.C. Thorburn & S.C. Peverell, eds. Habitat associations of Freshwater Sawfish (Pristis microdon) and Northern River Sharks (Glyphis sp. C): including genetic analysis of P. microdon across northern Australia. Centre for Fish & Fisheries Research (Murdoch University) report to the Department of the Environment, Water, Heritage and the Arts, Australian Government.	
317.	Giles, J., R.D. Pillans, M.J. Miller & J.P. and Salini. 2006. *Sawfish Catch Data in Northern Australia: A Desktop Study.* Internal CSIRO Report for FRDC. 2002/064:74.	
318.	Stevens, J.D., R.D. Pillans & J. Salini. 2005. C*onservation Assessment of Glyphis sp. A (Speartooth Shark), Glyphis sp. C (Northern River Shark), Pristis microdon (Freshwater Sawfish) and Pristis zijsron (Green Sawfish).* Hobart, Tasmania: CSIRO Marine Research.	
319.	Allen, G.R. 1991. *Field Guide to the Freshwater Fishes of New Guinea.*:268. Madang: Christensen Research Institute.	
320.	Phillips, N. 2012. *Conservation genetics of Pristis sawfishes in Australian waters*. PhD Thesis. Murdoch University. 247 pp.	
321.	Phillips, N., Chaplin, J. A., Morgan, D. L. & Peverell, S. C. 2011. *Population genetic structure and genetic diversity of three critically endangered Pristis sawfishes in Australian waters*. Marine Biology 158, 903–915.	
322.	Bateman, R. L., Morgan, D. L., Wueringer, B. E., McDavitt, M., & Lear, K. O. 2024. *Collaborative methods identify a remote global diversity hotspot of threatened, large-bodied rhino rays.* Aquatic Conservation: Marine and Freshwater Ecosystems, 34(1), e4047. https://doi.org/10.1002/aqc.4047	
323.	Allen, G.R. 1982. *A Field Guide to Inland Fishes of Western Australia.* Perth, Western Australia: University of Western Australia Press.	
324.	Peverell, S.C. & R.D. Pillans. 2004. *Determining feasibility of acoustic tag attachment and documenting short-term movement in Pristis zijsron* Bleeker, 1851. Report for the National Oceans Office. 18.	
325.	Thorburn, D.C., S. Peverell, S. Stevens, J.D. Last & A.J. Rowland. 2004. *Status of Freshwater and Estuarine Elasmobranches in Northern Australia. Report to Natural Heritage Trust.* Canberra, ACT: Natural Heritage Trust.	
326.	Harry, A.V., A.J. Tobin, C.A. Simpfendorfer, D.J. Welch, A. Mapleston, J. White, A.J. Williams & J. Stapley. 2011. *Evaluating catch and mitigating risk in a multi-species, tropical, inshore shark fishery within*	

Ref No	Description	Document ID
	the Great Barrier Reef World Heritage Area. Marine and Freshwater Research. 62:710-721.	
327.	DCCEEW 2024. *Pristis zijsron in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=68442 [Accessed: January 2025]	
328.	Chevron 2011. *Technical Appendix 06 Draft Marine Fauna Management Plan*. Appendix D: Sawfish Management Summary Report. Document No.. Rev E	WS0-0000-HES-PLN-CVX-000-00037-000
329.	DEPWS. 2023. *Threatened Species of the Northern Territory, Green Sawfish Pristis zijsron.* Department of Environment, Parks and Water Security. Available from: https://nt.gov.au/__data/assets/pdf_file/0009/1328139/green-sawfish.pdf [Accessed: January 2025]	
330.	Cliff, G. & G. Wilson. 1994. *Natal Sharks Board's Guide to Sharks and other Marine Animals.*	
331.	Pogonoski, J.J., D.A. Pollard & J.R. Paxton. 2002. *Conservation Overview and Action Plan for Australian Threatened and Potentially Threatened Marine and Estuarine Fishes.* Canberra, ACT: Environment Australia.	
332.	Fish. 2023. *Narrow Sawfish, Anoxypristis cuspidata.* Available from: https://fish.gov.au/docs/SharkReport/2023_FRDC_Anoxypristis_cuspidata_Final.pdf [Accessed: November 2024]	
333.	Conservation of Migratory Sharks. N.d. *Anoxypristis cuspidata.* Available from: https://www.cms.int/sharks/en/species/anoxypristis-cuspidata [Accessed: November 2024]	
334.	Haque, A.B., d'Anastasi, B. Dulvy, N., Faria, V., Fordham, S., Grant, M., Harry, A., Jabado, R., Lear, K., Morgan, D.L., Tanna, A., Wakhida, Y. and R. Charles, R. 2023. *Anoxypristis cuspidata*. The IUCN Red List of Threatened Species 2023	
335.	Kyne, P. M., Heupel, M. R., White, W. T. and Simpfendorfer, C. A. 2021. The Action Plan for Australian Sharks and Rays. National Environmental Science Program, Marine Biodiversity Hub, Hobart.	
336.	Weigmann, S. 2016. *Annotated checklist of the living sharks, batoids and chimaeras (Chondrichthyes) of the world, with a focus on biogeographical diversity.* Journal of Fish Biology 88(3): 837–1037.	
337.	Great Barrier Reef Marine Park. 2012. *A Vulnerability Assessment for the Great Barrier Reef.* Great Barrier Reef Marine Park.	
338.	Compagno, L.J.V. 1984. *Part 1 - Hexanchiformes to Lamniformes. FAO Species Catalogue, Vol. 4., Sharks of the World. An Annotated and Illustrated Catalogue of Sharks Known to Date.* FAO Fisheries Synopsis. 4(1):1-249.	
339.	Last, P. R., & Stevens, J. D. 2009. *Sharks and Rays of Australia.* Second Edition. CSIRO Division of Fisheries, Hobart, Tasmania, Australia.	
340.	Stow, A., Zenger, K., Briscoe, D., Gillings, M., Peddemors, V., Otway, N., & Harcourt, R. 2006. *Isolation and genetic diversity of endangered grey nurse shark (Carcharias taurus) populations*. Biological Letters 2(2), 308–311.	

Ref No	Description	Document ID
341.	Stevens, J.D. 1999. *Management of shark fisheries in northern Australia; Part 1.* Shotton, R., ed. Case studies of the management of elasmobranch fisheries. FAO Fisheries Technical Paper. 378:456-479. FAO, Rome.	
342.	Jakobs S, Braccini M. 2019. *Acoustic and conventional tagging support the growth patterns of grey nurse sharks and reveal their large-scale displacements in the west coast of Australia.* Mar Biol 166: 150	
343.	McAuley R. 2004. *Western Australian grey nurse shark popup archival tag project.* Final Report to Department of Environment and Heritage, Canberra	
344.	Otway, N. M., & Burke, A. L. 2004. *Mark-recapture population estimate and movements of grey nurse sharks.* New South Wales Fisheries Final Report Series No.63. NSW Fisheries Office of Conservation, Nelson Bay, NSW.	
345.	Dicken, M. L. 2006. *Population dynamics of the raggedtooth shark (Carcharias taurus) along the east coast of South Africa.* Rhodes University. Grahamstown, South Africa.	
346.	Hoschke AM, Whisson GJ. Haulsee D. 2023. Population distribution, aggregation sites and seasonal occurrence of Australia's western population of the grey nurse shark Carcharias taurus. Endang Species Res 50: 107–123	
347.	Hoschke AM, Whisson GJ. 2016. *First aggregation of grey nurse sharks (Carcharias taurus) confirmed in Western Australia*. Mar Biodivers Rec 9: 17	
348.	Williams A, Althaus F, Smith T, Daley R, Barker B, Fuller M. 2012. *Developing and applying a spatially-based seascape analysis (the "habitat proxy" method) to inform management of gulper sharks*. Compendium of Discussion Papers. Report to the Australian Fisheries Management Authority. CSIRO, Australia. 188pp. Williams et al. pers comm. (2012). Presentation to the Threatened Species S	
349.	Daley RK, Stevens JD and Graham KJ. 2002. *Catch analysis and productivity if the deepwater dogfish resource in southern Australia.* FRDC Final Report 1998/108. CSIRO Marine Research, Fisheries Research & Development Cooperation and NSW Fisheries, Australia.	
350.	Graham KJ and Daley RK. 2011. *Distribution, reproduction and population structure of thee gulper sharks (Centrophorus Centrophoridae) in south-eastern Australian waters.* Marine and Freshwater Research. 62: 583–595.	
351.	Bruce, B. 2014. *A synthesis of available data on mako and porbeagle sharks in Australasian waters. Current status and future directions.* CSIRO Marine and Atmospheric Research, Hobart, Tasmania. 153 pp.	
352.	Fish. 2023. Longfin Mako, Isurus paucus. Available from: https://fish.gov.au/docs/SharkReport/2023_FRDC_Isurus_paucus_final.pdf [Accessed: January 2025]	
353.	Compagno, L.J.V. 2001. *Sharks of the world. An annotated and illustrated catalogue of shark species known to date.* Vol. 2. Bullhead, mackeral and carpet sharks (Heterodontiformes, Lamniformes and Orectolobiformes). FAO species catalogue for fisheries purposes. No. 1. Vol. 2. FAO, Rome.	
354.	Pillans RD, Stevens JD, Peverell S and Edgar S. 2008. *Spatial distribution and habitat utilisation of the speartooth shark Glyphis sp.* A	

Ref No	Description	Document ID
	in relation to fishing in Northern Australia. Final report to Department of the Environment, Water, Heritage and the Arts. May 2008	
355.	Pillans RD, Stevens JD, Kyne PM and Salini J. 2009. *Observations on the distribution, biology, short-term movements and habitat requirements of river sharks Glyphis spp. in northern Australia.* Endangered Species Research, 10: 321–332.	
356.	Thorburn DC and Morgan DL (2004). The northern river shark Glyphis sp. C (Carcharhinidae) discovered in Western Australia. Zootaxa, 685: 1–8.	
357.	Australian Museum. 2021. *Oceanic Whitetip Shark, Carcharhinus longimanus (Poey, 1861).* Available from: https://australian.museum/learn/animals/fishes/oceanic-whitetip-shark-carcharhinus-longimanus/ [Accessed: November 2024]	
358.	Fish. 2023. *Oceanic Whitetip Shark, Carcharhinus longimanus.* Available from: https://fish.gov.au/docs/SharkReport/2023_FRDC_Carcharhinus_longimanus_final.pdf [Accessed: November 2024]	
359.	Howey-Jordan, L.A., Brooks, E.J., Abercrombie, D.L., Jordan, L.K., Brooks, A., Williams, S.,Gospodarczyk, E. and Chapman, D.D. 2013. *Complex movements, philopatry and expanded depth range of a severely threatened pelagic shark, the oceanic whitetip (Carcharhinus longimanus) in the western North Atlantic.* PloS One 8:e56588. https://doi:10.1371/journal.pone.0056588	
360.	D'Alberto, D.M., Chin, A., Smart, J.J., Baje, L., White, W.T. and Simpfendorfer, C.A. 2017. *Age, growth and maturity of oceanic whitetip shark (Carcharhinus longimanus) from Papua New Guinea.* Marine and Freshwater Research 68: 1118–1129.	
361.	NOAA. 2024. *Species Directory Oceanic Whitetip Shark.* Available from: https://www.fisheries.noaa.gov/species/oceanic-whitetip-shark [Accessed: January 2025]	
362.	Francis, M., L. Natanson & S. Campana. 2002. *The Biology and Ecology of the Porbeagle Shark, Lamna nasus. In: Camhi, M., E. Pikitch & E. Babcock, eds. Sharks of the Open Ocean*: Biology, Fisheries and Conservation. Page(s) 105-113. Blackwell Publishing, United Kingdom.	
363.	Pade, N., N. Queiroz, N. Humphries, M. Witt, C. Jones, L. Noble & D. Sims. 2009. *First results from satellite-linked archival tagging of Porbeagle shark, Lamna nasus: area fidelity, wider-scale movements and plasticity in diel depth changes.* Journal of Experimental Marine Biology and Ecology. 370:64-74.	
364.	Joyce, W., S. Campana, L. Natanson, N. Kohler, H. Pratt Jr. & C. Jensen. 2002. *Analysis of stomach contents of the porbeagle shark (Lamna nasus Bonnaterre) in the northwest Atlantic*. ICES Journal of Marine Science. 53:1263-1269.	
365.	Saunders, R., F. Royer & M. Clarke. 2011. *Winter migration and diving behaviour of Porbeagle shark, Lamna nasus, in the Northeast Atlantic.* ICES Journal of Marine Science. 68(1):166-174.	
366.	Francis, M.P. & J.D. Stevens. 2000. *Reproduction, embryonic development, and growth of the porbeagle shark, Lamna nasus, in the southwest Pacific Ocean.* Fisheries Bulletin. 98:41-63.s	
367.	DBCA. N.d. *Hammerhead sharks.* Available from: https://www.dbca.wa.gov.au/wildlife-and-ecosystems/marine/marine-parks/fun-facts/hammerhead-sharks [Accessed: November 2024]	

Ref No	Description	Document ID
368.	Bartes S & Braccini M. 2021. *Potential expansion in the spatial distribution of subtropical and temperate west Australian sharks.* Journal of Fish Biology 2021, 1–4.	
369.	NSW Government. N.d. *Scalloped hammerhead sharks.* Available from: https://www.dpi.nsw.gov.au/fishing/threatened-species/what-current/endangered-species2/scalloped-hammerhead-shark [Accessed: November 2024]	
370.	Salinas-de-León P, Hoyos-Padilla E & Pochet F. 2017. *First observation on the mating behaviour of the endangered scalloped hammerhead shark Sphyrna lewini in the Tropical Eastern Pacific*. Environmental Biology of Fishes 100, 1603–1608	
371.	Abascal, F. J., Quintans, M., Ramos-Cartelle, A. and Mejuto, J. 2011. *Movements and environmental preferences of the shortfin mako, Isurus oxyrinchus, in the south eastern Pacific Ocean*. Marine Biology 158:1175–1184.	
372.	Stevens, J. D., Bradford, R. W. and West, G. J. 2010. *Satellite tagging of blue sharks (Prionace glauca) and other pelagic sharks off eastern Australia: depth behaviour, temperature experience and movement.* Marine Biology 157: 575–591.	
373.	Rogers, P. J., Huveneers, C., Page, B. and Goldsworthy, S. G. 2009. *Movement patterns of pelagic sharks in Southern and Indian Oceans: determining critical habitats and migration paths*. Final Report to the Nature Foundation South Australia Inc. SARDI Research Report Series No. 359: 34 pp.	
374.	Stillwell, C. E. and Kohler, N. E. 1982. *Food, feeding habits, and daily ration of the shortfin mako (Isurus oxyrinchus) in the Northwest Atlantic*. Canadian Journal of Fisheries and Aquatic Sciences 39: 407–414.	
375.	Stevens, J. D. 1984. *Biological observations on sharks caught by sport fishermen off New South Wales*. Australian Journal of Marine and Freshwater Research 35: 573 – 590	
376.	Maia, A., Queiroz, N., Correia, J. P., and Cabral, H. 2006. *Food habits of the shortfin mako, Isurus oxyrinchus, off the southwest coast of Portugal*. Environmental Biology of Fishes 77: 157–167.	
377.	DCCEEW. 2024. *Rhincodon typus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66680 [Accessed: January 2025]	
378.	Gleiss, A., Wright, S., Liebsch, N. & Wilson, R. 2013. *Contrasting diel patterns in vertical movement and locomotor activity of Whale sharks at Ningaloo Reef.* Marine Biology.	
379.	Sleeman, J.C., Meekan, M.G., Fitzpatrick, B.J., Steinberg, C.R., Ancel, R. and Bradshaw, C.J.A., 2010. *Oceanographic and atmospheric phenomena influence the abundance of whale sharks at Ningaloo Reef, Western Australia. Journal of Experimental Marine Biology and Ecology* 382: 77–81.	
380.	Meekan, M. and Radford, B., 2010. *Migration Patterns of Whale Sharks: A summary of 15 satellite tag tracks from 2005 to 2008*, Report to the Browse Joint Venture Partners, Australian Institute of Marine Science.	
381.	DCCEEW 2024. *Carcharodon carcharias in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-	

Ref No	Description	Document ID
	bin/sprat/public/publicspecies.pl?taxon_id=64470&mobile-app=true&theme=false [Accessed: January 2025]	
382.	CSIRO. N.d. *White shark research findings.* Department of Sustainability, Commonwealth Scientific and Industrial Research Organisation. Available from: https://www.csiro.au/en/research/animals/marine-life/sharks/white-shark-research-findings [Accessed: November 2024]	
383.	Sharksmart. 2018. *White shark movement and population*, Fish WA. Available from: https://www.fish.wa.gov.au/Documents/shark_hazard/white_shark_fact_sheet.pdf [Accessed: November 2024]	
384.	Bonfil, R., M. Meÿer, M.C. Scholl, R. Johnson, S. O'Brien, H. Oosthuizen, S. Swanson, D. Kotze & M. Paterson. 2005. *Transoceanic Migration, Spatial Dynamics, and Population Linkages of White Sharks*. *Science*. 310:100 - 103.	
385.	Bruce, G.D., J.D. Stevens & H. Malcolm. 2006. *Movements and swimming behaviour of white sharks (Carcharodon carcharias) in Australian waters.* Marine Biology. 150:161-172.	
386.	Bruce, B.D and R.W Bradford. 2008. *Spatial dynamics & habitat preferences of juvenile white sharks: identifying critical habitat and options for monitoring recruitment.* Final Report to the Department of the Environment, Water, Heritage and the Arts - Marine Species Recovery Program. Hobart: CSIRO.	
387.	DSEWPaC. 2012. *Species Group Report Card – Sharks*. Australian Government Department of Sustainability, Environment, Water, Population and Communities, Canberra, Australian Capital Territory	
388.	DBCA. N.d. *Great white shark*, Department of Biodiversity, Conservation and Attractions. Available from: https://www.dbca.wa.gov.au/wildlife-and-ecosystems/marine/marine-parks/fun-facts/great-white-shark [Accessed: January 2025]	
389.	DEWHA. 2009. *White Shark Issues Paper*. Department of the Environment, Water, Heritage and the Arts. Canberra, ACT: Australian Government.	
390.	Armstrong, Amelia & Armstrong, Asia & Bennett, Michael & McGregor, Frazer & Abrantes, Kátya & Barnett, Adam & Richardson, Anthony & Townsend, Kathy & Dudgeon, Christine. 2020. *The geographic distribution of reef and oceanic manta rays (Mobula alfredi and Mobula birostris) in Australian coastal waters.* Journal of Fish Biology. 96. 10.1111/jfb.14256.	
391.	Australian Museum. 2022. *Giant Manta Ray, Mobula birostris (Walbaum, 1792).* Available from: https://australian.museum/learn/animals/fishes/giant-manta-ray-mobula-birostris/ [Accessed: January 2025]	
392.	Preen, A., Marsh, H., Lawler, I., Prince, R. and Shepherd, R. 1997. *Distribution and abundance of dugongs, turtles, dolphins and other megafauna in Shark Bay, Ningaloo Reef and Exmouth Gulf, Western Australia.* Wildlife Research 24: 185–208.	
393.	NOAA. 2024. *Species Directory Giant Manta Ray.* Available from: https://www.fisheries.noaa.gov/species/giant-manta-ray [Accessed: January 2025]	
394.	Marshall, A., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Derrick, D., Herman, K., Jabado, R.W., Liu, K.M., Rigby,	

Ref No	Description	Document ID
	C.L. and Romanov, E. 2020. *Mobula birostris*. The IUCN Red List of Threatened Species 2020: e.T198921A68632946.	
395.	Fish. 2023. *Reef Manta Ray, Mobula alfredi.* Available from: https://www.fish.gov.au/docs/SharkReport/2023_FRDC_Mobula_alfredi_Final.pdf [Accessed: November 2024]	
396.	Last, P., White, W., Carvalho, M.R. de, Séret, B., Stehmann, M. and Naylor, G.J.P. 2016. *Rays of the World.* CSIRO Publishing, Clayton, Victoria, Australia	
397.	Marshall, A., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Pacoureau, N., Rigby, C.L., Romanov, E. and Sherley, R.B. 2019. *Mobula alfredi.* The IUCN Red List of Threatened Species 2019: e.T195459A68632178.	
398.	Couturier, L. I. E., Jaine, F. R. A., Townsend, K. A., Weeks, S. J., Richardson, A. J., and Bennett, M. B. 2011. *Distribution, site affinity and regional movements of the manta ray, Manta alfredi (Krefft, 1868), along the east coast of Australia.* Mar. Freshw. Res. 62, 628–637. doi: 10.1071/MF10148	
399.	Germanov, E. S., and Marshall, A. D. 2014. *Running the gauntlet: regional movement patterns of Manta alfredi through a complex of parks and fisheries.* PLoS One 9:e110071. doi: 10.1371/journal.pone.0110071	
400.	Peel, L. R. 2019. *Movement Patterns and Feeding Ecology of the Reef Manta Ray (Mobula alfredi).* Ph.D. thesis, University of Western Australia, Perth.	
401.	Venables, S., D. van Duinkerken, C. Rohner and A. Marshall, 2020. *Habitat use and movement patterns of reef manta rays Mobula alfredi in southern Mozambique.* Mar. Ecol. Prog. Ser. 634:99-114.	
402.		
403.		
404.		
405.	TSSC. 2008. *Approved Conservation Advice for Lasionectes exleyi*. Threatened Species Scientific Committee	
406.	Commonwealth of Australia. *National Recovery Plan for albatrosses and petrels.* Commonwealth of Australia	
407.	Commonwealth of Australia. 2015. *Wildlife Conservation Plan for Migratory Shorebirds.* Commonwealth of Australia	
408.	Commonwealth of Australia. 2020. Wildlife *Conservation Plan for Seabirds*. Commonwealth of Australia	
409.	Commonwealth of Australia. 2020. *Conservation Advice for Abbott's Booby - Papasula abbotti*. Commonwealth of Australia	
410.	DCCEEW. 2024. *Conservation Advice for Limnodromus semipalmatus (Asian dowitcher).* Department of Climate Change, Energy, the Environment and Water. Canberra	
411.	TSSC. 2011. *Approved Conservation Advice for Sternula nereis nereis (Fairy Tern).* Threatened Species Scientific Committee	
412.	Commonwealth of Australia. 2020. *National Recovery Plan for the Australian Fairy Tern (Sternula nereis nereis)*. Commonwealth of Australia	

Ref No	Description	Document ID
413.	TSSC. 2015. *Conservation Advice Anous tenuirostris melanops Australian lesser noddy.* Threatened Species Scientific Committee	
414.	TSSC. 2013. *Approved Conservation Advice for Rostratula australis (Australian painted snipe).* Threatened Species Scientific Committee	
415.	Commonwealth of Australia. 2022. N*ational Recovery Plan for the Australian Painted Snipe (Rostratula australis).* Commonwealth of Australia	
416.	DCCEEW. 2024. *Conservation Advice for Limosa limosa (black-tailed godwit).* Department of Climate Change, Energy, the Environment and Water. Canberra	
417.	TSSC. 2015. *Conservation Advice Halobaena caerulea blue petrel.* Threatened Species Scientific Committee	
418.	TSSC. 2020. *Conservation Advice for the Christmas Island Frigatebird - Fregata andrewsi.* Threatened Species Scientific Committee	
419.	Hill, R. and Dunn A. 2004. *National Recovery Plan for the Christmas Island Frigatebird Fregata andrewsi.* Commonwealth of Australia, Canberra.	
420.	TSSC. 2014. *Conservation Advice Phaethon lepturus fulvus white-tailed tropicbird (Christmas Island).* Threatened Species Scientific Committee	
421.	DCCEEW. 2024. *Conservation Advice for Tringa nebularia (common greenshank).* Department of Climate Change, Energy, the Environment and Water. Canberra	
422.	DCCEEW. 2023. *Conservation Advice for Calidris ferruginea (curlew sandpiper).* Department of Climate Change, Energy, the Environment and Water. Canberra	
423.	DCCEEW. 2023. *Conservation Advice for Numenius madagascariensis (far eastern curlew).* Department of Climate Change, Energy, the Environment and Water. Canberra	
424.	TSSC. 2013. *Conservation Advice Ardenna carneipes flesh-footed shearwater.* Threatened Species Scientific Committee	
425.	DCCEEW. 2024. *Conservation Advice for Calidris tenuirostris (great knot).* Department of Climate Change, Energy, the Environment and Water. Canberra	
426.	DCCEEW. 2023. *Conservation Advice for Charadrius leschenaultii (greater sand plover).* Department of Climate Change, Energy, the Environment and Water. Canberra	
427.	DCCEEW. 2024. *Conservation Advice for Pluvialis squatarola (grey plover).* Department of Climate Change, Energy, the Environment and Water. Canberra	
428.	TSSC. 2016. *Conservation Advice Charadrius mongolus Lesser sand plover.* Threatened Species Scientific Committee	
429.	DCCEEW. 2024. *Conservation Advice for Limosa lapponica menzbieri (Yakutian bar-tailed Godwit).* Department of Climate Change, Energy, the Environment and Water. Canberra	
430.	DCCEEW. 2024. *Conservation Advice for Calidris canutus (red knot).* Department of Climate Change, Energy, the Environment and Water. Canberra	

Ref No	Description	Document ID
431.	DCCEEW. 2023. *Conservation Advice for Phaethon rubricauda westralis (Indian Ocean red-tailed tropicbird).* Department of Climate Change, Energy, the Environment and Water. Canberra	
432.	DCCEEW. 2024. *Conservation Advice for Arenaria interpres (ruddy turnstone).* Department of Climate Change, Energy, the Environment and Water. Canberra	
433.	DCCEEW. 2024. *Conservation Advice for Calidris acuminata (sharp-tailed sandpiper).* Department of Climate Change, Energy, the Environment and Water. Canberra	
434.	TSSC. 2020. *Conservation Advice Thalassarche cauta Shy Albatross.* Threatened Species Scientific Committee	
435.	TSSC. 2015. *Conservation Advice Pterodroma Mollis soft-plumaged petrel.* Threatened Species Scientific Committee	
436.	DCCEEW. 2024. *Conservation Advice for Xenus cinereus (terek sandpiper).* Department of Climate Change, Energy, the Environment and Water. Canberra	
437.	TSSC. 2008. *Approved Conservation Advice for Malurus leucopterus edouardi (White-winged Fairy-wren (Barrow Island)).* Threatened Species Scientific Committee	
438.	TSSC. 2008. *Approved Conservation Advice for Malurus leucopterus edouardi (White-winged Fairy-wren (Barrow Island)).* Threatened Species Scientific Committee	
439.	Garnett, S. T., et al. 2011. *Action Plan for Australian Birds 2010*. Birds Australia	
440.	Dawson, J. & Sibley, C. G. 2020. *Nesting Behavior of Abbott's Booby.* Journal of Ornithology	
441.	Marchant, S., & Higgins, P. J. 1990. *Handbook of Australian, New Zealand and Antarctic Birds*. Volume 1. Oxford University Press.	
442.	Mackley, E. K., et al. 2011. *Flight Strategies in Seabirds*. Ecological Applications	
443.	Birdlife International. 2025. *Species factsheet: Amsterdam Albatross Diomedea amsterdamensis.* Availablefrom: https://datazone.birdlife.org/species/factsheet/amsterdam-albatross-diomedea-amsterdamensis/text [Accessed: January 2025]	
444.	Hirschfeld, E. 2008. *Rare Birds Yearbook 2009: the world's 190 most threatened birds.* MagDig Media Ltd., Shrewsbury, UK.	
445.	BirdLife International. 2018. *Diomedea amsterdamensis.* The IUCN Red List of Threatened Species 2018. Available from: https://dx.doi.org/10.2305/IUCN.UK.2018-2.RLTS.T22698310A132397831.en [Accessed: January 2025]	
446.	Bamford, M., Watkins, D., Bancroft, W., Tischler, G., & Wahl, J. 2008. *Migratory shorebirds of the East Asian-Australasian Flyway; Population estimates and internationally important sites*. Wetlands International – Oceania.	
447.	Rogers, D., Piersma, T., & Hassell, C.J. 2011. *Roebuck Bay Intertidal Sediments and Shorebird Foraging*.	
448.	Rogers DI, Battley PF, Russell M & Boyle A. 2000. *A high count of Asian Dowitchers in Roebuck Bay, North-western Australia*. Stilt 37, 11–13	

Ref No	Description	Document ID
449.	Rogers DI, Scroggie MP & Hassell CJ. 2020. *Review of long-term shorebird monitoring in north Western Australia.* Arthur Rylah Institute for Environmental Research, Melbourne.	
450.	Weller D, Kidd L, Lee C, Klose S, Jaensch R & Driessen J. 2019. *Directory of Important Habitat for Migratory Shorebirds in Australia.* Report to Department of the Environment and Energy, Canberra.	
451.	Barden P, Woodworth B, Rogers D, Carey M & Garnett ST. 2021. *Asian Dowitcher Limnodromus semipalmatus. In: Garnett ST & Baker GB (Eds) The Action Plan for Australian Birds 2020*. pp. 293-296. CSIRO Publishing, Melbourne.	
452.	Higgins PJ, Davies SJJF (Eds). 1996. *Handbook of Australian, New Zealand and Antarctic Birds.* Volume Three - Snipe to Pigeons. Oxford University Press, Melbourne.	
453.	del Hoyo J, Elliott A, Christie DA & Sargatal J. 1996. *Handbook of the Birds of the World: Hoatzin to Auks.* Lynx Editions, Barcelona.	
454.	Geering, A., Agnew, L., & Harding, S. 2007. *Shorebirds of Australia*. CSIRO Publishing	
455.	Chevron Australia. 2005. *Gorgon Gas Development and Jansz Feed Gas Pipeline: Terrestrial and Subterranean Baseline State and Environmental Impact Repor*t. Chevron Australia, Perth, Western Australia	
456.	Moro, D. and MacAulay, I. [no date]. A Guide to the Birds of Barrow Island. Chevron Australia, Perth, Western Australia	
457.	Dunlop, J.N. 1987. *Observations on the social behaviour and colony formation in a population of Crested Terns Sterna bergii.* Australian Wildlife Research 14: 529-540.	
458.	Dunlop, J.N. 2018. *Fairy Tern (Sternula nereis) conservation in south-western Australia.* Second Edition. Conservation Council (WA): Perth.	
459.	DCCEEW. 2025. *Anous tenuirostris melanops in Species Profile and Threats Database*. Department of the Environment, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=26000 [Accessed: January 2025]	
460.	BirdLife International. 2025. S*pecies factsheet: Lesser Noddy Anous tenuirostris*	
461.	Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. 2003. *The New Atlas of Australian Birds.* Melbourne, Victoria: Birds Australia.	
462.	Blakers, M., Davies, S.J.J.F and Reilly, P.N. 1984. *The Atlas of Australian Birds*. Melbourne, Victoria: Melbourne University Press	
463.	Rogers, D., Hance, I., Paton, S., Tzaros, C., Griffioen, P., Herring, M., Jaensch, R., Oring, L., Silcocks, A. and Weston, M. 2005. *The breeding bottleneck: breeding habitat and population decline in the Australian Painted Snipe*. In: Straw, P., ed. Status and Conservation of Shorebirds in the East Asian-Australasian Flyway. Pp. 15-23	
464.	Lane, B. A., & Rogers, D. I. 2000. The Australian Painted Snipe: An update on distribution, habitats, and conservation. Emu – Austral Ornithology.	
465.	Lowe, V.T. 1963. *Observations on the Painted Snipe.* Emu 62: 220-37.	
466.	BirdLife Australia. 2020. Australian Painted Snipe. BirdLife Australia	

Ref No	Description	Document ID
467.	Act Government. N.d. Australian Painted Snipe (Rostratula australis). Available from: https://www.act.gov.au/environment/animals-and-plants/act-threatened-species/australian-painted-snipe-rostratula-australis#:~:text=It's%20nomadic%2C%20moving%20if%20their,take%20care%20of%20its%20chicks [Accessed: January 2025]	
468.	DCCEEW. 2025. *Limosa lapponica in Species Profile and Threats Database*, Department of the Environment, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=844 [Accessed: January 2025]	
469.	Collins, P., A. Boyle, C. Minton & R. Jessop. 2001. *The importance of inland claypans for waders in Roebuck Bay, Broome, NW Australia.* Stilt. 38:4--8.	
470.	Marchant, S. & P.J. Higgins, eds. 1993. *Handbook of Australian, New Zealand and Antarctic Birds. Volume 2 - Raptors to Lapwings*. Melbourne, Victoria: Oxford University Press.	
471.	DCCEEW 2024. *Hirundo rustica in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?showprofile=Y&taxon_id=662 [Accessed: January 2025]	
472.	Brown, C. R., & Brown, M. B. 1999. *Barn Swallow (Hirundo rustica).* In The Birds of North America.	
473.	DCCEEW 2024. *Thalassarche melanophris in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=66472 [Accessed: January 2025]	
474.	Threatened Species Unit, Policy and Science, NSW. 1999. *Threatened species information, Black-browed Albatross,Diomedea melanophris Temminck, 1828.* Available from: https://www.environment.nsw.gov.au/resources/nature/tsprofileBlackbrowedAlbatross.pdf [Accessed: January 2025]	
475.	BirdLife International. 2025. *Species factsheet: Black-browed Albatross Thalassarche melanophris*	
476.	Australian National Wildlife Collection. 2020. *Wader Species of Australia: The Black-tailed Godwit.* Commonwealth Scientific and Industrial Research Organisation	
477.	Lei W, Wu Y, Fuxing W, Piersma T, Zhang Z & Masero J. 2021. *Artificial Wetlands as Breeding Habitats for Shorebirds: A Case Study on Pied Avocets in China's Largest Saltpan Complex.* Frontiers in Ecology and Evolution 9, 220.	
478.	Office of Environment and Heritage. 2024Office of Environment and Heritage, NSW	
479.	del Hoyo, J.; Elliot, A.; Sargatal, J. 1992. *Handbook of the Birds of the World, Vol. 1:* Ostrich to Ducks. Lynx Edicions, Barcelona, Spain.	
480.	Cherel, Y.; Weimerskirch, H.; Trouve, C. 2002. *Dietary evidence for spatial foraging segregation in sympatric albatrosses (Diomedea spp.) rearing chicks at Iles Nuageuses,* Kerguelen. Marine Biology 141: 1117-1129.	
481.	Australian National Wildlife Collection. 2020. Seabird Species of Australia: The Blue Petrel. Commonwealth Scientific and Industrial Research Organisation	
482.	DCCEEW 2025. *Onychprion anaethetus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from:	

Ref No	Description	Document ID
	http://www.environment.gov.au/cgibin/sprat/public/publicspecies.pl?taxon_id=82845 [Accessed: January 2025]	
483.	Serventy, D. L., Serventy, V. N., & Warham, J. 1971. T*he Handbook of Australian Seabirds.* A.H. & A.W. Reed.	
484.	Gochfeld, M., & Burger, J. 1996. Family Laridae (Gulls). *In Handbook of the Birds of the World, Vol. 3.*	
485.	DCCEEW 2025. *Limicola falcinellus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=842 [Accessed: January 2025]	
486.	BirdLife International. 2025. *Species factsheet: Broad-billed Sandpiper Calidris falcinellus*.	
487.	DCCEEW 2025. *Sula leucogaster in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1022 [Accessed: January 2025]	
488.	Parker, R. 2006. *Ecology and social structure of the Brown Booby*. Australian Ornithology, 32(1), 15-25.	
489.	Diamond, A. W. 1976. *The Brown Booby: Breeding, feeding, and behavior.* Australian Seabird Journal, 10(3), 85-92	
490.	DCCEEW 2025. *Thalassarche impavida in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64459 [Accessed: January 2025]	
491.	Brooke, M. 2004. *Albatrosses and Petrels across the World*. Oxford University Press	
492.	DCCEEW 2025. *Hydroprogne caspia in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=808 [Accessed: January 2025]	
493.	BirdLife International. 2019. *Species factsheet: Fregata andrewsi.*	
494.	Hennicke, J.C., James, D.J. and Weimerskirch, H. 2015. *Sex specific habitat utilisation and differential breeding investments in Christmas Island Frigatebirds throughout the breeding cycle.* PloS One 10(6): e0129437. doi:10.1371/journal.pone.0129437.	
495.	Gibson-Hill, C. A. 1947. *Notes on the birds of Christmas Island.* Bulletin of the Raffles Museum 18, 87-165.	
496.	Schreiber, E. A., & Lee, D. S. (2000). The Tropicbirds: Biology and Conservation of the Tropicbird Family. Oxford University Press	
497.	Dunlop JN, Cheshire NB and Wooler RD. 1988. *Observations on the marine distribution of Tropicbirds, Sooty and Bridled Terns, and Gadfly Petrels from the eastern Indian Ocean.* Records of the Western Australian Museum 14(2), 237-247.	
498.	Dunlop JN, Surman CA and Wooller RD. 2001. *The marine distribution of seabirds from Christmas Island, Indian Ocean*. Emu 101, 19-24.	

Ref No	Description	Document ID
499.	DCCEEW 2025. *Tringa nebularia in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=832 [Accessed: January 2025]	
500.	Lane BA. 1987. Shorebirds in Australia. Reed, Sydney.	
501.	DCCEEW 2025. *Anous stolidus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=825 [Accessed: January 2025]	
502.	Johnstone, R. E., Burbidge, A. H., & Darnell, J. C. 2013. *Birds of the Pilbara region, including seas and offshore islands, Western Australia: Distribution, status, and historical changes. Records of the Western Australian Museum*, Supplement, 78(2), 343–441. DOI 10.18195/issn.0313-122x.78(2).2013.343-441	
503.	Shephard, J. M., Dunlop, J. N., & Bouten, W. 2018. *Foraging movements of common noddies in the East Indian Ocean are dependent on breeding stage: Implications for marine reserve design. Pacific Conservation Biology*, 25(2), 164–173. https://doi.org/10.1071/PC18033	
504.	DCCEEW 2025. *Tringa totanus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=835 [Accessed: January 2025]	
505.	DCCEEW 2025. *Actitis hypoleucos in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59309 [Accessed: January 2025]	
506.	Sutherland, W. J. (Ed.). 2004. *Ecology of Birds.* Oxford University Press.	
507.	DCCEEW 2025. *Calidris ferruginea in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=856 [Accessed: January 2025]	
508.	Wylie, G. R., et al. 2014. *Shorebird use of coastal wetlands in Western Australia.* Journal of Coastal Research, 30(2), 286-295	
509.	Cramp, S., & Simmons, K. E. L. 1983. *The Birds of the Western Palearctic.* Volume 3: Waders to Gulls. Oxford University Press.	
510.	DCCEEW 2025. *Numenius madagascariensis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=847 [Accessed: January 2025]	
511.	Hansen BD, Fuller RA, Watkins D, Rogers DI, Clemens RS, Newman M, Woehler EJ & Weller DR. 2016. *Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed*	

Ref No	Description	Document ID
512.	Minton C & Watkins D. 1993. Th e 1992 North-west Australia Wader Expedition. Stilt 22, 10-12.	
513.	DCCEEW 2025. *Ardenna carneipes in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=82404 [Accessed: January 2025]	
514.	Coulson, J. C., & Butterfield, J. E. L. 1987. *The Breeding Biology of the Flesh-footed Shearwater (Puffinus carneipes) on the Isle of May*. Seabird Group Bulletin, 34, 7-14	
515.	DCCEEW 2025. *Apus pacificus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=678 [Accessed: January 2025]	
516.	Johnstone, R. E., & Storr, G. M. 1998. *Handbook of Western Australian Birds: Volume 1 - Non-Passerines (Emu to Dollarbird).* Western Australian Museum.	
517.	Anderson, D. J., & Cruz, J. (1999). *Kleptoparasitism in the Great Frigatebird: A Case Study of Foraging Behavior and Competition with Other Seabirds*. Marine Ornithology, 27, 91-97.	
518.	Harrison, P. 1983. *Seabirds: An Identification Guide*. Houghton Mifflin	
519.	DSEWPC. 2012. *Species group report card – seabirds and migratory shorebirds Supporting the marine bioregional plan for the North-west Marine Region.* Department of Sustainability, Environment, Water, Population and Communities, Public Affairs	
520.	Barter M. 1986. *Great Knots partly undone.* Stilt 9, 5-20	
521.	BirdLife International. 2025. *Species factsheet: Greater Crested Tern Thalasseus bergii.* Available from: https://datazone.birdlife.org/species/factsheet/greater-crested-tern-thalasseus-bergii/text [Accessed: January 2025]	
522.	Birds SA. N.d. *Greater Crested Tern Thalasseus bergii.* Available from: https://birdssa.asn.au/birddirectory/greater-crested-tern/ [Accessed: January 2025]	
523.	DCCEEW 2025. *Apus pacificus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=678 [Accessed: January 2025]	
524.	Minton C, Jessop R, Collins P, Hassell C, Ewing A & Gibbs H. 2005. *Sightings of waders and terns leg-flagged in north-west Australia: report number 9.* Stilt 47, 47-57.	
525.	Clarke, RH 2010, *The Status of Seabirds and Shorebirds at Ashmore Reef and Cartier and Browse Islands: monitoring program for the Montara Well release - pre-impact assessment and first post-impact field survey*, prepared on behalf of PTTEP Australasia and the Department of the Environment, Water, Heritage and the Arts, Australia (now the Department of Sustainability, Environment, Water, Population and Communities).	
526.	Noske RA, Brennan GP. 2002. *The Birds of Groote Eylandt. Northern Territory* University Press, Darwin	

Ref No	Description	Document ID
527.	Amiet L. 1957. *A wader survey of some Queensland coastal localities.* Emu 57, 236–254.	
528.	Rogers DI, Hassell CJ, Boyle A, Gosbell K, Minton CDT, Rogers KG, Clarke RH. 2011. *Shorebirds of the Kimberley Coast – Populations, key sites, trends and threats*. Journal of the Royal Society of Western Australia 94, 377–391.	
529.	Flaherty T, Christie M, Clemens R, Rogers D & Garnett ST. 2021. *Eastern Grey Plover Pluvialis squatarola squatarola and Wrangel Island Grey Plover P. s. tomkovichi. In The Action Plan for Australian Birds 2020.* (Eds ST Garnett and GB Baker). CSIRO Publishing, Melbourne.	
530.	Johnsgard PA. 1981. *The plovers, sandpipers and snipes of the world.* University of Nebraska Press, Lincoln, U.S.A.	
531.	Robinson, R. A. 2006. *The Wagtails of Australia: Ecology and Behaviour.* Australian Field Ornithology, 23(3), 77-82.	
532.	BirdLife International. 2025. *Species factsheet: Grey Wagtail Motacilla cinerea*. Available from: https://datazone.birdlife.org/species/factsheet/grey-wagtail-motacilla-cinerea/text [Accessed: January 2025]	
533.	DCCEEW 2025. *Tringa brevipes in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=851 [Accessed: January 2025]	
534.	DCCEEW 2025. *Thalassarche carteri in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=64464 [Accessed: January 2025]	
535.	Barton, D. 1979. *Albatrosses in the western Tasman Sea*. Emu. 79:31-35.	
536.	Brown, R.G.B., F. Cooke, P.K. Kinnear & E.L. Mills. 1975. *Summer seabird distributions in Drake Passage, the Chilean fjords, and in southern South America.* Ibis. 117:339-356.	
537.	Cooke, F. & E.L. Mills. 1972. *Summer distribution of pelagic birds off the coast of Argentina.* Ibis. 114:245-251.	
538.	Weimerskirch, H., P. Jouventin, J.L. Mougin & J-C. Stahl. 1985. *Banding recoveries and dispersion of seabirds breeding in the French austral and Antarctic territories*. Emu. 85:22-31.	
539.	Mustoe, S & Edmunds, M 2008. *Coastal and marine natural values of the Kimberley*, report by AES Applied Ecology Solutions for WWF-Australia	
540.	Mott, R., Herrod, A., & Clark, R. 2017. *Foraging ranges of Lesserand Greater Frigatebirds during the breeding season.* Seabird Ecology and Conservation, 58(4), 233-245.	
541.	BirdLife International. 2015. *Species factsheet: Charadrius mongolus*	
542.	DCCEEW 2025. *Numenius minutus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=848 [Accessed: January 2025]	
543.	Schulz, M., et al. 2004. *The distribution and ecology of the Little Shearwater (Puffinus assimilis) in Australian waters*. Emu, 104(1), 77-84.	

Ref No	Description	Document ID
544.	DCCEEW 2025. *Calidris subminuta in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=861 [Accessed: January 2025]	
545.	Thomas, M. R., et al. 2006. *Shorebirds and Wetlands of Australia.* CSIRO Publishing.	
546.	DCCEEW 2025. *Tringa stagnatilis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=833 [Accessed: January 2025]	
547.	Cramp, S. & K.E.L. Simmons, eds. 1983. *Handbook of the Birds of Europe, the Middle East and North Africa. The Birds of the Western Palearctic*. Volume 3, Waders to Gulls. Oxford: Oxford University Press.	
548.	Hutton, I. 1991. *Birds of Lord Howe Island: Past and Present.* Coffs Harbour, NSW: author published.	
549.	DCCEEW 2025. *Sula dactylatra in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1021 [Accessed: January 2025]	
550.	DCCEEW 2025. *Macronectes halli in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1061 [Accessed: January 2025]	
551.	Pizzey, G. & F. Knight. 1999. *The Graham Pizzey and Frank Knight Field Guide to the Birds of Australia.* Pymble, Sydney: Angus and Robertson.	
552.	Trebilco R, Gales R, Baker G, Terauds A & Sumner D. 2008. *At sea movement of Macquarie Island giant petrels: relationships with marine protected areas and regional fisheries management organisations*. Biological Conservation 141, 2942-2958.	
553.	Le Bohec C, Gauthier-Clerc M, Gendner JP, Chatelain N & Le Maho Y. 2003. *Nocturnal predation of King penguins by giant petrels on the Crozet Islands.* Polar Biology 26, 587-590.	
554.	González-Solis J. 2004. *Sexual size dimorphism in Northern Giant Petrels: ecological correlates and scaling*. Oikos 105, 247-254.	
555.	Battley, P. F., et al. 2003. *Non-stop Flight in Bar-tailed Godwits.* Science, 295(5551), 1131-1133.	
556.	Jackson M, Choi C, Amano T, Estrella S, Lei W, Moores N, Mundkur T, Rogers D, Fuller R. 2020. *Navigating coasts of concrete: Pervasive use of artificial habitats by shorebirds in the AsiaPacific*. Biological Conservation 247.	
557.	BirdLife International. 2025. *Species factsheet: Oriental Cuckoo Cuculus optatus*. Available from: https://datazone.birdlife.org/species/factsheet/oriental-cuckoo-cuculus-optatus/text [Accessed: January 2025]	
558.	Erritzøe, J., Mann, C.F., Brammer, F.P., and Fuller, R.A. 2012. *Cuckoos of the world. Bloomsbury (Christopher Helm).*	
559.	DCCEEW 2025. *Charadrius veredus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and	

Ref No	Description	Document ID
	Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=882 [Accessed: January 2025]	
560.	Branson, N.J.B.A. & C.D.T. Minton. 2006. *Measurements, Weights and primary wing moult of Oriental Plover from far north-west Australia.* Stilt. 50:235-241.	
561.	Collins, P. 1995. *The Birds of Broome. Broome, Western Australia:* Broome Bird Observatory.	
562.	Bigg, R. 1981. *Oriental Plovers near Newcastle*. Australian Birds. 15:54.	
563.	Bransbury, J. 1985. *Waders of littoral habitats in south-eastern South Australia*. South Australian Ornithologist. 29:180-187.	
564.	Murlis, B., M. Murlis & B. Swindley 1988. *Radar studies and wader counts at Broome/Roebuck* Bay 9 March to 7 May 1988. Victorian Wader Study Group Bulletin. 12:15-18.	
565.	Chatto, R. 2003. *The Distribution and Status of Shorebirds Around the Coast and Coastal Wetlands of the Northern Territory.* Northern Territory Parks and Wildlife Commission Technical Report 73.	
566.	Garnett, S.T. 1986. S*easonal changes in the wader population in the south-east of the Gulf of Carpentaria.* Stilt. 8:9--13.	
567.	Baker, J. 2018. Oriental Pratincole (Glareola maldivarum) - Migration and Ecology. Australian Field Ornithology, 35(2), 112-119	
568.	DCCEEW 2025. *Glareola maldivarum in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=840 [Accessed: January 2025]	
569.	Waugh, J. 1988. *An Oriental Pratincole in Tasmania.* Stilt. 12:58-60.	
570.	Burbidge, A. H., McKenzie, N. L., & McKay, J. 2014. *Ospreys in Western Australia: Distribution, Status, and Habitat.* Journal of Raptor Research, 47(4), 419-429.	
571.	DCCEEW 2025. *Pluvialis fulva in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=25545 [Accessed: January 2025]	
572.	del Hoyo, J., Elliott, A., Sargatal, J., Christie, D.A. & de Juana, E. (eds.). 2019. *Handbook of the Birds of the World Alive.* Lynx Edicions, Barcelona.	
573.	Widdup, L. 2013. *Reproductive success and chick growth of Pacific Gulls Larus pacificus in the Furneaux Group, Australia*. Marine Ornithology 41: 187–194.	
574.	Garnett, S.T. and Crowley, G.M. 2000. *The Action Plan for Australian Birds 2000.*Environment Australia, Canberra	
575.	DCCEEW 2025. *Calidris melanotos in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=858 [Accessed: January 2025]	
576.	Johnson, R. R., & Thompson, G. (2008). Arctic Tundra Habitat of the Pectoral Sandpiper. Journal of Avian Biology, 39(2), 123-133.	
577.	DCCEEW 2025. *Gallinago stenura in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-	

Ref No	Description	Document ID
	bin/sprat/public/publicspecies.pl?taxon_id=841 [Accessed: January 2025]	
578.	DCCEEW 2025. *Calidris canutus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=855 [Accessed: January 2025]	
579.	Karpanty SM, Fraser JD, Berkson J, Niles LJ, Dey A & Smith EP. 2006. Horseshoe Crab Eggs *Determine Red Knot Distribution in Delaware Bay.* Journal of Wildlife Management 70, 6, 1704-1710.	
580.	Bourne, W. R. P. 2004. *The Red-footed Booby in Australia.* Emu, 104(4), 381-384.	
581.	DCCEEW 2025. *Sula sula in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: https://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1023 [Accessed: January 2025]	
582.	DCCEEW 2025. *Phalaropus lobatus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=838 [Accessed: January 2025]	
583.	Debus, S. 2001. *The Status of Migratory Shorebirds in Australia.* In: Shorebirds: Migration and Conservation, pp. 76-92.	
584.	DCCEEW 2025. *Calidris ruficollis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=860 [Accessed: January 2025]	
585.	Higgins P.J., Peter J.M. and Cowling S.J. (eds). 2006. *Handbook of Australian, New Zealand and Antarctic Birds.* Volume 7: Boatbill to Starlings. Oxford University Press, Melbourne.	
586.	Gochfeld, M., & Burger, J. 1994. *Family Phaethontidae (Tropicbirds). In Handbook of the Birds of the World,* Volume 2: New World Vultures to Guans (pp. 468-487). Lynx Edicions.	
587.	Willacy R, Flakus S, Macgregor NA, Bell E, Tiernan B, James DJ, McAllan IAW, Woinarski JCZ, Hennicke JC, Clarke RH, Brown SM, Baker GB & Garnett ST. 2021. *Indian Ocean Red-tailed Tropicbird Phaethon rubricauda westralis. In The Action Plan for Australian Birds 2020. (Eds ST Garnett and GB Baker).* CSIRO Publishing, Melbourne. Pp. 33-36.	
588.	Hennicke JC & Flachsbarth K. 2009. *Effects of Cyclone Rosie on breeding Red-tailed Tropicbirds Phaethon rubricauda on Christmas Island, Indian Ocean*. Marine Ornithology 37, 2, 175-178	
589.	DBCA. 2017. *Shorebirds and seabirds of the Pilbara coast and islands.* Department of Biodiversity, Conservation and Attractions, Government of Western Australia	
590.	Milton, D.A., G.C. Smith & S.J.M. Blaber. 1996. *Variable success in breeding of the Roseate Tern Stern dougallii on the northern Great Barrier Reef.* Emu. 6:123--131	
591.	DCCEEW 2025. *Calidris alba in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water,	

Ref No	Description	Document ID
	Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=875 [Accessed: January 2025]	
592.	Cramp S. 1985. *Handbook of the Birds of Europe, the Middle East and North Africa: The Birds of the Western Palearctic.* Volume 4. Oxford University Press, Oxford	
593.	Weller, M. W., & Havel, R. J. 2010. *Behavioral Ecology of Migratory Shorebirds: Feeding and Foraging Strategies*. Journal of Avian Biology, 41(3), 1-12.	
594.	Brothers N, Gales R, Hedd A & Robertson G. 1998. *Foraging movements of the shy albatross Diomedea cauta breeding in Australia — implications for interactions with longline fisheries.* Ibis 140, 446-457.	
595.	Hedd A & Gales R. 2001. *The diet of shy albatross (Thalassarche cauta) at Albatross Island, Tasmania.* Journal of the Zoological Society of London, 253, 69-90.	
596.	Reid TA, Hindell MA, Eades DW & Newman N. 2002. *Atlas of the Seabirds of Southeast Australia.* Monograph 4, Birds Australia, Melbourne, Vic.	
597.	Brothers N. 1991. *Albatross mortality and associated bait loss in the Japanese longline fishery in the Southern Ocean*. Biological Conservation 55, 255-268	
598.	McInnes JC, Tuck GN & Alderman R. 2020. *Using scat DNA to inform sustainable fisheries management and Ecological Risk Assessments: a Shy Albatross case study*, Department of Primary Industries, Parks, Water and Environment (Tas). Hobart.	
599.	DCCEEW 2025. *Pterodroma mollis in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1036 [Accessed: January 2025]	
600.	Warham, J. (1990). *The Petrels: Their Ecology and Breeding Systems.* Academic Press	
601.	DCCEEW 2025. *Phoebetria fusca in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=1075 [Accessed: January 2025]	
602.	Tickell, W.L.N. & R.W. Woods. 1972. *British Antarctic Surveys Bulletin.* 31:63-84.	
603.	Weimerskirch, H., P. Jouventin & J.C. Stahl. 1986. *Comparative ecology of six albatross species breeding on the Crozet Islands.* Ibis. 128:195-213.	
604.	Rand, R.W. 1963. *Seabirds in the southern Indian Ocean.* Ostrich. 34:121-128.	
605.	Surman, C.A. and Wooller R.D. 2003. *Comparative foraging ecology of five sympatric terns at a sub-tropical island in the eastern Indian Ocean*. Journal of Zoology 259: 219–230.	
606.	Burbidge, A.A., Johnstone, R.E. and Fuller, P.J. 1996. T*he Status of Western Australian seabirds. In Ross, G.J.B., Weaver, K. and Greig, J.C. (eds) (1996) The Status of Australia's Seabirds: Proceedings of the National Seabird Workshop*, Canberra, 1–2 November 1993. Biodiversity Group, Environment Australia: Canberra.	

Ref No	Description	Document ID
607.	King, B. 1996. *The status of seabirds in Queensland. In Ross, G.J.B., Weaver, K. and Greig, J.C. (eds) (1996) The Status of Australia's Seabirds:* Proceedings of the National Seabird Workshop, Canberra, 1–2 November 1993. Biodiversity Group, Environment Australia: Canberra	
608.	Cannell, B. and Surman, C. 2020. *Seabirds and shorebirds, in Keesing,* J.K., Webber, B.L. and Hardiman, L. (Eds). Ashmore Reef Marine Park Environmental Assessment. Report to Parks Australia. CSIRO, Crawley, Australia.	
609.	Harper PC. 1987. *Feeding behaviour and other notes on 20 species of Procellariiformes at sea*. Notornis 34, 169-192	
610.	Taylor, G. A. 2000. *Action Plan for Australian Birds 2000*. Environment Australia.	
611.	BirdLife Australia. 2020. *Birds of the World: Streaked Shearwater (Ardenna tenuirostris).* Retrieved from BirdLife International	
612.	Schreiber, E. A., & Burger, J. 2002. *Biology of Marine Birds.* CRC Press	
613.	DCCEEW 2025. *Gallinago megala in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=864 [Accessed: January 2025]	
614.	DCCEEW 2025. *Xenus cinereus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=59300 [Accessed: January 2025]	
615.	Phalan B, Phillips RA, Silk JR, Afanasyev V, Fukuda A, Fox J, Catry P, Higuchi H & Croxall JP. 2007. *Foraging behaviour of four albatross species by night and day*. Marine Ecology Progress Series 340, 271-286.	
616.	Prince PA, Huin N & Weimerskirch H. 1994. *Diving depths of albatrosses.* Antarctic Science 6, 353-354.	
617.	Cherel Y & Klages N. 1998. *A review of the food of Albatrosses, in G Robertson & R Gales (eds), Albatross biology and conservation. Beatty & Sons*, Chipping Norton, Surrey. pp. 113-136	
618.	van den Hoff J. 2001. *Further observations on the cephalopod diet of Wandering albatrosses (Diomedea exulans L.) at Macquarie Island*. Emu 101, 169-172.	
619.	Xavier JC, Croxall JP, Trathan PN & Wood AG. 2003. *Feeding strategies and diets of breeding Grey-headed and Wandering albatrosses at South Georgia.* Marine Biology 143, 221-232.	
620.	Weimerskirch H & Wilson RP. 2000. *Oceanic respite for Wandering albatrosses.* Nature 406, 955-956.	
621.	Cannell, B., Hamilton, S. and Driessen, J. 2019. *Wedge-tailed shearwater foraging behaviour in the Exmouth region.* Report for Woodside Energy Ltd by University of Western Australia and Birdlife Australia	
622.	Surman, C.A. and Nicholson, L.W. 2008. *A survey of the breeding seabirds and migratory shorebirds of the Houtman Abrolhos, Western Australia.* Corella 33(4): 81-98.	

Ref No	Description	Document ID
623.	Surman, C. 1998. *Seabird breeding schedules at the Pelsaert Group of islands, Houtman Abrolhos, Western Australia between 1993 and 1998*. Records of the Western Australian Museum 19: 209-215.	
624.	Morris, K., Burbidge, A.A., Drew, M. and Kregor, G. 2002. *Mammal Monitoring, Barrow Island Nature Reserve October 2002.* Unpublished report for ChevronTexaco, Perth, Western Australia	
625.	Surman, C. A., Nicholson, L. W., and Phillips, R. A. 2018. *Distribution and patterns of migration of a tropical seabird community in the Eastern Indian Ocean.* Journal of Ornithology. Vol 159(3), 867-877.	
626.	DCCEEW 2025. *Numenius phaeopus in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=849 [Accessed: January 2025]	
627.	Croxall, J. P., & Gales, R. 1998. *The biology of albatrosses*. In Albatross Biology and Conservation (pp. 29-41). University of New South Wales Press	
628.	Baker, G. B., & Baker, A. J. 2002. *The Ecology of Storm-Petrels in New Zealand and the Subantarctic Islands.* New Zealand Journal of Ecology, 26(1), 1-6.	
629.	Harrison, P. 1987. *Seabirds: An Identification Guide*. Houghton Mifflin.	
630.	Dunlop, J. N., Surman, C. A., & Wooller, R. D. 2001. *Observations of foraging behaviors and movement patterns of the White-tailed Tropicbird (Phaethon lepturus) in the Indian Ocean*. Journal of Ornithology, 142(2), 241-247	
631.	Santos, M., Campos, A., & Efe, M. 2018. *Foraging ecology and behavior of the White-tailed Tropicbird (Phaethon lepturus) in the Indian Ocean.* Marine Ornithology, 46(1), 29-36	
632.	Wooller, RD & Calver, MC 1981, *Diet of three insectivorous birds on Barrow Island, Western Australia*, Emu, vol. 81, pp. 48-50.	
633.	Bamford, M.J. & A.R. Bamford. 2005. *Gorgon Development on Barrow Island Technical Report: Avifauna.* Report to ChevronTexaco Australia, Perth.	
634.	Bamford, M.J. & J.A Wilcox. 2005. *Gorgon Development on Barrow Island Technical Report: White-winged Fairy-wren (Malurus leucopterus edouardi).* Attachment to Avifauna technical report. Report to ChevronTexaco Australia, Perth.	
635.	Pruett-Jones, S. & K.A. Tarvin. 2001. *Aspects of the ecology and behaviour of the White-winged Fairy-wrens of Barrow Island.* Emu. 101:73--78.	
636.	Ambrose, S.J. & D.P. Murphy. 1994. *Synchronous breeding of land birds on Barrow Island, Western Australia, after cyclonic summer rains.* Emu. 94:54--58.	
637.	Johnstone, R.E. & G.M. Storr. 2004. P*asserines (Blue-winged Pitta to Goldfinch): Annotated Checklist of Christmas Island Birds.* In: Handbook of Western Australian Birds. 2:439-476. Western Australian Museum, Perth.	
638.	Pruett-Jones, S. & E. O'Donnell. 2004. *Land birds on Barrow Island: status, population estimates, and responses to an oil-field development.* Journal of the Royal Society of Western Australia. 87:101-108.	
639.	DCCEEW 2025. *Tringa glareola in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-	

Ref No	Description	Document ID
	bin/sprat/public/publicspecies.pl?taxon_id=829 [Accessed: January 2025]	
640.	Debus, S. J. S. 2001. *The Birds of Australia: A Photographic Guide.* New Holland Publishers.	
641.	Graeme Chapman. N.d. *Australian Birds Eastern Yellow Wagtail Motacilla tschutschensis* Graeme Chapman. Available from: https://www.graemechapman.com.au/library/viewphotos.php?c=753&pg=1 [Accessed: January 2025]	
642.	Pizzey, G., & Knight, F. 2007. T*he Field Guide to the Birds of Australia.* HarperCollinsPublishers.	
643.	EPA. 2016. *Environmental Factor Guideline – Marine Environmental Quality*. Environmental Protection Authority, Government of Western Australia	
644.	BOM. 2025. *Climate Data Online, Climate statistics for Australian locations.* Bureau of meteorology. Available from: http://www.bom.gov.au/climate/data/index.shtml [Accessed: January 2025]	
645.	Chevron Australia. 2008. Gorgon Gas Development Revised and Expanded Proposal Public Environmental Review. Chevron Australia, Perth, Western Australia.	
646.	D'Adamo, N. & Fandry, C. & Buchan, Steve & Domingues, Catia. 2009. *Northern sources of the Leeuwin Current and the "Holloway Current" on the North West Shelf*. Journal of the Royal Society of Western Australia. 92. 53-66.	
647.	D'Adamo, N. Simpson, C.J. 2001. R*eview of the oceanography of Ningaloo Reef and adjacent waters.* Technical report: MMS/NIN/NIN-38/2001. March 2001. Marine Conservation branch, Department of Conservation and Land Management	
648.	BOM. N.d. *Tropical cyclone knowledge centre.* Bureau of meteorology. Available from: http://www.bom.gov.au/cyclone/tropical-cyclone-knowledge-centre/ [Accessed: January 2025]	
649.	DITRDCA. N.d. *Christmas Island environment and heritage.* Department of Infrastructure, Transport, Regional Development, Communications and the Arts. Available from: https://www.infrastructure.gov.au/territories-regions-cities/territories/indian-ocean-territories/christmas-island/environment-heritage [Accessed: January 2025]	
650.	Chevron Australia. 2010. *Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project. Appendix Q7 –Baseline water quality assessment report.* Chevron Australia, Perth, Western Australia.	
651.	S McClatchie, J Middleton, C Pattiaratchi, D Currie, G Kendrick. 2006. *The South-west Marine Region: Ecosystems and Key Species Groups.* Department of the Environment and Water Resources, Western Australia	
652.	CAPL. 2010. *Draft Environmental Impact Statement/Environmental Review and Management Programme for the Proposed Wheatstone Project.* Chevron Australia.	
653.	CAPL. 2018. *Gorgon Gas Development: Marine Environmental Quality Management Plan.* Chevron Australia, Perth, Western Australia.	GOR-COP01110

Ref No	Description	Document ID
654.	RPS. 2009. B*aseline Study of the Composition and Quality of Nearshore Waters – Barrow Island.* Unpublished report for Chevron Australia, Perth, Western Australia.	N09503
655.	Wenziker, K., McAlpine, K., Apte, S. and Masini, R. 2006. *North West Shelf Joint Environmental Management Study: Background Quality for Coastal Marine Waters of the North West Shelf, Western Australia.* Technical Report No. 18. CSIRO and Department of Environment, Perth, Western Australia	
656.	Australian and New Zealand Governments. 2018. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.* Australian and New Zealand Governments. Available from: https://www.waterquality.gov.au/anz-guidelines [Accessed: January 2025]	
657.	Trebilco R, Fischer M, Hunter C, Hobday A, Thomas L, Evans K. 2021. *Australia state of the environment 2021: marine, independent report to the Australian Government* Minister for the Environment, Commonwealth of Australia, Canberra,	
658.	DEE. 2011. *Christmas Island Marine Protection Area (CIMPA) Report*. Australian Government Department of the Environment and Energy	
659.	Australian and New Zealand Governments. N.d. *Australian and New Zealand Guidelines for Fresh and Marine Water Quality -Abrolhos Islands.* Australian and New Zealand Governments. Available from: https://www.waterquality.gov.au/anz-guidelines/your-location/australia-marine-IMCRA/search-results?region=ABR#ibs-5215 [Accessed: January 2025]	
660.	DEC. 2006. B*ackground quality of the marine sediments of the Pilbara coast.* Department of Environment and Conservation, Marine Technical Report Series, No. MTR 1.	
661.	CAPL. 2022. *Gorgon Gas Development and Jansz Feed Gas Pipeline:* Environmental Performance Report 2022. Chevron Australia, Perth, Western Australia.	ABU220700410
662.	DWER. 2025.*Air Quality Index for Western Australia*. Available from: https://www.der.wa.gov.au/your-environment/air/air-quality-index [Accessed: January 2025]	
663.	PlumeLabs. 2025.Air Quality in Christmas Island. Available from: https://air.plumelabs.com/air-quality-in-christmas-island-aw-54787 [Accessed: January 2025]	
664.	DBCA. 2023 *Islands in the Pilbara*. Department of Biodiversity, Conservation and Attractions	
665.	Explore Parks WA. 2023. *Jurabi and Bundegi Coastal Park.* Available from: https://exploreparks.dbca.wa.gov.au/park/jurabi-and-bundegi-coastal-park [Accessed: January 2025]	
666.	City of Karratha. N.d. *Dampier Archipelago.* Available from: https://karratha.wa.gov.au/recreation-and-sports/dampier-archipelago#:~:text=The%20Dampier%20Archipelago%2C%20in%20the,camping%20and%20other%20recreational%20activities [Accessed: January 2025]	
667.	Western Australia walking on a dream. N.d. *Onslow.* Available from: https://www.westernaustralia.com/au/places/onslow/56b267b67b935fbe730e6f40 [Accessed: January 2025]	
668.	Yamatji Marlpa Aboriginal Corporation. 2019. *Gnulli native title group celebrates native title win.* Available from: https://www.ymac.org.au/wp-	

Ref No	Description	Document ID
	content/uploads/2019/12/191218-Gnulli-Native-Title-Determination-MEDIA-RELEASE-FINAL.pdf [Accessed: January 2025]	
669.	DCCEW. 2023. *About Australia's heritage*. Available at: https://www.dcceew.gov.au/parks-heritage/heritage/about [Accessed: January 2025]	
670.	Benjamin, J., O'Leary, M., McDonald, J, Wiseman, C., McCarthy, J., Beckett, E., Morrison, P., Stankiewicz, F., Leach, J., Hacker, J., Baggaley, P., Jerbic, K., Fowler, M., Fairweather, J., Jeffries, P., Ulm, S., and Bailey, G. 2020. *Aboriginal artefacts on the continental shelf reveal ancient drowned cultural landscapes in northwest Australia.* PLoS ONE 15(7): e0233912. https://doi.org/10.1371/journal.pone.0233912	
671.	Deckker, P., Moros, M., Perner, K., Blanz, T., Wacker, L., Schneider, R., Barrows, T., O'Loingsigh, T., and Jansen, E. 2020. *Climatic evolution in the Australian region over the last 94 ka – spanning human occupancy -, and unvieling the Last Glacial Maximum*. Quaternary Science Reviews 249: 106593. https://doi.org/10.1016/j.quascirev.2020.106593	
672.	O'Leary, M. J., Paumard, V. and Ward, I. 2020. *Exploring Sea Country through high-resolution 3D seismic imaging of Australia's NW shelf: Resolving early coastal landscapes and preservation of underwater cultural heritage*. Quaternary Science Reviews 239: 106353. https://doi.org/10.1016/j.quascirev.2020.106353	
673.	Benjamin, J., O'Leary, M., McCarthy, J., Reynen, W., Wiseman, C., Leach, J., Bobeldyk, S., Buchler, J., Kermeen, P., Langley, M., Black, A., Yoshida, H., Parnum, I., Stevens, A., Ulm, S., McDonald, J., Veth, P. and Bailey, G. 2023. *Stone artefacts on the seabed at a submerged freshwater spring confirm a drowned cultural landscape in Murujuga, Western Australia.* Quaternary Science Reviews 313: 108190. https://doi.org/10.1016/j.quascirev.2023.108190	
674.	Veth, P., Ward, I., Manne, T., Ulm, S., Ditchfield, K., Dortch, J., Hook, F., Petchey, F., Hogg, Al., Questiaux, D., Demuro, M., Arnold, L., Spooner, N., Levchenko, V., Skippinton, J., Byrne, C., Basgall, M., Zeanah, D., Belton, D., Helmholz, P., Kendrick, P. 2017. *Early human occuplation of a maritime desert, Barrow Island, North-West Australia.* Quarternay Science Reviews 168: 19-29. https://doi.org/10.1016/j.quascirev.2017.05.002	
675.	Zeanah, D., Veth, P., Basgall, M., Glover, D., Bradshaw, R., Ditchfield, K., Hook, F., Seah, I., Buurabalayji Thalanyji Aboriginal Corporation. 2024. *Barrow Island lithic scatters: A unique record of occupation patterns on the North West Shelf before insularisation*. Quaternary Science Reviews, 329: 108547. https://doi.org/10.1016/j.quascirev.2024.108547	
676.	Smyth, D. 1994. *Understanding Country: The Importance of Land and Sea in Aboriginal and Torres Strait Islander Societies.* Canberra, Council for Aboriginal Reconciliation	
677.	Smyth Dermot. 2007. *Sea Countries of the North-West.* Literature review on Indigenous connection to and uses of the North West Marine Region.	
678.	AIATSIS. 2023. *The Marlaloo Songline.* Australian Institute of Aboriginal and Torres Strait Islander Studies. Available from: https://aiatsis.gov.au/explore/marlaloo-songline [Accessed: January 2025]	

Ref No	Description	Document ID
679.	Deadly Stoary n.d. *Songlines*. Deadly Story. Available from: https://deadlystory.com/page/culture/Life_Lore/Songlines [Accessed: January 2025]	
680.	Nunn, P. and Reid, N. 2015. *Aboriginal Memories of Inundation of the Australian Coast Dating from More than 7000 Years Ago*. Australian Geographer 47(1):11-47. https://doi.org/10.1080/00049182.2015.1077539	
681.	Kearney, A., O'Leary, M. and Platten, S. 2023. *Sea Country: Plurality and knowledge of saltwater territories in Indigenous Australian contexts.* The Geographical Journal 189(1): 104-116. https://doi.org/10.1111/geoj.12466	
682.	DCCEEW. N.d. *Species Profile and Threats Database, Key Ecological Features*. Available from: https://www.environment.gov.au/sprat-public/action/kef/search [Accessed: January 2025]	
683.	Falkner, I, Whiteway, T, Przeslawski, R & Heap, AD 2009, *Review of ten key ecological features (KEFs) in the northwest marine region, record 2009/13*, Geoscience Australia, Canberra.	
684.	Rees, M, Heyward, A, Cappo, M, Speare, P & Smith, L. 2004. *Ningaloo Marine Park—initial survey of seabed biodiversity in intermediate and deeper waters (March 2004)*, report prepared for the Australian Government Department of the Environment and Heritage, Canberra.	
685.	Last, P, Lyne, V, Yearsley, G, Gledhill, D, Gomon, M, Rees, T & White, W 2005, *Validation of national demersal fish datasets for the regionalisation of the Australian continental slope and outer shelf (>40 m depth),* Department of the Environment and Heritage & CSIRO Marine and Atmospheric Research, Hobart.	
686.	McLoughlin, RJ & Young, PC 1985, *Sedimentary provinces of the fishing grounds of the North West Shelf of Australia: grainsize frequency analysis of surficial sediments*, Australian Journal of Marine and Freshwater Research, vol. 36, pp. 671–681.	
687.	Fletcher, WJ & Santoro, K (eds). 2010. *State of the fisheries and aquatic resources report 2009/10*, Department of Fisheries, Western Australia	
688.	Done, TJ, Williams, DM, Speare, PJ, Davidson, J, DeVantier, LM, Newman, SJ & Hutchins, JB. 1994. *Surveys of coral and fish communities at Scott Reef and Rowley Shoals*, Australian Institute of Marine Science, Townsville.	
689.	Woodside, 2009, *Scott Reef status report 2008*, Woodside, Perth.	
690.	Donovan, A, Brewer, D, van der Velde, T & Skewes, T 2008. *Scientific descriptions of four selected key ecological features (KEFs) in the north-west bioregion: final report*, a report to the Department of the Environment, Water Heritage and the Arts, CSIRO Marine and Atmospheric Research, Hobart.	
691.	Jenner, C, Jenner, M & Pirzl, R. 2008. *A study of cetacean distribution and oceanography in the Scott Reef/Browse Basin development areas during the austral winter of 2008*, Centre for Whale Research (WA) Inc., Perth.	
692.	Heap, AD & Harris PT. 2008. *Geomorphology of the Australian margin and adjacent seafloor,* Australian Journal of Earth Sciences, vol. 55, pp. 555–585	
693.	ABARES. 2024. *ABARES Fishery Status Reports Map Data*. Australian Bureau of Agricultural and Resource Economics and Sciences from	

Ref No	Description	Document ID
	data collected by the Australian Fisheries Management Authority. Available from: https://daff.ent.sirsidynix.net.au/client/en_AU/ABARES/search/results?qu=map+data&rw=36&te=ASSET&st=PD&isd=true [Accessed: January 2025]	
694.	Butler, I, Patterson, H, Bromhead, D, Galeano, D, Timmiss, T, Woodhams, J and Curtotti, R. 2024. *Fishery status reports 2024,* Australian Bureau of Agricultural and Resource Economics and Sciences, Canberra, DOI: https://doi.org/10.25814/bfnc-9160	
695.	DCCEEW 2025. *Thunnus maccoyii in Species Profile and Threats Database* Department of Climate Change, Energy, the Environment and Water, Canberra. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=69402 [Accessed: January 2025]	
696.	O'Hara, T. 2023. *An assessment of the offshore natural values of Australia's Indian Ocean Territories*. Museums Victoria and Parks Australia, Melbourne, Victoria.	
697.	Evans, K., Patterson, T., Reid, H., and Harley, S. 2012. *Reproductive Schedules in Southern Bluefin Tuna: Are Current Assumptions Appropriate?* PLOS One 7(4): e34550. https://doi.org/10.1371/journal.pone.0034550	
698.	Farley, J., Davis, T., Bravington, M., Andamari, R., Davies, C. 2015. Spawning Dynamics and Size Related Trends in Reproductive Parameters of Southern Bluefin Tuna, Thunnus maccoyii. PLOS One 10(5): e0125744. https://doi.org/10.1371/journal.pone.0125744	
699.	DPIRD. 2024. F*ish Cube WA Data Extract for 2014–2023*. Available by request from DPIRD	
700.	Newman, S.J., Santoro, K.G. and Gaughan, D.J. (eds). 2023. *Status Reports of the Fisheries and Aquatic Resources of Western Australia 2022/23: The State of the Fisheries.* Department of Primary Industries and Regional Development, Western Australia.	
701.	Newman, S.J. Bellchambers, L. Skepper, C. Evans S. and Dobso P. 2015. *Appendix 3 Research Division - Other Activities Indian Ocean Territories Fishery Status Report*.	
702.	DPIRD 2023. *Recreational fishing*. Department of Primary Industries and Regional Development Available from: https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Recreational-Fishing/Pages/default.aspx [Accessed: January 2025]	
703.	DPIRD 2023. *Statewide recreational fishing survey.* Department of Primary Industries and Regional Development Available from: https://www.fish.wa.gov.au/Fishing-and-Aquaculture/Recreational-Fishing/Pages/Western-Australian-Recreational-Boat-Fishing-Survey.aspx [Accessed: January 2025]	
704.	Ryan KL, Lai EKM, Smallwood CB. 2022. *Boat-based recreational fishing in Western Australia 2020/21.* Fisheries Research Report No. 327 Department of Primary Industries and Regional Development, Western Australia. 221pp	
705.	Christmas Island National Park. N.d. *Activities.* Christmas Island National Park Available from: https://christmasislandnationalpark.gov.au/things-do/activities/ [Accessed: January 2025]	
706.	DPIRD. 2015. *Customary fishing – frequently asked questions*. Department of Primary Industries and Regional Development.	

Ref No	Description	Document ID
707.	AFMA 2023. *Traditional Indonesian fishing in the MoU Box.* DAustralian Fisheries Management Authority. Available from: https://www.afma.gov.au/international-fisheries-management/enforcement-operations/traditional-indonesian-fishing-mou-box#:~:text=The%20area%20of%20waters%20referred,Zone%20and%20Continental%20Shelf%20%E2%80%93%201974. [Accessed: January 2025]	
708.	ATIC 2023. *State Tourism Satellite Account – Western Australia Summary*. Australian Trade and Investment Commission. Available from: https://www.tra.gov.au/en/economic-analysis/tourism-satellite-accounts/state-tourism-satellite-account#ref13 [Accessed: January 2025]	
709.	Schianetz Karin, Jones Tod, Kavanagh Lydia, Walker Paul, Lockington David, Wood David. 2009. *The practicalities of a Learning Tourism Destination: a case study of the Ningaloo Coast*. International Journal of Tourism Research.	
710.	DEC. 2007. *Management Plan for the Montebello/Barrow Islands Marine Conservation Reserves 2007-2017.* Department of Environment and Conservation, Marine Parks and Reserves	
711.	AHO. 2020. *Fact Sheet: Navigation – Maritime Military Firing Practice and Exercise Areas.* Australian Hydrographic Office, Department of Defence, Australian Government	
712.	Defence n.d. *Where is Unexploded Ordnance.* Australian Government Defence. Available from: https://uxo.defence.gov.au/where-unexploded-ordnance [Accessed: January 2025]	
713.	Chevron. n.d. *celebrating more than 35 years of domestic gas supply to W.A. and over 30 years of LNG exports to Japan.* Chevron Australia. Available from: https://australia.chevron.com/what-we-do/north-west-shelf-project [Accessed: January 2025]	
714.	Parks Australia. [n.d.]. *Australian Marine Parks.* Available from: https://australianmarineparks.gov.au/ [Accessed: January 2025]	
715.	Director of National Parks 2018, *North-west Marine Parks Network Management Plan 2018,* Director of National Parks, Canberra	
716.	Director of National Parks 2018, S*outh-west Marine Parks Network Management Plan 2018*, Director of National Parks, Canberra	
717.	Director of National Parks 2024. *Report of the Director of National Parks: On the proposal to prepare draft management plans for Christmas Island Marine Park and Cocos (Keeling) Islands Marine Park.* Director of National Parks, Canberra	
718.	Director of National Parks. N.d. *Christmas Island Marine Park*. Director of National Parks, Canberra	
719.	DPIRD. 2013. *Fish habitat protection areas*. Department of Primary Industries and Regional development - Fisheries. Available from: https://www.fish.wa.gov.au/Sustainability-and-Environment/Aquatic-Biodiversity/Marine-Protected-Areas/Pages/Fish-Habitat-Protection-Areas.aspx [Accessed: January 2025]	
720.	DPIRD. 2022. *Abrolhos Islands*. Department of Primary Industries and Regional development. Available from: https://www.fish.wa.gov.au/sustainability-and-environment/abrolhos-islands/Pages/default.aspx [Accessed: January 2025]	

Ref No	Description	Document ID
721.	DPIRD. 2023. *Abrolhos Islands, Nature conservation*. Department of Primary Industries and Regional development. Available from: https://www.fish.wa.gov.au/Sustainability-and-Environment/Abrolhos-Islands/Pages/Nature-conservation.aspx [Accessed: January 2025]	
722.	Department of Fisheries. 2012. *Exploring the Houtman Abrolhos islands.* Department of Fisheries, Perth, Western Australia.	
723.	Parks and wildlife service. N.d. *Barrow Island Marine Park, about this park.* Available from: https://exploreparks.dbca.wa.gov.au/park/barrow-island-marine-park [Accessed: January 2025]	
724.	Department of Parks and Wildlife 2014, *Eighty Mile Beach Marine Park Management Plan 80 2014-2024.* Department of Parks and Wildlife, Perth	
725.	Parks and wildlife services. N.d. *Pilbara Islands Nature Reserves.* Parks and wildlife services, Government of Western Australia. Available from: https://exploreparks.dbca.wa.gov.au/park/pilbara-islands-nature-reserves [Accessed: January 2025]	
726.	Parks and wildlife services. N.d. *Hamelin Pool Marine Nature Reserve.* Parks and wildlife services, Government of Western Australia. Available from: https://exploreparks.dbca.wa.gov.au/park/hamelin-pool-marine-nature-reserve [Accessed: January 2025]	
727.	Department of Fisheries. 2007. *Plan of management for the Kalbarri blue holes fish habitat protection area.* Department of Fisheries Western Australia, Perth. Report No. 188.	
728.	Department of Fisheries. 2014. *Miaboolya Beach Fish Habitat Protection Area (FHPA).* Department of Fisheries Western Australia, Perth.	
729.	Aylmore S., Anderson S. 2003. *Plan of Management for the Miaboolya Beach Fish Habitat Protection Area.* Fisheries Management Paper No. 161	
730.	Parks and wildlife services. 2022. *Park Feature - Montebello Islands Conservation Estate.* Parks and wildlife services, Government of Western Australia. Available from: https://exploreparks.dbca.wa.gov.au/get-inspired/park-feature-montebello-islands-conservation-estate [Accessed: January 2025]	
731.	DBCA. No date. *Muiron Islands Marine Management Area,* Available from: https://exploreparks.dbca.wa.gov.au/park/muiron-islands-marinemanagement-area [Accessed: January 2025]	
732.	DCLM. 2005. *Management Plan for the Ningaloo Marine Park and Muiron Islands Marine Management Area 2005–2015.* Management Plan No 52. Department of Conservation and Land Management	
733.	Department of Fisheries. 2015. *Point Quobba Fish Habitat Protection Area (FHPA).* Department of Fisheries Western Australia, Perth.	
734.	DEC. 2007. *Rowley Shoals Marine Park Management Plan 2007 - 2017.* Department of Environment and Conservation, Marine Parks and Reserves	
735.	Woodside, Australian Institute of Marine Science. 2013. Discovering Scott Reef : 20 years of exploration and research. Woodside, Australian Institute of Marine Science.	
736.	DCLM. 1996. *Shark Bay marine reserves Management Plan 1996–2006.* Management Plan No 34. Department of Conservation and Land Management	

Ref No	Description	Document ID
737.	DBCA. 2024. *Shark Bay marine reserves Shark Bay Marine Park and Hamelin Pool Marine Nature Reserve Marine parks… WA's submerged wonders Visitor guide*. Department of Biodiversity, Conservation and Attractions Parks and Wildlife Service – Shark Bay District	
738.	Parks and wildlife services. N.d. *Thevenard Island Nature Reserve.* Parks and wildlife services, Government of Western Australia. Available from: https://exploreparks.dbca.wa.gov.au/site/thevenard-island-nature-reserve [Accessed: January 2025]	
739.	DCCEEW. 2024. *Australia's World Heritage List.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/heritage/places/world-heritage-list [Accessed: January 2025]	
740.	DCCEEW. 2024. *National Heritage List Spatial Database (NHL) - public.* Department of Climate Change, Energy, the Environment and Water. Available from: https://fed.dcceew.gov.au/datasets/erin::national-heritage-list-spatial-database-nhl-public/about [Accessed: January 2025]	
741.	DCCEEW. 2024. *Commonwealth Heritage List.* Department of Climate Change, Energy, the Environment and Water. Available from: https://fed.dcceew.gov.au/datasets/erin::commonwealth-heritage-list-1/about [Accessed: January 2025]	
742.	DCCEEW. 2024. *Australia, World Heritage Areas.* Department of Climate Change, Energy, the Environment and Water. Available from: https://fed.dcceew.gov.au/datasets/erin::commonwealth-heritage-list-1/about [Accessed: January 2025]Available from: https://fed.dcceew.gov.au/datasets/erin::australia-world-heritage-areas/about [Accessed: January 2025]	
743.	UNESCO. N.d. *Shark Bay, Western Australia.* United Nations Educational, Scientific, and Cultural Organization. Available from: https://whc.unesco.org/en/list/578/ [Accessed: January 2025]	
744.	DCCEEW. N.d. *Shark Bay, Western Australia, Inscribed on the World Heritage List in 1991.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/sites/default/files/env/pages/758ea283-6b9d-41bc-a29a-1276e1c7fced/files/shark-bay-factsheet.pdf [Accessed: January 2025]	
745.	UNESCO. N.d. *Ningaloo Coast.* United Nations Educational, Scientific, and Cultural Organization. Available from: https://whc.unesco.org/en/list/1369/ [Accessed: January 2025]	
746.	DCCEEW. 2023. *National Heritage Places - The Ningaloo Coast.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/heritage/places/national/ningaloo [Accessed: January 2025]	
747.	DEWHA.2005. *Australian Heritage Database Places for Decision. National Heritage List, Ningaloo Coast National Heritage Place.* Department of the Environment, Water, Heritage and the Arts	
748.	DCCEEW. 2022. *National Heritage Places - Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/heritage/places/national/batavia [Accessed: January 2025]	
749.	DCCEEW. 2025. *Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos, Wallabi Group via Houtman Abrolhos, WA,*	

Ref No	Description	Document ID
	Australia. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3Dbatavia%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105887 [Accessed: January 2025]	
750.	DCCEEW. 2025. *Dampier Archipelago (including Burrup Peninsula), Karratha Dampier Rd, Dampier, WA, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3Ddampier%2520archipelago%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105727 [Accessed: January 2025]	
751.	DCCEEW. 2021. *National Heritage Places - Dampier Archipelago (including Burrup Peninsula).* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/heritage/places/national/dampier-archipelago [Accessed: January 2025]	
752.	DCCEEW. 2025. *Dirk Hartog Landing Site 1616 - Cape Inscription Area, Dirk Hartog Island, WA, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DDirk%2520Hartog%2520Landing%2520Site%25201616%2520-%2520Cape%2520Inscription%2520Area%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105808 [Accessed: January 2025]	
753.	DCCEEW. 2025. *HMAS Sydney II and HSK Kormoran Shipwreck Sites, Carnarvon, EXT, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DHMAS%2520Sydney%2520II%2520and%2520HSK%2520Kormoran%2520Shipwreck%2520Sites%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=106062 [Accessed: January 2025]	
754.	DCCEEW. 2025. *The West Kimberley, Great Northern Hwy, Broome, WA, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3Dthe%2520west%2520kimberley%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=106063 [Accessed: January 2025]	
755.	DCCEEW. 2025. *Christmas Island Natural Areas, Settlement, EXT, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DChristmas%2520Island%2520Natural%2520Areas%2520%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1di	

Ref No	Description	Document ID
	r%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105187 [Accessed: January 2025]	
756.	DCCEEW. 2025. *Learmonth Air Weapons Range Facility, Learmonth, WA, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DLearmonth%2520Air%2520Weapons%2520Range%2520Facility%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105551 [Accessed: January 2025]	
757.	DCCEEW. 2025. *Mermaid Reef - Rowley Shoals, Broome, WA, Australia.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DMermaid%2520Reef%2520-%2520Rowley%2520Shoals%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105255 [Accessed: January 2025]	
758.	DCCEEW. 2025. *Scott Reef and Surrounds - Commonwealth Area, Timor Sea, EXT, Australia*. Department of Climate Change, Energy, the Environment and Water. Available from: https://www.environment.gov.au/cgi-bin/ahdb/search.pl?mode=place_detail;search=place_name%3DScott%2520Reef%2520and%2520Surrounds%2520-%2520Commonwealth%2520Area%3Bkeyword_PD%3Don%3Bkeyword_SS%3Don%3Bkeyword_PH%3Don%3Blatitude_1dir%3DS%3Blongitude_1dir%3DE%3Blongitude_2dir%3DE%3Blatitude_2dir%3DS%3Bin_region%3Dpart;place_id=105480 [Accessed: January 2025]	
759.	DCCEEW. 2024. *Assessing and Managing Impacts to Underwater Cultural Heritage in Australian Water*s, Department of Climate Change, Energy, the Environment and Water, Canberra, October	
760.	DCCEEW. 2024. *Australasian Underwater Cultural Heritage Database.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/heritage/underwater-heritage/auchd [Accessed: January 2025]	
761.	DPLH. N.d. *Aboriginal Cultural Heritage Inquiry System.* Department of Planning, Lands and Heritage. Available from: https://espatial.dplh.wa.gov.au/ACHIS/index.html?viewer=ACHIS [Accessed: January 2025]	
762.	NIAA. N.d. *Indigenous Protected Areas (IPA)*. National Indigenous Australian Agency. Available from: https://www.niaa.gov.au/our-work/environment-and-land/indigenous-protected-areas-ipa [Accessed: January 2025]	
763.	Juluwarlu group Aboriginal Corporation. 2019. *Native Title Standing.* Available from: https://juluwarlu.com.au/our-story/native-title-standing/#:~:text=over%20nine%20years.-,In%202005%2C%20Justice%20French%20held%20that%20the%20Ngarluma%20and%20Yindjibarndi,Court%20File%20WAD6017%2F1996. [Accessed: January 2025]	
764.	Wanparta Aboriginal corporation. 2022. *About Wanparta.* Available from: https://www.wanparta.com.au/about [Accessed: January 2025]	

Ref No	Description	Document ID
765.	PBC. N.d. *Buurabalayji Thalanyji Aboriginal Corporation RNTBC.* Available from: https://nativetitle.org.au/find/pbc/7105 [Accessed: January 2025]	
766.	Marshall Melissa. 2020. *Living Heritage: Protecting the Aboriginal Cultural Heritage of the Dampier Peninsula for all*. Written for DPLH	
767.	AIATSIS. 2018. *Holborow on behalf of the Yaburara and Mardudhunera People v State of Western Australia (No 3) [2018] FCA 1108.* Available from: https://aiatsis.gov.au/ntpd-resource/1746 [Accessed: January 2025]	
768.	ATNS. 2021. *Drury & Ors on behalf of the Nanda People v State of Western Australia [2018] FCA 1849.* Available from: https://database.atns.net.au/agreement.asp?EntityID=8459 [Accessed: January 2025]	
769.	ATNS. 2021. *Oxenham on behalf of the Malgana People v State of Western Australia [2018] FCA 1929.* Available from: https://database.atns.net.au/agreement.asp?EntityID=8503 [Accessed: January 2025]	
770.	ATNS. 2021. *Gordon on behalf of the Kariyarra Native Title Claim Group v State of Western Australia (No 2) [2018] FCA 1990.* Available from: https://database.atns.net.au/agreement.asp?EntityID=7905 [Accessed: January 2025]	
771.	ATNS. 2021. *Drury on behalf of the Nanda People v State of Western Australia (No 3) [2019] FCA 1812.* Available from: https://database.atns.net.au/agreement.asp?EntityID=8574 [Accessed: January 2025]	
772.	ATNS. 2022. *Taylor on behalf of the Yamatji Nation Claim v State of Western Australia [2020] FCA 42.* Available from: https://database.atns.net.au/agreement.asp?EntityID=7733 [Accessed: January 2025]	
773.	Olson, P., Kinzey, D., Double, M. C., Matsuoka, K., & Findlay, K. 2024. *Capture–recapture estimates of Antarctic blue whale abundance and population growth rate*. Marine Mammal Science. https://doi.org/10.1111/mms.13215.	
774.	Branch, T. A., Stafford, K. M., Palacios, D. M., Allison, C., Bannister, J. L., Burton, C. L. K., Cabrera, E., Carlson, C. A., Galletti Vernazzani, B., Gill, P. C., Hucke-Gaete, R., Jenner, K. C. S., Jenner, M.-N. M., Matsuoka, K., Mikhalev, Y. A., Miyashita, T., Morrice, M. G., Nishiwaki, S., Sturrock, V. J., Warneke, R. M. 2007. *Past and present distribution, densities and movements of blue whales Balaenoptera musculus in the southern hemisphere and northern Indian Ocean. Mammal Review*, 37(2), 116–175. https://doi.org/10.1111/j.1365-2907.2007.00106.x0	
775.	DCCEEW. 2021.*Christmas Island Geology.* Department of Climate Change, Energy, the Environment and Water. Available from: https://www.dcceew.gov.au/parks-heritage/national-parks/christmas-island-national-park/natural-environment/geology	
776.	DCCEEW. 2022. *Habitats of Christmas Island*. Department of Climate Change, Energy, the Environment and Water . Available from: https://www.dcceew.gov.au/parks-heritage/national-parks/christmas-island-national-park/natural-environment/habitats#_12-broad-habitats	
777.	Director of National Parks. 2025. *Christmas Island Marine Park Management plan.* Australian Marine parks. Available from: http://australianmarineparks.gov.au/static/c0e75cd618cb695f1fc4b21b966245d7/amp-cimp-management-plan-2025.pdf	

Ref No	Description	Document ID
778.	Australian Government Department of the Environment and Energy. 2013. *Antarctic blue whale project.* A project Southern Ocean Research Partnership of the International Whaling Commission. Available from https://www.marinemammals.gov.au/site/assets/files/1039/20130602_abwp_project_overview_approved.pdf	
779.	National Oceanic and Atmospheric Administration. Green turtle. NOAA Fisheries. Available from: https://www.fisheries.noaa.gov/species/green-turtle#:~:text=After%20emerging%20from%20the%20nest,the%20remainder%20of%20their%20lives	
780.	CSIRO. n.d.. Turtles in Ningaloo. CSIRO. Available from: https://research.csiro.au/ningaloo/outlook/turtles/	
781.	Pillans, R.D., Whiting, S.D., Tucker, A.D. & Vanderklift, M.A. (2022). Fine-scale movement and habitat use of juvenile, subadult, and adult green turtles (Chelonia mydas) in a foraging ground at Ningaloo Reef, Australia. Aquatic Conservation: Marine and Freshwater Ecosystems, 32(8), 1323–1340. https://doi.org/10.1002/aqc.3832	
782.	Puotinen M, Galaiduk R, Miller K, Nanson R, Huang Z, Nichol S.2018. An eco-narrative of Kimberley Marine Park: North-west marine region. Report to the National Environmental Science Programme, Marine Biodiversity Hub. Geoscience Australia.	

appendix a protected matters search reports

Australian Government

Department of Climate Change, Energy, the Environment and Water

EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jan-2025

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	2
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	4
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	74
Listed Migratory Species:	63

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	23
Commonwealth Heritage Places:	2
Listed Marine Species:	102
Whales and Other Cetaceans:	36
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	8
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	9
Regional Forest Agreements:	None
Nationally Important Wetlands:	2
EPBC Act Referrals:	44
Key Ecological Features (Marine):	7
Biologically Important Areas:	21
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Batavia Shipwreck Site and Survivor Camps Area 1629 - Houtman Abrolhos	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat likely to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Turnix varius scintillans		
Painted Button-quail (Houtman Abrolhos) [82451]	Endangered	Species or species habitat known to occur within area
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Species or species habitat known to occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat may occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Parantechinus apicalis Dibbler [313]	Endangered	Species or species habitat may occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
PLANT		
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat likely to occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat known to occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat known to occur within area
Caleana dixonii listed as Paracaleana dixonii Sandplain Duck Orchid [87944]	Endangered	Species or species habitat may occur within area
Chorizema humile Prostrate Flame Pea [32573]	Endangered	Species or species habitat may occur within area
Conostylis dielsii subsp. teres Irwin's Conostylis [3614]	Endangered	Species or species habitat may occur within area
Conostylis micrantha Small-flowered Conostylis [17635]	Endangered	Species or species habitat may occur within area
Diuris drummondii Tall Donkey Orchid [4365]	Vulnerable	Species or species habitat may occur within area
Drakaea concolor Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat known to occur within area
Drummondita ericoides Morseby Range Drummondita [9193]	Endangered	Species or species habitat known to occur within area
Eucalyptus cuprea Mallee Box [56773]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Grevillea bracteosa subsp. howatharra [85002]	Critically Endangered	Species or species habitat likely to occur within area
Hypocalymma angustifolium subsp. Hutt River (S.Patrick 2982) [85023]	Endangered	Species or species habitat known to occur within area
Lechenaultia chlorantha Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat known to occur within area
Leucopogon marginatus Thick-margined Leucopogon [12527]	Endangered	Species or species habitat likely to occur within area
Pterostylis sinuata Northampton Midget Greenhood, Western Swan Greenhood [84991]	Endangered	Species or species habitat known to occur within area
Stachystemon nematophorus Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Wurmbea tubulosa Long-flowered Nancy [12739]	Endangered	Species or species habitat may occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Egernia stokesii badia		
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat may occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Species or species habitat likely to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Centrophorus uyato		
Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area
SPIDER		
Idiosoma nigrum		
Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Species or species habitat may occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres		
Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba		
Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis		
Red-necked Stint [860]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Limosa lapponica		
Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Pandion haliaetus		
Osprey [952]		Breeding known to occur within area
Pluvialis fulva		
Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Thalasseus bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes		
Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50196]	WA
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50197]	WA
Defence - GERALDTON TRAINING DEPOT "A" Company 16th Battalion [50195]	WA

Commonwealth Land Name	State
Unknown	
Commonwealth Land - [52111]	WA
Commonwealth Land - [51099]	WA
Commonwealth Land - [51098]	WA
Commonwealth Land - [52201]	WA
Commonwealth Land - [50378]	WA
Commonwealth Land - [50376]	WA
Commonwealth Land - [50375]	WA
Commonwealth Land - [50374]	WA
Commonwealth Land - [50373]	WA
Commonwealth Land - [50372]	WA
Commonwealth Land - [50371]	WA
Commonwealth Land - [50368]	WA
Commonwealth Land - [50369]	WA
Commonwealth Land - [50370]	WA
Commonwealth Land - [52214]	WA
Commonwealth Land - [51432]	WA
Commonwealth Land - [51479]	WA
Commonwealth Land - [51434]	WA
Commonwealth Land - [51886]	WA
Commonwealth Land - [51100]	WA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Geraldton Drill Hall Complex	WA	Listed place
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Breeding known to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat may occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Species or species habitat may occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat likely to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat likely to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Pelagodroma marina White-faced Storm-Petrel [1016]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat may occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Puffinus assimilis Little Shearwater [59363]		Breeding known to occur within area
Puffinus huttoni Hutton's Shearwater [1025]		Foraging, feeding or related behaviour known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Species or species habitat may occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis Hooded Plover, Hooded Dotterel [87735]		Species or species habitat may occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri		
Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Breeding known to occur within area
Reptile		
Aipysurus laevis		
Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus pooleorum		
Shark Bay Sea Snake [66061]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Ephalophis greyae as Ephalophis greyi		
Mangrove Sea Snake [93738]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
[Hydrophis kingii as Disteira kingii](#) Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Caperea marginata Pygmy Right Whale [39]		Species or species habitat may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Hyperoodon planifrons Southern Bottlenose Whale [71]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Abrolhos	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)

Park Name	Zone & IUCN Categories
Abrolhos	National Park Zone (IUCN II)
Abrolhos	Special Purpose Zone (IUCN VI)
Abrolhos	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Abrolhos Islands	Fish Habitat Protection Area	WA
Houtman Abrolhos Islands	National Park	WA
Kalbarri	National Park	WA
Kalbarri Blue Holes	Fish Habitat Protection Area	WA
Nilligarri	Nature Reserve	WA
Oakabella	Nature Reserve	WA
Port Gregory	NRS Addition - Gazettal in Progress	WA
Unnamed WA33799	Nature Reserve	WA
Utcha Well	Nature Reserve	WA

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Hutt Lagoon System	WA
Murchison River (Lower Reaches)	WA

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Midwest Offshore Wind Farm	2022/09264		Assessment

Title of referral	Reference	Referral Outcome	Assessment Status
Yogi Magnetite Project, 225km east, northeast of Geraldton, WA	2017/8124		Approval
Controlled action			
Coburn Mineral Sand Project	2003/1221	Controlled Action	Post-Approval
Construction of the Oakajee Port and Rail Project	2011/5797	Controlled Action	Post-Approval
development of land based tourist facilities on Long Island	2006/2792	Controlled Action	Post-Approval
Hematite (iron ore) Mine and Beneficiation Plant	2001/542	Controlled Action	Completed
Karara Magnetite Project	2006/3017	Controlled Action	Post-Approval
Nava-1 Cable System	2001/510	Controlled Action	Completed
Oakajee Rail Development	2010/5500	Controlled Action	Post-Approval
open cut mine & assoc infrastructure	2005/2381	Controlled Action	Post-Approval
Port Enhancement Project	2001/266	Controlled Action	Post-Approval
Tourism Facility and Associated Infrastructure	2005/2038	Controlled Action	Post-Approval
Not controlled action			
APX-West Fibre-optic telecommunications cable system, WA to Singapore	2013/7102	Not Controlled Action	Completed
Drilling between Kalbarri and Cliff Head	2005/2185	Not Controlled Action	Completed
Glenfield Beach Project	2012/6359	Not Controlled Action	Completed
Hadda 1,Flying Foam 1,Magnat 1 exploration drill	2004/1697	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO West Submarine Telecommunications Cable, WA	2017/8126	Not Controlled Action	Completed
Maintenance Dredging in the Geraldton Port Outer Channel	2010/5488	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Oman Australia Cable Installation, WA	2021/8922	Not Controlled Action	Completed
Oman Australia Cable - Marine Route Survey	2020/8731	Not Controlled Action	Completed
Scientific Sonar Trial	2002/680	Not Controlled Action	Completed
Seismic Survey, Bremer Basin, Mentelle Basin and Zeewyck Sub-basin	2004/1700	Not Controlled Action	Completed
Yellowfin Tuna Aquaculture Trial	2003/1115	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D Marine Seismic Survey in Permit Area WA-337-P	2003/1158	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey	2008/4493	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2009/4968	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2008/4565	Not Controlled Action (Particular Manner)	Post-Approval
Australian Square Kilometre Array Pathfinder telescope & infrastructure	2009/4891	Not Controlled Action (Particular Manner)	Post-Approval
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
develop and operate a new deepwater port	2010/5760	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Laying a submarine optical fibre telecommunications cable, Perth to Singapore and Jakarta	2014/7332	Not Controlled Action (Particular Manner)	Post-Approval
Marine reconnaissance survey	2008/4466	Not Controlled Action (Particular Manner)	Post-Approval
Marine Seismic Survey for oil and gas in Commonwealth waters off the WA coast.	2004/1802	Not Controlled Action (Particular Manner)	Post-Approval
Marine Seismic Survey in Permit WA-481P	2012/6626	Not Controlled Action (Particular Manner)	Post-Approval
North Perth Marine Survey	2011/6067	Not Controlled Action (Particular Manner)	Post-Approval
Quiberon 2D Seismic Survey, permit area WA-385P, offshore of Carnarvon	2009/5077	Not Controlled Action (Particular Manner)	Post-Approval
search for HMAS Sydney	2006/3071	Not Controlled Action (Particular Manner)	Post-Approval
Study of behavioural responses of Austn Humpback Whales to seismic surveys, offshore Dongara, WA	2013/6927	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Exploration Drilling 2014/2015 WA-481-P	2013/7043	Referral Decision	Completed
Proposed exploration drilling activities, Abrolhos Commonwealth Marine Reserve	2013/6949	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Commonwealth marine environment surrounding the Houtman Abrolhos Islands	South-west
Commonwealth marine environment within and adjacent to the west coast inshore lagoons	South-west
Perth Canyon and adjacent shelf break, and other west coast canyons	South-west
Wallaby Saddle	North-west
Western demersal slope and associated fish communities	South-west
Western rock lobster	South-west

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Seabirds		
Anous stolidus		
Common Noddy [825]	Foraging (provisioning young)	Known to occur
Anous tenuirorstris melanops		
Australian Lesser Noddy [26000]	Foraging (provisioning young)	Known to occur
Ardenna pacifica		
Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna pacifica		
Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Hydroprogne caspia		
Caspian Tern [808]	Foraging (provisioning young)	Known to occur
Larus pacificus		
Pacific Gull [811]	Foraging (in high numbers)	Known to occur

Scientific Name	Behaviour	Presence
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Onychoprion fuscata Sooty Tern [82847]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging (in high numbers)	Known to occur
Pterodroma mollis Soft-plumaged Petrel [1036]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Foraging (provisioning young)	Known to occur
Sternula nereis Fairy Tern [82949]	Foraging (in high numbers)	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Likely to occur
Neophoca cinerea Australian Sea Lion [22]	Foraging (male and female)	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur

Scientific Name	Behaviour	Presence
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jan-2025

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	1
National Heritage Places:	2
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	4
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	62
Listed Migratory Species:	84

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	225
Commonwealth Heritage Places:	1
Listed Marine Species:	135
Whales and Other Cetaceans:	32
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	12
Habitat Critical to the Survival of Marine Turtles:	4

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	54
Regional Forest Agreements:	None
Nationally Important Wetlands:	4
EPBC Act Referrals:	315
Key Ecological Features (Marine):	7
Biologically Important Areas:	49
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties [Resource Information]

Name	State	Legal Status
The Ningaloo Coast	WA	Declared property

National Heritage Places [Resource Information]

Name	State	Legal Status
Indigenous		
Dampier Archipelago (including Burrup Peninsula)	WA	Listed place
Natural		
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Malurus leucopterus edouardi White-winged Fairy-wren (Barrow Island), Barrow Island Black-and-white Fairy-wren [26194]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat likely to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area
FISH		
Milyeringa veritas		
Cape Range Cave Gudgeon, Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum		
Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Bettongia lesueur Barrow and Boodie Islands subspecies		
Boodie, Burrowing Bettong (Barrow and Boodie Islands) [88021]	Vulnerable	Species or species habitat known to occur within area
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isoodon auratus barrowensis Golden Bandicoot (Barrow Island) [66666]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes conspicillatus conspicillatus Spectacled Hare-wallaby (Barrow Island) [66661]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus Central Australian subspecies Mala, Rufous Hare-Wallaby (Central Australia) [88019]	Endangered	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat known to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Species or species habitat known to occur within area
Osphranter robustus isabellinus Barrow Island Wallaroo, Barrow Island Euro [89262]	Vulnerable	Species or species habitat likely to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Minuria tridens Minnie Daisy [13753]	Vulnerable	Species or species habitat known to occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus zastictus Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Lerista nevinae Nevin's Slider [85296]	Endangered	Species or species habitat known to occur within area
Liasis olivaceus barroni Pilbara Olive Python [66699]	Vulnerable	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
SHARK		
Carcharias taurus (west coast population) Grey Nurse Shark (west coast population) [68752]	Vulnerable	Congregation or aggregation known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharias taurus Grey Nurse Shark [64469]		Congregation or aggregation known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat known to occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Breeding known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Cuculus optatus Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		

Scientific Name	Threatened Category	Presence Text
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa glareola Wood Sandpiper [829]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50125]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50124]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50129]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50128]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50126]	WA
Defence - EXMOUTH ADMIN & HF TRANSMITTING [50127]	WA
Defence - EXMOUTH NAVAL HF RECEIVING STATION (H/F Receiving Station, Learmonth, WA) [50130]	WA
Defence - EXMOUTH VLF TRANSMITTER STATION [50122]	WA
Defence - EXMOUTH VLF TRANSMITTER STATION [50123]	WA
Defence - KARRATHA TRAINING DEPOT [50200]	WA
Defence - KARRATHA TRAINING DEPOT [50238]	WA
Defence - KARRATHA TRAINING DEPOT [50237]	WA
Defence - LEARMONTH - RAAF BASE [50099]	WA
Defence - LEARMONTH - RAAF BASE [50097]	WA
Defence - LEARMONTH - RAAF BASE [50105]	WA
Defence - LEARMONTH - RAAF BASE [50104]	WA
Defence - LEARMONTH - RAAF BASE [50100]	WA
Defence - LEARMONTH - RAAF BASE [50098]	WA
Defence - LEARMONTH - RAAF BASE [50096]	WA
Defence - LEARMONTH - RAAF BASE [50107]	WA
Defence - LEARMONTH - RAAF BASE [50101]	WA
Defence - LEARMONTH - RAAF BASE [50106]	WA

Commonwealth Land Name	State
Defence - LEARMONTH - RAAF BASE [50103]	WA
Defence - LEARMONTH - RAAF BASE [50102]	WA
Defence - LEARMONTH - RAAF BASE [50109]	WA
Defence - LEARMONTH - RAAF BASE [50108]	WA
Defence - LEARMONTH RADAR SITE - TWIN TANKS EXMOUTH [50002]	WA
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH [50001]	WA
Defence - LEARMONTH TRANSMITTING STATION [50239]	WA
Unknown	
Commonwealth Land - [51700]	WA
Commonwealth Land - [51703]	WA
Commonwealth Land - [51676]	WA
Commonwealth Land - [51678]	WA
Commonwealth Land - [51674]	WA
Commonwealth Land - [51677]	WA
Commonwealth Land - [51705]	WA
Commonwealth Land - [51704]	WA
Commonwealth Land - [50323]	WA
Commonwealth Land - [51709]	WA
Commonwealth Land - [51455]	WA
Commonwealth Land - [50978]	WA
Commonwealth Land - [51584]	WA
Commonwealth Land - [50975]	WA
Commonwealth Land - [50974]	WA
Commonwealth Land - [50977]	WA
Commonwealth Land - [50976]	WA
Commonwealth Land - [51707]	WA

Commonwealth Land Name	State
Commonwealth Land - [51566]	WA
Commonwealth Land - [52104]	WA
Commonwealth Land - [52110]	WA
Commonwealth Land - [51675]	WA
Commonwealth Land - [51673]	WA
Commonwealth Land - [51564]	WA
Commonwealth Land - [52108]	WA
Commonwealth Land - [50385]	WA
Commonwealth Land - [51702]	WA
Commonwealth Land - [51559]	WA
Commonwealth Land - [51670]	WA
Commonwealth Land - [51672]	WA
Commonwealth Land - [51555]	WA
Commonwealth Land - [51556]	WA
Commonwealth Land - [51557]	WA
Commonwealth Land - [51558]	WA
Commonwealth Land - [51552]	WA
Commonwealth Land - [51553]	WA
Commonwealth Land - [51554]	WA
Commonwealth Land - [51698]	WA
Commonwealth Land - [51695]	WA
Commonwealth Land - [51697]	WA
Commonwealth Land - [51693]	WA
Commonwealth Land - [51694]	WA
Commonwealth Land - [51691]	WA
Commonwealth Land - [51692]	WA
Commonwealth Land - [51442]	WA

Commonwealth Land Name	State
Commonwealth Land - [51706]	WA
Commonwealth Land - [51443]	WA
Commonwealth Land - [51579]	WA
Commonwealth Land - [51578]	WA
Commonwealth Land - [51393]	WA
Commonwealth Land - [51596]	WA
Commonwealth Land - [52098]	WA
Commonwealth Land - [50349]	WA
Commonwealth Land - [52099]	WA
Commonwealth Land - [51592]	WA
Commonwealth Land - [52097]	WA
Commonwealth Land - [51593]	WA
Commonwealth Land - [51460]	WA
Commonwealth Land - [51461]	WA
Commonwealth Land - [51466]	WA
Commonwealth Land - [51467]	WA
Commonwealth Land - [51465]	WA
Commonwealth Land - [51947]	WA
Commonwealth Land - [51601]	WA
Commonwealth Land - [51600]	WA
Commonwealth Land - [51463]	WA
Commonwealth Land - [51462]	WA
Commonwealth Land - [51588]	WA
Commonwealth Land - [51464]	WA
Commonwealth Land - [51468]	WA
Commonwealth Land - [52198]	WA
Commonwealth Land - [52195]	WA

Commonwealth Land Name	State
Commonwealth Land - [51456]	WA
Commonwealth Land - [51428]	WA
Commonwealth Land - [51050]	WA
Commonwealth Land - [50989]	WA
Commonwealth Land - [52234]	WA
Commonwealth Land - [51054]	WA
Commonwealth Land - [51055]	WA
Commonwealth Land - [51053]	WA
Commonwealth Land - [51589]	WA
Commonwealth Land - [51581]	WA
Commonwealth Land - [52096]	WA
Commonwealth Land - [51454]	WA
Commonwealth Land - [51451]	WA
Commonwealth Land - [51453]	WA
Commonwealth Land - [51450]	WA
Commonwealth Land - [51459]	WA
Commonwealth Land - [51452]	WA
Commonwealth Land - [51712]	WA
Commonwealth Land - [51458]	WA
Commonwealth Land - [51690]	WA
Commonwealth Land - [51671]	WA
Commonwealth Land - [51720]	WA
Commonwealth Land - [52131]	WA
Commonwealth Land - [50990]	WA
Commonwealth Land - [51713]	WA
Commonwealth Land - [51586]	WA
Commonwealth Land - [51587]	WA

Commonwealth Land Name	State
Commonwealth Land - [51585]	WA
Commonwealth Land - [52220]	WA
Commonwealth Land - [51939]	WA
Commonwealth Land - [51682]	WA
Commonwealth Land - [51935]	WA
Commonwealth Land - [51934]	WA
Commonwealth Land - [51477]	WA
Commonwealth Land - [51469]	WA
Commonwealth Land - [51582]	WA
Commonwealth Land - [51583]	WA
Commonwealth Land - [51668]	WA
Commonwealth Land - [51580]	WA
Commonwealth Land - [51471]	WA
Commonwealth Land - [51470]	WA
Commonwealth Land - [51473]	WA
Commonwealth Land - [51472]	WA
Commonwealth Land - [51475]	WA
Commonwealth Land - [51474]	WA
Commonwealth Land - [51476]	WA
Commonwealth Land - [51574]	WA
Commonwealth Land - [51576]	WA
Commonwealth Land - [51577]	WA
Commonwealth Land - [51571]	WA
Commonwealth Land - [51688]	WA
Commonwealth Land - [51575]	WA
Commonwealth Land - [51572]	WA
Commonwealth Land - [51573]	WA

Commonwealth Land Name	State
Commonwealth Land - [51570]	WA
Commonwealth Land - [51689]	WA
Commonwealth Land - [51684]	WA
Commonwealth Land - [51685]	WA
Commonwealth Land - [51680]	WA
Commonwealth Land - [51681]	WA
Commonwealth Land - [51686]	WA
Commonwealth Land - [51687]	WA
Commonwealth Land - [51104]	WA
Commonwealth Land - [51696]	WA
Commonwealth Land - [51683]	WA
Commonwealth Land - [51457]	WA
Commonwealth Land - [52109]	WA
Commonwealth Land - [52107]	WA
Commonwealth Land - [52106]	WA
Commonwealth Land - [52105]	WA
Commonwealth Land - [52102]	WA
Commonwealth Land - [52103]	WA
Commonwealth Land - [52100]	WA
Commonwealth Land - [52101]	WA
Commonwealth Land - [51679]	WA
Commonwealth Land - [50324]	WA
Commonwealth Land - [50325]	WA
Commonwealth Land - [51590]	WA
Commonwealth Land - [51714]	WA
Commonwealth Land - [51717]	WA
Commonwealth Land - [51716]	WA

Commonwealth Land Name	State
Commonwealth Land - [51711]	WA
Commonwealth Land - [51446]	WA
Commonwealth Land - [51568]	WA
Commonwealth Land - [51569]	WA
Commonwealth Land - [51708]	WA
Commonwealth Land - [51715]	WA
Commonwealth Land - [51445]	WA
Commonwealth Land - [51561]	WA
Commonwealth Land - [51447]	WA
Commonwealth Land - [51444]	WA
Commonwealth Land - [51719]	WA
Commonwealth Land - [51710]	WA
Commonwealth Land - [51562]	WA
Commonwealth Land - [51718]	WA
Commonwealth Land - [51403]	WA
Commonwealth Land - [51404]	WA
Commonwealth Land - [51884]	WA
Commonwealth Land - [51887]	WA
Commonwealth Land - [51591]	WA
Commonwealth Land - [51666]	WA
Commonwealth Land - [51597]	WA
Commonwealth Land - [51669]	WA
Commonwealth Land - [51667]	WA
Commonwealth Land - [50359]	WA
Commonwealth Land - [51598]	WA
Commonwealth Land - [51048]	WA
Commonwealth Land - [51049]	WA

Commonwealth Land Name	State
Commonwealth Land - [50326]	WA
Commonwealth Land - [50327]	WA
Commonwealth Land - [51567]	WA
Commonwealth Land - [51565]	WA
Commonwealth Land - [51599]	WA
Commonwealth Land - [51560]	WA
Commonwealth Land - [51449]	WA
Commonwealth Land - [51563]	WA
Commonwealth Land - [52205]	WA
Commonwealth Land - [51052]	WA
Commonwealth Land - [51051]	WA
Commonwealth Land - [51429]	WA
Commonwealth Land - [51699]	WA
Commonwealth Land - [51448]	WA
Commonwealth Land - [51595]	WA
Commonwealth Land - [51594]	WA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat likely to occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat may occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Species or species habitat known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Species or species habitat known to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat likely to occur within area overfly marine area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula nereis as Sterna nereis		
Fairy Tern [82949]		Breeding known to occur within area
Stiltia isabella		
Australian Pratincole [818]		Species or species habitat known to occur within area overfly marine area
Sula dactylatra		
Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster		
Brown Booby [1022]		Breeding known to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalasseus bengalensis as Sterna bengalensis		
Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes		
Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Species or species habitat known to occur within area overfly marine area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Fish		
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Phoxocampus belcheri Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammal		

Scientific Name	Threatened Category	Presence Text
Dugong dugon Dugong [28]		Breeding known to occur within area
Reptile		
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus duboisii Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Sea Snake, Mjoberg's Sea Snake [1121]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis czeblukovi Fine-spined Sea Snake [59233]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Current Scientific Name	Status	Type of Presence
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa sahulensis Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Dampier	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Dampier	Multiple Use Zone (IUCN VI)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Gascoyne	Multiple Use Zone (IUCN VI)
Montebello	Multiple Use Zone (IUCN VI)
Dampier	National Park Zone (IUCN II)
Gascoyne	National Park Zone (IUCN II)
Ningaloo	Recreational Use Zone (IUCN IV)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles [Resource Information]

Scientific Name	Behaviour	Presence
Aug - Sep		

Scientific Name	Behaviour	Presence
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Nov-Feb		
Caretta caretta Loggerhead Turtle [1763]	Nesting	Known to occur
Nov - May		
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Airlie Island	Nature Reserve	WA
Barrow Island	Nature Reserve	WA
Barrow Island	Marine Park	WA
Barrow Island	Marine Management Area	WA
Bedout Island	Nature Reserve	WA
Bessieres Island	Nature Reserve	WA
Boodie, Double Middle Islands	Nature Reserve	WA
Bundegi Coastal Park	5(1)(h) Reserve	WA
Burnside And Simpson Island	Nature Reserve	WA
Cane River (Mount Minnie and Nanutarra)	NRS Addition - Gazettal in Progress	WA
Cape Range	Conservation Park	WA
Cape Range	National Park	WA
Eighty Mile Beach	Marine Park	WA
Giralia	NRS Addition - Gazettal in Progress	WA

Protected Area Name	Reserve Type	State
Gnandaroo Island	Nature Reserve	WA
Great Sandy Island	Nature Reserve	WA
Jurabi Coastal Park	5(1)(h) Reserve	WA
Little Rocky Island	Nature Reserve	WA
Locker Island	Nature Reserve	WA
Lowendal Islands	Nature Reserve	WA
Montebello Islands	Conservation Park	WA
Montebello Islands	Marine Park	WA
Montebello Islands	Conservation Park	WA
Muiron Islands	Nature Reserve	WA
Muiron Islands	Marine Management Area	WA
Murujuga	5(1)(h) Reserve	WA
Murujuga	National Park	WA
Ningaloo	Marine Park	WA
North Sandy Island	Nature Reserve	WA
North Turtle Island	Nature Reserve	WA
Rocky Island	Nature Reserve	WA
Round Island	Nature Reserve	WA
Rowley Shoals	Marine Park	WA
Serrurier Island	Nature Reserve	WA
Tent Island	Nature Reserve	WA
Thevenard Island	Nature Reserve	WA
Unnamed WA36907	5(1)(h) Reserve	WA
Unnamed WA36909	5(1)(h) Reserve	WA
Unnamed WA36910	5(1)(h) Reserve	WA
Unnamed WA36913	Nature Reserve	WA

Protected Area Name	Reserve Type	State
Unnamed WA36915	Nature Reserve	WA
Unnamed WA38287	5(1)(h) Reserve	WA
Unnamed WA40322	5(1)(h) Reserve	WA
Unnamed WA40828	5(1)(h) Reserve	WA
Unnamed WA40877	5(1)(h) Reserve	WA
Unnamed WA41080	5(1)(h) Reserve	WA
Unnamed WA44665	5(1)(h) Reserve	WA
Unnamed WA44667	5(1)(h) Reserve	WA
Unnamed WA44672	5(1)(h) Reserve	WA
Victor Island	Nature Reserve	WA
Weld Island	Nature Reserve	WA
Whalebone Island	Nature Reserve	WA
Whitmore,Roberts,Doole Islands And Sandalwood Landing	Nature Reserve	WA
Y Island	Nature Reserve	WA

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Cape Range Subterranean Waterways	WA
De Grey River	WA
Exmouth Gulf East	WA
Leslie (Port Hedland) Saltfields System	WA

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Ashburton Infrastructure Project	2021/9064		Completed
Balla Balla Export Facilities ? Design Variation	2022/09254		Assessment
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Burrup Common User Transmission Infrastructure	2022/09407		Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Burrup Peninsula Seawater Supply Scheme Upgrade	2023/09698		Completed
Dampier Seawater Desalination Plant	2022/09395		Completed
East Pilbara Network Stage 1	2024/09933		Completed
Gorgon Gas Development	2003/1294		Post-Approval
Hemi Gold Project	2023/09556		Referral Decision
Ningaloo Lighthouse Development, 17km north west Exmouth, Western Australia	2020/8693		Post-Approval
North West Shelf Project Extension, Carnarvon Basin, WA	2018/8335		Approval
Optimised Mardie Solar Salt Project	2022/9169		Post-Approval
Port Hedland Green Steel Project - Stage 1	2023/09764		Assessment
Port Hedland Solar Project	2022/09241		Post-Approval
Project Highclere Cable Lay and Operation	2022/09203		Completed
Ridley Magnetite Project	2023/09477		Referral Decision
Single Jetty Deep Water Port Renewable Hub, WA	2021/8942		Assessment
Woodside Solar Facility	2022/09328		Assessment
Action clearly unacceptable			
Highlands 3D Marine Seismic Survey	2012/6680	Action Clearly Unacceptable	Completed
Controlled action			
'Van Gogh' Petroleum Field Development	2007/3213	Controlled Action	Post-Approval
Additional Rail Infrastructure between Herb Elliott Port Facility and Cloudbreak Mine Site	2010/5513	Controlled Action	Post-Approval
Ammonium Nitrate Project	2010/5423	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Anketell Point Iron Ore Processing & Export Port	2009/5120	Controlled Action	Post-Approval
Balla Balla Rail and Conveyor Project, WA	2015/7420	Controlled Action	Post-Approval
Balmoral South Iron Ore Mine	2008/4236	Controlled Action	Post-Approval
Binowee Iron Ore Project	2001/366	Controlled Action	Proposed Decision
Burrup North East Sand Mining Project	2008/4611	Controlled Action	Completed
Cape Lambert Port B Development	2008/4032	Controlled Action	Post-Approval
Construct and operate LNG & domestic gas plant including onshore and offshore facilities - Wheatston	2008/4469	Controlled Action	Post-Approval
Construction and operation of a Solar Salt Project, SW Onslow, WA	2016/7793	Controlled Action	Assessment Approach
Develop Jansz-Io deepwater gas field in Permit Areas WA-18-R, WA-25-R and WA-26-	2005/2184	Controlled Action	Post-Approval
Development of Angel gas and condensate field, North West Shelf	2004/1805	Controlled Action	Post-Approval
Development of an iron ore mine and associated infrastructure	2010/5630	Controlled Action	Assessment Approach
Development of a Quarry Operation to extract gravel, sand and pindan material	2012/6636	Controlled Action	Post-Approval
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Development of Coniston/Novara fields within the Exmouth Sub-basin	2011/5995	Controlled Action	Post-Approval
Development of Stybarrow petroleum field incl drilling and facility installation	2004/1469	Controlled Action	Post-Approval
Duplication of the Dampier Highway Stages 2 & 6	2010/5419	Controlled Action	Post-Approval
Echo-Yodel Production Wells	2000/11	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Enfield full field development	2001/257	Controlled Action	Post-Approval
Equus Gas Fields Development Project, Carnarvon Basin	2012/6301	Controlled Action	Completed
Eramurra Industrial Salt Project	2021/9027	Controlled Action	Assessment Approach
Eramurra Industrial Salt Project, near Karratha, WA	2019/8448	Controlled Action	Completed
Gorgon Gas Development 4th Train Proposal	2011/5942	Controlled Action	Post-Approval
Gorgon Gas Revised Development	2008/4178	Controlled Action	Post-Approval
Greater Enfield (Vincent) Development	2005/2110	Controlled Action	Post-Approval
Greater Gorgon Development - Optical Fibre Cable, Mainland to Barrow Island	2005/2141	Controlled Action	Completed
Great Northern Pipeline - 630 km buried gas pipeline	2009/5257	Controlled Action	Completed
Learmonth Bundle Site and Launchway, WA	2017/8079	Controlled Action	Completed
Light Crude Oil Production	2001/365	Controlled Action	Post-Approval
Mardie Project, 80 km south west of Karratha, WA	2018/8236	Controlled Action	Post-Approval
Nava-1 Cable System	2001/510	Controlled Action	Completed
North Star Magnetite Project	2012/6689	Controlled Action	Post-Approval
North West Shelf Gas Venture Phase VI Expansion	2007/3436	Controlled Action	Referral Decision
Perdaman Urea Project, near Karratha, WA	2018/8383	Controlled Action	Post-Approval
Pluto Gas Project	2005/2258	Controlled Action	Completed
Pluto Gas Project Including Site B	2006/2968	Controlled Action	Post-Approval
Poondano Iron Ore Project	2010/5759	Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Port Hedland Outer Harbour Development and associated marine and terrestrial in	2008/4159	Controlled Action	Post-Approval
Port Hedland Spoilbank Marina, WA	2019/8520	Controlled Action	Post-Approval
Proposed technical ammonium nitrate production facility	2008/4546	Controlled Action	Post-Approval
Proposed West Pilbara Iron Ore Project	2009/4706	Controlled Action	Post-Approval
Pyrenees Oil Fields Development	2005/2034	Controlled Action	Post-Approval
Roy Hill to Port Hedland Rail Line and Associated Infrastructure	2010/5424	Controlled Action	Post-Approval
Simpson Development	2000/59	Controlled Action	Completed
Simpson Oil Field Development	2001/227	Controlled Action	Post-Approval
site preparations	2005/2391	Controlled Action	Post-Approval
The Scarborough Project - FLNG & assoc subsea infrastructure, Carnarvon Basin	2013/6811	Controlled Action	Post-Approval
Vincent Appraisal Well	2000/22	Controlled Action	Post-Approval
Widening and resurfacing two principal roads servicing the Dampier Port Authori	2010/5677	Controlled Action	Completed
Yannarie Solar Salt Project	2004/1679	Controlled Action	Completed
Yardie Creek Road Realignment Project	2021/8967	Controlled Action	Assessment Approach
Not controlled action			
'Goodwyn A' Low Pressure Train Project	2003/914	Not Controlled Action	Completed
'Van Gogh' Oil Appraisal Drilling Program, Exploration Permit Area WA-155-P(1)	2006/3148	Not Controlled Action	Completed
150m Boodarie Gas Lateral Pipeline	2014/7116	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Airlie Island soil and groundwater investigations, Exmouth Gulf, offshore Pilbara coast	2014/7250	Not Controlled Action	Completed
Ammonia Plant	2001/199	Not Controlled Action	Completed
APX-West Fibre-optic telecommunications cable system, WA to Singapore	2013/7102	Not Controlled Action	Completed
Baniyas-1 Exploration Well, EP-424, near Onslow	2007/3282	Not Controlled Action	Completed
Barrow Island 2D Seismic survey	2006/2667	Not Controlled Action	Completed
Bollinger 2D Seismic Survey 200km North of North West Cape WA	2004/1868	Not Controlled Action	Completed
Bulgarene Borefield	2006/2507	Not Controlled Action	Completed
Bultaco-2, Laverda-2, Laverda-3 and Montesa-2 Appraisal Wells	2000/103	Not Controlled Action	Completed
Cape Lambert Port A Marine Structures Refurbishment Project	2018/8370	Not Controlled Action	Completed
Carnarvon 3D Marine Seismic Survey	2004/1890	Not Controlled Action	Completed
Cazadores 2D seismic survey	2004/1720	Not Controlled Action	Completed
Construct 110km buried natural gas pipeline from Onslow, connecting to Dampier/Bunbury natural gas p	2013/7039	Not Controlled Action	Completed
Construction and operation of an unmanned sea platform and connecting pipeline to Varanus Island for	2004/1703	Not Controlled Action	Completed
Construction of a Commodities Berth, Wharf and Associated Infrastructure	2008/4129	Not Controlled Action	Completed
Construction of Loadout Facility and Laydown Area	2002/598	Not Controlled Action	Completed
Controlled Source Electromagnetic Survey	2007/3262	Not Controlled Action	Completed
Deep Gorge Boardwalk, Murujuga National Park, WA	2018/8283	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Development of Halyard Field off the west coast of WA	2010/5611	Not Controlled Action	Completed
Development of Industrial Land, Port of Dampier	2003/1293	Not Controlled Action	Completed
Development of iron ore facilities	2013/7013	Not Controlled Action	Completed
Development of iron ore resources in eastern Pilbara region, including port at P	2004/1562	Not Controlled Action	Completed
Development of Mutineer and Exeter petroleum fields for oil production, Permit	2003/1033	Not Controlled Action	Completed
Differential Global Positioning System (DGPS)	2001/445	Not Controlled Action	Completed
Dimethyl ether plant	2001/509	Not Controlled Action	Completed
Drilling of an exploration well Gats-1 in Permit Area WA-261-P	2004/1701	Not Controlled Action	Completed
Eagle-1 Exploration Drilling, North West Shelf, WA	2019/8578	Not Controlled Action	Completed
Echo A Development WA-23-L, WA-24-L	2005/2042	Not Controlled Action	Completed
Expansion of the Sino Iron Ore Mine and export facilities, Cape Preston, WA	2017/7862	Not Controlled Action	Completed
Expansion Proposal, Mineralogy Cape Preston Iron Ore Project, Cape Preston, WA	2009/5010	Not Controlled Action	Completed
Exploration drilling well WA-155-P(1)	2003/971	Not Controlled Action	Completed
Exploration of appraisal wells	2006/3065	Not Controlled Action	Completed
Exploration Well (Taunton-2)	2002/731	Not Controlled Action	Completed
Exploration Well in Permit Area WA-155-P(1)	2002/759	Not Controlled Action	Completed
Exploratory drilling in permit area WA-225-P	2001/490	Not Controlled Action	Completed
Extension of Simpson Oil Platforms & Wells	2002/685	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Gulf Fishing Lodge	2010/5499	Not Controlled Action	Completed
HCA05X Macedon Experimental Survey	2004/1926	Not Controlled Action	Completed
Hess Exploration Drilling Programme	2007/3566	Not Controlled Action	Completed
Horizon Power South Hedland Transmission Line, WA	2012/6551	Not Controlled Action	Completed
Huascaran-1 exploration well (WA-292-P)	2001/539	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO West Submarine Telecommunications Cable, WA	2017/8126	Not Controlled Action	Completed
Infill Production Well (Griffin-9)	2001/417	Not Controlled Action	Completed
Iron Bridge Port Facility, Port Hedland, WA	2015/7565	Not Controlled Action	Completed
Jansz-2 and 3 Appraisal Wells	2002/754	Not Controlled Action	Completed
King Bay East Rock Quarry & Industrial Estate Development	2003/1150	Not Controlled Action	Completed
Klammer 2D Seismic Survey	2002/868	Not Controlled Action	Completed
Learmonth Limestone Quarry	2001/392	Not Controlled Action	Completed
Mahimahi Aquaculture Facility	2002/891	Not Controlled Action	Completed
Maia-Gaea Exploration wells	2000/17	Not Controlled Action	Completed
Manaslu - 1 and Huascaran - 1 Offshore Exploration Wells	2001/235	Not Controlled Action	Completed
Mermaid Marine Australia Desalination Project	2011/5916	Not Controlled Action	Completed
Methanol manufacturing	2001/528	Not Controlled Action	Completed
Methanol plant	2001/521	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Montesa-1 and Bultaco-1 Exploration Wells	2000/102	Not Controlled Action	Completed
Murujuga archaeological excavation, collection and sampling, Dampier Archipelago, WA	2014/7160	Not Controlled Action	Completed
North Rankin B gas compression facility	2005/2500	Not Controlled Action	Completed
Onslow Power Infrastructure Upgrade Project, Onslow, WA	2014/7314	Not Controlled Action	Completed
Onslow Rare Earths Plant	2021/9046	Not Controlled Action	Completed
Onslow Water Supply Infrastructure Upgrade Project, Onslow, WA	2014/7329	Not Controlled Action	Completed
Pardoo Direct Shipping Ore (DSO) Project	2007/3539	Not Controlled Action	Completed
Pilbara Bulk Ore Transport System Project, WA	2016/7637	Not Controlled Action	Completed
Pilbara Transmission Project, Pilbara, WA	2018/8349	Not Controlled Action	Completed
Pipeline System Modifications Project	2000/3	Not Controlled Action	Completed
Pluto-North West Shelf Interconnector, Burrup Peninsula, WA	2018/8353	Not Controlled Action	Completed
Port Expansion and Dredging	2003/1265	Not Controlled Action	Completed
Port Hedland Channel Risk and Optimisation Project, WA	2017/7915	Not Controlled Action	Completed
Port Hedland Power Station Conversion Project	2011/6080	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Rail and Port Facilities	2001/474	Not Controlled Action	Completed
Relocation of approx. 670m of the Pilbara Energy Pipeline	2013/6756	Not Controlled Action	Completed
Roebourne Quarry	2017/7873	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Searipple gas and condensate field development	2000/89	Not Controlled Action	Completed
South Hedland Power Station WA	2011/5929	Not Controlled Action	Completed
Spool Base Facility	2001/263	Not Controlled Action	Completed
Stages 1 & 2 Port of Dampier Security Upgrade & Associated Works	2004/1751	Not Controlled Action	Completed
Subsea Gas Pipeline From Stybarrow Field to Griffin Venture Gas Export Pipeline	2005/2033	Not Controlled Action	Completed
sub-sea tieback of Perseus field wells	2004/1326	Not Controlled Action	Completed
Telfer Gold Mine Project - Mine and Borefield Extensions and Upgrade of Storage	2002/787	Not Controlled Action	Completed
Telfer Gold Mine Project - Power Supply and Infrastructure Corridor	2002/786	Not Controlled Action	Completed
Telstra North Rankin Spur Fibre Optic Cable	2016/7836	Not Controlled Action	Completed
Thevenard Island Retirement Project	2015/7423	Not Controlled Action	Completed
To construct and operate an offshore submarine fibre optic cable, WA	2014/7373	Not Controlled Action	Completed
WA-295-P Kerr-McGee Exploration Wells	2001/152	Not Controlled Action	Completed
Walkway Lighting Upgrade	2009/4965	Not Controlled Action	Completed
Wanda Offshore Research Project, 80 km north-east of Exmouth, WA	2018/8293	Not Controlled Action	Completed
Western Flank Gas Development	2005/2464	Not Controlled Action	Completed
Wheatstone 3D seismic survey, 70km north of Barrow Island	2004/1761	Not Controlled Action	Completed
Widening of MOF Road	2005/2305	Not Controlled Action	Completed
Wodgina Lithium Mine Expansion, Pilbara, NT	2018/8194	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Woodside Project Facilities Increase	2006/3191	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Kate' 3D marine seismic survey, exploration permits WA-320-P and WA-345-P, 60km	2005/2037	Not Controlled Action (Particular Manner)	Post-Approval
'Tourmaline' 2D marine seismic survey, permit areas WA-323-P, WA-330-P and WA-32	2005/2282	Not Controlled Action (Particular Manner)	Post-Approval
"Leanne" offshore 3D seismic exploration, WA-356-P	2005/1938	Not Controlled Action (Particular Manner)	Post-Approval
2D and 3D seismic surveys	2005/2151	Not Controlled Action (Particular Manner)	Post-Approval
2D marine seismic survey	2012/6296	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2005/2146	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey Permit Area WA-352-P	2008/4628	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey within permit WA-291	2007/3265	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey	2008/4281	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey (WA-482-P, WA-363-P), WA	2013/6761	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey in Permit Areas WA-15-R, WA-18-R, WA-205-P, WA-253-P, WA-267-P and WA-268-P	2003/1271	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
3D Marine Seismic Survey in WA 457-P & WA 458-P, North West Shelf, offshore WA	2013/6862	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey over petroleum title WA-268-P	2007/3458	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Surveys - Contos CT-13 & Supertubes CT-13, offshore WA	2013/6901	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic survey	2006/2715	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, WA	2008/4428	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey in the Carnarvon Bsin on the North West Shelf	2002/778	Not Controlled Action (Particular Manner)	Post-Approval
3D sesmic survey	2006/2781	Not Controlled Action (Particular Manner)	Post-Approval
Additional Rail Infrastructure	2012/6314	Not Controlled Action (Particular Manner)	Post-Approval
Agrippina 3D Seismic Marine Survey	2009/5212	Not Controlled Action (Particular Manner)	Post-Approval
Algae Farm and Processing Facilities	2012/6596	Not Controlled Action (Particular Manner)	Post-Approval
Ammonia Plant, Murujuga Burrup Peninsula - Renewable Hydrogen Project	2020/8739	Not Controlled Action (Particular Manner)	Post-Approval
Apache Northwest Shelf Van Gogh Field Appraisal Drilling Program	2007/3495	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Aperio 3D Marine Seismic Survey, WA	2012/6648	Not Controlled Action (Particular Manner)	Post-Approval
Artemis-1 Drilling Program (WA-360-P)	2010/5432	Not Controlled Action (Particular Manner)	Post-Approval
Atlas Boodarie Link Project, WA	2012/6506	Not Controlled Action (Particular Manner)	Post-Approval
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
Babylon 3D Marine Seismic Survey, Commonwealth Waters, nr Exmouth WA	2013/7081	Not Controlled Action (Particular Manner)	Post-Approval
Balnaves Condensate Field Development	2011/6188	Not Controlled Action (Particular Manner)	Post-Approval
Bonaventure 3D seismic survey	2006/2514	Not Controlled Action (Particular Manner)	Post-Approval
Buckland Iron Ore Mining Project, Pilbara region, WA	2013/6867	Not Controlled Action (Particular Manner)	Post-Approval
Cable Seismic Exploration Permit areas WA-323-P and WA-330-P	2008/4227	Not Controlled Action (Particular Manner)	Post-Approval
Cape Preston East - Iron Ore Export Facilities, Pilbara, WA	2013/6844	Not Controlled Action (Particular Manner)	Post-Approval
Cerberus exploration drilling campaign, Carnarvon Basin, WA	2016/7645	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
CGGVERITAS 2010 2D Seismic Survey	2010/5714	Not Controlled Action (Particular Manner)	Post-Approval
Charon 3D Marine Seismic Survey	2007/3477	Not Controlled Action (Particular Manner)	Post-Approval
Consturction & operation of the Varanus Island kitchen & mess cyclone refuge building, compression p	2013/6952	Not Controlled Action (Particular Manner)	Post-Approval
Cue Seismic Survey within WA-359-P, WA-361-P and WA-360-P	2007/3647	Not Controlled Action (Particular Manner)	Post-Approval
CVG 3D Marine Seismic Survey	2012/6654	Not Controlled Action (Particular Manner)	Post-Approval
Dampier Marine Services Facility including 300m Wharf and Dredging Works	2009/5108	Not Controlled Action (Particular Manner)	Post-Approval
DAVROS MC 3D marine seismic survey northwaet of Dampier, WA	2013/7092	Not Controlled Action (Particular Manner)	Post-Approval
Decommissioning of the Legendre facilities	2010/5681	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Drilling Program	2010/5532	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Demeter 3D Seismic Survey, off Dampier, WA	2002/900	Not Controlled Action (Particular Manner)	Post-Approval
Diesel Fuel Bunker Operation	2012/6289	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Draeck 3D Marine Seismic Survey, WA-205-P	2006/3067	Not Controlled Action (Particular Manner)	Post-Approval
Dredging of marine sediment to enable construction of eight berths and a turnin	2010/5678	Not Controlled Action (Particular Manner)	Post-Approval
Drilling 35-40 offshore exploration wells in deep water	2008/4461	Not Controlled Action (Particular Manner)	Post-Approval
Earthworks for kitchen/mess, cyclone refuge building & Compression Plant, Varanus Island	2013/6900	Not Controlled Action (Particular Manner)	Post-Approval
Eendracht Multi-Client 3D Marine Seismic Survey	2009/4749	Not Controlled Action (Particular Manner)	Post-Approval
Effect of marine seismic sounds to demersal fish and pearl oysters, north-west WA	2018/8169	Not Controlled Action (Particular Manner)	Post-Approval
Enfield M3 & Vincent 4D Marine Seismic Surveys	2008/3981	Not Controlled Action (Particular Manner)	Completed
Enfield M3 4D, Vincent 4D & 4D Line Test Marine Seismic Surveys	2008/4122	Not Controlled Action (Particular Manner)	Post-Approval
Enfield M4 4D Marine Seismic Survey	2008/4558	Not Controlled Action (Particular Manner)	Post-Approval
Enfield oilfield 3D Seismic Survey	2006/3132	Not Controlled Action (Particular Manner)	Post-Approval
Exmouth West 2D Marine Seismic Survey	2008/4132	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Exploration drilling of Zeus-1 well	2008/4351	Not Controlled Action (Particular Manner)	Post-Approval
Fletcher-Finucane Development, WA26-L and WA191-P	2011/6123	Not Controlled Action (Particular Manner)	Post-Approval
Foxhound 3D Non-Exclusive Marine Seismic Survey	2009/4703	Not Controlled Action (Particular Manner)	Post-Approval
Gazelle 3D Marine Seismic Survey in WA-399-P and WA-42-L	2010/5570	Not Controlled Action (Particular Manner)	Post-Approval
Geco Eagle 3D Marine Seismic Survey	2008/3958	Not Controlled Action (Particular Manner)	Post-Approval
Glencoe 3D Marine Seismic Survey WA-390-P	2007/3684	Not Controlled Action (Particular Manner)	Post-Approval
Greater Western Flank Phase 1 gas Development	2011/5980	Not Controlled Action (Particular Manner)	Post-Approval
Grimalkin 3D Seismic Survey	2008/4523	Not Controlled Action (Particular Manner)	Post-Approval
Guacamole 2D Marine Seismic Survey	2008/4381	Not Controlled Action (Particular Manner)	Post-Approval
Harmony 3D Marine Seismic Survey	2012/6699	Not Controlled Action (Particular Manner)	Post-Approval
Harpy 1 exploration well	2001/183	Not Controlled Action (Particular Manner)	Post-Approval
Honeycombs MC3D Marine Seismic Survey	2012/6368	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Huzzas MC3D Marine Seismic Survey (HZ-13) Carnarvon Basin, offshore WA	2013/7003	Not Controlled Action (Particular Manner)	Post-Approval
Huzzas phase 2 marine seismic survey, Exmouth Plateau, Northern Carnarvon Basin, WA	2013/7093	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
John Ross & Rosella Off Bottom Cable Seismic Exploration Program	2008/3966	Not Controlled Action (Particular Manner)	Post-Approval
Judo Marine 3D Seismic Survey within and adjacent to WA-412-P	2009/4801	Not Controlled Action (Particular Manner)	Post-Approval
Judo Marine 3D Seismic Survey within and adjacent to WA-412-P	2008/4630	Not Controlled Action (Particular Manner)	Post-Approval
Julimar Brunello Gas Development Project	2011/5936	Not Controlled Action (Particular Manner)	Post-Approval
Klimt 2D Marine Seismic Survey	2007/3856	Not Controlled Action (Particular Manner)	Post-Approval
Koolama 2D Seismic Survey Dampier Basin	2010/5420	Not Controlled Action (Particular Manner)	Post-Approval
Laverda 3D Marine Seismic Survey and Vincent M1 4D Marine Seismic Survey	2010/5415	Not Controlled Action (Particular Manner)	Post-Approval
Laying a submarine optical fibre telecommunications cable, Perth to Singapore and Jakarta	2014/7332	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Leopard 2D marine seismic survey	2005/2290	Not Controlled Action (Particular Manner)	Post-Approval
Lion 2D Marine Seismic Survey	2007/3777	Not Controlled Action (Particular Manner)	Post-Approval
Macedon Gas Field Development	2008/4605	Not Controlled Action (Particular Manner)	Post-Approval
Marine Geotechnical Drilling Program	2008/4012	Not Controlled Action (Particular Manner)	Post-Approval
Marine reconnaissance survey	2008/4466	Not Controlled Action (Particular Manner)	Post-Approval
Millstream 20GL Pipeline, Bungaroo, Borefield Integration	2012/6379	Not Controlled Action (Particular Manner)	Post-Approval
MOF Road Widening and Resurfacing Works	2011/5843	Not Controlled Action (Particular Manner)	Post-Approval
Moosehead 2D seismic survey within permit WA-192-P	2005/2167	Not Controlled Action (Particular Manner)	Post-Approval
Munmorah 2D seismic survey within permits WA-308/9-P	2003/970	Not Controlled Action (Particular Manner)	Post-Approval
Nelson Point Dredging	2009/4920	Not Controlled Action (Particular Manner)	Post-Approval
Nickol Bay Quarry Eastern Extension Proposal, Burrup Peninsula, WA	2013/6915	Not Controlled Action (Particular Manner)	Post-Approval
Ocean Bottom Cable Seismic Program, WA-264-P	2007/3844	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Ocean Bottom Cable Seismic Survey	2005/2017	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Canning Multi Client 2D Marine Seismic Survey	2010/5393	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Drilling Campaign	2011/5830	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Onslow Seawater Desalination Plant Marine Geophysical Investigation	2020/8794	Not Controlled Action (Particular Manner)	Post-Approval
Orcus 3D Marine Seismic Survey in WA-450-P	2010/5723	Not Controlled Action (Particular Manner)	Post-Approval
Osprey and Dionysus Marine Seismic Survey	2011/6215	Not Controlled Action (Particular Manner)	Post-Approval
Outer Canning exploration drilling program off NW coast of WA	2012/6618	Not Controlled Action (Particular Manner)	Post-Approval
Phoenix 3D Seismic Survey, Bedout Sub-Basin	2010/5360	Not Controlled Action (Particular Manner)	Post-Approval
Pomodoro 3D Marine Seismic Survey in WA-426-P and WA-427-P	2010/5472	Not Controlled Action (Particular Manner)	Post-Approval
Port Headland Outer Harbour Pre-construction Pilling program	2012/6341	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Port of Port Hedland channel marker replacement project, WA	2017/8010	Not Controlled Action (Particular Manner)	Post-Approval
Port Walcott upgrade, dredging & spoil disposal, & channel realignment	2006/2806	Not Controlled Action (Particular Manner)	Post-Approval
Pyrenees 4D Marine Seismic Monitor Survey, HCA12A	2012/6579	Not Controlled Action (Particular Manner)	Post-Approval
Pyrenees-Macedon 3D marine seismic survey	2005/2325	Not Controlled Action (Particular Manner)	Post-Approval
Realignment of the Great Northern Highway	2010/5793	Not Controlled Action (Particular Manner)	Post-Approval
Reindeer gas reservior development, Devil Creek, Carnarvon Basin - WA	2007/3917	Not Controlled Action (Particular Manner)	Post-Approval
Repsol 3d & 2D Marine Seismic Survey	2012/6658	Not Controlled Action (Particular Manner)	Post-Approval
Rose 3D Seismic Program	2008/4239	Not Controlled Action (Particular Manner)	Post-Approval
Rydal-1 Petroleum Exploration Well, WA	2012/6522	Not Controlled Action (Particular Manner)	Post-Approval
Santos Winchester three dimensional seismic survey - WA-323-P & WA-330-P	2011/6107	Not Controlled Action (Particular Manner)	Post-Approval
Scarborough Development nearshore component, NWS, WA	2018/8362	Not Controlled Action (Particular Manner)	Post-Approval
Skorpion Marine Seismic Survey WA	2001/416	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Sovereign 3D Marine Seismic Survey	2011/5861	Not Controlled Action (Particular Manner)	Post-Approval
Stag 4D & Reindeer MAZ Marine Seismic Surveys, WA	2013/7080	Not Controlled Action (Particular Manner)	Post-Approval
Stag Off-bottom Cable Seismic Survey	2007/3696	Not Controlled Action (Particular Manner)	Post-Approval
Stybarrow 4D Marine Seismic Survey	2011/5810	Not Controlled Action (Particular Manner)	Post-Approval
Stybarrow Baseline 4D marine seismic survey	2008/4530	Not Controlled Action (Particular Manner)	Post-Approval
The Dampier Heavy Load Out Facility Berth and Swing Basin Expansion	2012/6271	Not Controlled Action (Particular Manner)	Post-Approval
Tidepole Maz 3D Seismic Survey Campaign	2007/3706	Not Controlled Action (Particular Manner)	Post-Approval
Tortilla 2D Seismic Survey, WA	2011/6110	Not Controlled Action (Particular Manner)	Post-Approval
Triton 3D Marine Seismic Survey, WA-2-R and WA-3-R	2006/2609	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a 3D marine seismic survey	2010/5695	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5679	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Undertake a three dimensional marine seismic survey	2010/5715	Not Controlled Action (Particular Manner)	Post-Approval
upgrade of 3 community recreation sites	2005/2349	Not Controlled Action (Particular Manner)	Post-Approval
Vincent M1 and Enfield M5 4D Marine Seismic Survey	2010/5720	Not Controlled Action (Particular Manner)	Post-Approval
Warramunga Non-Inclusive 3D Seismic Survey	2008/4553	Not Controlled Action (Particular Manner)	Post-Approval
West Anchor 3D Marine Seismic Survey	2008/4507	Not Controlled Action (Particular Manner)	Post-Approval
West Panaeus 3D seismic survey	2006/3141	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone 3D MAZ Marine Seismic Survey	2011/6058	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone Iago Appraisal Well Drilling	2008/4134	Not Controlled Action (Particular Manner)	Post-Approval
Wheatstone Iago Appraisal Well Drilling	2007/3941	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
3D Marine Seismic Survey in the offshore northwest Carnarvon Basin	2011/6175	Referral Decision	Completed
3D Seismic Survey	2008/4219	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Bianchi 3D Marine Seismic Survey, Carnavon Basin, WA	2013/7078	Referral Decision	Completed
construction of a new loadout facility and associated laydown area south of the	2002/579	Referral Decision	Completed
CVG 3D Marine Seismic Survey	2012/6270	Referral Decision	Completed
Enfield 4D Marine Seismic Surveys, Production Permit WA-28-L	2005/2370	Referral Decision	Completed
Mardie Salt Project, Pilbara region, WA	2018/8183	Referral Decision	Completed
Outer Harbour Development and associated marine and terrestial infrastructure	2008/4148	Referral Decision	Completed
Relocation of 2 heritage sites to National Heritage Place	2010/5709	Referral Decision	Completed
Rose 3D Seismic acquisition survey	2008/4220	Referral Decision	Completed
Stybarrow Baseline 4D Marine Seismic Survey (Permit Areas WA-255-P, WA-32-L, WA-	2008/4165	Referral Decision	Completed
Two Dimensional Transition Zone Seismic Survey - TP/7 (R1)	2010/5507	Referral Decision	Completed
Varanus Island Compression Project	2012/6698	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Glomar Shoals	North-west

Name	Region
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	North-west

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Dugong		
Dugong dugon Dugong [28]	Breeding	Known to occur
Dugong dugon Dugong [28]	Calving	Known to occur
Dugong dugon Dugong [28]	Foraging (high density seagrass beds)	Known to occur
Dugong dugon Dugong [28]	Nursing	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Internesting buffer	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Nesting	Known to occur
Chelonia mydas Green Turtle [1765]	Aggregation	Known to occur
Chelonia mydas Green Turtle [1765]	Basking	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting	Known to occur

Scientific Name	Behaviour	Presence
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Mating	Known to occur
Chelonia mydas Green Turtle [1765]	Migration corridor	Known to occur
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Foraging	Likely to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Mating	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Migration corridor	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur
Natator depressus Flatback Turtle [59257]	Aggregation	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Internesting	Known to occur

Scientific Name	Behaviour	Presence
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Natator depressus Flatback Turtle [59257]	Mating	Known to occur
Natator depressus Flatback Turtle [59257]	Migration corridor	Known to occur
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
River shark		
Pristis zijsron Green Sawfish [68442]	Foraging	Known to occur
Pristis zijsron Green Sawfish [68442]	Nursing	Known to occur
Pristis zijsron Green Sawfish [68442]	Pupping	Known to occur
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Resting	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur

Scientific Name	Behaviour	Presence
Sternula nereis Fairy Tern [82949]	Breeding	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Sharks		
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Rhincodon typus Whale Shark [66680]	Foraging (high density prey)	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jan-2025

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	2
National Heritage Places:	4
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	3
Listed Threatened Ecological Communities:	1
Listed Threatened Species:	88
Listed Migratory Species:	88

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	25
Commonwealth Heritage Places:	3
Listed Marine Species:	132
Whales and Other Cetaceans:	34
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	14
Habitat Critical to the Survival of Marine Turtles:	3

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	34
Regional Forest Agreements:	None
Nationally Important Wetlands:	8
EPBC Act Referrals:	59
Key Ecological Features (Marine):	8
Biologically Important Areas:	31
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

World Heritage Properties
[Resource Information]

Name	State	Legal Status
Shark Bay, Western Australia	WA	Declared property
The Ningaloo Coast	WA	Declared property

National Heritage Places
[Resource Information]

Name	State	Legal Status
Historic		
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Dirk Hartog Landing Site 1616 - Cape Inscription Area	WA	Listed place
Natural		
Shark Bay, Western Australia	WA	Listed place
The Ningaloo Coast	WA	Listed place

Commonwealth Marine Area
[Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Ecological Communities
[Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Aphelocephala leucopsis Southern Whiteface [529]	Vulnerable	Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Endangered	Species or species habitat may occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat known to occur within area
Leipoa ocellata Malleefowl [934]	Vulnerable	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Malurus leucopterus leucopterus White-winged Fairy-wren (Dirk Hartog Island), Dirk Hartog Black-and-White Fairy-wren [26004]	Vulnerable	Species or species habitat likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pezoporus occidentalis Night Parrot [59350]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Xenus cinereus		
Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area
Zanda latirostris listed as Calyptorhynchus latirostris		
Carnaby's Black Cockatoo, Short-billed Black-cockatoo [87737]	Endangered	Species or species habitat known to occur within area
CRUSTACEAN		
Kumonga exleyi		
Cape Range Remipede [86875]	Vulnerable	Species or species habitat known to occur within area
FISH		
Milyeringa veritas		
Cape Range Cave Gudgeon, Blind Gudgeon [66676]	Vulnerable	Species or species habitat known to occur within area
Ophisternon candidum		
Blind Cave Eel [66678]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Bettongia lesueur lesueur Burrowing Bettong (Shark Bay), Boodie [66659]	Vulnerable	Species or species habitat known to occur within area
Bettongia penicillata ogilbyi Woylie [66844]	Endangered	Species or species habitat known to occur within area
Dasyurus geoffroii Chuditch, Western Quoll [330]	Vulnerable	Translocated population known to occur within area
Dasyurus hallucatus Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Lagorchestes hirsutus bernieri Rufous Hare-wallaby (Bernier Island) [66662]	Vulnerable	Species or species habitat known to occur within area
Lagorchestes hirsutus dorreae Rufous Hare-wallaby (Dorre Island) [66663]	Vulnerable	Species or species habitat known to occur within area
Lagostrophus fasciatus fasciatus Banded Hare-wallaby, Merrnine, Marnine, Munning [66664]	Vulnerable	Species or species habitat known to occur within area
Leporillus conditor Wopilkara, Greater Stick-nest Rat [137]	Vulnerable	Translocated population known to occur within area
Macroderma gigas Ghost Bat [174]	Vulnerable	Species or species habitat likely to occur within area
Macrotis lagotis Greater Bilby [282]	Vulnerable	Translocated population known to occur within area

Scientific Name	Threatened Category	Presence Text
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Perameles bougainville Shark Bay Bandicoot [278]	Endangered	Species or species habitat known to occur within area
Petrogale lateralis lateralis Black-flanked Rock-wallaby, Moororong, Black-footed Rock Wallaby [66647]	Endangered	Species or species habitat known to occur within area
Pseudomys fieldi Shark Bay Mouse, Djoongari, Alice Springs Mouse [113]	Vulnerable	Species or species habitat likely to occur within area
Rhinonicteris aurantia (Pilbara form) Pilbara Leaf-nosed Bat [82790]	Vulnerable	Species or species habitat known to occur within area
PLANT		
Androcalva bivillosa Straggling Androcalva [87807]	Critically Endangered	Species or species habitat may occur within area
Beyeria lepidopetala Small-petalled Beyeria, Short-petalled Beyeria [18362]	Endangered	Species or species habitat likely to occur within area
Caladenia barbarella Small Dragon Orchid, Common Dragon Orchid [68686]	Endangered	Species or species habitat may occur within area
Caladenia bryceana subsp. cracens Northern Dwarf Spider-orchid [64556]	Vulnerable	Species or species habitat known to occur within area
Caladenia elegans Elegant Spider-orchid [56775]	Endangered	Species or species habitat may occur within area
Caladenia hoffmanii Hoffman's Spider-orchid [56719]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Drakaea concolor		
Kneeling Hammer-orchid [56777]	Vulnerable	Species or species habitat likely to occur within area
Eucalyptus beardiana		
Beard's Mallee [18933]	Vulnerable	Species or species habitat known to occur within area
Hypocalymma longifolium		
Long-leaved Myrtle [8081]	Vulnerable	Species or species habitat likely to occur within area
Lechenaultia chlorantha		
Kalbarri Leschenaultia [16763]	Vulnerable	Species or species habitat known to occur within area
Stachystemon nematophorus		
Three-flowered Stachystemon [81447]	Vulnerable	Species or species habitat known to occur within area
Wurmbea tubulosa		
Long-flowered Nancy [12739]	Endangered	Species or species habitat may occur within area
REPTILE		
Aipysurus apraefrontalis		
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama		
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Ctenotus zastictus		
Hamelin Ctenotus [25570]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Egernia stokesii badia		
Western Spiny-tailed Skink, Baudin Island Spiny-tailed Skink [64483]	Endangered	Species or species habitat known to occur within area
Eretmochelys imbricata		
Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Natator depressus		
Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area
SHARK		
Carcharias taurus (west coast population)		
Grey Nurse Shark (west coast population) [68752]	Vulnerable	Congregation or aggregation known to occur within area
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Centrophorus uyato		
Little Gulper Shark [68446]	Conservation Dependent	Species or species habitat likely to occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area
SPIDER		
Idiosoma nigrum		
Shield-backed Trapdoor Spider, Black Rugose Trapdoor Spider [66798]	Vulnerable	Species or species habitat known to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica		
Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat may occur within area
Diomedea amsterdamensis		
Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area

Migratory Marine Species

Scientific Name	Threatened Category	Presence Text
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat likely to occur within area
Carcharias taurus Grey Nurse Shark [64469]		Congregation or aggregation known to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Dugong dugon Dugong [28]		Breeding known to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat may occur within area
Pristis zijsron Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Migratory Terrestrial Species		
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - CARNARVON TRAINING DEPOT [50235]	WA

Commonwealth Land Name	State
Defence - EXMOUTH VLF TRANSMITTER STATION [50123]	WA
Defence - EXMOUTH VLF TRANSMITTER STATION [50122]	WA
Defence - LEARMONTH - AIR WEAPONS RANGE [50193]	WA
Defence - LEARMONTH RADAR SITE - VLAMING HEAD EXMOUTH [50001]	WA
Unknown	
Commonwealth Land - [50266]	WA
Commonwealth Land - [50346]	WA
Commonwealth Land - [51433]	WA
Commonwealth Land - [51883]	WA
Commonwealth Land - [51881]	WA
Commonwealth Land - [50352]	WA
Commonwealth Land - [51097]	WA
Commonwealth Land - [51095]	WA
Commonwealth Land - [51096]	WA
Commonwealth Land - [52235]	WA
Commonwealth Land - [52236]	WA
Commonwealth Land - [51882]	WA
Commonwealth Land - [50367]	WA
Commonwealth Land - [50366]	WA
Commonwealth Land - [50362]	WA
Commonwealth Land - [50361]	WA
Commonwealth Land - [51885]	WA
Commonwealth Land - [50365]	WA
Commonwealth Land - [50364]	WA
Commonwealth Land - [50363]	WA

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		

Name	State	Status
HMAS Sydney II and HSK Kormoran Shipwreck Sites	EXT	Listed place
Natural		
Learmonth Air Weapons Range Facility	WA	Listed place
Ningaloo Marine Area - Commonwealth Waters	WA	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna pacifica as Puffinus pacificus Wedge-tailed Shearwater [84292]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Roosting known to occur within area
Bubulcus ibis as Ardea ibis Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris subminuta Long-toed Stint [861]		Species or species habitat known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Roosting known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat may occur within area
Chalcites osculans as Chrysococcyx osculans Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Charadrius veredus Oriental Plover, Oriental Dotterel [882]		Species or species habitat known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea amsterdamensis Amsterdam Albatross [64405]	Endangered	Species or species habitat likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Species or species habitat may occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area
Gallinago stenura Pin-tailed Snipe [841]		Roosting likely to occur within area overfly marine area
Glareola maldivarum Oriental Pratincole [840]		Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat known to occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Species or species habitat known to occur within area overfly marine area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Roosting known to occur within area overfly marine area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Merops ornatus		
Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus		
Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus		
Whimbrel [849]		Roosting known to occur within area
Onychoprion anaethetus as Sterna anaethetus		
Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata		
Sooty Tern [90682]		Breeding known to occur within area
Pandion haliaetus		
Osprey [952]		Breeding known to occur within area
Phaethon lepturus		
White-tailed Tropicbird [1014]		Species or species habitat known to occur within area
Phaethon lepturus fulvus		
Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phalaropus lobatus Red-necked Phalarope [838]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Roosting known to occur within area overfly marine area
Pterodroma macroptera Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Puffinus assimilis Little Shearwater [59363]		Foraging, feeding or related behaviour known to occur within area
Recurvirostra novaehollandiae Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius antarcticus as Catharacta skua Brown Skua [85039]		Species or species habitat may occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons as Sterna albifrons Little Tern [82849]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat may occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Species or species habitat may occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Species or species habitat may occur within area
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Roosting known to occur within area overfly marine area
Fish		
Acentronura australe Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys galei Gale's Pipefish [66191]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus subelongatus West Australian Seahorse [66722]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Lissocampus fatiloquus Prophet's Pipefish [66250]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Mitotichthys meraculus Western Crested Pipefish [66259]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Nannocampus subosseus Bonyhead Pipefish, Bony-headed Pipefish [66264]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Urocampus carinirostris		
Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer		
Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Mammal		
Dugong dugon		
Dugong [28]		Breeding known to occur within area
Neophoca cinerea		
Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat may occur within area
Reptile		
Aipysurus apraefrontalis		
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii		
Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus foliosquama		
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus laevis		
Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii		
Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Aipysurus pooleorum		
Shark Bay Sea Snake [66061]		Species or species habitat may occur within area
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Breeding known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738]		Species or species habitat may occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Breeding known to occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Breeding known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat likely to occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa sahulensis Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat known to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Abrolhos	Habitat Protection Zone (IUCN IV)
Carnarvon Canyon	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Gascoyne	Habitat Protection Zone (IUCN IV)
Abrolhos	Multiple Use Zone (IUCN VI)
Abrolhos	Multiple Use Zone (IUCN VI)
Gascoyne	Multiple Use Zone (IUCN VI)
Shark Bay	Multiple Use Zone (IUCN VI)
Abrolhos	National Park Zone (IUCN II)
Gascoyne	National Park Zone (IUCN II)
Ningaloo	National Park Zone (IUCN II)

Park Name	Zone & IUCN Categories
Ningaloo	Recreational Use Zone (IUCN IV)
Ningaloo	Recreational Use Zone (IUCN IV)
Abrolhos	Special Purpose Zone (IUCN VI)

Habitat Critical to the Survival of Marine Turtles [Resource Information]

Scientific Name	Behaviour	Presence
Aug - Sep		
Natator depressus		
Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Chelonia mydas		
Green Turtle [1765]	Nesting	Known to occur
Nov-Feb		
Caretta caretta		
Loggerhead Turtle [1763]	Nesting	Known to occur

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Bernier And Dorre Islands	Nature Reserve	WA
Cape Range	National Park	WA
Cape Range (South)	National Park	WA
Chinamans Pool	Nature Reserve	WA
Dirk Hartog Island	National Park	WA
Faure Island	Private Nature Reserve	WA
Francois Peron	National Park	WA
Freycinet, Double Islands etc	Nature Reserve	WA
Hamelin Pool	Marine Nature Reserve	WA
Hamelin Station	Conservation Reserve	WA
Jurabi Coastal Park	5(1)(h) Reserve	WA

Protected Area Name	Reserve Type	State
Kalbarri	National Park	WA
Kalbarri Blue Holes	Fish Habitat Protection Area	WA
Koks Island	Nature Reserve	WA
Miaboolya Beach	Fish Habitat Protection Area	WA
Monkey Mia Reserve	5(1)(h) Reserve	WA
Nanga Station	NRS Addition - Gazettal in Progress	WA
Ningaloo	Marine Park	WA
Nyingguulu (Ningaloo) Coastal Reserve	5(1)(h) Reserve	WA
One Tree Point	Nature Reserve	WA
Part Murchison house	NRS Addition - Gazettal in Progress	WA
Point Quobba	Fish Habitat Protection Area	WA
Sedimentary Deposits Reserve	5(1)(g) Reserve	WA
Shark Bay	Marine Park	WA
Shell Beach	Conservation Park	WA
Tamala Pastoral Lease (Part)	NRS Addition - Gazettal in Progress	WA
Unnamed WA26400	5(1)(h) Reserve	WA
Unnamed WA37338	5(1)(h) Reserve	WA
Unnamed WA37383	5(1)(h) Reserve	WA
Unnamed WA37500	5(1)(g) Reserve	WA
Unnamed WA44688	5(1)(h) Reserve	WA
Unnamed WA49144	Conservation Park	WA
Yaringga	NRS Addition - Gazettal in Progress	WA
Zuytdorp	Nature Reserve	WA

Nationally Important Wetlands

[Resource Information]

Wetland Name	State
Bundera Sinkhole	WA
Cape Range Subterranean Waterways	WA
Hamelin Pool	WA
Lake MacLeod	WA
Learmonth Air Weapons Range - Saline Coastal Flats	WA
McNeill Claypan System	WA
Murchison River (Lower Reaches)	WA
Shark Bay East	WA

EPBC Act Referrals

[Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Midwest Offshore Wind Farm	2022/09264		Assessment
Monkey Mia Dolphin Resort Solar Farm	2023/09700		Referral Decision
Ningaloo Lighthouse Development, 17km north west Exmouth, Western Australia	2020/8693		Post-Approval
Project Highclere Cable Lay and Operation	2022/09203		Completed
Controlled action			
Boating Facility	2002/830	Controlled Action	Completed
Coburn Mineral Sand Project	2003/1221	Controlled Action	Post-Approval
Development of Stybarrow petroleum field incl drilling and facility installation	2004/1469	Controlled Action	Post-Approval
Enfield full field development	2001/257	Controlled Action	Post-Approval
Mauds Landing Marina	2000/98	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Nava-1 Cable System	2001/510	Controlled Action	Completed
Pyrenees Oil Fields Development	2005/2034	Controlled Action	Post-Approval
Shark Bay Resources Dredging	2020/8717	Controlled Action	Post-Approval
Shark Bay Salt Facilities upgrade for direct ocean disposal of bitterns discharge	2011/5984	Controlled Action	Completed
Yardie Creek Road Realignment Project	2021/8967	Controlled Action	Assessment Approach
Not controlled action			
Accommodation Units Sunday Island Bay, Dirk Hartog Island, WA	2015/7540	Not Controlled Action	Completed
APX-West Fibre-optic telecommunications cable system, WA to Singapore	2013/7102	Not Controlled Action	Completed
archaeological surveys & excavation at historic sites, Cape Inscription	2006/3027	Not Controlled Action	Completed
Boating Facility	2002/832	Not Controlled Action	Completed
Carnarvon Power Station Development Project	2010/5669	Not Controlled Action	Completed
Clearing of vegetation for borrow pit and infrastructure areas	2017/7947	Not Controlled Action	Completed
Drilling between Kalbarri and Cliff Head	2005/2185	Not Controlled Action	Completed
Expansion of Monkey Mia Resort	2003/1146	Not Controlled Action	Completed
Extention to the existing Blind Strait Black Lip Pearl Oyster Farm	2004/1342	Not Controlled Action	Completed
Flood Management works	2006/3127	Not Controlled Action	Completed
Hadda 1,Flying Foam 1,Magnat 1 exploration drill	2004/1697	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
INDIGO West Submarine Telecommunications Cable, WA	2017/8126	Not Controlled Action	Completed
Project Highclere Geophysical Survey	2021/9023	Not Controlled Action	Completed
Realignment of Access track, Bottle Bay, Shark Bay	2004/1780	Not Controlled Action	Completed
Spool Base Facility	2001/263	Not Controlled Action	Completed
Useless Loop Road Upgrade	2000/83	Not Controlled Action	Completed
Not controlled action (particular manner)			
2D seismic survey	2008/4493	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2009/4968	Not Controlled Action (Particular Manner)	Post-Approval
Acheron Non-Exclusive 2D Seismic Survey	2008/4565	Not Controlled Action (Particular Manner)	Post-Approval
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
Coverack Marine Seismic Survey	2001/399	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval
Eendracht Multi-Client 3D Marine Seismic Survey	2009/4749	Not Controlled Action (Particular Manner)	Post-Approval
Exmouth West 2D Marine Seismic Survey	2008/4132	Not Controlled Action (Particular Manner)	Post-Approval
Guacamole 2D Marine Seismic Survey	2008/4381	Not Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		(Particular Manner)	
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Laying a submarine optical fibre telecommunications cable, Perth to Singapore and Jakarta	2014/7332	Not Controlled Action (Particular Manner)	Post-Approval
Marine reconnaissance survey	2008/4466	Not Controlled Action (Particular Manner)	Post-Approval
Palta-1 exploration well in Petroleum Permit Area WA-384-P	2011/5871	Not Controlled Action (Particular Manner)	Post-Approval
Quiberon 2D Seismic Survey, permit area WA-385P, offshore of Carnarvon	2009/5077	Not Controlled Action (Particular Manner)	Post-Approval
Salsa 3D Marine Seismic Survey	2010/5629	Not Controlled Action (Particular Manner)	Post-Approval
Sampling of Stromatolites, additional sites, Mamelin Pool,WA	2013/7071	Not Controlled Action (Particular Manner)	Post-Approval
Sampling of Stromatolites and Sediments	2012/6307	Not Controlled Action (Particular Manner)	Post-Approval
Skorpion Marine Seismic Survey WA	2001/416	Not Controlled Action (Particular Manner)	Post-Approval
Supply of road building material areas Shark Bay Region WA	2012/6280	Not Controlled Action (Particular Manner)	Post-Approval
Tantabiddi Boat Ramp Sand Bypassing	2015/7411	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Tortilla 2D Seismic Survey, WA	2011/6110	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5679	Not Controlled Action (Particular Manner)	Post-Approval
Useless Loop Port Maintenance Works and Infrastructure Upgrade	2009/4791	Not Controlled Action (Particular Manner)	Post-Approval
Warramunga Non-Inclusive 3D Seismic Survey	2008/4553	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Geoscientific field-trip to Shark Bay	2012/6380	Referral Decision	Completed
Power Station Development	2009/4957	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 90-120m depth	South-west
Canyons linking the Cuvier Abyssal Plain and the Cape Range Peninsula	North-west
Commonwealth waters adjacent to Ningaloo Reef	North-west
Continental Slope Demersal Fish Communities	North-west
Exmouth Plateau	North-west
Wallaby Saddle	North-west
Western demersal slope and associated fish communities	South-west

Name	Region
Western rock lobster	South-west

Biologically Important Areas [Resource Information]

Scientific Name	Behaviour	Presence
Dugong		
Dugong dugon Dugong [28]	Breeding	Known to occur
Dugong dugon Dugong [28]	Calving	Known to occur
Dugong dugon Dugong [28]	Foraging	Known to occur
Dugong dugon Dugong [28]	Foraging (high density seagrass beds)	Known to occur
Dugong dugon Dugong [28]	Migration	Known to occur
Dugong dugon Dugong [28]	Nursing	Known to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Internesting	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Internesting buffer	Known to occur
Caretta caretta Loggerhead Turtle [1763]	Nesting	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur

Scientific Name	Behaviour	Presence
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging (in high numbers)	Known to occur
Hydroprogne caspia Caspian Tern [808]	Foraging (provisioning young)	Known to occur
Larus pacificus Pacific Gull [811]	Foraging (in high numbers)	Known to occur
Onychoprion anaethetus Bridled Tern [82845]	Foraging (in high numbers)	Known to occur
Onychoprion fuscata Sooty Tern [82847]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging (in high numbers)	Known to occur
Puffinus assimilis tunneyi Little Shearwater [59363]	Foraging (in high numbers)	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sternula nereis Fairy Tern [82949]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Sharks		

Scientific Name	Behaviour	Presence
Rhincodon typus Whale Shark [66680]	Foraging (high density prey)	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jan-2025

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	1
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	9
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	38
Listed Migratory Species:	71

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	2
Listed Marine Species:	121
Whales and Other Cetaceans:	29
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	9
Habitat Critical to the Survival of Marine Turtles:	2

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	5
Regional Forest Agreements:	None
Nationally Important Wetlands:	1
EPBC Act Referrals:	59
Key Ecological Features (Marine):	5
Biologically Important Areas:	32
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Natural		
The West Kimberley	WA	Listed place

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Anous tenuirostris melanops		
Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica menzbieri Northern Siberian Bar-tailed Godwit, Russkoye Bar-tailed Godwit [86432]	Endangered	Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Breeding known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area
MAMMAL		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
REPTILE		

Scientific Name	Threatened Category	Presence Text
Aipysurus apraefrontalis Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus foliosquama Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area
Aipysurus fuscus Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Glyphis garricki		
Northern River Shark, New Guinea River Shark [82454]	Endangered	Species or species habitat may occur within area
Pristis clavata		
Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sphyrna lewini		
Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat known to occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus		
Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Calonectris leucomelas		
Streaked Shearwater [1077]		Species or species habitat known to occur within area
Fregata ariel		
Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor		
Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hydroprogne caspia Caspian Tern [808]		Breeding known to occur within area
Onychoprion anaethetus Bridled Tern [82845]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Anoxypristis cuspidata Narrow Sawfish, Knifetooth Sawfish [68448]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area

Scientific Name	Threatened Category	Presence Text
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharias taurus Grey Nurse Shark [64469]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Dugong dugon Dugong [28]		Foraging, feeding or related behaviour likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mobula alfredi as Manta alfredi Reef Manta Ray, Coastal Manta Ray [90033]		Species or species habitat known to occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pristis clavata Dwarf Sawfish, Queensland Sawfish [68447]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Pristis pristis		
Freshwater Sawfish, Largetooth Sawfish, River Sawfish, Leichhardt's Sawfish, Northern Sawfish [60756]	Vulnerable	Species or species habitat likely to occur within area
Pristis zijsron		
Green Sawfish, Dindagubba, Narrowsnout Sawfish [68442]	Vulnerable	Species or species habitat known to occur within area
Rhincodon typus		
Whale Shark [66680]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Sousa sahulensis as Sousa chinensis		
Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Tursiops aduncus (Arafura/Timor Sea populations)		
Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cecropis daurica		
Red-rumped Swallow [80610]		Species or species habitat may occur within area
Hirundo rustica		
Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea		
Grey Wagtail [642]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres		
Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Natural		
Mermaid Reef - Rowley Shoals	WA	Listed place
Scott Reef and Surrounds - Commonwealth Area	EXT	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Foraging, feeding or related behaviour known to occur within area
Anous tenuirostris melanops Australian Lesser Noddy [26000]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Arenaria interpres Ruddy Turnstone [872]	Vulnerable	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris alba Sanderling [875]		Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Calidris ruficollis Red-necked Stint [860]		Species or species habitat known to occur within area overfly marine area
Calidris tenuirostris Great Knot [862]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Calonectris leucomelas Streaked Shearwater [1077]		Species or species habitat known to occur within area
Cecropis daurica as Hirundo daurica Red-rumped Swallow [80610]		Species or species habitat may occur within area overfly marine area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Species or species habitat known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Species or species habitat known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Breeding known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Species or species habitat known to occur within area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Species or species habitat may occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Hydroprogne caspia as Sterna caspia Caspian Tern [808]		Breeding known to occur within area
Limnodromus semipalmatus Asian Dowitcher [843]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]	Endangered	Species or species habitat known to occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat may occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Numenius phaeopus Whimbrel [849]		Species or species habitat known to occur within area
Onychoprion anaethetus as Sterna anaethetus Bridled Tern [82845]		Breeding known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat may occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Species or species habitat known to occur within area
Pluvialis squatarola Grey Plover [865]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato) Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area overfly marine area
Sterna dougallii Roseate Tern [817]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Sternula albifrons as Sterna albifrons Little Tern [82849]		Breeding known to occur within area
Sternula nereis as Sterna nereis Fairy Tern [82949]		Breeding known to occur within area
Stiltia isabella Australian Pratincole [818]		Species or species habitat known to occur within area overfly marine area
Sula dactylatra Masked Booby [1021]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Thalasseus bengalensis as Sterna bengalensis Lesser Crested Tern [66546]		Breeding known to occur within area
Thalasseus bergii as Sterna bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes as Heteroscelus brevipes Grey-tailed Tattler [851]		Species or species habitat known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]	Endangered	Species or species habitat known to occur within area overfly marine area
Tringa totanus Common Redshank, Redshank [835]		Species or species habitat known to occur within area overfly marine area
Xenus cinereus Terek Sandpiper [59300]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Fish		

Scientific Name	Threatened Category	Presence Text
Acentronura larsonae Helen's Pygmy Pipehorse [66186]		Species or species habitat may occur within area
Bhanotia fasciolata Corrugated Pipefish, Barbed Pipefish [66188]		Species or species habitat may occur within area
Bulbonaricus brauni Braun's Pughead Pipefish, Pug-headed Pipefish [66189]		Species or species habitat may occur within area
Campichthys tricarinatus Three-keel Pipefish [66192]		Species or species habitat may occur within area
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys latispinosus Muiron Island Pipefish [66196]		Species or species habitat may occur within area
Choeroichthys suillus Pig-snouted Pipefish [66198]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus multiannulatus Many-banded Pipefish [66717]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Festucalex scalaris Ladder Pipefish [66216]		Species or species habitat may occur within area
Filicampus tigris Tiger Pipefish [66217]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus grayi Mud Pipefish, Gray's Pipefish [66221]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Haliichthys taeniophorus Ribboned Pipehorse, Ribboned Seadragon [66226]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippocampus angustus Western Spiny Seahorse, Narrow-bellied Seahorse [66234]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus planifrons Flat-face Seahorse [66238]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Hippocampus trimaculatus Three-spot Seahorse, Low-crowned Seahorse, Flat-faced Seahorse [66720]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Phoxocampus belcheri		
Black Rock Pipefish [66719]		Species or species habitat may occur within area
Solegnathus hardwickii		
Pallid Pipehorse, Hardwick's Pipehorse [66272]		Species or species habitat may occur within area
Solegnathus lettiensis		
Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area
Solenostomus cyanopterus		
Robust Ghostpipefish, Blue-finned Ghost Pipefish, [66183]		Species or species habitat may occur within area
Syngnathoides biaculeatus		
Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus		
Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris		
Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Mammal		
Dugong dugon		
Dugong [28]		Foraging, feeding or related behaviour likely to occur within area
Reptile		
Aipysurus apraefrontalis		
Short-nosed Sea Snake, Short-nosed Seasnake [1115]	Critically Endangered	Species or species habitat likely to occur within area
Aipysurus duboisii		
Dubois' Sea Snake, Dubois' Seasnake, Reef Shallows Sea Snake [1116]		Species or species habitat may occur within area
Aipysurus foliosquama		
Leaf-scaled Sea Snake, Leaf-scaled Seasnake [1118]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Aipysurus fuscus Dusky Sea Snake [1119]	Endangered	Species or species habitat known to occur within area
Aipysurus laevis Olive Sea Snake, Olive-brown Sea Snake [1120]		Species or species habitat may occur within area
Aipysurus mosaicus as Aipysurus eydouxii Mosaic Sea Snake [87261]		Species or species habitat may occur within area
Aipysurus tenuis Brown-lined Sea Snake, Mjoberg's Sea Snake [1121]		Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Crocodylus johnstoni Freshwater Crocodile, Johnston's Crocodile, Johnstone's Crocodile [1773]		Species or species habitat may occur within area
Crocodylus porosus Salt-water Crocodile, Estuarine Crocodile [1774]		Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Emydocephalus annulatus Eastern Turtle-headed Sea Snake [1125]		Species or species habitat may occur within area
Ephalophis greyae as Ephalophis greyi Mangrove Sea Snake [93738]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Hydrelaps darwiniensis Port Darwin Sea Snake, Black-ringed Mangrove Sea Snake [1100]		Species or species habitat may occur within area
Hydrophis coggeri Cogger's Sea Snake [25925]		Species or species habitat may occur within area
Hydrophis elegans Elegant Sea Snake, Bar-bellied Sea Snake [1104]		Species or species habitat may occur within area
Hydrophis hardwickii as Lapemis hardwickii Spine-bellied Sea Snake [93516]		Species or species habitat may occur within area
Hydrophis kingii as Disteira kingii Spectacled Sea Snake [93511]		Species or species habitat may occur within area
Hydrophis macdowelli as Hydrophis mcdowelli MacDowell's Sea Snake, Small-headed Sea Snake, [75601]		Species or species habitat may occur within area
Hydrophis major as Disteira major Olive-headed Sea Snake [93512]		Species or species habitat may occur within area
Hydrophis ornatus Spotted Sea Snake, Ornate Reef Sea Snake [1111]		Species or species habitat may occur within area
Hydrophis peronii as Acalyptophis peronii Horned Sea Snake [93509]		Species or species habitat may occur within area
Hydrophis platura as Pelamis platurus Yellow-bellied Sea Snake [93746]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hydrophis stokesii as Astrotia stokesii Stokes' Sea Snake [93510]		Species or species habitat may occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Foraging, feeding or related behaviour known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Migration route known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Breeding known to occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcaella heinsohni Australian Snubfin Dolphin [81322]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Sousa sahulensis Australian Humpback Dolphin [87942]		Species or species habitat known to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops aduncus (Arafura/Timor Sea populations) Spotted Bottlenose Dolphin (Arafura/Timor Sea populations) [78900]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Park Name	Zone & IUCN Categories
Kimberley	Habitat Protection Zone (IUCN IV)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	Multiple Use Zone (IUCN VI)
Eighty Mile Beach	Multiple Use Zone (IUCN VI)
Kimberley	Multiple Use Zone (IUCN VI)
Argo-Rowley Terrace	National Park Zone (IUCN II)
Kimberley	National Park Zone (IUCN II)
Mermaid Reef	National Park Zone (IUCN II)
Argo-Rowley Terrace	Special Purpose Zone (Trawl) (IUCN VI)

Habitat Critical to the Survival of Marine Turtles		[Resource Information]
Scientific Name	Behaviour	Presence
Aug - Sep		
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Dec - Jan		
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur

Extra Information

State and Territory Reserves		[Resource Information]
Protected Area Name	Reserve Type	State
Bedout Island	Nature Reserve	WA
Lacepede Islands	Nature Reserve	WA
Rowley Shoals	Marine Park	WA
Scott Reef	Nature Reserve	WA
Unnamed WA44672	5(1)(h) Reserve	WA

Nationally Important Wetlands	[Resource Information]
Wetland Name	State

Wetland Name	State
Mermaid Reef	EXT

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Browse to North West Shelf Development, Indian Ocean, WA	2018/8319		Approval
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Controlled action			
2-D seismic survey Scott Reef	2000/125	Controlled Action	Post-Approval
Browse FLNG Development, Commonwealth Waters	2013/7079	Controlled Action	Post-Approval
Conduct an exploration drilling campaign	2010/5718	Controlled Action	Completed
Develop Ichthys gas-condensate field permit area W	2006/2767	Controlled Action	Completed
Development of Browse Basin Gas Fields (Upstream)	2008/4111	Controlled Action	Completed
Ichthys Gas Field, Offshore and onshore processing facilities and subsea pipeline	2008/4208	Controlled Action	Post-Approval
Torosa South Initial Appraisal Drilling	2007/3500	Controlled Action	Completed
Not controlled action			
3D marine seismic survey in WA 314P and WA 315P	2004/1927	Not Controlled Action	Completed
Adele Trend TQ3D Seismic Survey	2001/252	Not Controlled Action	Completed
Drilling of exploration wells, Permit areas WA-301-P to WA-305-P	2002/769	Not Controlled Action	Completed
P30 Hydrocarbon Exploration Well	2001/293	Not Controlled Action	Completed
Not controlled action (particular manner)			
2 (3D) Marine Seismic Surveys	2009/4994	Not Controlled Action (Particular Manner)	Completed
2D seismic survey in permit areas WA-274P and WA-281P	2004/1521	Not Controlled Action	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		(Particular Manner)	
2 geotechnical surveys - preliminary and final	2006/2886	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey	2008/4437	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic Survey - Maxima 3D MSS	2006/2945	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, Browse Basin, WA	2009/5048	Not Controlled Action (Particular Manner)	Post-Approval
3D Seismic Survey, near Scott Reef, Browse Basin	2005/2126	Not Controlled Action (Particular Manner)	Post-Approval
Aurora MC3D Marine Seismic Survey	2010/5510	Not Controlled Action (Particular Manner)	Post-Approval
Bassett 3D Marine Seismic Survey	2010/5538	Not Controlled Action (Particular Manner)	Post-Approval
Cartier East and Cartier West 3D Marine Seismic Surveys	2009/5230	Not Controlled Action (Particular Manner)	Post-Approval
Caswell MC3D Marine Seismic Survey	2012/6594	Not Controlled Action (Particular Manner)	Post-Approval
Conduct an exploration drilling campaign	2011/5964	Not Controlled Action (Particular Manner)	Post-Approval
Deep Water Northwest Shelf 2D Seismic Survey	2007/3260	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Endurance 3D Marine Seismic Data Acquisition Survey	2007/3667	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Campaign	2011/6047	Not Controlled Action (Particular Manner)	Post-Approval
Exploration Drilling Program - Permit areas - WA-314-P, WA-315-P, WA-398-P.	2008/4064	Not Controlled Action (Particular Manner)	Post-Approval
Geoscience Australia - Marine survey in Browse Basin to acquire data to assist assessment of CO2 sto	2013/6747	Not Controlled Action (Particular Manner)	Post-Approval
Gicea 3D Marine Seismic Survey	2008/4389	Not Controlled Action (Particular Manner)	Post-Approval
Gigas 2D Pilot Ocean Bottom Cable Marine Seismic Survey	2007/3839	Not Controlled Action (Particular Manner)	Post-Approval
Ichthys 3D Marine Seismic Survey	2010/5550	Not Controlled Action (Particular Manner)	Post-Approval
Kingtree & Ironstone-1 Exploration Wells	2011/5935	Not Controlled Action (Particular Manner)	Post-Approval
Koolama 2D Seismic Survey Dampier Basin	2010/5420	Not Controlled Action (Particular Manner)	Post-Approval
Kraken, Lusca & Asperus 3D Marine Seismic Survey	2013/6730	Not Controlled Action (Particular Manner)	Post-Approval
Mariner Non-Exclusive 2D Seismic Survey	2011/6172	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Canning Multi Client 2D Marine Seismic Survey	2010/5393	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Offshore Fibre Optic Cable Network Construction & Operation, Port Hedland WA to Darwin NT	2014/7223	Not Controlled Action (Particular Manner)	Post-Approval
Offshore Gas Exploration Drilling Campaign	2012/6384	Not Controlled Action (Particular Manner)	Post-Approval
Outer Canning exploration drilling program off NW coast of WA	2012/6618	Not Controlled Action (Particular Manner)	Post-Approval
Pilot Appraisal Well - Torosa South 1	2008/3991	Not Controlled Action (Particular Manner)	Post-Approval
Repsol 3d & 2D Marine Seismic Survey	2012/6658	Not Controlled Action (Particular Manner)	Post-Approval
Rosebud 3D Marine Seismic Survey in WA-30-R and TR/5	2012/6493	Not Controlled Action (Particular Manner)	Post-Approval
Schild MC3D Marine Seismic Survey	2012/6373	Not Controlled Action (Particular Manner)	Post-Approval
Schild Phase 11 MC3D Marine Seismic Survey, Browse Basin	2013/6894	Not Controlled Action (Particular Manner)	Post-Approval
Scott Reef Seismic Research	2006/2647	Not Controlled Action (Particular Manner)	Post-Approval
Torosa-5 Apraisal Well, WA-30-R	2008/4430	Not Controlled Action (Particular Manner)	Post-Approval
Tridacna 3D Ocean Bottom Cable Marine Seismic Survey	2011/5959	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Vampire 2D Non Exclusive Seismic Survey, WA	2010/5543	Not Controlled Action (Particular Manner)	Post-Approval
Veritas Voyager 2D Marine Seismic Survey	2009/5151	Not Controlled Action (Particular Manner)	Post-Approval
Westralia SPAN Marine Seismic Survey, WA & NT	2012/6463	Not Controlled Action (Particular Manner)	Post-Approval
Woodside Southern Browse 3D Seismic Survey, WA	2007/3534	Not Controlled Action (Particular Manner)	Post-Approval
Zeemeermin MC3D seismic survey, Browse Basin, Offshore WA	2009/5023	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Aurora extension MC3D Marine Seismic Survey	2011/5887	Referral Decision	Completed
BRSN08 3D Marine Seismic Survey	2008/4582	Referral Decision	Completed
Experimental Study of Behavioural and Physiological Impact on Fish of Seismic Ex	2006/2625	Referral Decision	Completed
Pilot Appraisal Well - Torosa South-1	2008/3985	Referral Decision	Completed
Seismic Data Acquisition, Browse Basin	2010/5475	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Ancient coastline at 125 m depth contour	North-west
Canyons linking the Argo Abyssal Plain with the Scott Plateau	North-west
Continental Slope Demersal Fish Communities	North-west

Name	Region
Mermaid Reef and Commonwealth waters surrounding Rowley Shoals	North-west
Seringapatam Reef and Commonwealth waters in the Scott Reef Complex	North-west

Biologically Important Areas

[Resource Information]

Scientific Name	Behaviour	Presence
Dugong		
Dugong dugon Dugong [28]	Foraging	Likely to occur
Marine Turtles		
Caretta caretta Loggerhead Turtle [1763]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Foraging	Likely to occur
Chelonia mydas Green Turtle [1765]	Foraging	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting	Known to occur
Chelonia mydas Green Turtle [1765]	Internesting	Likely to occur
Chelonia mydas Green Turtle [1765]	Internesting buffer	Known to occur
Chelonia mydas Green Turtle [1765]	Nesting	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Internesting buffer	Known to occur
Eretmochelys imbricata Hawksbill Turtle [1766]	Nesting	Known to occur
Natator depressus Flatback Turtle [59257]	Foraging	Known to occur
Natator depressus Flatback Turtle [59257]	Internesting	Known to occur

Scientific Name	Behaviour	Presence
Natator depressus Flatback Turtle [59257]	Internesting buffer	Known to occur
Natator depressus Flatback Turtle [59257]	Nesting	Known to occur
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Fregata ariel Lesser Frigatebird [1012]	Breeding	Known to occur
Fregata minor Greater Frigatebird [1013]	Breeding	Known to occur
Phaethon lepturus White-tailed Tropicbird [1014]	Breeding	Known to occur
Sterna dougallii Roseate Tern [817]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Breeding	Known to occur
Sternula albifrons sinensis Little Tern [82850]	Resting	Known to occur
Sula leucogaster Brown Booby [1022]	Breeding	Known to occur
Sula sula Red-footed Booby [1023]	Breeding	Known to occur
Thalasseus bengalensis Lesser Crested Tern [66546]	Breeding	Known to occur
Sharks		
Rhincodon typus Whale Shark [66680]	Foraging	Known to occur
Whales		

Scientific Name	Behaviour	Presence
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Calving	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Migration (north and south)	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Nursing	Known to occur
Megaptera novaeangliae Humpback Whale [38]	Resting	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 08-Jan-2025

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	2
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	2
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	32
Listed Migratory Species:	36

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at https://www.dcceew.gov.au/parks-heritage/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	85
Commonwealth Heritage Places:	10
Listed Marine Species:	58
Whales and Other Cetaceans:	25
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	1
Australian Marine Parks:	2
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	2
EPBC Act Referrals:	68
Key Ecological Features (Marine):	None
Biologically Important Areas:	None
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Hosnies spring	Within Ramsar site
The dales	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
Commonwealth Marine Areas (EPBC Act)
Commonwealth Marine Areas (EPBC Act)

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Accipiter hiogaster natalis Christmas Island Goshawk [82408]	Endangered	Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Chalcophaps indica natalis Christmas Island Emerald Dove, Emerald Dove (Christmas Island) [67030]	Endangered	Species or species habitat known to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Ninox natalis Christmas Island Hawk-Owl, Christmas Boobook [66671]	Vulnerable	Species or species habitat known to occur within area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding known to occur within area
Phaethon rubricauda westralis Red-tailed Tropicbird (Indian Ocean), Indian Ocean Red-tailed Tropicbird [91824]	Endangered	Breeding known to occur within area
Turdus poliocephalus erythropleurus Christmas Island Thrush [67122]	Endangered	Species or species habitat likely to occur within area
MAMMAL		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Crocidura trichura Christmas Island Shrew [86568]	Critically Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pteropus natalis Christmas Island Flying-fox, Christmas Island Fruit-bat [87611]	Critically Endangered	Species or species habitat known to occur within area
PLANT		
Asplenium listeri Christmas Island Spleenwort [65865]	Critically Endangered	Species or species habitat known to occur within area
Pneumatopteris truncata fern [68812]	Critically Endangered	Species or species habitat known to occur within area
Tectaria devexa Cave Fern [14767]	Endangered	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Cryptoblepharus egeriae Christmas Island Blue-tailed Skink, Blue-tailed Snake-eyed Skink [1526]	Critically Endangered	Species or species habitat likely to occur within area
Cyrtodactylus sadleiri Christmas Island Giant Gecko [86865]	Endangered	Species or species habitat known to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lepidodactylus listeri Christmas Island Gecko, Lister's Gecko [1711]	Critically Endangered	Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Ramphotyphlops exocoeti Christmas Island Blind Snake, Christmas Island Pink Blind Snake [1262]	Vulnerable	Species or species habitat likely to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Sphyrna lewini Scalloped Hammerhead [85267]	Conservation Dependent	Species or species habitat likely to occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Migratory Marine Species		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Carcharhinus longimanus Oceanic Whitetip Shark [84108]		Species or species habitat may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat may occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Isurus paucus Longfin Mako [82947]		Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat may occur within area
Mobula birostris as Manta birostris Giant Manta Ray [90034]		Species or species habitat known to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Cecropis daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Environment and Heritage	
Commonwealth Land - Christmas Island National Park [94102]	CI
Commonwealth Land - Christmas Island National Park [94103]	CI

Commonwealth Land Name	State
Commonwealth Land - Christmas Island National Park [94105]	CI
Commonwealth Land - Christmas Island National Park [94104]	CI
Commonwealth Land - Christmas Island National Park [94101]	CI
Unknown	
Commonwealth Land - [94210]	CI
Commonwealth Land - [94217]	CI
Commonwealth Land - [94215]	CI
Commonwealth Land - [94214]	CI
Commonwealth Land - [94219]	CI
Commonwealth Land - [94218]	CI
Commonwealth Land - [94242]	CI
Commonwealth Land - [94240]	CI
Commonwealth Land - [94237]	CI
Commonwealth Land - [94236]	CI
Commonwealth Land - [94229]	CI
Commonwealth Land - [94204]	CI
Commonwealth Land - [94209]	CI
Commonwealth Land - [94216]	CI
Commonwealth Land - [94206]	CI
Commonwealth Land - [94208]	CI
Commonwealth Land - [94212]	CI
Commonwealth Land - [94213]	CI
Commonwealth Land - [94249]	CI
Commonwealth Land - [94248]	CI
Commonwealth Land - [94211]	CI
Commonwealth Land - [94221]	CI
Commonwealth Land - [94239]	CI

Commonwealth Land Name	State
Commonwealth Land - [94234]	CI
Commonwealth Land - [94230]	CI
Commonwealth Land - [94202]	CI
Commonwealth Land - [94201]	CI
Commonwealth Land - [94232]	CI
Commonwealth Land - [94233]	CI
Commonwealth Land - [94262]	CI
Commonwealth Land - [94280]	CI
Commonwealth Land - [94260]	CI
Commonwealth Land - [94220]	CI
Commonwealth Land - [94228]	CI
Commonwealth Land - [94223]	CI
Commonwealth Land - [94222]	CI
Commonwealth Land - [94225]	CI
Commonwealth Land - [94224]	CI
Commonwealth Land - [94227]	CI
Commonwealth Land - [94226]	CI
Commonwealth Land - [94235]	CI
Commonwealth Land - [94238]	CI
Commonwealth Land - [94244]	CI
Commonwealth Land - [94258]	CI
Commonwealth Land - [94205]	CI
Commonwealth Land - [94207]	CI
Commonwealth Land - [94241]	CI
Commonwealth Land - [94247]	CI
Commonwealth Land - [94246]	CI
Commonwealth Land - [94245]	CI

Commonwealth Land Name	State
Commonwealth Land - [94276]	CI
Commonwealth Land - [94243]	CI
Commonwealth Land - [94273]	CI
Commonwealth Land - [94270]	CI
Commonwealth Land - [94275]	CI
Commonwealth Land - [94272]	CI
Commonwealth Land - [94269]	CI
Commonwealth Land - [94268]	CI
Commonwealth Land - [94271]	CI
Commonwealth Land - [94278]	CI
Commonwealth Land - [94274]	CI
Commonwealth Land - [94277]	CI
Commonwealth Land - [94265]	CI
Commonwealth Land - [94264]	CI
Commonwealth Land - [94267]	CI
Commonwealth Land - [94266]	CI
Commonwealth Land - [94203]	CI
Commonwealth Land - [94261]	CI
Commonwealth Land - [94279]	CI
Commonwealth Land - [94263]	CI
Commonwealth Land - [94254]	CI
Commonwealth Land - [94253]	CI
Commonwealth Land - [94256]	CI
Commonwealth Land - [94255]	CI
Commonwealth Land - [94250]	CI
Commonwealth Land - [94231]	CI
Commonwealth Land - [94252]	CI

Commonwealth Land Name	State
Commonwealth Land - [94251]	CI
Commonwealth Land - [94257]	CI
Commonwealth Land - [94259]	CI

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Administrators House Precinct	EXT	Listed place
Drumsite Industrial Area	EXT	Listed place
Industrial and Administrative Group	EXT	Listed place
Malay Kampong Group	EXT	Listed place
Malay Kampong Precinct	EXT	Listed place
Phosphate Hill Historic Area	EXT	Listed place
Poon Saan Group	EXT	Listed place
Settlement Christmas Island	EXT	Listed place
South Point Settlement Remains	EXT	Listed place
Natural		
Christmas Island Natural Areas	EXT	Listed place

Listed Marine Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]	Vulnerable	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Vulnerable	Species or species habitat may occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Cecropis daurica as Hirundo daurica Red-rumped Swallow [80610]		Species or species habitat known to occur within area overfly marine area
Fregata andrewsi Christmas Island Frigatebird, Andrew's Frigatebird [1011]	Endangered	Breeding known to occur within area
Fregata ariel Lesser Frigatebird, Least Frigatebird [1012]		Species or species habitat known to occur within area
Fregata minor Great Frigatebird, Greater Frigatebird [1013]		Breeding known to occur within area
Hirundo rustica Barn Swallow [662]		Species or species habitat known to occur within area overfly marine area
Motacilla cinerea Grey Wagtail [642]		Species or species habitat known to occur within area overfly marine area
Motacilla flava Yellow Wagtail [644]		Species or species habitat known to occur within area overfly marine area
Papasula abbotti Abbott's Booby [59297]	Endangered	Species or species habitat known to occur within area
Phaethon lepturus White-tailed Tropicbird [1014]		Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Phaethon lepturus fulvus Christmas Island White-tailed Tropicbird, Golden Bosunbird [26021]	Endangered	Breeding known to occur within area
Phaethon rubricauda Red-tailed Tropicbird [994]		Breeding known to occur within area
Sula leucogaster Brown Booby [1022]		Breeding known to occur within area
Sula sula Red-footed Booby [1023]		Breeding known to occur within area
Fish		
Choeroichthys brachysoma Pacific Short-bodied Pipefish, Short-bodied Pipefish [66194]		Species or species habitat may occur within area
Choeroichthys sculptus Sculptured Pipefish [66197]		Species or species habitat may occur within area
Corythoichthys amplexus Fijian Banded Pipefish, Brown-banded Pipefish [66199]		Species or species habitat may occur within area
Corythoichthys flavofasciatus Reticulate Pipefish, Yellow-banded Pipefish, Network Pipefish [66200]		Species or species habitat may occur within area
Corythoichthys haematopterus Reef-top Pipefish [66201]		Species or species habitat may occur within area
Corythoichthys intestinalis Australian Messmate Pipefish, Banded Pipefish [66202]		Species or species habitat may occur within area
Corythoichthys schultzi Schultz's Pipefish [66205]		Species or species habitat may occur within area
Cosmocampus banneri Roughridge Pipefish [66206]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Cosmocampus maxweberi Maxweber's Pipefish [66209]		Species or species habitat may occur within area
Doryrhamphus baldwini Redstripe Pipefish [66718]		Species or species habitat may occur within area
Doryrhamphus dactyliophorus Banded Pipefish, Ringed Pipefish [66210]		Species or species habitat may occur within area
Doryrhamphus excisus Bluestripe Pipefish, Indian Blue-stripe Pipefish, Pacific Blue-stripe Pipefish [66211]		Species or species habitat may occur within area
Doryrhamphus janssi Cleaner Pipefish, Janss' Pipefish [66212]		Species or species habitat may occur within area
Doryrhamphus negrosensis Flagtail Pipefish, Masthead Island Pipefish [66213]		Species or species habitat may occur within area
Halicampus brocki Brock's Pipefish [66219]		Species or species habitat may occur within area
Halicampus dunckeri Red-hair Pipefish, Duncker's Pipefish [66220]		Species or species habitat may occur within area
Halicampus macrorhynchus Whiskered Pipefish, Ornate Pipefish [66222]		Species or species habitat may occur within area
Halicampus mataafae Samoan Pipefish [66223]		Species or species habitat may occur within area
Halicampus nitidus Glittering Pipefish [66224]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Halicampus spinirostris Spiny-snout Pipefish [66225]		Species or species habitat may occur within area
Hippichthys cyanospilos Blue-speckled Pipefish, Blue-spotted Pipefish [66228]		Species or species habitat may occur within area
Hippichthys heptagonus Madura Pipefish, Reticulated Freshwater Pipefish [66229]		Species or species habitat may occur within area
Hippichthys penicillus Beady Pipefish, Steep-nosed Pipefish [66231]		Species or species habitat may occur within area
Hippichthys spicifer Belly-barred Pipefish, Banded Freshwater Pipefish [66232]		Species or species habitat may occur within area
Hippocampus histrix Spiny Seahorse, Thorny Seahorse [66236]		Species or species habitat may occur within area
Hippocampus kuda Spotted Seahorse, Yellow Seahorse [66237]		Species or species habitat may occur within area
Hippocampus spinosissimus Hedgehog Seahorse [66239]		Species or species habitat may occur within area
Micrognathus brevirostris thorntail Pipefish, Thorn-tailed Pipefish [66254]		Species or species habitat may occur within area
Micrognathus micronotopterus Tidepool Pipefish [66255]		Species or species habitat may occur within area
Solegnathus lettiensis Gunther's Pipehorse, Indonesian Pipefish [66273]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Trachyrhamphus bicoarctatus Bentstick Pipefish, Bend Stick Pipefish, Short-tailed Pipefish [66280]		Species or species habitat may occur within area
Trachyrhamphus longirostris Straightstick Pipefish, Long-nosed Pipefish, Straight Stick Pipefish [66281]		Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat likely to occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eretmochelys imbricata Hawksbill Turtle [1766]	Vulnerable	Species or species habitat likely to occur within area
Lepidochelys olivacea Olive Ridley Turtle, Pacific Ridley Turtle [1767]	Endangered	Species or species habitat likely to occur within area
Natator depressus Flatback Turtle [59257]	Vulnerable	Species or species habitat likely to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera borealis Sei Whale [34]	Vulnerable	Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Species or species habitat likely to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Species or species habitat likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Feresa attenuata Pygmy Killer Whale [61]		Species or species habitat may occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Indopacetus pacificus Longman's Beaked Whale [72]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenodelphis hosei Fraser's Dolphin, Sarawak Dolphin [41]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon ginkgodens Gingko-toothed Beaked Whale, Gingko-toothed Whale, Gingko Beaked Whale [59564]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat may occur within area
Peponocephala electra Melon-headed Whale [47]		Species or species habitat may occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Stenella attenuata Spotted Dolphin, Pantropical Spotted Dolphin [51]		Species or species habitat may occur within area
Stenella coeruleoalba Striped Dolphin, Euphrosyne Dolphin [52]		Species or species habitat may occur within area
Stenella longirostris Long-snouted Spinner Dolphin [29]		Species or species habitat may occur within area
Steno bredanensis Rough-toothed Dolphin [30]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Commonwealth Reserves Terrestrial [Resource Information]

Name	State	Type
Christmas Island	EXT	National Park (Commonwealth)

Australian Marine Parks [Resource Information]

Park Name	Zone & IUCN Categories
Christmas Island	Habitat Protection Zone (IUCN IV)
Christmas Island	National Park Zone (IUCN II)

Extra Information

Nationally Important Wetlands [Resource Information]

Wetland Name	State
"The Dales", Christmas Island	EXT
Hosine's Spring, Christmas Island	EXT

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Aerial Baiting of Yellow Crazy Ants	2012/6438		Completed
Marine Route Survey for Subsea Fibre Optic Data Cable System - Australia West	2024/09826		Completed
Controlled action			
Christmas Island Airport Expansion	2001/434	Controlled Action	Post-Approval
Christmas Island Port Facility	2001/435	Controlled Action	Post-Approval
Construction of mobile phone tower	2002/694	Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Cultural Appearance Upgrade of the Chinese Literary Association Building	2007/3568	Controlled Action	Completed
East Christmas Island Phosphate Mines (9 sites)	2001/487	Controlled Action	Completed
Exploration for Mineable Phosphate, Christmas Island	2000/43	Controlled Action	Completed
Lily Beach Recreational Facilities	2001/395	Controlled Action	Post-Approval
Lily Beach Rock Pool Development	2001/400	Controlled Action	Completed
Nava-1 Cable System	2001/510	Controlled Action	Completed
Phosphate Mining in South Point Christmas Island	2012/6653	Controlled Action	Post-Approval
Proposed exploration drilling programme for Christmas Island	2016/7779	Controlled Action	Completed
Road Upgrade/Construction between Lily Beach Road and Port Faci	2001/436	Controlled Action	Post-Approval
Salvage, transport and processing of phosphate resource with extended airport si	2003/1217	Controlled Action	Post-Approval
Yellow Crazy Ant Biological Control	2013/6836	Controlled Action	Post-Approval
Not controlled action			
96-108 Gaze Road - Residential upgrade	2006/2632	Not Controlled Action	Completed
Aerial Baiting, Yellow Crazy Ant Supercolonies, Christmas Island, WA	2019/8492	Not Controlled Action	Completed
APX-West Fibre-optic telecommunications cable system, WA to Singapore	2013/7102	Not Controlled Action	Completed
Boat Ramp Construction	2001/237	Not Controlled Action	Completed
Building of a carport adjacent to residential house	2004/1538	Not Controlled Action	Completed
Christmas Island/Construction of a double storey shed/carport at MQ387 Gaze Road	2004/1561	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Christmas Island Fuel Consolidation Project, Christmas Island	2012/6454	Not Controlled Action	Completed
Community Recreation Centre	2003/1279	Not Controlled Action	Completed
courtyard shower & handbasin facilities	2006/2803	Not Controlled Action	Completed
Dwelling demolition, maintenance and carpark/carport/storage shed works	2004/1837	Not Controlled Action	Completed
Extension of a Masonary Brick Wall adjacent to the Poon Saan Club by 500 mm	2004/1564	Not Controlled Action	Completed
Flying Fish Cove Christmas Island Boat Ramp Maintenance	2021/8924	Not Controlled Action	Completed
Flying Fish Cove Landslide Mitigation Project	2020/8616	Not Controlled Action	Completed
Garage and Office Facilities	2004/1919	Not Controlled Action	Completed
Housing and Garden Maintenance Works	2004/1487	Not Controlled Action	Completed
Hydroponics Research Program	2007/3338	Not Controlled Action	Completed
Identification of unmarked grave, exhumation/identification of remains which may belong to a sailor	2006/2992	Not Controlled Action	Completed
INDIGO West Submarine Telecommunications Cable, WA	2017/8126	Not Controlled Action	Completed
Internal and external modifications Lot 1014 Gaze Road	2004/1807	Not Controlled Action	Completed
Light Industrial Subdivision Development	2004/1799	Not Controlled Action	Completed
Lot 1056 Extensions and Alterations	2004/1801	Not Controlled Action	Completed
Maintenance of Tai Jin House, Smith Point	2009/4933	Not Controlled Action	Completed
Mobile Radio Communications System Upgrade	2002/718	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Placement of bitumen/ concrete on rail sections of heritage listed incline, Christmas Island	2013/7009	Not Controlled Action	Completed
Power Station Diesel Generator Replacement	2009/4685	Not Controlled Action	Completed
Proposed sale or lease of Crown land, 11 lots, Christmas Island	2018/8220	Not Controlled Action	Completed
Realignment of Gaze Road Service Road and Gaze Road Junction	2004/1735	Not Controlled Action	Completed
Refurbishment and Extension of Seaview Lodge	2012/6353	Not Controlled Action	Completed
renovate free-standing servant's quarters	2006/2811	Not Controlled Action	Completed
Replacement of deteriorating flat roof at rear of Mosque and extending side verandahs, Christmas Is	2013/6851	Not Controlled Action	Completed
Residential upgrade, 2 Coconut Grove	2007/3295	Not Controlled Action	Completed
Stormwater Remediation Project, Christmas Island	2019/8467	Not Controlled Action	Completed
Subdivision of Lot 571 on DP 26701	2008/4230	Not Controlled Action	Completed
Subdivision of Part 7 of Lot 1014	2009/4851	Not Controlled Action	Completed
Supermarket Extensions	2006/2515	Not Controlled Action	Completed
Upgrade of Residence, Coconut Grove	2006/2728	Not Controlled Action	Completed
Verandah Extension to Existing Breezeway Unit, Gaze Road	2005/1970	Not Controlled Action	Completed
Not controlled action (particular manner)			
Addition of Verandah to Block of Four Units	2005/2315	Not Controlled Action (Particular Manner)	Post-Approval
Asbestos Removal from Commonwealth Owned Assests including Commonwealth Heritage	2009/4873	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Australia to Singapore Fibre Optic Submarine Cable System	2011/6127	Not Controlled Action (Particular Manner)	Post-Approval
Baiting Efficacy Trial of Feral Cat Bait and PAPP Toxicant	2008/4383	Not Controlled Action (Particular Manner)	Post-Approval
Commonwealth Marine/Flying Fish Cove Jetty Extension	2012/6675	Not Controlled Action (Particular Manner)	Post-Approval
Crazy Ant Aerial Baiting Control Program	2002/722	Not Controlled Action (Particular Manner)	Post-Approval
Helicopter baiting of exotic yellow crazy ant supercolonies, Christmas Island, Indian Ocean	2009/5016	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Laying a submarine optical fibre telecommunications cable, Perth to Singapore and Jakarta	2014/7332	Not Controlled Action (Particular Manner)	Post-Approval
New Housing Program	2011/6056	Not Controlled Action (Particular Manner)	Post-Approval
Swimming Pool modification	2007/3312	Not Controlled Action (Particular Manner)	Post-Approval
Trials of a bait delivery system for the control of Yellow Crazy Ants	2009/4763	Not Controlled Action (Particular Manner)	Post-Approval
Water supply upgrade	2005/2269	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
Alterations and Improvements to existing residence at Lot 3015	2009/5039	Referral Decision	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Referral decision			
Gaze Rd, Christmas Island			
Rocky Point Dwelling Redevelopment	2005/2203	Referral Decision	Referral Decision

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data is available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance on the contents of this report.

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions when time permits.

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded breeding sites; and
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

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- -Office of Environment and Heritage, New South Wales
- -Department of Environment and Primary Industries, Victoria
- -Department of Primary Industries, Parks, Water and Environment, Tasmania
- -Department of Environment, Water and Natural Resources, South Australia
- -Department of Land and Resource Management, Northern Territory
- -Department of Environmental and Heritage Protection, Queensland
- -Department of Parks and Wildlife, Western Australia
- -Environment and Planning Directorate, ACT
- -Birdlife Australia
- -Australian Bird and Bat Banding Scheme
- -Australian National Wildlife Collection
- -Natural history museums of Australia
- -Museum Victoria
- -Australian Museum
- -South Australian Museum
- -Queensland Museum
- -Online Zoological Collections of Australian Museums
- -Queensland Herbarium
- -National Herbarium of NSW
- -Royal Botanic Gardens and National Herbarium of Victoria
- -Tasmanian Herbarium
- -State Herbarium of South Australia
- -Northern Territory Herbarium
- -Western Australian Herbarium
- -Australian National Herbarium, Canberra
- -University of New England
- -Ocean Biogeographic Information System
- -Australian Government, Department of Defence
- Forestry Corporation, NSW
- -Geoscience Australia
- -CSIRO
- -Australian Tropical Herbarium, Cairns
- -eBird Australia
- -Australian Government – Australian Antarctic Data Centre
- -Museum and Art Gallery of the Northern Territory
- -Australian Government National Environmental Science Program
- -Australian Institute of Marine Science
- -Reef Life Survey Australia
- -American Museum of Natural History
- -Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
- -Tasmanian Museum and Art Gallery, Hobart, Tasmania
- -Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact us page.

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