Environment plan
Appendix 7-3
Existing environment of Risk EMBA

Stromlo-1 exploration drilling program

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1.0 Existing environment of the Risk EMBA

The Risk EMBA is the geographical area encompassing the environment that may be affected by the unplanned events associated with the planned activities within the PSZ. The maximum extent of an oil spill due to a loss of well control (LOWC) resulting in a major blowout is the dimensioning factor for this area. has been used to inform the oil spill response planning and oil spill risk assessment (Section 7.0).

This description of the Risk EMBA, in addition to the description of the Impact EMBA (Section 4.0) addresses OPGGS(E) Regulation 13(2), which requires an Environment Plan to include a description of the environment that may be affected by the petroleum activity (EMBA) and to detail relevant values and sensitivities of that EMBA.

1.1 Defining the Risk EMBA

The extent of the Risk EMBA (Figure 1.1) has been derived from stochastic analysis modelling of 100 runs for a hypothetical oil spill for a worst-case discharge scenario (Appendix 7-1).

A small number of discrete cells containing outlier data were excluded from the mapped output because they were modelled to have negligible probabilities of exposure and impact. The outlier data represented instances of sea surface contact at the lowest threshold modelled from single scenarios. Open water areas within the Risk EMBA contour where the modelling predicted that surface contact is unlikely to occur have also been removed for clarity. Outliers in the predicted areas of shoreline oil contact have not been removed from the Risk EMBA given the higher perceived importance of shoreline oil exposure for many stakeholders.

1.2 Sources of data

A search using the EPBC Act Protected Matters Search Tool (PMST) was conducted in September 2018 for the Risk EMBA. The PMST report (Appendix 7.2) was used to identify matters of national environmental significance (MNES) and other matters protected under the EPBC Act. As the PMST report generated results that were considered to be outside of the Risk EMBA, it was filtered by removing (mainly terrestrial) species that do not occur within, and areas that do not overlap with, the Risk EMBA, including the adjacent coastline.

Species-specific information was gathered using the DEE Species Profile and Threats (SPRAT) database, species recovery plans, published conservation advice and peer-reviewed scientific publications. A key source of relevant baseline information was the Great Australian Bight Research Program (GABRP), which led to the publication of series of reports and scientific publications; many of which are currently under peer review by scientific journals.

Information on the seabed and sea floor state was gathered during a geotechnical survey in 2013 and augmented by information and findings from the recent CSIRO-led Great Australian Bight Research Program and Great Australian Bight Deepwater Marine Program (GABDMP). The Great Australian Bight research programs transformed the deep waters of the Great Australian Bight from one of the least known deep-water ecosystems in Australia, to one of the best known. In combination, the studies represent the:

- deepest systematic benthic survey ever undertaken in the Australian region
- discovery of 257 species new to science and 887 species new to the Great Australian Bight
- first study of deep-water hydrocarbon degrading microbes.

Metocean data was derived from collected raw data in the Great Australian Bight (2012) and historical databases.

Information on fisheries was derived from state and Commonwealth online and published fishery reports and from personal communication with government fishery experts. It should be noted that there is often a lag of several years in publishing fishing catch statistics and in many cases recent catch and effort data are not available.

1.2.1 Great Australian Bight Research Program

The Great Australian Bight Research Program (GABRP) was a four-year, $20 million research program funded by Joint Venture partners Equinor Australia B.V. (then Statoil) and BP p.l.c., the Commonwealth Scientific and Industrial Research Organisation (CSIRO), and Marine Innovation Southern Australia partners – the South Australian Research and Development Institute (SARDI), University of Adelaide and Flinders University. The overall aim of the Great Australian Bight Research Program was to improve understanding of the environmental, economic and social values of the Great Australian Bight (Great Australian Bight). It was undertaken between April 2013 and September 2017 by multi-disciplinary research teams from CSIRO, SARDI, the University of Adelaide and Flinders University. More than 100 scientists were involved in the Great Australian Bight Research Program, which comprised seven themes including five with an ecological focus:

Oceanography – collection and analysis of data to develop ocean models to better understand the connections between deep, off-shelf regions on the continental shelf and coastal regions, and the dynamic effect of the ocean on sea floor and pelagic biodiversity.

Open water (pelagic) ecosystem and environmental drivers – collection of information on the community structure, dynamics and biodiversity of microbes, plankton and micronekton in the Great Australian Bight. Research included assessing food web structure in relation to currents, turbidity, light levels, stratification, nutrient concentrations and turbulence.

Sea floor (benthic) biodiversity – studies of the abundance and distribution of faunal biodiversity on and in the seabed.

Ecology of iconic species and apex predators – studies of the ecology and abundance of key iconic species such as whales, sea lions and dolphins, and apex predators such as southern bluefin tuna and sharks. This included studying their distribution and behaviour to develop movement and habitat models for these species.

Petroleum geology and geochemistry – identification and characterisation of natural petroleum seepage in specific areas of the Great Australian Bight.

Socio-economic analysis – development of a socio-economic profile of communities potentially affected by petroleum activities. Through consultation, community concerns and perceptions of key issues regarding likely future activities were examined, along with the economic dependence of individual regional communities on activities related to the Great Australian Bight.

Integration and modelling – development of a quantitative model of the structure and dynamics of the Bight's ecosystem, which could be integrated into ecosystem models that can be used to conduct more informed and refined ecological risk assessments for future development activities that may be conducted in the Great Australian Bight.

Information obtained by the Great Australian Bight Research Program will be publicly available for use by all stakeholders interested in the region, including Commonwealth and state government regulators, other commercial operators, academics, environmental groups and the general community.

1.2.2 Great Australian Bight Deepwater Marine Program

The most recent research program in the area is the Great Australian Bight Deepwater Marine Program (GABDMP), which included multiple surveys led by CSIRO in partnership with Chevron Australia. The program was completed in 2018 and the objectives were to:

- increase the knowledge of the sedimentary evolution of the Bight Basin
- characterise the volcanic seamounts, canyons and potential hydrocarbon seeps on the sea floor
- conduct an environmental and biological assessment of the benthic biota.

Some of the findings from the Great Australian Bight Deepwater Marine Program (summarised in Ross et al. 2017a, 2018) are included in this section, in particular the description of the seabed in the area and around the drill site. There were multiple surveys associated with this research program.

In addition to the research projects outlined above, additional information has been included from various science symposia and associated journal papers. Results from internal studies on seismic 3D data and Equinor Australia B.V. sponsored geotechnical/meteorological surveys has been included where relevant.

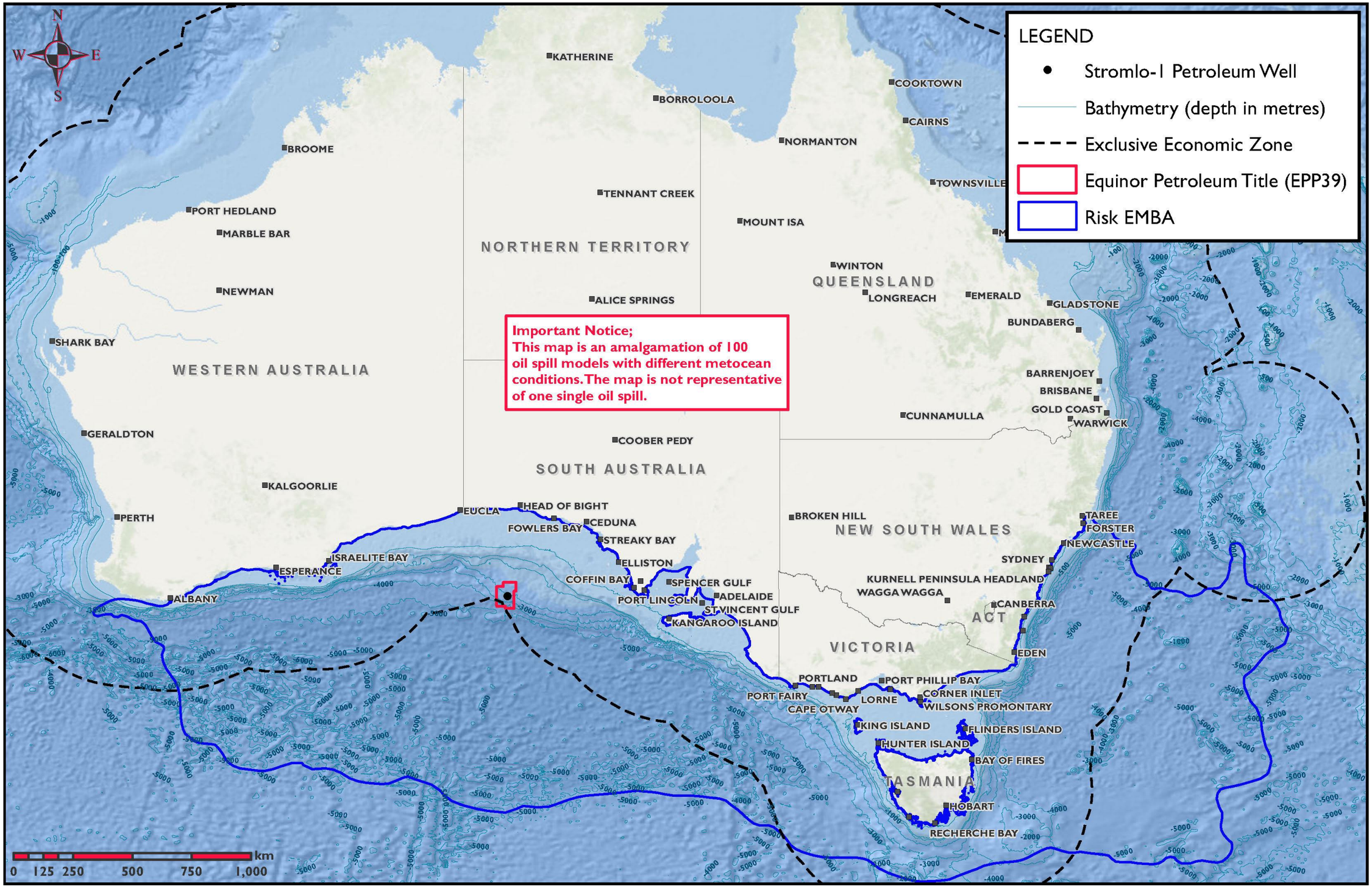


Figure 1.1 Stromlo-1 exploration drilling program Risk EMBA

1.3 Regional overview

The Risk EMBA includes Commonwealth waters of the South-west, South-east and Temperate East Marine regions and state waters of Western Australia, South Australia, Victoria, New South Wales and Tasmania. The EPP39 permit area and Stromlo-1 well location is located entirely within Commonwealth waters in the South-west Marine Region. At its closest point, the well location is approximately 400 km south-west of Ceduna on the South Australian coast.

The following sub-regions are represented in the Risk EMBA:

- Western Great Australian Bight the area between Denmark and Cocklebiddy, Western Australia
- Central Great Australian Bight – the area between Cocklebiddy, Western Australia to Coffin Bay, South Australia
- Eastern Great Australian Bight – the area between Coffin Bay, South Australia, and a line from Cape Otway, Victoria, east of King Island to Cape Grim, Tasmania
- Victoria central coast – the shoreline and nearshore waters between Cape Otway and Wilsons Promontory
- Victoria west coast – the shoreline and nearshore waters between Cape Otway and the Victorian–New South Wales border
- Western Bass Strait Islands – islands in the western portion of the Bass Strait such as King Island, Three Hummock Island, Hunter Island and Robbins Island
- North-eastern Bass Strait Islands – islands in the north-east section of the Bass Strait such as the Kent Group, Deal Island, Hogan Island and Curtis Island
- South-eastern Bass Strait Islands – islands in the south-east section of the Bass Strait such as the Furneaux Group, Flinders Island, Cape Barren Island, Clarke Island and the Sister Islands Group
- Tasmania north coast – the shoreline and nearshore waters east of Woolnorth and west of Cape Portland
- Tasmania west coast – the shoreline and nearshore waters west of Woolnorth and Recherche Bay
- Tasmania east coast – the shoreline and nearshore waters east of Cape Portland and Recherche Bay
- New South Wales south coast – the shoreline and nearshore waters between the Victoria-New South Wales border and Sydney
- New South Wales central coast – the shoreline and nearshore waters between Sydney and south of Newcastle.

Marine bioregional plans are in place for the South-west and Temperate East Marine regions (DSEWPaC 2012a, 2012b), and a profile has been developed for the South-east Marine Region (DoE 2015a). These plans describe the marine environment and conservation values of the region, set out broad biodiversity objectives, identify regional priorities, and outline strategies and actions to address these priorities.

1.3.1 South-west Marine Region

The main physical features of the region as described in DSEWPaC (2012a) are:

- a narrow continental shelf on the west coast from the subtropics to temperate waters off south-west Western Australia
- a wide continental shelf dominated by sandy carbonate sediments of marine origin (i.e. crushed shells from snails and other small animals and calcareous algae) in the Great Australian Bight
- high wave energy on the continental shelf around the whole region
- a steep, muddy continental slope that includes many canyons, the most significant being the Perth Canyon, the Albany canyon group and the canyons in the vicinity of Kangaroo Island
- large tracts of poorly understood abyssal plains at depths greater than 4000 m
- the Diamantina Fracture Zone, a rugged area of steep mountains and troughs off south-west Australia at depths greater than 4000 m
- the Naturaliste Plateau, an extension of Australia's continental mass that provides deep-water habitat at depths of 2000–5000 m

- islands and reefs in both subtropical (e.g. Houtman Abrolhos Islands) and temperate waters (e.g. Recherche Archipelago)
- complex and unusual oceanographic patterns, driven largely by the Leeuwin Current and its associated currents, that have a significant influence on biodiversity distribution and abundance.

1.3.2 South-east Marine Region

The South-east Marine Region (approximately 1,632,402 km²) stretches from the far south coast of New South Wales, around Tasmania and Victoria and west to Kangaroo Island off South Australia. The main physical features of the region as described in the South-east Marine Region Profile (DoE 2015a) include:

- a narrow (10–25 km) continental shelf in most parts of the region, except Bass Strait
- the shelf break (which includes the edges of the continental shelf and the upper slope) serves to intensify currents, eddies and upwellings, creating a rich and productive area for biodiversity, including species that are fished commercially and recreationally
- sea floor canyons along the continental margin, which provide habitat for sessile invertebrates such as corals, which in turn attract other organisms and higher-order species
- being oceanographically complex, with subtropical influences from the north and subpolar influences from the south.

1.3.3 Temperate East Marine Region

The Temperate East Marine Region comprises Commonwealth waters from the southern boundary of the Great Barrier Reef Marine Park to Bermagui in southern New South Wales, including waters surrounding Lord Howe and Norfolk Islands. The main physical features of the region as described in DSEWPaC (2012d) are:

- three seamount chains that run parallel to the east coast – the Tasmantid and Lord Howe seamount chains and the Norfolk Ridge
- the East Australian Current brings warm waters from the Coral Sea south along the outer edge of the continental shelf until it moves offshore at approximately 33°S (offshore from the central coast of New South Wales); along its path, it gives rise to large eddy features that support important areas of enhanced productivity
- the Tasman Front, which forms between 20°S and 30°S and represents the meeting point for two distinct bodies of water (the warm, nutrient-poor Coral Sea and the cold, nutrient-rich Tasman Sea); localised oceanographic processes along the Tasman Front trap nutrients and plankton, creating an important region of enhanced productivity and connectivity pathways
- the canyons of the eastern continental slope, which add critical habitat diversity to the region.

1.4 Conservation values and sensitivities

Conservation values and sensitivities listed and protected under the EPBC Act include Matters of Environmental Significance (MNES) and Other Protected Matters. After filtering the results generated by the protected matters search tool, MNES occurring, or potentially occurring, within the Risk EMBA include:

- two Commonwealth Marine Areas
- 63 Listed Threatened Species
- 84 Listed Migratory Species.

Other Matters protected by the EPBC Act include:

- 168 Listed Marine Species
- 41 whales and other cetaceans (many of which are also Listed Threatened or Migratory Species)
- 27 Australian Marine Parks.

The full EPBC Act Protected Matters report is provided in Appendix 7-2. The results generated from the protected matters search tool for the Risk EMBA are summarised in the following sections.

1.4.1 Matters of National Environmental Significance (MNES)

1.4.1.1 Commonwealth Marine Areas

Two Commonwealth Marine Areas intersect the Risk EMBA: the Australian Economic Exclusion Zone (EEZ) and Territorial Sea, and the Extended Continental Shelf.

1.4.1.2 Listed Threatened Species

A total of 63 Listed Threatened Species are either likely to, or may occur within, the Risk EMBA, including:

- 41 bird species
- seven marine mammal species
- five marine reptile species
- 10 fish species.

The relevant sections of this EP discuss the likelihood of these species and their biologically important areas occurring within the Risk EMBA.

1.4.1.3 Listed Migratory Species

A total of 84 Listed Migratory Species are either likely to or may occur within the Risk EMBA (many of which are also threatened species), including 24 marine species (i.e. sharks, turtles and mammals) and 60 bird species.

1.4.1.4 MNES not present in the Risk EMBA

Matters of national environmental significance which are not represented in the Risk EMBA are:

- World Heritage properties
- national heritage places
- Wetlands of International Importance
- the Great Barrier Reef Marine Park
- nuclear actions and water resources, in relation to coal seam gas or coal mining, are matters of national environmental significance, but do not form part of the activity and are not discussed further.

1.4.2 Other matters protected by the EPBC Act

1.4.2.1 Listed marine species

A total of 168 Listed Marine Species are either likely to or may occur within the Risk EMBA.

1.4.2.2 Whales and other cetaceans

The Protected Matters search determined that 41 cetacean species or their habitat, may occur within the Risk EMBA.

1.4.3 Australian Marine Parks (Commonwealth Marine Reserves)

Twenty-seven Australian Marine Parks exist within, or directly adjacent to, the Risk EMBA (Table1.1; the PMST report indicated 23 within the searched area).

In 2017, the Director of National Parks (DNP) commissioned an independent review of the Commonwealth Marine Reserves, and consequently issued a proclamation to change the name of 58 marine reserves to "Marine Parks". These Australian marine parks (AMPs) are managed by Parks Australia in accordance with six management plans – one for each of the five marine park networks (the North, North-west, South-west, South-east and Temperate East networks) and one for the Coral Sea (https://parksaustralia.gov.au/marine/parks/ accessed 11 September 2018). These management plans came into effect on 1 July 2018. The South-west Marine Parks Network comprises 14 marine parks managed in accordance with the South-west Marine Parks Network Management Plan 2018 (Director of National Parks 2018). This network includes the Great Australian Bight Marine Park within which the Stromlo-1 well is located (Figure 1.2). A summary of conservation values and management principles for this and other marine parks found within the Risk EMBA is provided in Table 1.1.

Marine parks within the South-east Marine Region are managed under the South-east Commonwealth Marine Reserve Network Management Plan 2013–23 (DNP 2013). These management plans provide the rules about what activities can and cannot occur within marine park zones, and petroleum titleholders must ensure that their offshore environment plans are consistent with the zoning and rules that apply to mining operations in marine parks, as described in the management plans. They must also ensure that impacts on the representative values of the parks will be of an acceptable level and managed to as low as reasonably practicable (ALARP) (NOPSEMA 2018).

Under the management plans, planned mining operations are generally allowable in Multiple Use Zones and Special Purpose Zones (IUCN category VI) or "blue zone", except for Special Purpose (Mining Exclusion) Zones. In keeping with this, the Stromlo-1 well is located within a Multiple Use Zone (Figure 1.2). Mining operations are not allowed to occur in any other zones of the parks (NOPSEMA 2018). Management plans for the South-west, North-west, North and Temperate East Networks of AMPs allow actions required to response to unplanned oil pollution incidents, including environmental monitoring and remediation, to be conducted in all zones without an authorisation issued by the DNP. This is provisional on actions being taken in accordance with an EP that has been accepted by NOPSEMA, and the DNP being notified in the event of oil pollution within a marine park, or where an oil spill response must be taken within a marine park, so far as reasonably practicable prior to response action being taken (NOPSEMA 2018). In the South-east Marine Park network, oil pollution response, environmental monitoring and remediation activities are allowable under existing authorisations (class approvals) in IUCN category VI zones, when undertaken in accordance with and EP accepted under the OPGGS(E) Regulations 2009. In the event of an oil pollution incident that may affect zones other than IUCN category VI zones, prompt consultation with the DNP is required (NOPSEMA 2018).

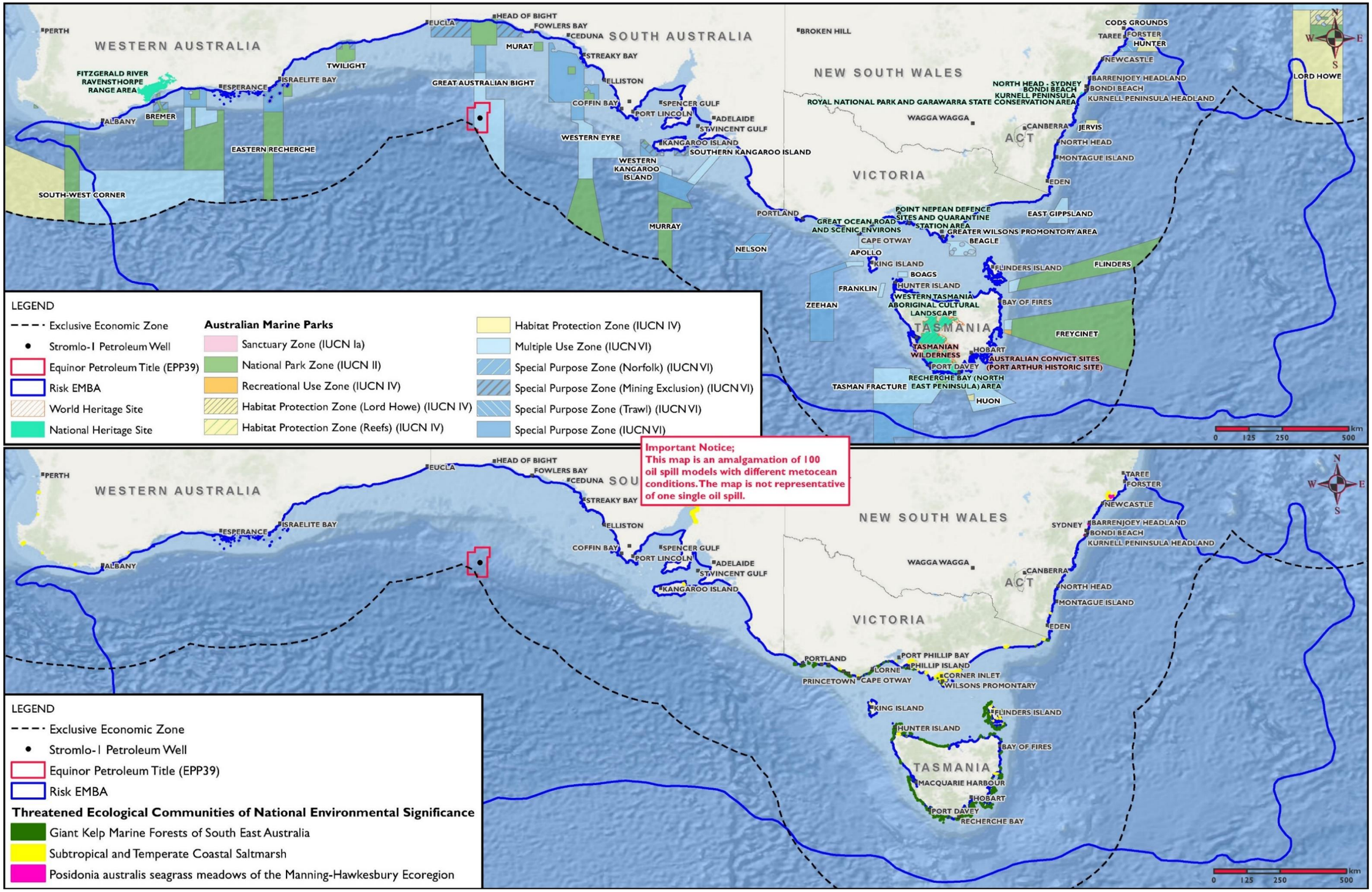


Figure 1.2 Australian marine parks and threatened ecological communities located within the Risk EMBA

Table 1.1 Australian marine parks within, or immediately adjacent to, the Risk EMBA

Marine park	Major conservation values	Relevant management plan and IUCN management principles
South-west Marine Region		
Great Australian Bight	• Globally important seasonal calving habitat for threatened southern right whales • Important foraging areas for threatened Australian sea lions, threatened white sharks, migratory sperm whales, migratory short-tailed shearwaters • Examples of the western ecosystems of the Great Australian Bight Shelf Transition and the easternmost ecosystems of the Southern Province • Three key ecological features – ancient coastline 90–120 m depth (high productivity) – benthic invertebrate communities of the eastern Great Australian Bight (communities with high species diversity) – areas important for small pelagic fish (species group with an important ecological role)	Type B and Type C CMR South-west Marine Region Management Plan. Marine National Park Zone – IUCN Category II (7728 km²) – protected and managed to preserve its natural condition. Petroleum exploration is excluded from this zone. Multiple Use Zone – IUCN Category VI (22,682 km²) – managed to ensure long-term protection and maintenance of biological diversity with a sustainable flow of natural products and services to meet community needs. Some commercial fishing is permissible and petroleum exploration and development is permissible. The project area occurs entirely within this zone.
South-west Corner	• Important migratory area for protected humpback whales and blue whales • Important foraging areas for threatened white sharks, threatened Australian sea lions, threatened Indian yellow-nosed albatrosses, soft-plumaged petrels, migratory sperm whales, migratory flesh-footed shearwaters, short-tailed shearwaters and Caspian terns • Seasonal calving habitat for threatened southern right whales • Representation of three provincial bioregions (the South-west Transition and Southern Province in the off-shelf area, and the South-west Shelf Province on the continental shelf) and two meso-scale bioregions (southern end of the Leeuwin-Naturaliste meso-scale bioregion and western and central parts of the Western Australia South Coast meso-scale bioregion) • Six key ecological features – Albany canyon group (high productivity, feeding aggregations) – Cape Mentelle upwelling (high productivity) – Diamantina Fracture Zone (unique sea floor feature likely to support deep-water communities characterised by high species diversity and endemism) – Naturaliste Plateau (unique sea floor feature, likely to support deep-water communities characterised by high species diversity and endemism) – western rock lobster habitat (species with an important ecological role) – Commonwealth marine environment surrounding the Recherche Archipelago (high biodiversity, breeding and resting aggregations, including the most extensive areas of reef on the shelf within the South-west Marine Region) • Representation of the Donnelly Banks, east of Augusta, characterised by higher productivity and including nursery habitats	Type B reserve Marine National Park Zone – IUCN Category II (128,676 km²) Habitat Protection Zone – IUCN Category IV (91,904 km²) Multiple Use Zone – IUCN Category VI (36,868 km²) Special Purpose Zone – IUCN Category VI (4900 km²) Special Purpose Zone (Oil & Gas Exclusion) – IUCN Category VI (9550 km²)
Bremer	• Important seasonal calving habitat for threatened southern right whales • Important foraging areas for threatened white sharks, threatened Australian sea lions, threatened Indian yellow-nosed albatrosses, soft-plumaged petrels and flesh-footed shearwaters • Important migratory areas for protected humpback whales • Bremer Canyon, where sperm whales and killer whales are known to aggregate • Representation of the Southern Province and the South-west Shelf Province on the continental shelf and the Western Australia South Coast meso-scale bioregion • One key ecological feature: Albany canyon group (high productivity, feeding aggregations)	Type B reserve Marine National Park Zone – IUCN Category II (284 km²) Multiple Use Zone – IUCN Category VI (2838 km²) Special Purpose Zone – IUCN Category VI (1350 km²)
Eastern Recherche	• Important seasonal calving habitat for threatened southern right whales • Important foraging areas for threatened white sharks, threatened Australian sea lions and migratory flesh-footed shearwaters • Examples of the sea floor habitats and communities of the eastern end of the Southwest Shelf province and the Southern province (including the Western Australian South Coast and Eucla meso-scale bioregions) • Examples of the westernmost ecosystems of the Great Australian Bight Shelf Transition • Two key ecological features – meso-scale eddies (high productivity, feeding aggregations) – Commonwealth waters surrounding the Recherche Archipelago (high biodiversity, breeding and resting aggregations, including the most extensive areas of reef on the shelf within the South-west Marine Region)	Type B reserve Marine National Park Zone – IUCN Category II (16,072 km²) Special Purpose Zone – IUCN Category VI (4502 km²)
Twilight	• Important seasonal calving habitat for threatened southern right whales • Habitats surrounding important haul-out site for threatened Australian sea lions • Important foraging areas for threatened white sharks and migratory flesh-footed shearwaters • Examples of the westernmost ecosystems of the Great Australian Bight Shelf Transition (including examples of the Eucla meso-scale bioregion) • Increased connectivity of highly protected shelf ecosystems and representation of the south coast continental shelf environments	Type B reserve Marine National Park Zone – IUCN Category II (4641 km²)

Marine park	Major conservation values	Relevant management plan and IUCN management principles
Murat	• Important seasonal calving habitat for threatened southern right whales • Habitats surrounding important haul-out site for threatened Australian sea lions • Important foraging areas for threatened white sharks and migratory flesh-footed shearwaters • Examples of the westernmost ecosystems of the Great Australian Bight Shelf Transition (including examples of the Eucla meso-scale bioregion) • Increased connectivity of highly protected shelf ecosystems and representation of the south coast continental shelf environments	Type B reserve Marine National Park Zone – IUCN Category II (4641 km²)
Western Eyre	• Important foraging areas for threatened Australian sea lions, threatened white sharks, threatened blue whales, migratory sperm whales, migratory short-tailed shearwaters and Caspian terns • Important seasonal calving habitat for threatened southern right whales • Examples of the westernmost ecosystems of the Spencer Gulf Shelf Province (including the Eyre meso-scale bioregion) and the easternmost ecosystems of the Great Australian Bight Shelf Transition (including the Murat meso-scale bioregion) • Examples of the easternmost ecosystems of the Southern Province • Five key ecological features – ancient coastline 90–120 m depth (high productivity) – Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwelling (high productivity, breeding and feeding aggregations) – meso-scale eddies (high productivity and feeding aggregations) – benthic invertebrate communities of the eastern Great Australian Bight (communities with high species diversity) – areas important for small pelagic fish (species group with an important ecological role)	Type B reserve Marine National Park Zone – IUCN Category II (17,439 km²) Multiple Use Zone – IUCN Category VI (16 107 km²) Special Purpose Zone – IUCN Category VI (24,400 km²)
Western Kangaroo Island	• Important foraging areas for threatened Australian sea lions, threatened white sharks, threatened blue whales, migratory sperm whales, migratory short-tailed shearwaters and Caspian terns • Important seasonal calving habitat for threatened southern right whales • Examples of the southernmost ecosystems of the Spencer Gulf Shelf Province (including the Eyre meso-scale bioregion) • Two key ecological features – ancient coastline 90–120 m depth (high productivity) – Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwelling (high productivity, breeding and feeding aggregations)	Type B reserve Marine National Park Zone – IUCN Category II (120 km²) Special Purpose Zone – IUCN Category VI (2215 km²)
Southern Kangaroo Island	• Important foraging areas for threatened Australian sea lions and threatened white sharks • Important seasonal calving habitat for threatened southern right whales • Examples of the southernmost ecosystems of the Spencer Gulf Shelf Province (including the Eyre meso-scale bioregion) • One key ecological feature: Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwelling (high productivity, breeding and feeding aggregations)	Type B reserve Special Purpose Zone – IUCN Category VI (630 km²)
South-east Marine Region		
Murray	• Examples of ecosystems, habitats and communities associated with the Spencer Gulf Shelf Province, the Southern Province and the West Tasmanian Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, escarpment, knoll/abyssal hill, shelf, slope and terrace • Features with high biodiversity and productivity: Bonney coast upwelling, shelf rocky reefs and hard substrate • Important foraging areas for blue, sei and fin whales, Australian sea lions, wandering, black-browed, yellow-nosed and shy albatrosses, great-winged petrels, flesh-footed and short-tailed shearwaters, and white-faced storm petrels • Important breeding area for southern right whales • Important migration area for humpback whales	Type A reserve Marine National Park Zone – IUCN Category II (12,749 km²) Special Purpose Zone – IUCN Category VI (7147 km²) Multiple Use Zone – IUCN Category VI (5907 km²)
Nelson	• Examples of ecosystems, habitats and communities associated with the West Tasmanian Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, knoll/abyssal hill, plateau and slope • Important migration area for humpback, blue, fin and sei whales (likely migration)	Type A reserve Special Purpose Zone – IUCN Category VI (6,123 km²)
Zeehan	• Examples of ecosystems, habitats and communities associated with the Tasmania Province, the West Tasmania Transition and the Western Bass Strait Shelf Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, deep/hole/valley, knoll/abyssal hill, shelf and slope • Important migration area for blue and humpback whales • Important foraging areas for black-browed, wandering and shy albatrosses, and great-winged and cape petrels	Type A reserve Special Purpose Zone – IUCN Category VI (18,967 km²) Multiple Use Zone – IUCN Category VI (933 km²)
Apollo	• Ecosystems, habitats and communities associated with the Western Bass Strait Shelf Transition and the Bass Strait Shelf Province and associated with the sea floor features: deep/hole/valley and shelf • Important migration area for blue, fin, sei and humpback whales • Important foraging area for black-browed and shy albatrosses, Australasian gannets, short-tailed shearwaters and crested terns • Cultural and heritage site: wreck of the MV City of Rayville	Type A reserve Multiple Use Zone – IUCN Category VI (1,184 km²)

Marine park	Major conservation values	Relevant management plan and IUCN management principles
Beagle	• Ecosystems, habitats and communities associated with the Southeast Shelf Transition and associated with the sea floor features: basin, plateau, shelf and sill • Important migration and resting area for southern right whales • Important foraging area for Australian fur seals, killer whales, white sharks, shy albatrosses, Australasian gannets, short-tailed shearwaters, pacific and silver gulls, crested terns, common diving petrels, fairy prions, black-faced cormorants and little penguins • Cultural and heritage sites: the wreck of the steamship SS *Cambridge* and the wreck of the ketch *Eliza Davies*	Type A reserve Multiple Use Zone – IUCN Category VI (2,928 km²)
Boags	• Ecosystems, habitats and communities associated with the Bass Strait Shelf Province and associated with the sea floor features: plateau and tidal sand wave/sandbank • Important foraging area for shy albatrosses, Australasian gannets, short-tailed shearwaters, fairy prions, black-faced cormorants, common diving petrels and little penguins	Type A reserve Multiple Use Zone – IUCN Category VI (537 km²)
East Gippsland	• Examples of ecosystems, habitats and communities associated with the Southeast Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, escarpment and knoll/abyssal hillslope • Features with high biodiversity and productivity: Bass Cascade; upwelling east of Eden • Important foraging area for wandering, black-browed, yellow-nosed and shy albatrosses, great-winged petrels, wedge-tailed shearwaters and cape petrels • Important migration area for humpback whales	Type A reserve Multiple Use Zone – IUCN Category VI (4,137 km²)
Flinders	• Examples of ecosystems, habitats and communities associated with the Tasmania Province, the Tasmanian Shelf Province, the Southeast Transition and the Southeast Shelf Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, plateau, seamount/guyot, shelf and slope • Features with high biodiversity and productivity: east Tasmania subtropical convergence zone • Important foraging area for wandering, black-browed, yellow-nosed and shy albatrosses, northern giant petrels, Gould's and cape petrels, killer whales, white sharks and Harrison's dogfishes • Important migration area for humpback whales	Type A reserve Marine National Park Zone – IUCN Category II (25,812 km²) Multiple Use Zone – IUCN Category VI (1231 km²)
Franklin	• Examples of ecosystems, habitats and communities associated with the Tasmanian Shelf Province and the Western Bass Strait Shelf Transition and associated with the sea floor features: shelf, deep/hole/valley, escarpment and plateau • Important foraging area for shy albatrosses, short-tailed shearwaters, Australasian gannets, fairy prions, little penguins, common diving petrels, black-faced cormorants and silver gulls	Type A reserve Multiple Use Zone – IUCN Category VI (671 km²)
Freycinet	• Examples of ecosystems, habitats and communities associated with the Tasmania Province, the Tasmanian Shelf Province and the Southeast Transition and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, escarpment, knoll/abyssal hill, saddle, seamount/guyot, shelf and terrace • Features with high biodiversity and productivity: east Tasmania subtropical convergence zone • Important foraging area for wandering, black-browed and shy albatrosses, cape petrels, fairy prions, sei whales and killer whales • Important migration and resting area for southern right whales • Important migration area for humpback whales	Type A reserve Marine National Park Zone – IUCN Category II (56,793 km²) Recreational Use Zone – IUCN Category IV (323 km²) Multiple Use Zone – IUCN Category VI (826 km²)
Huon	• Examples of ecosystems, habitats and communities associated with the Tasmanian Shelf Province and the Tasmania Province and associated with the sea floor features: canyon, knoll/abyssal hill (seamount), pinnacle, saddle, shelf and terrace • Features with high biodiversity and productivity: seamounts south and east of Tasmania (the former Tasmanian Seamounts Marine Reserve was incorporated into the Huon Reserve in 2007. The Tasmanian seamounts are 170 km south of Hobart and there are approximately 70, situated in unusually close proximity to one another. They rise sharply from the ocean floor at depths of 1000–2000 m beneath the sea surface and peak at depths of 660–1940 m • Important foraging area for black-browed, Buller's and shy albatrosses, great-winged petrels, short-tailed shearwaters, fairy prions, Australian fur seals and killer whales • Important migration area for humpback whales	Type A reserve Habitat Protection Zone – IUCN Category IV (389 km²) Multiple Use Zone – IUCN Category VI (9602 km²)
South Tasman Rise	• Examples of ecosystems, habitats and communities associated with the Tasmanian Province and associated with the sea floor features: abyssal plain/deep ocean floor, canyon, plateau, seamount/guyot and slope • Important foraging areas for wandering and black-browed albatross, short-tailed shearwaters and white-headed and white-chinned petrels	Type A reserve Special Purpose Zone – IUCN Category VI (27,704 km²)
Tasman Fracture	• Examples of ecosystems, habitats and communities associated with the Tasmania Province, the Tasmanian Shelf Province and the West Tasmania Transition and associated with the sea floor features: abyssal plain/deep ocean floor, basin, canyon, knoll/abyssal hill, pinnacle, plateau, ridge, saddle, shelf, slope, terrace and trench/trough • Important migration area for humpback whales • Important foraging areas for white sharks, New Zealand fur seals, wandering, black-browed and shy albatrosses, white-chinned petrels, common diving petrels, short-tailed shearwaters and fairy prions	Type A reserve Marine National Park Zone – IUCN Category II (692 km²) Special Purpose Zone – IUCN Category VI (21,313 km²) Multiple Use Zone – IUCN Category VI (20,496 km²)

Marine park	Major conservation values	Relevant management plan and IUCN management principles
Temperate East Region		
Jervis	• Some canyons incise the mid-slope at depths of 1500–3500 m and some extend to a depth of 5000 m • Sea floor features represented in the reserve include abyssal-plain/deep ocean floor, canyons, shelf, and slope • Examples of the ecosystems of the Central Eastern Province, the Southeast Shelf Transition and the Batemans Shelf meso-scale bioregion • Includes two key ecological features – one of three shelf-incising canyons occurring in the region (unique sea floor feature with ecological properties of regional significance) – shelf rocky reefs (unique sea floor feature with ecological properties of regional significance	Type B reserve Multiple Use Zone – IUCN Category VI (1965 km²) Special Purpose Zone – IUCN Category VI (508 km²)
Hunter	• Important habitat for the critically endangered east coast population of grey nurse sharks • Biologically important areas for humpback whales, white sharks and several migratory seabirds • Examples of the ecosystems of the Central Eastern Province and the Central Eastern Shelf Province provincial bioregions and the Manning Shelf meso-scale bioregion • A range of sea floor features including abyssal-plain/deep ocean floor, canyons, shelf, slope, and terrace geomorphic features • Includes one key ecological feature: – shelf rocky reefs (unique sea floor feature with ecological properties of regional significance)	Type B reserve Multiple Use Zone – IUCN Category VI (4518 km²) Special Purpose Zone – IUCN Category VI (1739 km²)
Central Eastern	• Biologically important areas for the humpback whale, white shark and several migratory seabirds • Examples of the ecosystems of the Central Eastern Province, Central Eastern Shelf Transition, and Tasman Basin Province provincial bioregions and the Tweed-Moreton meso-scale bioregion • Represents sea floor features including abyssal-plain/deep ocean floor, canyon, pinnacle, slope, knoll/abyssal-hills/hills/mountains/peak, and seamount/guyot • Includes two key ecological features – canyons on the eastern continental slope (part of one of three shelf-incising canyons occurring in the region is represented) – Tasmantid seamount chain (known breeding and feeding areas for several open ocean species such as billfish and marine mammals)	Type B reserve Habitat Protection Zone – IUCN Category IV (20,707 km²) IUCN zones outside of the Risk EMBA: Marine National Park – IUCN Category II (8,110 km²) Habitat Protection Zone – IUCN Category IV (52,066 km²) Multiple Use Zone – IUCN Category VI (9,878 km²)
Lord Howe	• Biologically important areas for protected humpback whales and several migratory seabirds • A major seabird breeding area with 14 species found on the islands including masked boobies, grey ternlets, red-tailed tropic birds, black-winged petrels and Kermadec petrels • Key location for the black cod • Due to the convergence of warmer tropical and cooler temperate waters around the reserve, many species found there are at the northern or southern extent of their range • Examples of the ecosystems of the Lord Howe Province and the Tasman Basin Province provincial bioregions • Represents sea floor features including basin, plateau, saddle, seamount/guyot and deep ocean valley • Includes three key ecological features – the Lord Howe seamount chain (high productivity; aggregations of marine life; biodiversity and endemism) – Elizabeth and Middleton reefs (aggregations of marine life; biodiversity and endemism) – Tasman Front and eddy field (high productivity; aggregations of marine life; biodiversity and endemism)	Type B reserve Habitat Protection Zone – IUCN Category IV (45,898 km²) IUCN zones outside of the Risk EMBA: Marine National Park Zone – IUCN Category II (10,488 km²) Recreational Use Zone – IUCN Category IV (1170 km²) Habitat Protection Zone (Lord Howe) – IUCN Category IV (5136 km²) Multiple Use Zone – IUCN Category VI (38,446 km²)
Cod Grounds	• Established in May 2007 in Commonwealth waters just south of Port Macquarie in New South Wales, to protect a significant aggregation site for the critically endangered east coast population of grey nurse sharks • Biologically important areas for the protected humpback whale, vulnerable white shark and several migratory seabirds • Examples of the ecosystems of the Central Eastern Shelf Province provincial bioregion and the Manning Shelf meso-scale bioregion • The area is a series of underwater pinnacles, which is a significant aggregation site for the critically endangered east coast population of grey nurse sharks • Representation of the shelf sea floor feature	Type A reserve Marine National Park Zone – IUCN Category II (4 km²)

1.4.4 Threatened ecological communities

Three threatened ecological communities (TECs) listed as MNES under the EPBC Act were identified within the Risk EMBA in the PMST report. These are described below.

1.4.4.1 Subtropical and temperate coastal saltmarsh

Subtropical and Temperate Coastal Saltmarsh (TEC) is listed as a Vulnerable TEC under the EPBC Act.

Subtropical and Temperate Coastal Saltmarsh is distributed across subtropical and temperate coastal regions of southern Australian from Shark Bay, Western Australia (26°S), to the South-east Queensland IBRA bioregion boundary (23°S). The TEC is usually associated with soft substrate shores of estuaries and embayments (sandy and/or muddy) along low wave energy coastlines (DSEWPaC 2013a). The physical environment for the TEC is coastal areas under regular or intermittent tidal influence, with saltmarsh being the key vegetation type; that is, salt-tolerant grasses, herbs, sedges, rushes and shrubs generally less than 50 cm high (DSEWPaC 2013a). The saltmarsh provides important habitat for invertebrates, fish, birds and mammals (DSEWPaC 2013a).

In Australia, saltmarsh flora includes many species (>100) but it is dominated by relatively few families. There is also often a high degree of endemism at the species level although many non-endemic species also occur. This reflects the fact that only a select few families have the physiology to deal with the harsh saltmarsh environment. The two most widely represented coastal saltmarsh plant families are the Chenopodiaceae and Poaceae.

The Subtropical and Temperate Coastal Saltmarsh ecological communities in South Australia have the highest floristic biodiversity (about 75% of saltmarsh plant species in Australia) and often occur in large areas behind the open coastline of sheltered waters such as in the Gulfs (DSEWPaC 2013a). Species diversity of Western Australia saltmarsh is similarly high (DSEWPaC 2013a). There are several differences in species composition and abundance between the east and west coasts of Australia for coastal saltmarsh. For example, the south-west of Western Australia is an important region globally for high diversity and endemicity of several groups, such as Tecticornia and Triglochin (samphires) or Puccinellia (salt grass) (DSEWPaC 2013a).

Species characteristic of the ecological community, due to their dominance in at least some of its range, include:

- *Austrostipa stipoides* (spear grass) – up to 1 m, in better drained landward margins
- *Gahnia filum* (clumped sedge, can grow up to 1.5 m), with *Gahnia trifida* in Western Australia
- *Juncus kraussii* (sea rush) – dominates in fresher conditions in estuaries or seepage zones
- *Samolus repens* (creeping brookweed, water pimpernel) – low-growing herb (DSEWPaC 2013a).

Conservation advice (DSEWPaC 2013a) developed for Subtropical and Temperate Coastal Saltmarsh identifies clearing and fragmentation, land-claim (or infilling), altered hydrology or tidal restriction, invasive species, climate change, mangrove encroachment, recreation, pollution/litter, acid sulfate soils, grazing, insect control, evaporative salt production and other mining, and inappropriate fire regimes as key threats and provides guidance on priority threat abatement actions to support the communities recovery. The conservation advice describes pollution from oil spills as a major potential threat to the TEC. An ongoing connection with the tidal regime is of critical importance to the survival of this TEC (DSEWPaC 2013a).

Subtropical and Temperate Coastal Saltmarsh occur in shallow waters within the Risk EMBA, the nearest location where the TEC is known to occur is hundreds of kilometres from the well location.

1.4.4.2 Giant Kelp Marine Forests of South-East Australia

Giant Kelp Marine Forests of South East Australia are listed as an Endangered TEC and are protected under the EPBC Act. Giant kelps (*Macrocystis pyrifera*) are a cold-water brown algal species that form the foundation of this ecological community, which is restricted to the cold temperate waters of south-east Australia. With sea surface temperatures rising on the east coast of Australia over the last 40 years the giant kelp forest communities have progressively been lost from their historical range (DSEWPaC 2012c). The largest extent of this TEC is in Tasmanian coastal waters. Some patches may also be found in Victoria and in south-east South Australia (DSEWPaC 2012c), from Cape Jaffa south to Port MacDonnell (Scientific Working Group 2011) (Figure 1.3).

Giant kelps grow on rocky reefs, typically at depths of 8 m and greater, with the fronds grow vertically toward the water surface. The kelp species itself is not protected but rather the community, which is defined by the typical sea level where it occurs and fronds forming a closed or semi-closed surface or subsurface canopy (DSEWPaC 2012c).

Giant kelp is noted as growing inside fringing reefs in water depths of 2–10 m, but not as dense forests, rather as scattered individuals at densities of up to 10 per 100 m^2. Outside of the fringing reefs, forests can occur at depths of 10–125 m, but they are patchy in space and time, appearing rapidly after strong upwellings and persisting until winter storms tear them off their base (Scientific Working Group 2011).

Giant kelps are the largest and fastest growing marine plants. Their presence on a rocky reef adds vertical structure to the marine environment that creates significant habitat for marine fauna and increasing local marine biodiversity. Species known to shelter within the kelp forests include weedy sea dragons (*Phyllopteryx taeniolatus*), six-spined leather jacket (*Mesuchenia freycineti*), brittle stars (*Ophiuroid* spp.), urchins, sponges, blacklip abalone (*Tosia* spp.) and southern rock lobster (*Jasus edwardsii*). The large biomass and productivity of giant kelps also provides a range of ecosystem services to the coastal environment, such as shading the seabed, stabilising the substratum, dampening water movement, extracting nutrients from the water and providing a rich source of food (Scientific Working Group 2011). Blacklip abalone and other molluscs are known to feed extensively on giant kelp, and lobsters at the next trophic level feed on these molluscs. In this way, giant kelp has an important role to play with the fishing industries centred on these species (Scientific Working Group 2011).

Giant Kelp Marine Forests of South East Australia are found in shallow waters within the Risk EMBA and the nearest location where the TEC is known to occur is approximately 750 km from the well location.

Source: Scientific Working Group (2011)

Figure 1.3 Approximate location of giant kelp forests along the south-east South Australia coast

1.4.4.3 *Posidonia australis* seagrass meadows of the Manning-Hawkesbury Ecoregion

Posidonia australis seagrass meadows of the Manning-Hawkesbury Ecoregion are listed as an Endangered TEC and are protected under the EPBC Act. *P. australis* is a subtidal meadow-forming seagrass species with a distribution that extends across southern Australia from Shark Bay in Western Australia to Wallis Lake, New South Wales. The TEC includes the assemblage of plants, animals and micro-organisms associated with seagrass meadows dominated by *P. australis* occurring in the warm temperate Manning Shelf and Hawkesbury Shelf bioregions on the east coast of Australia (DoE 2015a).

The geographic extent of *P. australis* has declined significantly over the past ~70 years and is now limited to the sheltered environments of a limited number of permanently open estuaries from Wallis Lake (32°S) to Port Hacking (34°S) along the New South Wales coast (DoE 2015b). Within these estuaries the TEC typically occurs in water depths of 1–10 m on sand and silty mud substrate (DoE 2015b).

P. australis meadows provide habitat for a diverse range of plants and animals including nursery habitat for many important fish and invertebrate species (including commercially harvested species); support estuarine food webs by providing a surface for the establishment of epiphytes, epifauna and infauna that provide an important food and detrital resource for larger invertebrates, fish and other foraging fauna; stabilise sediments and prevent erosion of nearshore areas by mitigating currents and reducing wave energy; protect water quality and sequester carbon (DoE 2015b). Among the estuarine communities of south-eastern Australia there are bioregional differences in the species associated with *P. australis* meadows. The following species of particular significance for conservation are associated with *P. australis* meadows in the warm temperate Manning Shelf and Hawkesbury Shelf bioregions and not the adjacent cool temperate Batemans or Two Fold Shelf bioregions: *Arothron hispidus* (stars and stripes puffer), *Batrachomoeus dubius* (eastern frog fish), *Birubius* sp., *Euristhmus lepturus* (longtail catfish), *Lucifer hanseni* (ghost prawn), *Lutjanus russelli* (Moses' snapper), *Paramonacanthus otisensis* (dusky leather jacket), *Portunus pelagicus* (Asian blue swimming crab), *Sphyraena obtusata* (striped barracuda) and *Vincentia conspersa* (southern cardinal fish) (DoE 2015b).

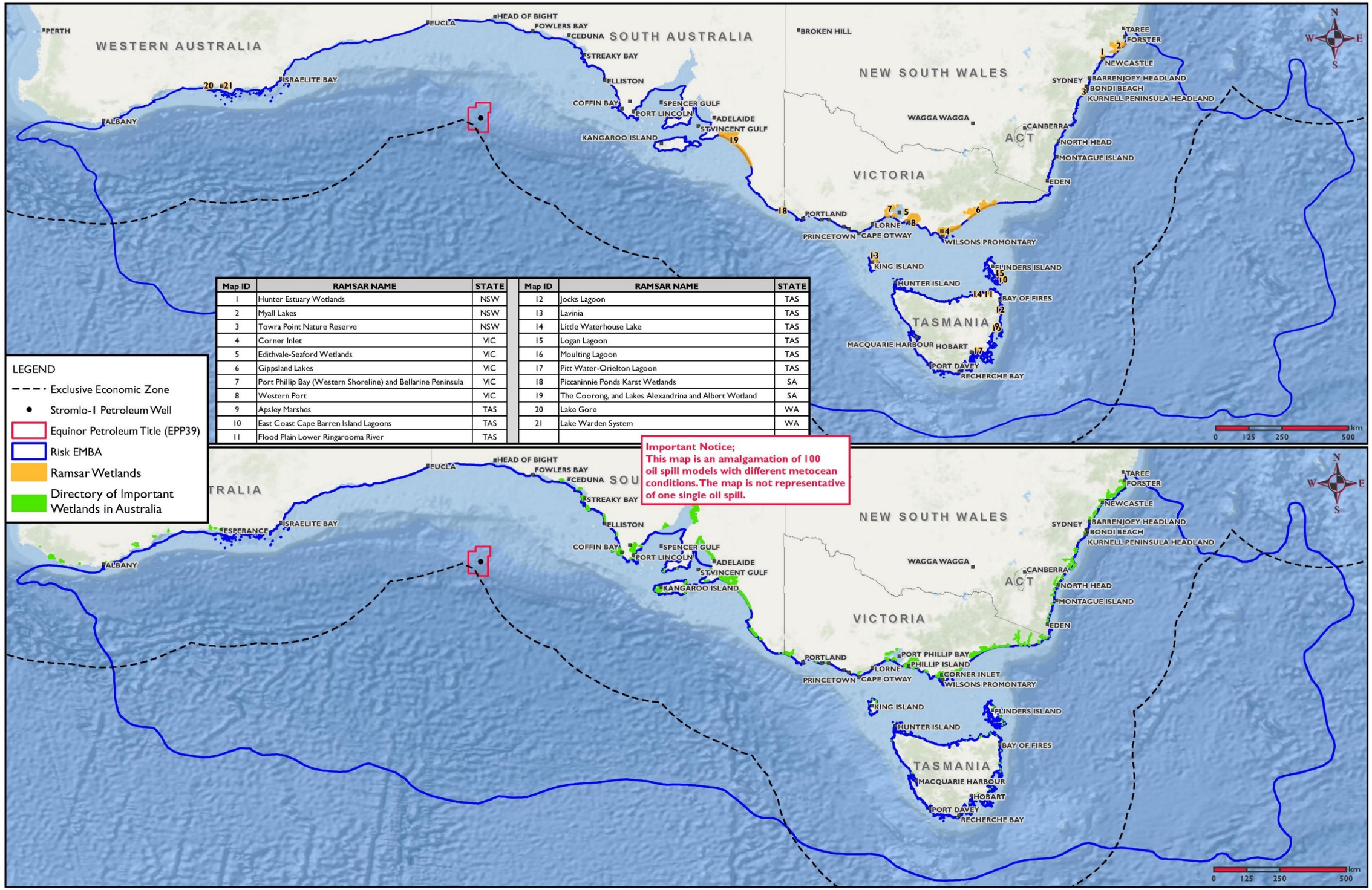
Conservation advice (DoE 2015b) developed for *Posidonia australis* Seagrass Meadows of the Manning-Hawkesbury Ecoregion identifies coastal development, dredging, boat mooring and other boat related activities, catchment disturbance and pollution, and climate change as key threats and provides guidance on priority threat abatement actions to support the recovery of the ecological community.

Posidonia australis Seagrass Meadows of the Manning-Hawkesbury Ecoregion ecological communities are found in sheltered parts of estuaries along the furthest stretch of coast from the well location within the Risk EMBA.

1.4.5 Ramsar wetlands

The Ramsar Convention on Wetlands of International Importance especially as Waterfowl Habitat is an international treaty for the conservation and sustainable use of wetlands. Thirteen Ramsar sites are situated within and along the shoreline of the Risk EMBA (Table 1.2; Figure 1.4). These wetland sites have been listed as MNES under the EPBC Act on the basis that they are "Wetlands of International Importance" and include two sites each in South Australia and New South Wales, four sites each in Victoria and Tasmania, and one site in Western Australia. The location of each Ramsar site within the Risk EMBA is described below for each state. The wetland sites are managed by state governments under the individual management plans described in Table 1.2.

Each Ramsar site has an "ecological character description" (ECD) that provides baseline information about the wetland's values and the components, processes and services that characterise the Ramsar site. The ECD also identifies limits of acceptable change, threats to the Ramsar site's ecological character, knowledge gaps in the site's components and processes, and recommendations for future monitoring.



Map ID	RAMSAR NAME	STATE	Map ID	RAMSAR NAME	STATE
1	Hunter Estuary Wetlands	NSW	12	Jocks Lagoon	TAS
2	Myall Lakes	NSW	13	Lavinia	TAS
3	Towra Point Nature Reserve	NSW	14	Little Waterhouse Lake	TAS
4	Corner Inlet	VIC	15	Logan Lagoon	TAS
5	Edithvale-Seaford Wetlands	VIC	16	Moulting Lagoon	TAS
6	Gippsland Lakes	VIC	17	Pitt Water-Orielton Lagoon	TAS
7	Port Phillip Bay (Western Shoreline) and Bellarine Peninsula	VIC	18	Piccaninnie Ponds Karst Wetlands	SA
8	Western Port	VIC	19	The Coorong, and Lakes Alexandrina and Albert Wetland	SA
9	Apsley Marshes	TAS	20	Lake Gore	WA
10	East Coast Cape Barren Island Lagoons	TAS	21	Lake Warden System	WA
11	Flood Plain Lower Ringarooma River	TAS			

Figure 1.4 Ramsar wetlands and directory of important wetlands located within the Risk EMBA

Table 1.2 Wetlands of international importance (Ramsar) within the Risk EMBA

Ramsar site	State	Relevant plans	Ecological character description
Myall Lakes Wetland	New South Wales	Myall Lakes National Park, Little Broughton Island and Storm petrel Nature Reserves Plan of Management (NPWS 2002)	Myall Lakes Ramsar site Ecological Character Description (Office of Environment and Heritage New South Wales 2012)
Towra Point Nature Reserve	New South Wales	Towra Point Nature Reserve Plan of Management (NPWS 2001)	Towra Point Nature Reserve Site Ecological Character Description (Department of Environment, Climate Change and Water New South Wales 2010)
Piccaninnie Ponds Karst Wetlands	South Australia	Ramsar Management Plan for Piccaninnie Ponds Karst Wetlands (Butcher et al. 2011)	Piccaninnie Ponds Karst Wetlands Ecological Character Description (Water's Edge Consulting and Associates for the Department of Environment, Water and Natural Resources 2011)
The Coorong, and Lakes Alexandrina and Albert Wetland	South Australia	Coorong, and Lakes Alexandrina and Albert Ramsar Management Plan (DEH 2000)	The Coorong, and Lakes Alexandrina and Albert Wetland Ecological Character Description (South Australia DEH 2006)
East Coast Cape Barren Island Lagoons	Tasmania	–	East Coast Cape Barren Island Lagoons Ecological Character Description (DSEWPaC 2012d)
Flood Plain Lower Ringarooma River	Tasmania	Flood Plain Lower Ringarooma River Ramsar Wetland Site: Management Plan (GHD 2008)	Flood Plain Lower Ringarooma River Ecological Character Description (Newall & Lloyd 2012)
Lavinia	Tasmania	Lavinia Nature Reserve Management Plan (DPIPWE 2000)	Lavinia Ecological Character Description (DPIPWE 2000a)
Logan Lagoon	Tasmania	Logan Lagoon Conservation Area (Ramsar Site) Draft Management Plan 2000 (DPIPWE 2000b)	Logan Lagoon Ecological Character Description (Elgin Associates Pty Ltd 2012)
Corner Inlet	Victoria	Corner Inlet Ramsar Site Strategic Management Plan (DNRE 2002)	Corner Inlet Ramsar site Ecological Character Description (DSEWPaC 2011a)
Gippsland Lakes	Victoria	Gippsland Lakes Ramsar Site Management Plan (EGCMA 2015)	Gippsland Lakes Ecological Character Description (DSEWPaC 2011b)
Port Phillip Bay (Western Shoreline)	Victoria	Port Phillip Bay (Western Shoreline) & Bellarine Peninsula Ramsar Site Strategic Management Plan (DSE 2003) Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Draft Ramsar Site Management Plan Summary	–
Western Port	Victoria	Western Port Ramsar Site Management Plan (DELWP 2017)	Western Port Ramsar Site Ecological Character Description (DSEWPaC 2010) Ecological Character Description Addendum Western Port Ramsar Site (Hale 2016)
Lake Gore	Western Australia	Esperance and Recherche parks and reserves management plan 84 (DPAW 2016)	Lake Gore Ecological Character Description (DEC 2009)

1.4.5.1 New South Wales

Myall Lakes Wetland

The Myall Lakes Wetland Ramsar site (44,612 ha) is within the Myall Lakes National Park, around 75 km north of Newcastle on the New South Wales coast. The site boundary intersects the Risk EMBA along the coast.

Myall Lakes National Park comprises four main lakes (the Bombah Broadwater, Boolambayte, Two Mile and Myall Lakes) together with the lesser areas of Nerong Creek, sections of the Upper and Lower Myall River, Boolambayte Creek, Fame Cove Inlet and Broughton Island. The Ramsar site incorporates several distinct wetlands associated with the waterways and dune systems. These wetlands are 0.75–5 km inland and are separated from the coast by high sand dunes.

Myall Lakes Ramsar site supports high plant diversity with 946 species of terrestrial flora, two mangrove species (*Avicennia marina* and *Aegiceras corniculatum*), 10 species of submerged aquatic flora recorded including seagrass *(Ruppia megacarpa*) and saltmarsh species (*Sarcocornia quinqueflora*, *Suaeda australis*, *Baumea juncea* and *Juncus kraussii*) (DEE 2018a).

Animal species diversity is similarly high and over 300 species have been recorded in the area, of which approximately two-thirds are birds. The wetlands regularly support large numbers of waterbirds and waders including ducks, swans, egrets and terns (DEE 2018a).

Contemporary use of the Ramsar site is mostly recreational activities such as sailing, swimming, power boating, canoeing, bush walking, four-wheel driving and bird watching. The area is also popular with commercial and recreational fishers. Myall Lakes National Park also contains numerous major items of indigenous heritage, including middens (DEE 2018a).

Towra Point Nature Reserve

The Towra Point Nature Reserve Ramsar site (604 ha) lies on the northern side of Kurnell Peninsula, forming the southern and eastern shores of Botany Bay, and is approximately 16 km from the Sydney city centre. It is the largest and most diverse estuarine wetland complex remaining in the Sydney basin region and comprises a mixture of spits, bars, mudflats, dunes and beaches (DEE 2018a).

Towra Point Nature Reserve consists of a variety of habitats such as seagrass meadows, mangroves, saltmarshes, dune woodlands, Casuarina forest, small occurrences of littoral rainforest and sand dune grasslands. Marine habitats within the Ramsar site are regionally significant, with the reserve containing around 40% of the remaining mangrove communities and 60% of the remaining saltmarsh communities around Sydney (DEE 2018a).

Towra Point Nature Reserve is also an important area for bird species, with approximately 200 species recorded in the area. This includes 34 species listed under international migratory bird conservation agreements. Large numbers of eastern curlews, lesser golden plovers and ruddy turnstones have also been recorded within the Ramsar site. The state-listed threatened little tern and pied oystercatcher are known to breed within the reserve (DEE 2018a).

Towra Point Aquatic Reserve, which is adjacent to the nature reserve, includes much of the remaining important seagrasses, mangroves and migratory wading bird habitats in Botany Bay. It represents major habitat supporting commercial and recreational fish stocks in the coastal Sydney region (DEE 2018a).

1.4.5.2 South Australia

Piccaninnie Ponds Karst Wetlands

The Piccaninnie Ponds Karst Wetlands Ramsar Site (862 ha) is an exceptional example of karst and coastal fen wetlands, with groundwater springs reaching more than 110 m in depth. The system is an important remnant of an extensive system of wetlands that once occupied much of the south-east of South Australia (DSEWPaC 2013b).

Key areas in the site include major groundwater discharge sites of Piccaninnie Ponds, referred to as the Main Ponds, Hammerhead Pond and Crescent Pond. Water leaves the site via a number of outlets, principally Outlet Creek and the Pick Swamp drain outlet, which connect the site to the marine environment. Along the beach are several fresh groundwater beach springs. There are also several other small unnamed springs, which are also groundwater discharge points (DSEWPaC 2013b).

The wetlands support a number of nationally threatened species, including the orange-bellied parrot and the Australasian bittern. It is a known winter roosting and feeding location for the critically endangered orange-bellied parrot. The site also provides habitat for 79 waterbird species including 24 species listed under international agreements and 50 Australian migratory or marine species (DSEWPaC 2013b).

The site supports ten of the 21 native fish species found in the drainage division, such as the Yarra pygmy perch and dwarf galaxias, as a breeding and spawning location. The surface waters of Pick Swamp also support the Glenelg spiny freshwater crayfish, one of seven nationally listed species found at the site. The

karst wetland system also provides habitat for an extensive and diverse assemblage of endangered, rare and other flora and fauna that are highly representative of the pre-European biodiversity of the Lower Limestone Coast region of South Australia (DSEWPaC 2013b).

The wetlands are also culturally important. The Traditional Owners of the land, the Bunganditj (Boandik) people, and local indigenous people of the south-east have a strong connection with the site, recognising the importance of groundwater discharge and connections between culture and wetland health (DSEWPaC 2013b).

Coorong, and Lakes Alexandrina and Albert Wetland

The Coorong and Lakes Alexandrina and Albert Wetland Ramsar wetlands are at the mouth of the Murray River in South Australia, approximately 760 km east of the well location. This boundary of this wetland network encapsulates the coastal dune network to the high-water mark, thus intersecting the Risk EMBA.

The Murray River flows into Lake Alexandrina and out to the Southern Ocean through the Murray Mouth estuary. The Coorong is a long, shallow, brackish to hypersaline lagoon more than 100 km in length, separated from the Southern Ocean by a narrow sand dune peninsula. Twenty-three wetland types have been identified in the Ramsar site, including estuarine waters, coastal brackish/saline lagoons, permanent freshwater lakes, permanent freshwater marshes, and seasonally flooded agricultural land (DEH 2000).

The Coorong and Lakes Alexandrina and Albert Wetland site supports some threatened ecological communities and species, as well as extensive and diverse waterbird, fish and plant assemblages. The site supports a threatened chaffy saw-sedge vegetation community, and threatened plant species such as the silver daisy-bush and metallic sun-orchid. Threatened animal species include the southern bell frog, Murray cod, and Mount Lofty Ranges southern emu-wren (DEH 2000).

The Coorong and Lakes Alexandrina and Albert are also an important area for waterbirds. At least 85 bird species including the Australasian bittern, glossy ibis and sharp-tailed sandpiper have been recorded from the Ramsar site, 25 of which are listed under international migratory conservation agreements (DEH 2000).

1.4.5.3 Victoria

Corner Inlet

The Corner Inlet Ramsar site (67,186 ha) is a large tide-dominated embayment adjacent to the southernmost tip of the Australian mainland. The inlet consists of a submerged plain covered by sand or mud flats with well-developed seagrass beds, and large sand islands. A radiating system of deeper channels supports efficient tidal exchange over the flats and the areas between the islands.

The site is essentially one large area of marine embayment, tidal channels and sandy barrier islands that includes:

- marine/estuarine areas within Corner Inlet
- land areas (above the high-water mark) covering the sand islands and spits along the south-eastern site boundary
- nearshore coastal areas fringing the mainland (DSEWPaC 2011a).

The major features of Corner Inlet that form its ecological character are:

- the large geographical area
- the wetland types, extensive *Posidonia* seagrass meadows, intertidal sand or mud flats, mangroves, saltmarshes and permanent shallow marine water
- the diversity of aquatic and semi-aquatic habitats
- abundant flora and fauna including significant proportions of the total global population of several waterbird species (DSEWPaC 2011a).

Due to its large area and the diversity of habitats present, the Corner Inlet Ramsar site supports internationally significant populations of several aquatic and semi-aquatic species (DSEWPaC 2011a). The site has high biodiversity values, which are summarised by DNRE (2002) as follows:

- approximately 390 species of indigenous flora and approximately 160 species of indigenous terrestrial fauna have been recorded at the site

- to date, 24, 26 and 27 bird species listed under JAMBA, CAMBA and ROKAMBA, respectively, have been recorded at the site
- a total of 25 bird species listed under the Bonn Convention have been recorded at the site
- over 390 species of marine invertebrates have been recorded in the site, including three invertebrate species that appear to be restricted to Corner Inlet and which have been recommended for listing as vulnerable species under the Victorian *Flora and Fauna Guarantee Act 1988*
- a variety of marine mammals occur in the site including bottlenose dolphins and Australian fur seals, as well as occasional records of common dolphins, New Zealand fur seals, leopard seals and southern right whales
- abundant flora and fauna including significant proportions of the total global population of several waterbird species (DSEWPaC 2011a).

Waterbird breeding is a key life history function in the context of maintaining the ecological character of the site, with important sites present the sand barrier islands.

Corner Inlet supports nationally threatened fauna species including:

- orange-bellied parrot
- growling grassfrog
- fairy tern
- Australian grayling.

Gippsland Lakes

The Gippsland Lakes Ramsar site (60,015 ha) consists of a group of coastal lagoons and marsh environments that are separated from the sea by a barrier system of sand dunes and fringed on the seaward side by the Ninety Mile Beach.

The ecosystem processes that underpin the habitats of the Gippsland Lakes Ramsar site include hydrology and hydrodynamics (with the site heavily influenced by both freshwater riverine inputs and marine saline inflows), water quality and sediment nutrient dynamics, geomorphology, climate, shoreline and coastal processes and a range of biological processes (BMT WBM 2011).

Several key wetland habitat types are present including:

- marine subtidal aquatic beds (seagrass/aquatic plants)
- coastal brackish or saline lagoons (open water phytoplankton-dominated habitats)
- freshwater wetlands
- brackish wetlands
- saltmarsh/hypersaline wetlands (BMT WBM 2011).

The site also supports an assemblage of vulnerable or endangered wetland flora and fauna that contribute to biodiversity as well as supporting key fisheries habitats and stocks of commercial and recreational significance (BMT WBM 2011).

Port Phillip Bay (Western Shoreline)

The Port Phillip Bay (Western Shoreline) Ramsar site (22,650 ha) comprises a number of shorelines, intertidal zone and adjacent wetland areas located around western Port Phillip Bay, the Bellarine Peninsula, the lower Barwon River wetlands and Mud Islands, Victoria. It is protected under the Port Phillip Bay (Western Shoreline) & Bellarine Peninsula Ramsar Site Strategic Management Plan (DSE 2003), which defines the key values as:

- representativeness – it includes all eight wetlands types
- natural function – the interactions of physical, biological and chemical components of wetlands that enable them to perform certain natural functions and making them a vital element of the landscape
- flora and fauna – contain the genetic and ecological diversity of the flora and fauna of the region, with at least 332 floral species (22 state threatened species) and 304 species of fauna (29 threatened species)
- waterbirds – provides habitat for migratory shorebirds, including some of international and national importance

- cultural heritage – many aboriginal sites, particularly shell middens and artefact scatters have been found at the site
- scenic – provides vistas of open water and marshland in a comparatively pristine condition
- economic – use of natural resources in agriculture, fisheries, recreation and tourism
- education and interpretation – offer a wide range of opportunities for education and interpretation of wildlife, marine ecosystems, geomorphological processes and various assemblages of aquatic and terrestrial vegetation
- recreation and tourism – provide activities such as recreational fishing, birdwatching, hunting, boating, swimming, sea kayaking and camping and activities by commercial operators
- scientific – site for long-term monitoring of waterbirds and waders.

Western Port

Western Port (59,950 ha) is in south-eastern Australia, approximately 60 km south-east of Melbourne, Victoria. Western Port consists of large shallow intertidal areas dissected by deeper channels, and a narrow strip of adjacent coastal land in some areas.

The site is protected under the Western Port Ramsar Site Management Plan (DELWP 2017), which describes the values as:

- supports a diversity and abundance of fish and recreational fishing
- the soft sediment and reef habitats support a diversity and abundance of marine invertebrates
- supports bird species, including 115 waterbird species, of which 12 are migratory waders of international significance
- provides important breeding habitat for waterbirds, including listed threatened species
- provides habitat to six species of bird and one fish species that are listed as threatened under the EPBC Act
- rocky reefs comprise a small area within the Ramsar site, but includes the intertidal and subtidal reefs at San Remo, which support a high diversity, threatened community and Crawfish Rock, which supports 600 species
- the Western Port Ramsar Site has three Marine National Parks, one national park and has been designated as a Biosphere Reserve under the UNESCO's Man and the Biosphere program
- the Ramsar site is within the traditional lands of the Boonwurrung, who maintain strong connections to the land and waters
- the site contains the commercial Port of Hastings that services around 75 ships per year and contributes around $67 million annually to the region's economy.

1.4.5.4 Tasmania

East Coast Cape Barren Island Lagoons

The East Coast Cape Barren Island Lagoons Ramsar site is on the eastern shore of Cape Barren Island in the Furneaux Group of islands, Bass Strait, to the north-east of Tasmania. The site is 4,473 ha in size (approximately 10% of the area of Cape Barren Island) and has a maximum elevation of <20 m ASL. The site extends from just north of Tar Point down to Jamieson's Bay, excluding Cape Barren, and then extends westwards from the coast for a distance varying from 1 to 4 km (DSEWPaC 2012d).

The geomorphic conditions and associated hydrology of the site have resulted in a unique diversity and range of wetland types. It is the most extensive example of such a system in the Tasmanian Drainage Division biogeographic region. The site is a complex of freshwater, brackish, saline and sometimes hypersaline lagoons, wetlands and estuaries. These characteristics have formed due to a dune system that has been slowly developing in an easterly direction, leaving shallow sandy soils, depressions and intermittently flowing water courses (DSEWPaC 2012d). The lagoons provide habitat for a wide range of vegetation communities and flora species. Sixteen plant species that have been recorded within the site are listed as threatened in Tasmania.

Specifically, this site is considered important for the following (DSEWPaC 2012d):

- vegetation associated with the wetlands plays an important role in stabilising the highly dynamic coastal system

- it has a significant place in recent history of the Tasmanian Aboriginal community cultural heritage and is of spiritual and religious significance
- it is a regional example of a near natural coastal wetland
- it supports rare plant species and communities at the limit of their ranges.

Flood Plain Lower Ringarooma River

The Flood Plain Lower Ringarooma River Ramsar site (3519 ha) is a complex wetland, coastal and estuarine ecosystem that provides habitat for important and nationally threatened species. The site can be separated into three zones – a coastal zone, an estuary zone and an aquatic (freshwater) zone. The coastal zone covers the entire coast of the site (3–4 km), including the combined mouth of the Boobyalla and Ringarooma rivers and their delta. The Ramsar wetland types that occur within the freshwater zone include: seasonal waterways, permanent freshwater marshes, pools and ponds, with emergent vegetation; seasonal freshwater marshes and pools, including seasonally flooded meadows and sedge marshes; shrub-dominated wetlands; and freshwater, tree-dominated wetlands (freshwater swamp forest) (Newall & Lloyd 2012).

The series of shallow freshwater lagoons at the site are an important feeding and nesting place for many species of waterbirds. Approximately 3 km of beaches are included in the site, from which a number of shorebirds have been recorded including the hooded plover (*Thinornis rubricollis*), red-capped plover (*Charadrius ruficapillus*), greenshank (*Tringa nebularia*), red-necked stint (*Calidris ruficollis*), ruddy turnstone (*Arenaria interpres*), curlew sandpiper (*Calidris ferruginea*), black-fronted dotterel (*Elseyornis melanops*) and fairy tern (*Sterna nereis*). Approximately 40 species of wetland-dependent plants have been recorded at the site (Newall & Lloyd 2012). The site supports six fauna species listed on the IUCN Red List or as nationally threatened under the EPBC Act, including four wetland-dependent species.

Lavinia

The Lavinia Ramsar site (7034 ha) is on the north-east coast of King Island, Tasmania. The boundary of the site forms the Lavinia State Reserve, with major wetlands in the reserve including the Sea Elephant River estuary area, Lake Martha Lavinia, Penny's Lagoon, and the Nook Swamps. It is subject to the Lavinia Nature Reserve Management Plan (2000).

The shifting sands of the Sea Elephant River's mouth have caused a large back-up of brackish water in the Ramsar site, creating the saltmarsh that extends up to 5 km inland. The present landscape is the result of several distinct periods of dune formation. The extensive Nook Swamps, which run roughly parallel to the coast, occupy a flat depression between the newer parallel dunes to the east of the site and the older dunes further inland. Water flows into the wetlands from the catchment through surface channels and groundwater and leaves mainly from the bar at the mouth of the Sea Elephant River and seepage through the young dune systems emerging as beach springs.

The Lavinia State Reserve is one of the few largely unaltered areas of the island and contains much of the remaining native vegetation on King Island. The vegetation communities include Succulent Saline Herbland, Coastal Grass and Herbfield, Coastal Scrub and King Island Eucalyptus globulus Woodland. The freshwater areas of the Nook Swamps are dominated by swamp forest. Nook Swamps and the surrounding wetlands contain extensive peatlands.

The site is an important refuge for a collection of regional and nationally threatened species, including the nationally endangered orange-bellied parrot. This parrot is heavily dependent upon the samphire plant, which occurs in the saltmarsh, for food during migration. They also roost at night in the trees and scrub surrounding the Sea Elephant River estuary. Several species of birds that use the reserve are rarely observed on the Tasmanian mainland, including the dusky moorhen, nankeen kestrel, rufous night heron and the golden-headed cisticola.

The site is currently used for conservation and recreation, including boating, fishing, camping and off-road driving. There are artefacts of Indigenous Australian occupation on King Island that date back to the last ice age when the island was connected to Tasmania and mainland Australia via the Bassian Plain.

Logan Lagoon

The Logan Lagoon Ramsar site (2257 ha) is in the south-east corner of Flinders Island (Tasmania) in the Bass Strait and is part of an extensive eastern Flinders Island parallel dune-coastal barrier system. The site is 6 km north-east of the township of Lady Barron and is bounded by the sea to the east and south, Cameron Inlet to the north and private property for most of its western edge (Finley et al. 2010). The Ramsar site is comprised a diverse range of seasonal and permanent marshlands, grass and heathlands, forests and woodlands within the Tasmanian bioregion.

Flinders Estuary is the main hydrological feature at the site, comprising approximately 40% of the reserved area. The major inputs to the lagoon are surface water inflows from Pot Boil Creek and its tributaries, direct rainfall over the lagoon, groundwater discharge from the uppermost aquifer beneath the lagoon, and inflows of sea water via the lagoon entrance. The lagoon has a neutral pH, salinities similar to sea water, is relatively clear and has moderate levels of nutrients, particularly phosphate. The elevated levels of nutrients are most likely the result of run-off from nearby farmland in the catchment (Finley et al. 2010).

Logan Lagoon is an important site for resident and migratory birds. Over 160 bird species have been recorded on Flinders Island, many of which occur in the site. Several threatened species and 21 migratory waders have been recorded at the site. Other non-avian fauna also use the site for foraging, breeding or as habitat refuge; many have conservation value, such as the endangered freshwater fish, the dwarf galaxias (Finley et al. 2010).

1.4.5.5 Western Australia

Lake Gore

The Lake Gore Ramsar Site (4017 ha), approximately 34 km west of Esperance on the south coast of Western Australia, comprises two nature reserves (1) the eastern part of Warrenup Lakes Nature Reserve (NR 26885) designated for the “conservation of flora”, and (2) the Lake Gore Nature Reserve (NR 32419) designated for the purpose of “water and conservation of flora and fauna” (DEC 2009). Together these areas contain an inland wetland system that includes a large lake (Lake Gore, 3.5 km from the coast) and a downstream system of interconnected lakes, flats and marshes. These areas are managed under the Esperance and Recherche parks and Reserves Management Plan 84, which incorporates numerous other areas and approximately 490 km of coastline (DPaW 2016).

The wetlands provide significant waterbird habitat and refuge including those listed under the international migratory agreements (CAMBA, JAMBA, ROKAMBA and CMS), although these typically occur inland at Lake Gore. The numbers of Australian shelducks (*Tadorna tadornoides*) – along with banded stilts (*Cladorhynchus leucocephalus*), chestnut teals (*Anas castanea*) and hooded plovers (*Thinornis rubricollis*) – recorded at the site have been significant, exceeding 1% of their respective population thresholds (Wetlands International 2006; cited in DEC 2009).

Although the Lake Gore Ramsar site boundary intersects the Risk EMBA, the wetlands themselves are located more than 1 km inland and are separated from the coast by sand dunes and a limestone ridge, so do not intersect with the Risk EMBA.

1.5 State protected areas

1.5.1 State marine parks and reserves

Marine parks and reserves protect habitats, animals, plants, cultural heritage and geological formations. There are numerous state-protected marine parks and reserves within the Risk EMBA. All the state marine parks and reserves boundaries are distant to the well location, the nearest being those within South Australia state waters (approximately 330 km away).

1.5.1.1 South Australia

One South Australia national park (Adelaide International Bird Sanctuary National Park – Winaityinaityi Pangkara) and 19 marine parks are located within the Risk EMBA.

The Adelaide International Bird Sanctuary National Park – Winaityinaityi Pangkara (14,663 ha) encompasses areas of land to the low water mark and extends along more than 50 km of coastline on the east coast of the Gulf St Vincent. The first stages of the National Park were proclaimed in 2016 and 2017 under the *Wildlife Act 1972* (South Australia), with additional areas proposed to be incorporated in the future. The national park is managed under the Adelaide International Bird Sanctuary National Park – Winaityinaityi Pangkara Draft Management Plan (DEWNR 2018). The plan describes key environmental, cultural and social values including:

- nationally and internationally significant numbers of migratory and resident shorebirds. At least 52 shorebird species, including 37 migratory species, have been recorded in the area, with 23 of these species being migratory shorebirds recognised under three international agreements. These include two nationally critically endangered species – the curlew sandpiper (*Calidris ferruginea*) and the far eastern curlew (*Numenius madagascariensis*)
- important feeding, roosting and breeding habitat for many other coastal birds and seabirds, including the samphire or slenderbilled thornbill (*Acanthiza iredalei*), elegant parrot (*Neophema elegans*), rock parrot (*Neophema petrophila*), little egret (*Egretta garzetta*), grey plover (*Pluvialis squatarola*) and fairy tern (*Sternula nereis*)
- a high diversity of native species, including nine fauna and one flora species listed as nationally threatened under the EPBC Act, and 17 species listed as threatened in South Australia under the *National Parks and Wildlife Act 1972*
- an integral component of the subtropical and temperate coastal saltmarsh threatened ecological community, listed as vulnerable under the EPBC Act and containing the largest area of critical habitat for the nationally vulnerable beaded samphire (*Tecticornia flabelliformis*)
- intertidal mudflats and mangrove communities listed as vulnerable in South Australia under the *National Parks and Wildlife Act 1972*
- an interconnected landscape of profound cultural significance for the Kaurna people, which includes species of significance such as the black swan (Kudlyo) and Australian pelican (Yaltu)
- places for the Kaurna people to practise both traditional and contemporary cultural practices
- places where people can access the beaches for respectful recreational use with locals taking place in activities such as fishing, crabbing, bird watching, horse riding (both professional and recreational), beach driving and walking
- an area which can provide a broader range of nature-based recreational activities and tourism experiences for both locals and visitors.

The 19 marine parks in South Australia waters were declared in 2009 under the *Marine Parks Act 2007* (South Australia) and cover more than 2,600,000 ha of sea. All 19 South Australia marine parks lie within the Risk EMBA. Each marine park is comprised numerous zones, including:

- General Managed Use Zones established so that an area may be managed to provide protection for habitats and biodiversity within a marine park, while allowing ecologically sustainable development and use
- Habitat Protection Zones established so that an area may be managed to provide protection for habitats and biodiversity within a marine park, while allowing activities and uses that do not harm habitats or the functioning of ecosystems
- Sanctuary Zones established so that an area may be managed to provide protection and conservation for habitats and biodiversity within a marine park, especially by prohibiting the removal or harm of plants, animals or marine products
- Restricted Access Zones established so that an area may be managed by limiting access to the area.

Each South Australia marine park is described below.

Far West Coast

Far West Coast Marine Park is between the Western Australian border and the Tchalingaby Sandhills, within the Eucla Bioregion (DEWNR 2012c). The park covers 1690 km^2 and encompasses the existing Great Australian Bight Marine Park, as well as partially overlaying the Nullarbor National Park and Wahgunyah Conservation Park up to medium to high water (DEWNR 2012c).

The region is influenced by some of the highest wind and wave energies in South Australia. The Bunda Cliffs form important nesting sited for sea birds and act as key breeding and haul-out sites for Australian sea lions. The diversity of algae, fish and invertebrate species have been influenced by the east-flowing Leeuwin Current. The area supports a wide range of flora and fauna including species of conservation importance. The area is regularly used as a breeding and calving ground for southern right whales.

The characteristics and values of the Far West Coast Marine Park include:

- various habitats of limestone cliffs interspersed by rocky headlands, narrow intertidal rock platforms, reefs and beaches backed by sand dune systems

- commercial fisheries operating in the Far West Coast Marine Park include the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the Marine Scalefish Fishery and Shark Fishery
- tourism includes whale watching, recreational fishing and four-wheel driving
- the Far West Coast Native Title Claim includes the waters of the marine park
- the Mirning, Wirangu and Yalata Anangu Aboriginal peoples have traditional associations with areas of the marine park, with the Yalata Indigenous Protected Area lying at the edge of the marine park.

Nuyts Archipelago

The Nuyts Archipelago Marine Park (3998 km^2) is the largest single marine park in South Australia's marine parks network. Situated on the west coast of South Australia in the Murat Bioregion, it includes the Nuyts reef complex, Fowlers Bay, islands of the Nuyts Archipelago and adjacent coastal bays (DEWNR 2012j). The marine park overlays parts or all of a number of other protected areas but the port of Thevenard is excluded (DEWNR 2012j).

The marine park contains a complex, interconnected network of highly varied habitats such as islands, shallow bays and estuaries of varying type and orientation, resulting in a high diversity of species and productivity. Differing wave energies create diversity in habitats for species found within the marine park. High wave energy has resulted in in shaping cliffs and rocky reef within the region, while low wave energy in other parts of the marine park is conducive to the extensive seagrass meadows and mangrove forests. These low-energy habitats provide important nursery and feeding grounds for commercially and recreationally important crustacean and fish species (DEWNR 2012j).

The characteristics and values of the Nuyts Archipelago Marine Park include:

- an aquaculture industry predominantly based on Pacific oysters, with razor fish and abalone also grown within the region
- five commercial fisheries operate within the Nuyts Archipelago Marine Park – the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the West Coast Prawn Fishery, Marine Scalefish Fishery and the Charter Fishery
- tourism includes recreational charter fishing, whale watching, scenic cruises, four-wheel driving and expedition cruise ships
- popular destination for scuba divers, snorkelers, swimmers, recreational fishers and sightseers
- Aboriginal heritage sites located along the coastline of the Nuyts Archipelago Marine Park
- Wirangu Aboriginal people have traditional associations with the region
- the Far West Coast Native Title Claim includes some areas of the marine park
- coast scattered with fragile remains of whaling stations and shipwrecks, which have historical and archaeological significance
- monuments of geological significance that include preserved history of sea levels and sedimentation from the last 11,000 years.

West Coast Bays

West Coast Bays Marine Park (789 km^2) is on the west coast of South Australia and includes Sceale, Venus and Baird bays within the Eyre Bioregion (DEWNR 2012r). Beginning at the southern end of Rincon Beach, the marine park extends to near Point Westall and encompasses Nicholas Baudin Island and Baird Bay Island conservation parks, as well as Point Labatt Aquatic Reserve (DEWNR 2012r).

West Coast Bays Marine Park is influenced by strong south-westerly winds and swells, varying currents and nutrient-rich upwellings. Various habitats have been created by the diverse high-energy surf beaches, cliffs and rocky headlands to the sheltered conditions of Venus Bay and Baird Bay. A key species of this marine park is one of the world's smallest live-bearing seastar species, *Parvulastra parvivipara*, which is endemic to the Western Eyre Peninsula and found at locations such as Point Labatt and Smooth Pool.

Other unique features include an important mainland breeding colony (Point Labatt), and an island breeding colony (Nicholas Baudin Island) of the nationally and state listed vulnerable Australian sea lion (Goldsworthy & Page 2009), the nationally and state listed vulnerable bead glasswort and state listed rare cushion samphire, as well a nursery ground for gummy sharks (Venus Bay) (Stevens & West 1997).

The characteristics and values of the West Coast Bays Marine Park include:

- extractive mining leases and mineral exploration licence applications exist within the vicinity of West Coast Bays Marine Park
- tourism includes charter fishing, swimming with sea lions and other popular water sports
- popular destination for scuba diving, snorkelling, swimming m recreational fishing and camping
- Wirangu Aboriginal people have traditional association with areas of the marine park, with parts of the West Coast Bays Marine Park being included in the Wirangu No. 2 Title Claim (1997)
- historic fragile remains of a whaling station and several shipwrecks lie within the West Coast Bays Marine Park
- two jetties associated with the fishing industry are of importance to the local community.

Investigator Marine Park

Investigator Marine Park is on the west coast of the Eyre Peninsular in the Eyre Bioregion and covers more than 1185 km^2 over four areas (DEWNR 2012f). The marine park includes the areas south of Elliston to near Point Drummond and the offshore islands of the Investigator Group Conservation Park and Wilderness Protection Area, as well as the Cap Island Conservation Park (DENR 2010).

The marine park is influenced by the warm Leeuwin Current, the cool Flinders Current and seasonal nutrient-rich upwellings, creating a unique and varied ecosystem. The marine park is characterised by rising offshore islands, cliffs and high-energy surf beaches along the mainland coast. These diverse habitats support a wide range of flora and fauna along with endemic species and species of conservation importance.

The characteristics and values of the Investigator Marine Park include:

- Four commercial fisheries operate within the marine park – the Western Zone Abalone Fishery, the Northern Rock Lobster Fishery, the Marine Scalefish Fishery and the Charter Fishery.
- A mineral exploration licence and a mineral exploration licence application cover all of Flinders Island, which is surrounded by the marine park.
- Tourism includes recreational and charter fishing, scenic cruises, scuba diving and expedition cruise ships.
- An annual shore-based fishing competition attracts many recreational fishers to the area.
- The Wirangu and Nauo-Barngarla Aboriginal people have traditional associations with the areas of the marine park and parts of the Nauo-Barngala Native Title Claim (1997) are included in areas of the marine park.
- Point Drummond is listed as a geological monument.

Thorny Passage

Thorny Passage Marine Park is in the Eyre Bioregion and covers 2472 km^2 (DEWNR 2012n). The marine park includes the waters off the lower Eyre Peninsular, extending from Frenchman Bluff to Memory Cove and overlays both Rocky and Greenly islands (DEWNR 2012n).

Thorny Passage Marine Park is comprised various habitats including the sheltered bays, inlets, reefs, seagrass meadows, tidal sandflats of Coffin Bay, along with rugged rocky coastlines, steep headlands and cliffs, high-energy surf beaches, offshore islands and large areas of sandy sea floor habitat. Marine life is influenced by the warm Leeuwin Current from the west, the cold Flinders Current from the south-east and cold nutrient-rich upwellings originating in deep water off the continental shelf, creating a biodiverse environment home to many endemic and iconic species. These species include the white shark, Australian sea lion, southern bluefin tuna, 13 whale species, site-attached reef fish, and nationally and internationally protected shorebird and seabird species (Baker 2004).

The characteristics and values of the Thorny Passage Marine Park include:

- an aquaculture industry predominantly based on Pacific oysters farmed in Coffin Bay
- commercial fisheries operating in this area include the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the West Coast Prawn Fishery, the Sardine Fishery, the Marine Scalefish Fishery, the Miscellaneous Fishery (Urchin) and the Charter Fishery
- tourism includes charter fishing, scenic cruises, diving, four-wheel driving and expedition cruise ships
- popular destination for beach and water sport activities

- the Nauo and Barngala Aboriginal peoples have traditional associations with areas of the marine park
- there are two Native Title claims that include areas of the marine park
- whaling stations, shipwrecks and jetties all with archaeological significance are found within the marine park
- several sections of the coastline are considered geological monuments.

Sir Joseph Banks Group

Sir Joseph Banks Group Marine Park (2627 km^2) is in the lower western Spencer Gulf and includes parts of the Eyre and Spencer Gulf Bioregions (DEWNR 2012k). The marine park is located adjacent to Tumby Bay and includes the islands of Sir Joseph Banks Group and Dangerous Reef (DEWNR 2012k). The marine park overlays two other protected areas, the Tumby Island Conservation Park and the Sir Joseph Banks Group Conservation Park (DEWNR 2012k).

The marine park covers a group of 20 low-lying islands and waters adjacent to Tumby Bay, along with a Wetland of National Importance. Habitats within the marine park include, shallow reefs, sheltered bays, seagrass meadows, saltmarsh communities and deep-water habitats of the lower Spencer Gulf. These habitats support a diverse range of flora and fauna including many species of national importance (DEWNR 2012k).

The characteristics and values of the Sir Joseph Banks Group Marine Park include:

- a dangerous reef hosts one of the largest breeding colonies of Australian sea lions in the world (Goldsworthy & Page 2009).
- pregnant female white sharks are often found in the area, potentially due to the abundance of sea lion prey. King George whiting utilises the area as breeding and nursery grounds. The endemic leafy seadragon inhabits the inshore seagrass beds (Baker 2004)
- the Sir Joseph Banks Group Marine Park hosts a variety of invertebrate species and several bird species which are protected under international treaties
- the Lower Eyre Peninsular aquaculture zone policy exists in this marine park
- southern bluefin tuna, mussels, abalone and other finfish farming occurs in the policy area
- commercial fisheries operating in the marine park include the Western Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the Spencer Gulf Prawn Fishery, the Sardine Fishery, the Marine Scalefish Fishery, and the Charter Fishery
- tourism includes recreational and charter fishing, charter sailing and diving, marine mammal watching and scenic cruises
- the marine park is popular for recreational shore and boat fishing, diving, swimming, camping, sightseeing and beach activities
- the Nauo–Barngala Aboriginal people have traditional associations with areas of the marine park
- shipwrecks and building remains can be found within the marine park (Robinson et al. 1996).

Neptune Islands Group

Neptune Islands Group (Ron and Valerie Taylor) Marine Park (146 km^2) is in the Eyre Bioregion, in offshore waters south of the Thorny Passage Marine Park (DEWNR 2012i). The marine park encompasses the whole of the Neptune Islands Conservation Park (DENR 2010).

Full exposure to high wind and wave energy, the warm Leeuwin Current and the cool Flinders Current results in a vast range of habitats within the marine park. These habitats range from exposed granite mountains to intertidal reefs and sandy sea floors, supporting a wide range of flora and fauna including many species of conservation importance (Baker 2004).

The characteristics and values of the Neptune Islands Group (Ron and Valerie Taylor) Marine Park include:

- five commercial fisheries operate within the Marine Park – the Northern Zone Rock Lobster Fishery, Sardine Fishery, Marine Scalefish Fishery, Abalone Fishery and Charter Fishery
- tourism includes white shark cage diving, recreational and charter fishing, expedition cruise ships and marine mammal watching
- several shipwrecks can be found within the park.

Gambier Islands Group

Gambier Islands Group Marine Park (120 km^2) is within the Eyre Bioregion, in the waters of the mouth of Spencer Gulf (DEWNR 2012e). The marine park is inclusive of the Gambier Islands Conservation Park, including the North Island, South West Rock and Peaked Rocks (DEWNR 2012e).

The marine park is influenced by high exposure to wind, wave and swell energy as well as warm and cool currents and saline waters. The park encompasses a range of habitats from exposed cliffs and rocky shores to sandy beaches and seagrass meadows, thus supporting a wide range of flora and fauna including many species of conservation importance (DEWNR 2012e).

Commercially important fish species including King George whiting, trevally, Western Australian salmon and Australian herring populate the waters surrounding the islands. The marine park is also an important habitat for Australian sealions and seabirds of conservation importance.

The characteristics and values of the Gambier Islands Group Marine Park include:

- commercial fisheries operating within the marine park include the Sardine Fishery, Charter Fishery, Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery and Spencer Gulf Prawn Fishery
- tourism includes diving, fishing charters and sightseeing around the island
- a jetty, lighthouse and airstrip on Wedge Island facilitate tourism
- traditional associations of Aboriginal people with the marine park are unknown.

Eastern Spencer Gulf

Eastern Spencer Gulf Marine Park (784 km^2) is on the eastern side of the gulf, extending from Wauraltee Beach north of Port Rickaby, to Cape Elizabeth, within the Spencer Gulf Bioregion (DEWNR 2012a). The marine park encompasses Wardang Island along with the islands and waters of Goose Island Conservation Park and Goose Island Aquatic Reserve (DENR 2010).

The region is moderately exposed to wind and waves and is influenced by the mixing of the warmer waters from the Spencer Gulf and cooler waters from the Southern Ocean (DENR 2010). Habitats across the park vary between saltmarshes, seagrass meadows, granite and limestone reefs, sandy sea floor, islands, sandy beaches backed by large dune systems and intertidal rock platforms (Baker 2004). These habitats support a large range of flora and fauna including species of conservation concern (DEWNR 2012a).

The coastline of Wardang Island supports nesting sites for endangered seabirds as well as haul-out sites for the vulnerable Australian sea lion.

The characteristics and values of the Eastern Spencer Gulf Marine Park include:

- commercial fisheries operating within the marine park include the Spencer Gulf Prawn Fishery, the Central Zone Abalone Fishery, the Marine Scalefish Fishery and the Charter Fishery
- the Eastern Spencer Gulf aquaculture zone policy exists in this marine park
- tourism includes recreational and charter fishing, boating and diving
- popular destination for recreational fishers, boat users, snorkelers and scuba divers
- the Narungga Aboriginal people have traditional associations with areas of the marine park
- an Indigenous Land Use Agreement (ILUA) exists over areas of the marine park and a fishing ILUA is also under development.

Southern Spencer Gulf

Southern Spencer Gulf Marine Park spans the transition zones of three bioregions (Spencer Gulf, Eyre and Gulf of St Vincent) (DEWNR 2012m). The marine park is 2972 km^2 and extends from the western tip of Yorke Peninsula and across to the central north coast of Kangaroo Island (DEWNR 2012m). The marine park encompasses the Althorpe Islands Conservation Park and parts of the Innes National Park Leven Beach Conservation Park and Western River Wilderness Area (DENR 2010).

The marine park is influenced by varying sea floor depths and varying wind and wave exposures, which have ultimately shaped the changing coastline. Parts of the marine park are characterised by low-energy beaches backed by extensive sand dunes, shallow embayments dominated by seagrass meadows and low-profile reefs. Other parts of the marine park consist of various habitats from exposed cliffs, offshore islands and headlands fronted by high-energy intertidal reefs and rocky shore platforms, to both sheltered and high-energy sand beaches (Baker 2004).

The characteristics and values of the Southern Spencer Gulf Marine Park include:

- the Althorpe Islands Conservation Park includes haul out sites for the vulnerable Australian sea lion and the New Zealand fur seal
- cliff habitats provide important nesting sites for endangered seabirds (DENR 2010)
- commercial fisheries operating within the marine park include the Spencer Gulf Prawn Fishery, the Central Zone Abalone Fishery, the Northern Zone Rock Lobster Fishery, the Sardine Fishery, the Marine Scalefish Fishery and the Charter Fishery
- tourism includes recreational and charter fishing, charter sailing, recreational diving and expedition cruise ships
- the Narungga Aboriginal people have traditional associations with areas of the marine park
- an Indigenous Land Use Agreement (ILUA) exists over areas of the marine park and a fishing ILUA is also under development.

Lower Yorke Peninsula

The Lower York Peninsula Marine Park (850 km^2) extends around the heel of Yorke Peninsula, from Point Davenport Conservation Park to near Stansbury, including Troubridge Island, in the Gulf of St Vincent Bioregion (DEWNR 2012h). The marine park encompasses Coobowie Bay and Troubridge Aquatic Reserves, Troubridge Island Conservation Park and partially overlays Point Davenport Conservation Park (DENR 2010). The ports of Klein Point and Point Giles are excluded from the marine park (DEWNR 2012h).

Influenced by strong tidal currents that pass through Investigator Strait and Backstairs Passage, the park's habitats reflect these characteristics. The shoreline is dominated by sandy beaches backed by well-vegetated sand dunes and sections of cliffs and rocky coast. Reefs extend from the intertidal shore platforms giving way to either bare sand bottom or seagrass meadows.

The characteristics and values of the Lower Yorke Peninsula Marine Park include:

- the park includes two estuaries
- Point Davenport is listed as a Wetland of National Importance
- Troubridge Shoals provide important feeding and resting grounds for local and migratory shorebirds for which Australia has obligations under international treaties
- over 40 species of shorebirds have been recorded on Troubridge Island
- cliff habitats from Troubridge Point to Port Moorowie provide important nesting sites for endangered seabirds
- commercial fisheries operating within the marine park include the Gulf St Vincent Prawn Fishery, the Central Zone Abalone Fishery, the Marine Scalefish Fishery and the Charter Fishery
- tourism includes recreational and charter fishing, diving and sightseeing
- the Narungga Aboriginal people have traditional associations with areas of the marine park
- an Indigenous Land Use Agreement (ILUA) exists over areas of the marine park
- a fishing ILUA is under development
- the Troubridge island lighthouse and cottages are included in the State Heritage Register.

Upper Gulf St Vincent

The Upper Gulf St Vincent Marine Park is situated north of a line from Parara Point to the northern end of Port Gawler Beach within the Gulf St Vincent Bioregion (DEWNR 2012o). The port of Ardrossan is excluded from the marine park. The marine park partially overlays Wills Creek Conservation Park and Clinton Conservation Park (DEWNR 2012o).

The Gulf St Vincent is an inverse estuary with higher salinity at the top of the gulf, influenced by temperatures and large tidal ranges. The Upper Gulf St Vincent is recognised as a Wetland of National Importance containing a variety of coastal and marine habitats including saltmarsh, sand flats, mudflats, mangroves and tidal creeks. These habitats form important nesting and feeding sites for local and migratory shorebirds. Mangrove forests line the coast from Wills Creek Conservation Park to Middle Beach, which is a recognised breeding and nursery ground for many well-known marine species. The Upper Gulf St Vincent also supports some of the most extensive seagrass meadows in South Australia.

The characteristics and values of the Upper Gulf St Vincent Marine Park include:

- commercial fisheries operating in the marine park include the Blue Crab Fishery, Marine Scalefish Fishery and Charter Fishery
- tourism includes recreational and charter fishing, boat users, scuba divers and swimmers
- the Kaurna and Narungga Aboriginal peoples have traditional associations with areas of the marine park
- the Kaurna people have lodged native title claims over parts of the marine park
- parts of the marine park are also subject to an Indigenous Land Use Agreement with the Narungga People of Yorke Peninsula.

Franklin Harbor

Franklin Harbor Marine Park (636 km^2) is on the central western side of Spencer Gulf, between Gibbon Point and Munyaroo Conservation Park, across the transition zone between the Spencer Gulf and North Spencer Gulf bioregions (DEWNR 2012d). The marine park either partially or entirely overlays several other protected areas such as the Franklin Harbor and Munyaroo Conservation Park (DEWNR 2012d).

The marine park is influenced by a highly saline warm water ecosystem typical of the Spencer Gulf. Habitats supported by this ecosystem include saltmarshes, mangrove forests, tidal flats beaches and adjacent dense seagrass meadows, as well as sandy sea floor habitats within sheltered waters. Offshore habitats within the marine park include low-profile platform reef and sandy sea floor habitat, while the high-energy, south-facing coastline has cliffs and more exposed beaches.

The habitats within the Franklin Harbor Marine Park support a variety of marine and coastal flora and fauna species, some of ecological importance. The sheltered areas of the Franklin Harbor are an important nursery area for many recreationally and commercially important juvenile species. The sheltered beaches of Franklin Harbor act as an important habitat for many internationally protected bird species.

The characteristics and values of the Franklin Harbor Marine Park include:

- six commercial fisheries operate within the marine park – the Spencer Gulf Prawn Fishery, Blue Crab Fishery (Spencer Gulf Zone), Marine Scalefish Fishery, Sardine Fishery, Abalone Fishery (Central Zone) and Charter Fishery
- Franklin Harbor supports an aquaculture industry dominated by Pacific oysters and is one of the largest oyster growing areas in South Australia
- tourism includes recreational and charter fishing, boating, beach walking, bird watching, and water sports
- submarine communication cables transiting Spencer Gulf supply valuable essential services to the Eyre Peninsula community
- the Barngarla Aboriginal people have traditional associations with the areas of the Franklin Harbor Marine Park and the Barngala Native Title Claim (lodged in 1996) covers the whole of the park.

Upper Spencer Gulf

The Upper Spencer Gulf Marine Park is situated north of a line from the southern end of the Whyalla-Cowleds Landing Aquatic Reserve on the western side of the gulf to Jarrold Point on the eastern shore (DEWNR 2012q). The marine park is in the North Spencer Gulf Bioregion and covers 1602 km^2 (DEWNR 2012q).

The marine park incorporates coastal Crown lands including beaches, sand dunes, estuaries and saltmarshes. The marine park includes a number of other protected areas including Blanche Harbour-Douglas Bank, Yatala Harbour and Whyalla-Cowleds Landing Aquatic Reserves, and overlays part of Winninowie Conservation Park (DEWNR 2012q). The areas of Whyalla and Port Bonython, and the port of Port Pirie are excluded from the marine park.

The Gulf is described as an inverse estuary with higher salinity present at the top of the Gulf induced by higher temperatures and a large tidal range. The Upper Spencer Gulf is a recognised Wetland of National Importance possessing a variety of coastal and marine habitats. These habitats include saltmarsh, tidal flats and some of the largest stands of mangroves in South Australia. These habitats act as important nesting and feeding sites for local and migratory shorebirds. The gulf is alternatively characterised by sheltered beaches, rocky shorelines, headland reefs, nearshore patch reefs and the most extensive seagrass meadows in South Australia.

The characteristics and values of the Upper Spencer Gulf Marine Park include:

- Point Lowly is recognised as an area of major significance for spawning aggregations of the giant Australian cuttlefish.
- Commercial fisheries operating in the marine park include Spencer Gulf Prawn Fishery, Blue Crab Fishery, Charter Fishery and Marine Scalefish Fishery.
- The Fitzgerald Bay Aquaculture Zone policy exists within the marine park.
- Tourism includes recreational and charter fishing, fishing competitions, sightseeing cruises and diving/snorkelling with cuttlefish.
- Significant commercial shipping activity occurs in the region.
- The region is part of a broad scale copper-gold geological province within the state and is of economic interest to the resources sector.
- The Nukunu, Kujani, Kokatha and Barngarla Aboriginal peoples have traditional associations with areas of the marine park.
- The Nukunu and Barngarla peoples have registered native title claims that contain parts of the Upper Spencer Gulf Marine Park.

Encounter

Encounter Marine Park (3119 km^2) is in the waters off southern metropolitan Adelaide and the Fleurieu Peninsula, extending past the Murray Mouth to the Coorong Coast (DEWNR 2012b). The marine park covers all waters of Backstage Passage and the north-eastern shores of Kangaroo Island (DEWNR 2012b). The marine park partially or completely overlays several other protected areas, including the Coorong National Park, Beatrice Islet, Busby Islet, Cape Willoughby, Deep Creek, Baudin, Lashmar, Newland Head, Pelican Lagoon, Pullen Island, West Island and the Pages Conservation Park, and Granite Island Recreation Park (DEWNR 2012b). Encounter Marine Park also borders Nepean Bay Conservation Park, Moana Sands Conservation Park and Onkaparinga River Recreation Park (DEWNR 2012b).

The marine park supports a diversity of habitats including sheltered and high-energy sandy beaches; coastal cliffs and rocky headlands; intertidal, shallow and deep limestone and granite reefs; islands, sheltered bays, estuaries and saltmarshes; and seagrass meadows, sandy sea floors and deep-water trenches (DEWNR 2012b). These habitats within the marine park support a wide range of flora and fauna of conservation importance.

The characteristics and values of the Encounter Marine Park include:

- Commercial fisheries operating within the marine park are the Gulf St Vincent Prawn Fishery, Central Zone Rock Lobster Fishery, Marine Scalefish Fishery (including Gulf St Vincent/Kangaroo Island, and the Lakes and Coorong – including Pipi –Fishery) Charter Fishery and Sardine Fishery.
- Tourism includes recreational and charter fishing, water sports, charter sailing, diving.
- The Kaurna and Ngarrindjeri Aboriginal peoples have traditional associations with areas of the marine park including estuarine and coastal environments, which provide food and resources to local Aboriginal people and still hold cultural significance today.
- Parts of the Ngarrindjeri and Others Native Title Claim, and the Kaurna People's Native Title Claim are included in areas of the Encounter Marine Park.

Western Kangaroo Island

Western Kangaroo Island Marine Park (1020 km^2) is between Cape Forbin and Sanderson Bay including the Casuarina Islets and Lipson Reef, situated within the Eyre Bioregion (DEWNR 2012s). The marine park includes both North and South Casuarina islets and partially overlays Ravine des Casoars and Cape Torrens wilderness protection areas (DEWNR 2012s).

Southern and western coasts of the marine park are highly exposed to strong winds and large swells as well as seasonal nutrient-rich upwellings. The shoreline of the park is dominated by rugged, exposed cliffs and headlands. The reefs extend from intertidal wave-cut shore platforms along most of the coastline and transition to sandy sea floor habitats. The marine park includes estuaries and rivers and Wetlands of National Importance.

The characteristics and values of the Western Kangaroo Island Marine Park include:

- three species of pinnipeds are found within the park

- notable tourist destination
- commercial fisheries operating in the marine park include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Sardine Fishery, Charter Fishery and the Marine Scalefish fishery (Gulf St Vincent/Kangaroo Island)
- several protected shipwreck sites and state and Commonwealth heritage listed lighthouses and associated jetty, store and landing sites
- geological monuments listed within the marine park.

Southern Kangaroo Island

Southern Kangaroo Island Marine Park (673 km^2) is situated across the Eyre and Coorong bioregions, bordering the southern coast of Kangaroo Island between D'Estrees Bay and the western end of Seal Bay Conservation Park (DEWNR 2012l). The park encompasses Seak Bay-Bales Beach Aquatic Reserve, partially overlays the Seal Bay Conservation Park and borders the Cape Gantheaume Wilderness Protection Area (DEWNR 2012l). The park also includes North Rock, Young Rocks and South West Rock.

The Southern Kangaroo Island Marine Park is fully exposed to the strong winds and large swells of the Southern Ocean that have in turn shaped its rugged coastline over the years. Habitats within the park are characterised by exposed cliffs, rocky headlands and wave-cut shore platforms along with deep-water reefs interspersed by sandy sea floors. The only seagrass bed is within the slightly more sheltered D'Estrees Bay. The entire coastline of the Cape Gantheaume Conservation Park is listed as a Wetland of National Importance with shorebirds present from October to March each year (DEWNR 2012l).

The characteristics and values of the Southern Kangaroo Island Marine Park include:

- breeding colony for vulnerable Australian sea lions at Seal Bay
- rugged and remote coastline ideal for nesting seabirds
- tourism includes up-close viewing of Australian sea lions, boating, fishing, scuba diving and snorkelling
- commercial fisheries operating within the marine park include the Central Zone Abalone Fishery, Northern Zone Rock Lobster Fishery, Marine Scalefish Fishery (Gulf St Vincent/Kangaroo Island), Charter Fishery and the Giant Crab Fishery
- archaeological remains scattered along the coast north of Point Tinline are protected as part of the state heritage listed D'Estrees Bay whaling site.

Upper South East

The Upper South East Marine Park is between the Coorong and Otway bioregions and covers 906 km^2 (DEWNR 2012p). The marine park is divided into two sections from 11 km north of Tea Tree Crossing on the Coorong Ocean Beach to the Maria Creek Outlet at Kingston SE, and from Wright Bay to the northernmost point of Stinky Bay (DEWNR 2012o). The park encompasses Baudin Rocks Conservation Park, partially overlays the Coorong National Park and Little Dip Conservation Park and is adjacent to the Guichen Bay Conservation Park (DEWNR 2012o).

Home to a diverse range of habitats, the Upper South East Marine Park is characterised by high-energy sandy beaches, fringing limestone and platform reefs, and dense seagrass beds and kelp forests – all strongly influenced by natural processes such as the Bonney Upwelling. The Bonney Upwelling helps drive the regions high biological activity, stimulating the whole food chain with the nutrients it delivers (DEWNR 2012o). These habitats support a wide range of flora and fauna of conservation importance.

The characteristics and values of the Upper South East Marine Park include:

- Baudin Rocks is an important breeding and haul-out site for vulnerable Australian fur seals
- commercial fisheries operating within the marine park include the Southern Zone Abalone Fishery, Southern Zone Rock Lobster Fishery, Charter Fishery, Marine Scalefish Fishery, Lakes and Coorong Fishery and Miscellaneous Giant Crab Fishery
- an aquaculture zone is located in Lacepede Bay which allows for the farming of finfish
- tourism through camping, four-wheel driving, fishing
- two Aboriginal groups, the Ngarrindjeri and Buandig peoples, have traditional associations with areas of the marine park.
- parts of the Ngarrindjeru and Others Native Title Claim are included in areas of the Upper South East Marine Park.

Lower South East

Lower South East Marine Park (360 km^2) is in the Otway Bioregion and is divided into two sections: the area adjacent to Canunda National Park, and the area extending from Port MacDonnell Bay just west of French Point to the South Australian–Victorian border (DEWNR 2012g). The marine park partially overlays Piccaninnie Ponds Conservation Park.

The marine park is home to a diverse range of habitats ranging from high-energy sandy beaches and freshwater springs, various reef types, to kelp forests and algal communities and is strongly influenced by natural processes such as the Bonney Upwelling (DEWNR 2012g). These habitats support a wide range of flora and fauna of conservational importance. Throughout the marine park are many important sites for seabirds and local and migratory shorebirds. The region is considered to be a highly important nesting site for the state listed vulnerable hooded plover in the south-east (DEWNR 2012g).

The characteristics and values of the Lower South East Marine Park include:

- commercial fisheries operating in the marine park include the Southern Zone Abalone Fishery, the Southern Zone Rock Lobster Fishery, the Marine Scalefish Fishery and the Miscellaneous Giant Crab Fishery
- tourism includes recreational and charter fishing, four-wheel driving, fishing competitions, diving and cruise ship visits
- the Buandig Aboriginal people have traditional associations with areas of the marine park.

1.5.1.2 Western Australia

Marine parks and reserves have been progressively established in Western Australian state waters since 1987 under the *Conservation and Land Management Act 1984* (Western Australia). There are no Western Australian marine parks, but one nature reserve (Investigator Island), within the Risk EMBA.

The Investigator Island Nature Reserve does not extend to intertidal habitat, although Investigator Island is managed for the conservation of flora and fauna under the DPaW (2016) Esperance and Recherche Parks and Reserves Management Plan 84, which identifies the rocky shores and platforms of island as being inhabited by a breeding colony of Australian sea lions and little penguins.

1.5.1.3 Victoria

Victoria has a representative system of 13 Marine National Parks and 11 Marine Sanctuaries established in 2002 under the *National Parks Act 1975* (Victoria) that are highly protected areas covering approximately 63,000 ha or 5.3% of Victoria state marine waters (Parks Victoria n.d.). Other marine protected areas in Victoria marine waters (i.e. Marine Parks, Marine and Coastal Parks, and Marine Reserves) are managed as multiple use zones. Eight of these Marine National Parks and seven of the marine sanctuaries are within the Risk EMBA.

Marine National Parks

Discovery Bay Marine National Park

The Discovery Bay Marine National Park is 20 km west of Portland and covers 2770 ha, including part of the largest coastal basalt formation in western Victoria. In deep water (30–60 m) there are low reefs formed from ancient shorelines or dunes. There is a rich diversity of marine life within this park due to the cold, nutrient-rich waters of the area. The deep calcarenite reefs support diverse sponge gardens while the shallower reefs support the brown alga *Ecklonia radiata*. The offshore waters support a diverse array of invertebrates including southern rock lobster, black-lip abalone and gorgonians. The waters also support great white sharks and blue whales during the summer breeding season.

The Discovery Bay National Park is protected as part of the Ngootyoong Gunditj Ngootyoong Mara South West Management Plan (Parks Victoria 2007a), which covers over 116,000 ha of public land and freehold Gunditjmara land in south-western Victoria. The plan (Parks Victoria 2015) describes some key values of the Discovery Bay (which includes the National Park and the coastal reserve), namely:

- recognised roosting, feeding and nesting area for birds such as the hooded plover
- important habitat for the orange-bellied parrot
- subtidal reefs with giant kelp forest communities (TEC)

- a foredune and dune complex that was formerly recognised on the national estate
- surfing, boating and passive recreation
- tourism such as dune buggy tours.

Twelve Apostles Marine National Park

The Twelve Apostles Marine National Park (75 km^2) is 7 km east of Port Campbell and covers 16 km of coastline from east of Broken Head to Pebble Point, extending 5.5 km offshore (Plummer et al. 2003).

The area is representative of the Otway Bioregion and is characterised by a submarine network of towering canyons, caves, arches and walls with a large variety of seaweed and sponge gardens plus resident schools of reef fish. The park contains calcarenite reef supporting the highest diversity of intertidal and subtidal invertebrates found on that rock type in Victoria (Parks Victoria 2006a). The park includes the large sandy subtidal areas that are extremely high in biodiversity, with 860 species recorded in a 10 m^2 area.

The Twelve Apostles Marine Park is managed in conjunction with the Arches Marine Sanctuary under the Management Plan for Twelve Apostles Marine National Park and The Arches Marine Sanctuary (Parks Victoria 2006). The plan describes the key environmental, cultural and social values as:

- unique limestone rock formations, including the Twelve Apostles
- a range of marine habitats representative of the Otway marine bioregion
- Indigenous culture based on spiritual connection to sea country and a history of marine resource use
- the *Loch Ard* shipwreck
- underwater limestone formations of arches and canyons
- a diverse range of encrusting invertebrates
- a spectacular dive site.

Point Addis Marine National Park

Point Addis Marine National Park lies east of Anglesea and covers 4600 ha. This park protects representative samples of subtidal soft sediments, subtidal rocky reef, rhodolith beds and intertidal rocky reef habitats. The park also provides habitat for a range of invertebrates, fish, algae, birds and wildlife. The world-famous surfing destination of Bells Beach is within Point Addis Marine National Park.

It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2005). The plan identifies the following environmental, cultural and social values for the parks and sanctuaries:

- sandy beaches, subtidal soft sediments, subtidal rocky reefs, rhodolith beds and intertidal reefs
- a high diversity of algal, invertebrate and fish species
- a high diversity of sea slugs (opisthobranchs) and other invertebrate communities within Point Danger Marine Sanctuary
- evidence of a long history of Indigenous use, including many Indigenous places and objects adjacent to the park and sanctuaries near dunes, headlands, estuaries and creeks
- surf breaks, including those at Bells Beach, which are culturally important to many people associated with surfing
- coastal seascapes of significance for many who live in the area or visit
- recreational and tourism values
- spectacular underwater scenery for snorkelling and scuba diving
- intertidal areas for exploring rock pools
- opportunities for a range of recreational activities
- a spectacular seascape complementing well-known visitor experiences on the Great Ocean Road.

Wilsons Promontory Marine National Park

Wilsons Promontory National Park is in South Gippsland, about 200 km south-east of Melbourne, and at 15,550 ha is Victoria's largest marine protected area. It extends along 17 km of mainland coastline around the southern tip of Wilsons Promontory and is managed through the Wilsons Promontory Marine National Park and Wilsons Promontory Marine Park Management Plan (Parks Victoria 2006b). The plan describes the key environmental, cultural and social values as:

- granite habitats, which are unusual in Victorian marine waters, including extensive heavy reefs with smooth surfaces, boulders and rubble and low-profile reefs
- biological communities with distinct biogeographic patterns, including shallow subtidal reefs, deep subtidal reefs
- intertidal rocky shores, sandy beaches, seagrass and subtidal soft substrates
- abundant and diverse marine flora and fauna, including hundreds of fish species and invertebrates such as sponges, ascidians, sea whips and bryozoans
- 68 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits
- important breeding sites for a significant colony of Australian fur seals
- important habitat for several threatened shorebird species, including species listed under international migratory bird agreements
- outstanding landscapes, seascapes and spectacular underwater scenery
- seascape, cultural places and objects of high traditional and cultural significance to Indigenous people
- Indigenous cultural lore and interest maintained by the Gunai/Kurnai and Boonwurrung peoples
- important maritime and other history
- historic shipwrecks, many of which are listed on the Victorian Heritage Register.

Bunurong Marine National Park

- The Bunurong Marine National Park and Bunurong Marine Park are managed through the Bunurong Marine National Park Management Plan (Parks Victoria 2006c). The plan identifies the key values of the parks as:
- extensive intertidal rock platforms and subtidal rocky reefs with a geology and form that is uncommon along the Victorian coast
- abundant and diverse marine flora and fauna including over 22 species of marine flora and fauna recorded, or presumed to be, at their eastern or western distributional limits
- highest diversity of intertidal and shallow subtidal invertebrate fauna recorded in Victoria on sandstone
- a high proportion of the common invertebrates occurring along the Victorian coast
- high diversity of vegetation communities, many of which are considered rare, depleted or endangered within the region
- important coastal habitat for several threatened species
- spectacular coastal scenery, featuring rugged sandstone cliffs, rocky headlands, intertidal rock platforms and sandy coves
- Eagles Nest, a prominent rock stack, recognised as a site of national geological and geomorphological significance
- one of the richest Mesozoic fossil areas in Victoria
- landscape and seascape of cultural significance to Indigenous people
- numerous places and objects of significance to Indigenous people
- a European history rich in diversity, including sites associated with shipping, coal mining, holidaying and living on the coast
- two historical shipwrecks listed on the Victorian Heritage Register
- opportunities for cultural values investigation in an area protected from human disturbance
- extensive subtidal reefs with magnificent underwater seascapes, offering numerous opportunities for diving and snorkelling
- highly accessible intertidal rock platforms offering opportunities for rock-pooling, marine education and interpretation
- spectacular coastal drive, with numerous lookouts and panoramic views of the coast and surrounding waters
- coastline offering opportunities for swimming, surfing, boating, fishing and rock-pooling in a natural setting.

Ninety Mile Beach Marine National Park

Ninety Mile Beach Marine National Park (2750 ha) protects an example of an internationally significant sandy environment, recognised for its exceptionally high diversity of marine invertebrates. Low calcarenite reefs offshore support a unique invertebrate biota, including colourful sponge gardens. The long sandy beach provides extensive habitat for shorebirds, including international migratory waders and the threatened hooded plover. It is managed under the Ninety Mile Beach Marine National Park (Parks Victoria 2006d). The plan identifies the key values of the parks as:

- very high diversity of invertebrates in soft sediments
- scattered low calcarenite reefs providing habitat for a distinctive marine invertebrate fauna, especially sponges
- important habitat for threatened shorebird species, including species listed under international migratory bird agreements
- seascape and places of high cultural significance to the Traditional Owners
- recreation and tourism values
- opportunities for beach walking and other permitted activities on a remote area of open coast beach throughout the park.

Point Hicks Marine National Park

Point Hicks Marine National Park (4000 ha) is alongside Croajingolong National Park in East Gippsland. The area including the park is enriched with cultural significance, from early indigenous occupation to reputably being the first land on the south-eastern Australian mainland to be sighted by Europeans in 1770. The Point Hicks Marine National Park also protects a diverse and colourful array of marine species and communities. It is managed under the Point Hicks Marine National Park Management Plan (Parks Victoria 2006e). The plan identifies the key values of the parks as:

- a diversity of habitats including subtidal and intertidal reefs, subtidal soft sediment and sandy beaches
- a very high diversity of fauna including intertidal and subtidal invertebrates
- co-occurrence of eastern temperate, southern cosmopolitan and temperate species, as a result of the mixing of warm eastern and cool southern waters
- a range of rocky habitats, from large boulders to smaller rocks and stones
- marine mammals such as dolphins, whales, Australian fur seals and New Zealand fur seals
- transient reptiles from northern waters, including turtles and sea snakes
- threatened fauna, including whales and several bird species
- outstanding landscapes, seascapes and spectacular underwater scenery
- outstanding active coastal landforms within and adjoining the park, such as granite reefs and mobile sand dunes
- excellent opportunities for scientific investigation and learning
- outstanding opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time
- seascape of high cultural significance to Indigenous people
- places of significance to Indigenous people
- a diverse and rich maritime and post-settlement history, including shipwrecks and evidence of shipping history
- recreational and tourism values
- opportunities for a range of remote nature based recreational activities within a pristine environment
- spectacular views of Croajingolong National Park and the Point Hicks Lighthouse
- opportunities to view the park from the shore and explore the park without going underwater, by walking along the sandy beaches or investigating the rocky intertidal area
- opportunities for interpretation and education about the marine environment.

Marine Sanctuaries

Merri Marine Sanctuary

The Merri Marine Sanctuary is on the Victorian south-west coast near Warrnambool, approximately 260 km west of Melbourne. Merri Marine Sanctuary (25 ha) is at the mouth of the Merri River, west of Warrnambool Harbour. The sanctuary contains a mixture of habitats including intertidal reef, sand, shallow reef and rocky overhang. These areas provide a nursery for many fish species and a habitat for many algae species, hardy invertebrates and shorebirds. Bottlenose dolphins and fur seals are regular visitors to the shore (Parks Victoria 2007b).

The sanctuary is managed under the Merri Marine Sanctuary Management Plan (Parks Victoria 2007b), which identifies key values for the sanctuary including:

- culturally significant to Indigenous communities that have a long association with the area
- Merri River, wetlands and islands and headlands provide a variety of habitats
- provision of nursery for many fish species and habitat for algal species, hardy invertebrates and shorebirds.

The Arches Marine Sanctuary

The Arches Marine Sanctuary protects 45 ha of ocean directly south of Port Campbell. It has a spectacular dive site of limestone formations, rocky arches and canyons. The sanctuary is also ecologically significant, supporting habitats such as kelp forests and a diverse range of sessile invertebrates on the arches and canyons. These habitats support schools of reef fish, seals and a range of invertebrates such as lobster, abalone and sea urchins. The Arches Marine Sanctuary is managed in conjunction with the Twelve Apostles Marine Park under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2006f).

Marengo Reefs Marine Sanctuary

The Marengo Reefs Marine Sanctuary (12 ha) is in Victoria state waters near Marengo and Apollo Bay, which are on the Great Ocean Road, approximately 220 km south-west of Melbourne. The sanctuary protects two small reefs and a wide variety of microhabitats. Protected conditions on the leeward side of the reefs are unusual on this high wave-energy coastline and allow for dense growths of bull kelps and other seaweed. There is an abundance of soft corals, sponges and other marine invertebrates and over 56 species of fish have been recorded in and around the sanctuary. Seals rest on the outer island of the reef and there are two shipwrecks (the Grange and Woolamai) in the sanctuary (Parks Victoria 2007c).

The Marengo Reefs Marine Sanctuary Management Plan (Parks Victoria 2007c) identifies the environmental, cultural and social values as:

- subtidal soft sediments, subtidal rocky reefs and intertidal reefs
- a high diversity of algal, invertebrate and fish species
- an Australian fur seal haul-out area
- evidence of a long history of Indigenous use, including many Indigenous places and objects nearby
- wrecks of coastal and international trade vessels in the vicinity of the sanctuary
- spectacular underwater scenery for snorkelling and scuba diving
- intertidal areas for exploring rock pools
- opportunities for a range of aquatic recreational activities including seal watching.

Eagle Rock Marine Sanctuary

Eagle Rock Marine Sanctuary (17 ha) is about 40 km south-west of Geelong, close to Aireys Inlet. The sanctuary extends from high water mark around Split Point between Castle Rock and Sentinel Rock. It extends offshore for about 300 m and includes Eagle Rock and Table Rock. The main habitats protected by the sanctuary include intertidal and subtidal soft sediment, intertidal and subtidal reefs, and the water column. It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2005).

Point Danger Marine Sanctuary

Point Danger Marine Sanctuary (25 ha) is 20 km south-west of Geelong, close to the township of Torquay and nearby Jan Juc. It extends from the high-water mark at Point Danger offshore for approximately 600 m east and 400 m south, encompassing an offshore rock platform. It is managed under the Management Plan for Point Addis Marine National Park, Point Danger Marine Sanctuary and Eagle Rock Marine Sanctuary (Parks Victoria 2005).

Barwon Bluff Marine Sanctuary

Barwon Bluff Marine Sanctuary (17 ha) protects a system of intertidal and subtidal reefs and beach areas extending from the base of The Bluff where the Barwon River meets Bass Strait. The eastern half of the reef is basalt, formed from lava flow, and is exposed to the flow of the river. The western side is old sandstone and influenced by ocean swell. On the outer edges of the reef are the wrecks of two ships.

The beaches and intertidal platforms provide habitat for migratory and threatened seabirds and shorebirds including petrels (e.g. *Macronectes giganteus* and *Halobaena caerulea*), albatrosses (*Thalassarche cauta*), knots (*Calidris tenuirostris*), egrets (*Ardea modesta* and *A. ibis*), terns (*Hydroprogne caspia, Sternula nereis* and *Sterna striata*) and many others (Parks Victoria 2007d). The sanctuary supports an abundance of fish and invertebrates, a colourful and diverse range of algae, and marine mammals passing through the area (Parks Victoria 2007d). It is managed under the Barwon Bluff Marine Sanctuary Management Plan (Parks Victoria 2007d).

Mushroom Reef Marine Sanctuary

Mushroom Reef Marine Sanctuary (56.7 ha) protects unique basalt reefs at Flinders near the western entrance to Western Port. The sanctuary is notable for its diversity of marine life and significant roosting, feeding and breeding areas for Migratory and Threatened bird species.

Thirty-seven marine species have been recorded or are presumed to be at their distributional limit including a number of algae (including 26 species of red algae, e.g. *Lomentaria pyramidalis*), shrimp (e.g. *Tozeuma kimberi*), crabs (e.g. *Pachygrapsus transverses*), marine snails (e.g. *Cheirodonta labiata*), sea cucumbers (e.g. *Apsolidium handrecki*) and a chiton (*Ischnochiton virgatus*) (Parks Victoria 2012). The sanctuary has 15 conservation listed seabirds and shorebirds including the critically endangered grey-tailed tattler (*Heteroscelus brevipes*). Several Vulnerable species including the fairy prion (*Pachyptila turtur*), shy (*Thalassarche cauta*) and black-browed (*T. melanophris*) albatrosses and others of varying conservation significance are found in or near the sanctuary (Parks Victoria 2007e).

In addition to its ecological values, the Mushroom Reef Marine Sanctuary is considered significant for its value for underwater recreation and potentially for marine education. It is managed under the Mushroom Reef Marine Sanctuary Management Plan (Parks Victoria 2007e).

Beware Reef Marine Sanctuary

The Beware Reef Marine Sanctuary (220 ha) is an offshore sanctuary approximately 400 km east of Melbourne and 30 km south-east of Orbost, in the East Gippsland region. It lies 5 km offshore to the south-east of Cape Conran. The sanctuary is managed under the Beware Reef Marine Sanctuary Management Plan (Parks Victoria 2006g), which identifies its key values as:

- a diversity of habitats, including subtidal and intertidal reefs, exposed reefs and subtidal soft sediment
- a haul-out area for Australian fur seals and New Zealand fur seals
- a diversity of invertebrates and fish species
- a reef environment, including shipwrecks, rich in marine biota
- threatened fauna, including several bird species and marine mammals
- outstanding landscapes, seascapes and spectacular underwater scenery
- excellent opportunities for scientific investigation and learning
- opportunities to build knowledge of marine protected areas and their management and to further understand marine ecological function and changes over time
- a seascape of high cultural significance to Indigenous people
- a place of significance to Indigenous people
- a diverse and rich maritime and post settlement history
- three historic shipwrecks
- opportunities for boat-based recreational activities including diving and snorkelling within a pristine environment
- spectacular views of Cape Conran Coastal Park
- opportunities for interpretation and education about the marine environment.

1.5.1.4 Tasmania

MPAs in Tasmanian state waters have been progressively established since 1991 under the *National Parks and Wildlife Act 1970* (Tasmania) and are classed as either Marine Reserves or Marine Conservation Areas. Tasmania has approximately 48,500 ha under reserve within their marine and estuarine environments (not including the Macquarie Island Marine Protected Area). 1.1% of Tasmania 's immediate coastal waters are fully protected no-take areas. No management plans are in place for Tasmanian MPAs.

There are two Marine Reserves and no Marine Conservation Areas in the Risk EMBA. These are described below.

Marine reserves

Kent Group Marine Reserve

The Kent Group Marine Nature Reserve covers some 29,000 ha and the Sanctuary Zone covers the western part of the Kent Group including Dover and Erith Islands and Murray Passage as well as part of the western coast of Deal Island (TPWS 2012). The marine habitats of the Kent Group include shallow and deep reefs as well as extensive sponge beds in deeper water. It includes the southernmost strongholds of several fish species including the violet roughy, mosaic leatherjacket and Wilson's weedfish, and the southern limit of distribution of Maori wrasse, one spot puller and Bank's shovelnose. The Kent Group is significant as it is especially rich in fish species, having the highest diversity in Tasmania (TPWS 2012).

Port Davey Marine Reserve

The Port Davey Marine Reserve (17,753 ha) lies within the Southwest National Park and the Tasmanian Wilderness World Heritage Area. Encompassing Port Davey, Bathurst Channel and Bathurst Harbour, the reserve extends inland for more than 20 km to the north and east, up to the high-water mark of all rivers, bays and estuaries (TPWS 2013).

In Bathurst Harbour and Bathurst Channel a very unusual marine environment has been created by a deep layer of dark red brown, tannin-rich freshwater, which overlies tidal salt water. The tannins restrict sunlight penetration to the top few metres, limiting the growth of marine plants. In their place live colourful and delicate marine invertebrates. In the clearer marine waters of Port Davey – away from the influence of the freshwater tannins – a more typical Tasmanian underwater world exists. Diverse kelp forests and abundant fish thrive beneath the surging Southern Ocean waves (TPWS 2013).

The Risk EMBA intersects the Habitat Protection Zone (restricted take) at the Mouth of Port Davey but does not include the Habitat Protection Zone (no take) in the upper reaches.

1.5.1.5 New South Wales

The New South Wales system of marine protected areas includes six marine parks and 12 aquatic reserves protected under the *Marine Estate Management Act 2014* (New South Wales). This includes the three marine parks and eight aquatic reserves located within the Risk EMBA described below.

Marine parks

Batemans Marine Park

Batemans Marine Park (85,000 ha) on the New South Wales south coast extends from the most northerly point of Murramarang Beach near Bawley Point to the southern side of Wallaga Lake entrance at Murunna Point. It includes all waters offshore to the three nautical mile limit of state; offshore islands including Tollgate Islands and Montague Island, and numerous inshore rivers, estuaries, bays, lagoons, inlets, and saline and brackish coastal lakes. Most inshore areas of the marine park are located outside of the Risk EMBA.

Batemans Marine Park is managed through the Batemans Marine Park Operational Plan (New South Wales MPA 2010a). The plan identifies the key values of the park including:

- a variety of landforms and habitats such as rocky shores, offshore rocky reefs, kelp beds, seagrasses, mangroves, sponge gardens, sandy beaches, estuaries and open waters
- a high proportion of rocky shores (unique in New South Wales), both adjacent to the mainland and surrounding the islands, and large expanses of rocky reef that support a diverse array of fish, invertebrates and algae

- Montague Island Nature Reserve, within the park, which is
  - a breeding place for over 40,000 seabirds
  - a nesting location for three shearwater species, crested terns and silver gulls
  - a nesting site for 8000–12,000 little penguins
  - an Australian and New Zealand fur seal haul-out site
  - threatened marine species such as black rockcods, grey nurse and great white sharks, and humpback and southern right whales
  - important habitat for other rare endemic marine species such as eastern blue devilfish, several species of syngnathids (seahorses, sea dragons, pipefish and pipe horses), and the "blind slug" (Smeagol hilaris) – a pulmonate mollusc only found amongst gravel or cobble gutters at Merry Beach, south of Ulladulla
  - important habitat for other marine mammals such as killer whales and populations of Australian and New Zealand fur seals
  - habitat for numerous seabird and shorebird species including little terns, hooded plovers, sooty and pied oyster catchers and albatrosses
  - popular sites for recreational and tourist activities such as swimming, walking, running, wildlife observing, surfing, fishing, diving, snorkelling, sailing, kayaking and beach going
  - important Aboriginal heritage and cultural sites, particularly Barunguba (Montague Island), but also the Murramarang Aboriginal Area that is located onshore directly adjacent to the marine park.

Jervis Bay Marine Park

The Jervis Bay Marine Park (22,000 ha) includes the semi-enclosed waters of Jervis Bay, numerous tidal creeks and over 100 km of coastline and adjacent ocean, extending 1.5 km offshore from Kinghorn Point in the north to Sussex Inlet in the south. The nearshore waters to the north and south of Jervis Bay are included within the Risk EMBA but the majority of the area within Jervis Bay as well as the tidal creeks are located outside of the Risk EMBA.

The Jervis Bay Marine Park is managed under the Jervis Bay Marine Park Operational Plan (New South Wales MPA 2003), which identifies key values of the marine park including:

- a variety of landforms and habitats such as deep-water cliffs, exposed and sheltered sandy beaches, rock platforms, rocky reefs, soft-sediment bottoms, kelp forests, small estuaries, expansive seagrass meadows, mangrove forests and open ocean
- habitat for many resident and migratory marine species, with some species located at their northern or southernmost boundaries of their natural distribution
- over 230 algal species, hundreds of invertebrates and over 210 reef fish species, and sharks, rays, many marine mammals, birds and reptiles
- threatened marine species such as black rockcods, grey nurse sharks, humpback and southern right whales
- threatened bird species found on the rocky shores such as hooded plovers and ospreys
- important habitat for other rare endemic marine species such as eastern blue devilfish and several species of syngnathids
- important tourist attractions such as whale watching, and numerous scuba diving and snorkelling sites
- many culturally significant Aboriginal heritage sites within and adjacent to the park.

Port Stevens–Great Lakes Marine Park

The Port Stephens–Great Lakes Marine Park (98,000 ha) extends from Cape Hawke near Forster south to Birubi Beach at the northern end of Stockton Beach and includes all waters offshore to the three nautical mile state limit, as well as all of Port Stephens, the Karuah River, the Myall River, Myall and Smiths lakes, and their creeks and tributaries to the tidal limit. The inshore areas of the marine park do not lie within the Risk EMBA.

The Port Stevens–Great Lakes Marine Park is managed under the Port Stephens–Great Lakes Marine Park Operational Plan (New South Wales MPA 2010b), which identifies key values of the marine park including:

- a diverse range of habitats including intertidal and subtidal reefs, soft sediments, beaches, seagrass beds, mangroves, saltmarsh and open waters, which all support distinct groups of plants and animals
- reef habitats exhibiting a particularly diverse range of flora and fauna including abundant macroalgae and a variety of coralline and foliose algae, as well as rich assemblages of tropical and temperate fish and invertebrate species
- the state's largest
  - drowned river valley, Port Stephens
  - brackish barrier lake system, Myall Lakes
  - intermittently open and closed lake, Smiths Lake
- the state's second largest island, Broughton Island
- Cabbage Tree Island, the primary breeding site for the threatened Gould's petrel (Australia's rarest endemic seabird)
- around 100 bird species commonly occur amongst the inshore waters and along the coast, including numerous migratory shorebirds
- around 30 species of marine mammals occur within the region; bottlenose dolphins (genus *Tursiops*) are most abundant but rare and threatened cetacean species such as sei and fin whales and the dusky dolphin have also been recorded
- other threatened marine species such as the black rock cod, grey nurse shark, green, loggerhead and hawksbill turtles, and humpback and southern right whales
- several aggregation sites for the threatened grey nurse shark including Little Broughton Island, Forster Pinnacle, Sawtooth Rocks and Big/Little Seal rocks
- important habitat for other rare endemic marine species such as eastern blue devilfish, Queensland groper and several species of syngnathids
- quality recreational fishing and productive commercial fishing grounds, aquaculture, many popular scuba diving sites, and regionally significant tourism activities such as whale and dolphin watching
- a number of significant Aboriginal cultural and spiritual sites within or adjacent to the park such as middens, burial sites and traditional campsites.

Aquatic reserves

The primary purpose of aquatic reserves in New South Wales is to conserve biodiversity, or particular components of biodiversity (such as specific ecosystems, communities or species), in a specified area of the marine estate (DPI, no date). Where consistent with the primary purpose, secondary purposes of aquatic reserves are to:

- provide for the management and use of resources in the aquatic reserve in a manner that is consistent with the principles of ecologically sustainable development
- enable the aquatic reserve to be used for scientific research and education
- provide opportunities for public appreciation and enjoyment of the aquatic reserve
- support Aboriginal cultural uses of the aquatic reserve.

Some reserves aim to conserve particular aspects of marine biodiversity such rocky shore habitats and species, while others aim to conserve areas of marine ecosystems more generally (DPI, no date).

The eight aquatic reserves located within the Risk EMBA are:

- Bushranger's Bay Aquatic Reserve
- Boat Harbour Aquatic Reserve
- Cape Banks Aquatic Reserve
- Bronte-Coogee Aquatic Reserve
- Cabbage Tree Bay Aquatic Reserve
- Long Reef Aquatic Reserve
- Narrabeen Head Aquatic Reserve
- Barrenjoey Head Aquatic Reserve.

1.5.2 State protected wetlands

There are 67 “marine and coastal zone” “nationally important wetlands” that are situated along the shoreline of the Risk EMBA including 10 in South Australia, 22 in Tasmania, eight in Victoria and five in New South Wales, as listed below.

1.5.2.1 South Australia

- American River Wetland System
- Busby & Beatrice Islets
- Clinton
- Coffin Bay Coastal Wetland System
- Cygnet Estuary
- D’Estrees Bay
- Grassdale Lagoon
- Lashmar Lagoon and Chapman River
- Point Labatt
- The Coorong, Lake Alexandrina and Lake Albert.

1.5.2.2 Tasmania

- Aspley Marshes
- Boullanger Bay – Robbins Passage
- Calverts Lagoon
- Douglas River
- Earlham Lagoon
- Fergusons Lagoon
- Flyover Lagoon (1 and 2)
- Freshwater Lagoon
- Goulds Lagoon
- Lavinia Nature Reserve
- Little Thirsty Lagoon
- Logan Lagoon
- Maria Island Marine Reserve
- Moulting Lagoon
- Orielton Lagoon
- Oyster Cove
- River Derwent
- Rocky Cape Marine Area
- Sellars Lagoon
- Syndicate Lagoon
- Tegarons Lagoon 2
- Unnamed Wetland (TAS008, TAS009, TAS010, TAS011, TAS012, TAS013, TAS014, TAS038, TAS051, TAS052, TAS081).

1.5.2.3 New South Wales

- Beecroft Peninsula
- Jervis Bay
- Jervis Bay Sea Cliffs
- Towra Point Estuarine Wetlands
- Wollumboola.

1.5.2.4 Victoria

- Corner Inlet
- Lake King Wetlands
- Lake Tyers
- Lower Aire River Wetlands
- Mud Islands
- Swan Bay & Swan Island
- Yambuk Wetlands
- Western Port.

A number of other terrestrial state protected wetlands were returned in the PMST search for matters protected under the EPBC Act but are outside the bounds of the Risk EMBA. These were wetlands categorised as "Inland", and those within the "marine and coastal zone" situated above the maximum tidal elevation of the area with no seasonal or permanent connection with the ocean.

A wetland may be listed as nationally important if it meets any of the following criteria (DEE 2017a):

- It is a good example of a wetland type occurring within a biogeographic region in Australia.
- It is a wetland which plays an important ecological or hydrological role in the natural functioning of a major wetland system/complex.
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles or provides a refuge when adverse conditions such as drought prevail.
- The wetland supports one per cent or more of the national populations of any native plant or animal taxa.
- The wetland supports native plant or animal taxa or communities which are considered Endangered or Vulnerable at the national level.
- The wetland is of outstanding historical or cultural significance.

1.5.3 State protected terrestrial areas

Numerous state protected terrestrial areas (e.g. National Parks, Nature Reserves, Conservation Parks, Conservation Reserves, Wilderness Protection Areas and Aquatic Reserves) occur along the coast of the Risk EMBA. These areas have generally been proclaimed to conserve onshore areas of national, state or regional significance of wildlife, natural features, or Aboriginal or European heritage although some extend to the low water mark of the intertidal zone. The shoreline components of these parks are comprised the intertidal communities and habitats outlined in Section 1.5.1, and where relevant the heritage properties are described in Section 1.6.3. A description of each protected area's terrestrial features and values is not provided, given that the non-shoreline portions of these protected areas are outside the Risk EMBA.

The state protected terrestrial area that have a shoreline component are listed below:

- Acraman Creek
- Adelaide International Bird Sanctuary National Park - Winaityinaityi Pangkara
- Althorpe Islands
- Avoid Bay Islands
- Baird Bay Islands
- Baudin
- Beatrice Islet
- Busby Islet

- Butcher Gap
- Cap Island
- Cape Blanche
- Cape Bouguer
- Cape Torrens
- Chadinga
- Coffin Bay
- Coorong
- Cygnet Estuary
- Deep Creek
- Douglas Point
- Eba Island
- Fowlers Bay
- Gambier Islands
- Granite Island
- Great Australian Bight Marine
- Greenly Island
- Innes
- Investigator Group
- Lesueur
- Leven Beach
- Lincoln
- Lipson Island
- Little Dip
- Memory Cove
- Neptune Islands
- Newland Head
- Nicolas Baudin Island
- Nullarbor
- Nuyts Archipelago
- Nuyts Archipelago
- Nuyts Reef
- Olive Island
- Piccaninnie Ponds
- Pigface Island
- Point Bell
- Point Davenport
- Point Labatt
- Ravine des Casoars
- Rocky Island (North)
- Rocky Island (South)
- Seal Bay
- Searcy Bay
- Sinclair Island
- Sir Joseph Banks Group
- The Pages
- Torrens Island
- Troubridge Island
- Tumby Island
- Venus Bay
- Vivonne Bay
- Wahgunyah
- Waldegrave Islands
- Western River
- Whidbey Isles
- Wills Creek
- Wittelbee.

1.6 Key ecological features

Key Ecological Features (KEFs) 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. Nineteen KEFs are present within the extent of the Risk EMBA (Figure 1.5). Seven occur in the South-west Marine Region, eight in the South-east Marine Region and four in the Temperate East Marine Region. The descriptions of each KEF from the relevant plan or profile developed for each region are included in Table 1.3.

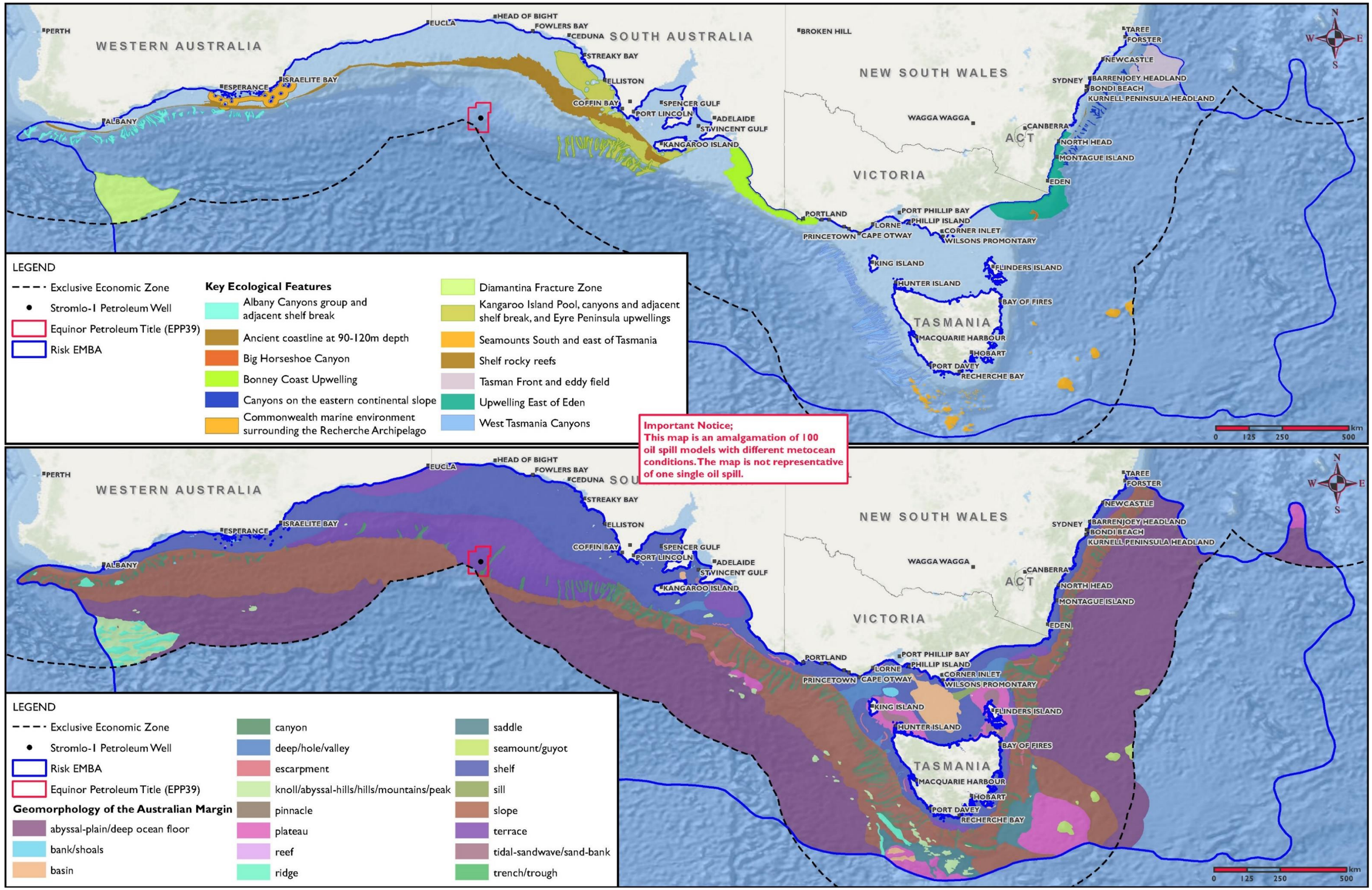


Figure 1.5 Key Ecological Features (KEFs) and geomorphological features within the Risk EMBA

Table 1.3 Key Ecological Features within each marine region of the Risk EMBA

Key Ecological Features (KEFs)	Description
South-west Marine Region	
Albany Canyons group and adjacent shelf break	The Albany canyons group consists of 32 canyons that cut deeply into 700 km of steep continental slope. The canyon system extends from Broke Canyon in the west to the Albany, Vancouver, Wilyunup, Bremer and Malcolm canyons to the east (DSEWPaC 2012a). The canyons are believed to be associated with small periodic upwellings that enhance productivity and attract aggregations of marine life. In contrast to other canyon systems in the South-west Marine Region, the Albany canyons are immediately adjacent to, and interact with, a large section of continental shelf break. Anecdotal evidence indicates that this area supports fish aggregations that attract large predatory fish, sharks, and toothed, deep-diving whales such as sperm whales (DSEWPaC 2012a).
Ancient coastline at 90–120 m depth	The ancient coastline at 90–120 m depth KEF occurs along the entire width of the Great Australian Bight. The area features relatively high productivity and aggregations of marine life, and high levels of biodiversity and endemism. The seabed of this escarpment is dominated by sponge communities of significant biodiversity and structural complexity(DSEWPaC 2012a).
Benthic invertebrate communities of the eastern Great Australian Bight	Soft sediment benthic invertebrate communities of the eastern Great Australian Bight shelf form some of the world's most diverse soft sediment ecosystems. A 2002 survey of benthic marine life sampled 798 species, including 360 species of sponge, 138 ascidians and 93 bryozoans, many of which were new to science (DSEWPaC 2012a). The shelf in this area of the South-west Marine Region is part of the world's largest cool-water carbonate province. Invertebrate skeletons and shells make up over 80% of the shelf sediments (DSEWPaC 2012a). The benthic invertebrate communities of the eastern Great Australian Bight KEF are not spatially defined but the majority of the shelf and the shelf break in the eastern Great Australian Bight likely supports high levels of productivity that in turn support diverse benthic invertebrate communities. Section 1.4.2 of the EP describes the known benthic species and communities of the Great Australian Bight as well as recent sampling of benthic invertebrates undertaken as part of the GABRP in the eastern and central Great Australian Bight.
Commonwealth Marine Environment surrounding the Recherche Archipelago	This KEF contains the most extensive area of reef in the South-west Marine Region (35,203 km^2 of reef habitat). The reef and seagrass habitats support a high species diversity of warm temperate species including 263 known species of fish, 347 known species of molluscs, 300 known species of sponges and 242 known species of macro-algae (DSEWPaC 2012a). The islands also provide haul-out (resting areas) and breeding sites for Australian sea lions and New Zealand fur seals (DSEWPaC 2012a).
Kangaroo Island Pool, canyons and adjacent shelf break, and Eyre Peninsula upwellings	This KEF encompasses a series of canyons (Nuyts, Pearson, Whidbey, Lincoln, Gambier, Althorpe, De Douedic, Sprigg, Seal, Kangaroo and Gantheaume) and the adjacent shelf break. The canyons are also thought to be an important pupping area for school sharks and the adjacent shelf break is known for high yields of giant crabs and southern rock lobsters. The sea floor features are unique and of regional ecological significance as they interact with seasonal undersea currents, upwelling nutrient rich deep ocean water and creating the Kangaroo Island "Pool". The upwelling supports aggregations of krill, small pelagic fish and squid, which, in turn, attract marine mammals (e.g. pygmy blue whales, sperm whales, dolphins and New Zealand fur seals), sharks, large predatory fish and seabirds (DSEWPaC 2012a).
Small pelagic fish of the South-west Marine Region	Small pelagic fish are an important component of pelagic ecosystems, providing a link between primary production and higher predators, such as other fish, sharks, seabirds, seals and cetaceans. In the South-west Marine Region, the small pelagic fish include ten species, these being sardine, scaly mackerel, Australian anchovy, round herring, sandy sprat, blue sprat, jack mackerel, blue or slimy mackerel, red bait and saury (DSEWPaC 2012c). The small pelagic fish KEF is not spatially defined but small pelagic fish are expected to be distributed in pelagic habitats throughout the South-west Marine Region with the abundance of species within the Risk EMBA determined by their individual ecologies. Small pelagic fish are known to occur in all CMRs in the South-west Marine Region, including the Great Australian Bight Marine Park (DSEWPaC 2012a).
The Diamantina Fracture Zone	This KEF is located off the south-west coast of Western Australia and contains an extremely rugged area of sea floor (more than 100,000 km^2) of closely spaced ridges and troughs with a characteristic east-west orientation. It also contains the greatest depths in Australian waters, down to 5900 m deep. Very little is known about the ecology of this remote, deep-water feature but marine its size and physical complexity mean that it is likely to support deep-water communities characterised by high species diversity and endemism (DSEWPaC 2012a).
South-east Marine Region	
Bass Cascade	The Bass Cascade KEF is not spatially defined. The "underwater waterfall" effect is brought about by the northward flow of Bass Strait waters in winter, which are more saline and slightly warmer than surrounding Tasman Sea waters. As the water approaches the mainland in the area of the Bass Canyon group it forms an undercurrent that flows down the continental slope. The cascading water has a displacing effect causing nutrient-rich waters to rise, which in turn leads to increased primary productivity in those areas. The cascading water also concentrates nutrients and some fish and whales are known to aggregate along its leading edge(DoE 2015a).
Big Horseshoe Canyon	The Big Horseshoe Canyon is the easternmost arm of the Bass Canyon systems. The steep, rocky slopes provide hard substrate habitat for attached large megafauna. Sponges and other habitat forming species provide structural refuges for benthic fishes, including the commercially important pink ling. It is the only known temperate location of the stalked crinoid, *Metacrinus cyaneu* (DoE 2015a).
	The Bonney Coast Upwelling is a predictable, seasonal upwelling bringing cold nutrient-rich water to the sea surface and supporting regionally high productivity and high species diversity in an area where such sites are relatively rare and mostly of smaller scale(DoE 2015a). It is one of 12 widely recognised and well-known areas worldwide where blue whales are known to feed in relatively high numbers (DoE 2015g). Throughout the summer period (November–March) along the Bonney Coast (Robe, South Australia to Portland, Victoria), a succession of slowly propagating, high-pressure features move eastwards to the south of the continent. Due to their orientation, certain sections of the southern shelf are subject to south easterly winds that produce conditions that favour upwelling (DoE 2015a). Pygmy blue whales (*Balaenoptera musculus*) aggregate to feed along the Bonney coast during these upwellings, as they are attracted by the presence of coastal krill (*Nyctiphanes australis*) that swarm in surface waters at these times (DoE 2015a). In addition to whales, many endangered and listed species frequent the area, possibly also relying on the abundance of krill that provide a food source to many seabirds and fish. The high productivity of the Bonney Upwelling is also capitalised on by other higher predator species such as little penguins and Australian fur seals feeding on baitfish (DoE 2015a).
East Tasmania subtropical convergence zone	This zone of enhanced pelagic productivity occurs where eddies of the East Australian Current interact with subantarctic waters driven by westerly winds. The East Tasmania subtropical convergence zone KEF is not spatially defined although the northern and southern extent of the feature are approximately level with the north east tip of Tasmania and the Tasman Peninsula (DoE 2015a). This is a complex feature that is characterised by autumn and spring phytoplankton blooms that form the basis of a productive food chain that supports cetaceans, seals, sharks and seabirds (DoE 2015a). The phytoplankton blooms are important for krill, which attract pelagic species including migratory commercial fish stocks such as southern bluefin tuna, barracouta and jack mackerel (DoE 2015a).
Seamounts south and east of Tasmania	These seamounts are a chain or cluster of seamounts rising from the abyssal plain, continental rise or plateau situated 200 km or more from shore (east of Flinders Island to the south-east of southern Tasmania) (DoE 2015a). Seamounts can sometimes influence and intensify currents, creating localised upwelling and turbulent mixing. Accelerated water flows are thought to create upwellings of nutrient-rich waters from the sea floor (DoE 2015g). Seamounts with hard substrate summits and slopes provide attachment points for sessile invertebrates, while the soft sediments can be habitat for species that burrow into the sediments (DoE 2015a).

Key Ecological Features (KEFs)	Description
Shelf rocky reefs and hard substrates	Rocky reefs and hard grounds are located in all areas of the South-east Marine Region continental shelf including Bass Strait, from the subtidal zone shore to the continental shelf break. The continental shelf break generally occurs in 150–220 m water depth but the shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m (DoE 2015a). However, the shelf rocky reefs and hard substrates KEF is not spatially defined. On the continental shelf, rocky reefs and hard grounds provide attachment sites for macroalgae and sessile invertebrates, increasing the structural diversity of shelf ecosystems. The reefs provide habitat and shelter for fish and are important for aggregations of biodiversity and enhanced productivity (DoE 2015a).
Upwelling east of Eden	Dynamic eddies of the East Australian Current cause episodic productivity events when they interact with the continental shelf and headlands. The episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish (DoE 2015a). The upwelling supports regionally high primary productivity that supports fisheries and biodiversity, including top-order predators, marine mammals and seabirds. This area is one of two feeding areas for blue whales and humpback whales, known to arrive when significant krill aggregations form. The area is also important for seals, other cetaceans, sharks and seabirds (DoE 2015a).
West Tasmania Canyons	The West Tasmania Canyons are located on the edge of the continental shelf offshore of the north-west corner of Tasmania and as far south as Macquarie Harbour. These canyons can influence currents, act as sinks for rich organic sediments and debris, and can trap waters or create upwellings that result in productivity and biodiversity hot spots. For example, plumes of sediment and nutrient-rich water can be seen at or near the heads of canyons (DoE 2015a). Sponges are concentrated near the canyon heads, with the greatest diversity between 200 and 350 m depth. Sponges are associated with an abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts (DoE 2015a).
Temperate East Marine Region	
Canyons on the Eastern continental slope	Submarine canyons are widespread features around the Australian continent and island margins, and a large number of these features are present on the eastern continental slope. The canyons have a marked influence on the diversity and abundance of species on the eastern continental slope, driven by the combined effects of steep and rugged topography, ocean currents, sea floor types and nutrient availability. They significantly contribute to the overall habitat diversity of the sea floor, by providing hard surfaces in depth zones where soft sediment habitats prevail. Large benthic animals such as sponges and feather stars are abundant, with particularly high diversity found in the upper slope regions (150–700 m) (DSEWPaC 2012b). The canyons also create localised changes in productivity in the water column above them, providing feeding opportunities for a range of range of higher trophic level species, including crustaceans, echinoderms, bivalves, cephalopods and fish that are then attracted to these regions (DSEWPaC 2012b).
Shelf rocky reefs	Benthic communities on rock outcrops and boulder substrates shift along the continental shelf south of the Great Barrier Reef from algal-dominated communities to those dominated by attached invertebrates (including large sponges, moss animals and soft corals), typically occurring at approximately 45 m depth (DSEWPaC 2012b). These invertebrates create a complex habitat that supports a multitude of animals including crabs, snails, worms and starfish. The habitats also contain a diverse assemblage of bottom-dwelling fishes that show distinct patterns of association with shelf-reef habitats (DSEWPaC 2012b).
Tasman front and eddy field	The Tasman Front, located between 27°S and 33°S, is a region of intermediate productivity that separates the warm, nutrient-poor waters of the Coral Sea from the cold, nutrient-rich waters of the Tasman Sea. Across the southern portion of the Temperate East Marine Region, the Tasman Front creates a complex oceanographic environment that includes warm-core eddies, a number of which are semi-permanent (DSEWPaC 2012d). These cause waters to mix vertically, resulting in patches of productivity that are important for mid-level consumers including turtles and top fish predators, as well as catch in the Eastern Tuna and Billfish Fishery (DSEWPaC 2012b). The feature is also important for providing connectivity of tropical species to the Lord Howe seamount chain and Norfolk Ridge (DSEWPaC 2012b).
Tasmantid Seamount Chain	The Tasmantid seamount chain is a prominent chain of underwater volcanic mountains, plateaux and terraces that runs north–south at approximately 155°E, extending into the Tasman Basin. At the deepest point of the chain, features rise to a depth of 1400–900 m below sea level. At the northernmost extent, features rise to a depth of 400–150 m below sea level, with some breaking the surface to form islands. The Tasmantid seamount chain contains a range of habitats, from deep sea sponge gardens to near-pristine tropical coral reef systems. Collectively, these are biological hot spots with high species diversity. They are also known feeding and breeding grounds for a number of open ocean species (e.g. billfish, marine turtles, marine mammals) and have high species endemism (DSEWPaC 2012b).

2.0 Physico-chemical environment

2.1 Bathymetry

Water depths within the Risk EMBA range from the shoreline to greater than 4500 m. The Stromlo-1 well location occurs entirely within the lower continental or abyssal slope of the Great Australian Bight at a water depth of 2239 m (Figure 1.1). The greater Great Australian Bight slope is up to 250 km wide and features mid-slope terraces and numerous deep submarine canyons (GA 2005), most of which are located to the south-east of the Stromlo-1 well location.

Two conical, volcanic seamounts known as Anna's Pimple and Murray's Mount have been mapped in the northern half of EPP39. These seamounts are approximately 800 m in diameter and 200 m high (Currie & Sorokin 2011) and lie in water depths of about 1800 m. At their closest, they are approximately 20 km from the Stromlo-1 well location. Recent research from the Great Australian Bight Deepwater Marine Program has indicated around ten other similar volcanic seamounts in the greater Great Australian Bight area.

North-west of the well location are mass wastage features, where soft sediments have been shed off the slope to reveal underlying harder seabed. East of the well location is the headwall of an incised canyon that cross cuts the abyssal slope, above which is a striated channel that has been formed by the movement of shelfal sediments across the continental slope. Another two incised canyons are visible further north.

Rogers et al. (2013) state that about 70% of the seabed in the Great Australian Bight is soft unconsolidated sediments. Due to large variations in bathymetry, however, there are marked differences in sedimentary composition and benthic assemblage structure across the South Australia region. The Offshore Southern Australia region extends from Cape Leeuwin in Western Australia to Cape Howe in New South Wales, and south to the South Tasman Rise and the Australian Maritime Jurisdiction of the Kerguelen Plateau (http://www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/offshore-southern-australia; accessed 14 September 2018). Major features of this region include the Otway Basin, Gippsland Basin, Bass Basin, Sorell Basin and the Bremer Sub-basin of the Bight Basin, as well as the Sydney Basin off New South Wales.

Water depths vary throughout the Otway Basin with maximum depths greater than 3000 m. The sea floor features of the region are diverse and include seamounts, canyons, escarpments, soft sediments and rocky reefs. Submarine canyons are a prominent feature running across the extent of the survey area and include the West Tasmanian Canyons KEF. Sections of the continental shelf, including Bass Strait, possess a mosaic of rocky reefs and soft sediments, supporting a wide range of species from broad taxonomic groups. A key ecological feature of the region is the deepsea floor canyons ranging from 200 to 3000 m in depth that are known to intensify local currents and the concentration of nutrients to enhance productivity and biodiversity (DoE 2015a).

The Gippsland Basin is a series of massive sediment flats, interspersed with small patches of reef, bedrock and consolidated sediment. Nearshore sediments consist of coarse sands with isolated areas of gravels, shells and pebbles. Finer, muddy sands occur further offshore in the mid-shelf regions. Sedimentation is generally low due to the small supply from rivers and the relatively low productivity of carbonate. Submarine canyons within the Gippsland Basin include the Big Horseshoe Canyon. The seabed bathymetry across the region is highly variable. A steep inshore profile (0–20 m water depth) extends to a less steep inner (20–60 m water depth) and moderate profile (60–120 m water depth), concluding with a flat outer shelf plain (>120 m water depth), and a steep slope into the Bass Canyon in the east (Black et al. 1991).

Bass Basin is a shallow depression approximately 120 km wide and 400 km long in the centre of Bass Strait. Two plateaus, the Bassian Rise and King Island Rise, located on the eastern and western margins of Bass Strait, respectively, are composed of a basement of Palaeozoic granite. These features form sills separating Bass Basin from the adjacent ocean basins. Associated with the <50 m deep Bassian Rise is the Furneaux Islands, the largest of which is Flinders Island (max. elevation 760 m). The surface of the King Island Rise also occurs in water depths of <50 m and includes the shallow (40 m) Tail Bank at its northern margin as well as King Island itself. Subaqueous dunes (sand waves) and tidal current ridges occur on the seabed over the Bassian and King Island Rises. Malikides (1988) estimated that subaqueous dunes cover approximately 6000 km^2 of the seabed in Bass Strait. Slater (1969) reported that Banks Strait exhibits a number of erosional (deep rocky channels) and depositional (tidal sand ridges and dunes) features. The largest of the tidal sand ridges, Moriarty Bank, lies east of Clarke Island and is approximately 20 km long and 4 km wide, orientated east–west, sub-parallel to the flow of tidal currents.

The Sorell Basin underlies parts of the continental shelf and slope off western Tasmania and is contiguous with the Otway Basin to the north (Geoscience Australia 2018, www.ga.gov.au/scientific-topics/energy/province-sedimentary-basin-geology/petroleum/offshore-southern-australia/bight). It contains Early–Late Cretaceous mostly non-marine sediments (fluvial and red beds), overlain by younger post-rift paralic and shallow marine siliciclastics and carbonates. The transition from continental shelf to abyssal plain across a continental slope is of relatively gentle and uniform grade. Canyon incision and erosion affect the upper slope.

The Bremer Sub-basin extends over an area of about 14,800 km^2 under the outer shelf and continental slope (100–4500 m water depth) in the western part of the Bight Basin, offshore of Albany and Esperance. The Bremer Sub-basin contains a series of half graben that were initiated in the Jurassic. Rift structures from the Bremer Sub-basin appear to step-down to the south into the depocentres of the adjoining deep-water Recherche Sub-basin. (Bradshaw 2005).

The Sydney Basin extends for 380 km along the east coast of New South Wales south of latitude 33°S and has an onshore area of about 36 000 km^2 (Geoscience 2018). About 4800 m of Permian and Triassic sedimentary rocks are preserved in the basin.

2.2 Seabed sediments

The seabed in Australian waters is diverse and complex, with recent mapping identifying 21 types of geomorphic features. These include major features such as the continental shelf, slope, rise, plateaus and abyssal plain, and smaller features such as basins, terraces, reefs and seamounts.

2.2.1 Continental shelf sediments

The continental shelf is defined as the seabed between the shoreline and 200 m depths. The continental shelf in the Great Australian Bight is up to 260 km wide before dropping off into the broad Ceduna Terrace on the continental slope. Shelf sediments are primarily biogenic in origin as the adjacent land mass is arid and there is no riverine input (James et al. 2001; James & Bone 2011). The environment adjacent to the Great Australian Bight is characterised by very low rainfall (with no major rivers and thus a very low supply of terrigenous sediments to the ocean), the shelf bedforms of the Great Australian Bight are largely biogenic and form part of the world's largest expanses of temperate carbonate sediments. The inner shelf supports abundant carboniferous macrophytes and is an area of active sediment production and accumulation. The middle shelf is an area of sediment erosion and winnowing, while the outer shelf is a region of sedimentary deposition and variable sediment production.

As a result, the sediments are generally coarse-grained and gravelly inshore but become progressively finer and muddier with increasing depth and distance offshore. PIRSA (2007) reports that the marine substrate on the shelf between the Western Australia–South Australia border and the Gulf of St Vincent is comprised a vast basement of granitic rocks.

2.2.2 Continental slope sediments (including the well site)

The continental slope is defined as the seabed between 200 and 3000 m depths. As the continental slope drops gradually beyond the shelf of the Great Australian Bight, it consists of two marginal terraces; the Ceduna Terrace in the east and the Eyre Terrace in the west. Both terraces are separated from the continental shelf by an incipient slope between the shelf break and the uppermost smooth surface of the terrace.

Slope sediments tend to be muddy foraminiferal, spicule and pteropod oozes, often containing skeletal remains of bryozoans, molluscs and echinoderms transported downslope from the adjacent shelf (James et al. 2001; James & Bone 2011) The muds are a mixture of approximately 66% fine biofragments and 33% fine pelagic components (McLeary et al. 2003). Sediment samples were part of both the Great Australian Bight research and the geotechnical survey performed by Fugro (2013). These were typically very dense clays at 1500–2000 m sites.

2.2.3 Continental rise and abyssal plain sediments

One of the most notable features of the seabed in the Great Australian Bight is the development of an extensive and wide continental rise that flanks the foot of the slope and extends towards the abyssal plain. The rise is delineated by changes in gradient with the slope and the abyss and forms a largely unbroken apron skirting the complete length of the southern continental slope. In the south-east, the rise extends from about 3000 m depth before merging into the Abyssal Plain (5000–5500 m depth). The seabed here is soft and muddy and the surficial sediments are characterised by foraminiferal and coccolith oozes.

2.3 Currents

Four distinct currents occur within the Great Australian Bight: the shelf-edge Leeuwin Current (LC) and the South Australian Current (SAC), the deep ocean Flinders Current (FC), and the nearshore Coastal Current (CC) (Figure 2.1; Middleton et al. 2017). Shelf and edge currents within the Great Australian Bight are generally seasonal in nature, with the notable exception of the eastward SAC. The typical magnitude of these currents is from 5 to 25 cm/s. These are relatively slower compared to other major current systems around the Australian continent (e.g. the East Australian Current; Middleton et al. 2017 or West Australian Current at approximately 20-35cm/s). Despite the relatively low magnitudes of these current systems within the Great Australian Bight they nevertheless can transport particulate matter and marine biota over distances of 390–2000 km over several months (Middleton et al. 2017).

The Leeuwin Current is a key driver of biological activity in the Great Australian Bight and has a strong seasonal element and strong inter-annual variability. It brings a warm surface water mass from the west into the Great Australian Bight during winter (Figure 2.1) but is absent in summer (Figure 2.2). The inter-annual variation in the current can exceed the seasonal variation and is generally controlled by El Niño Southern Oscillation events. During strong El Niño years, the Leeuwin Current is reduced and during strong La Niña years it is enhanced (Middleton et al. 2017).

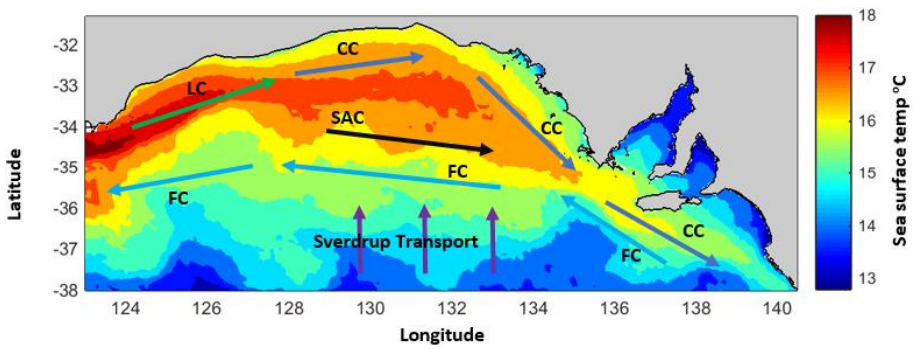
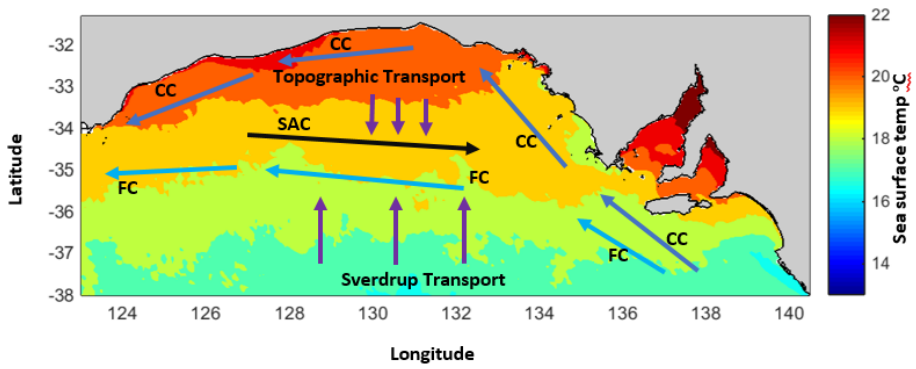


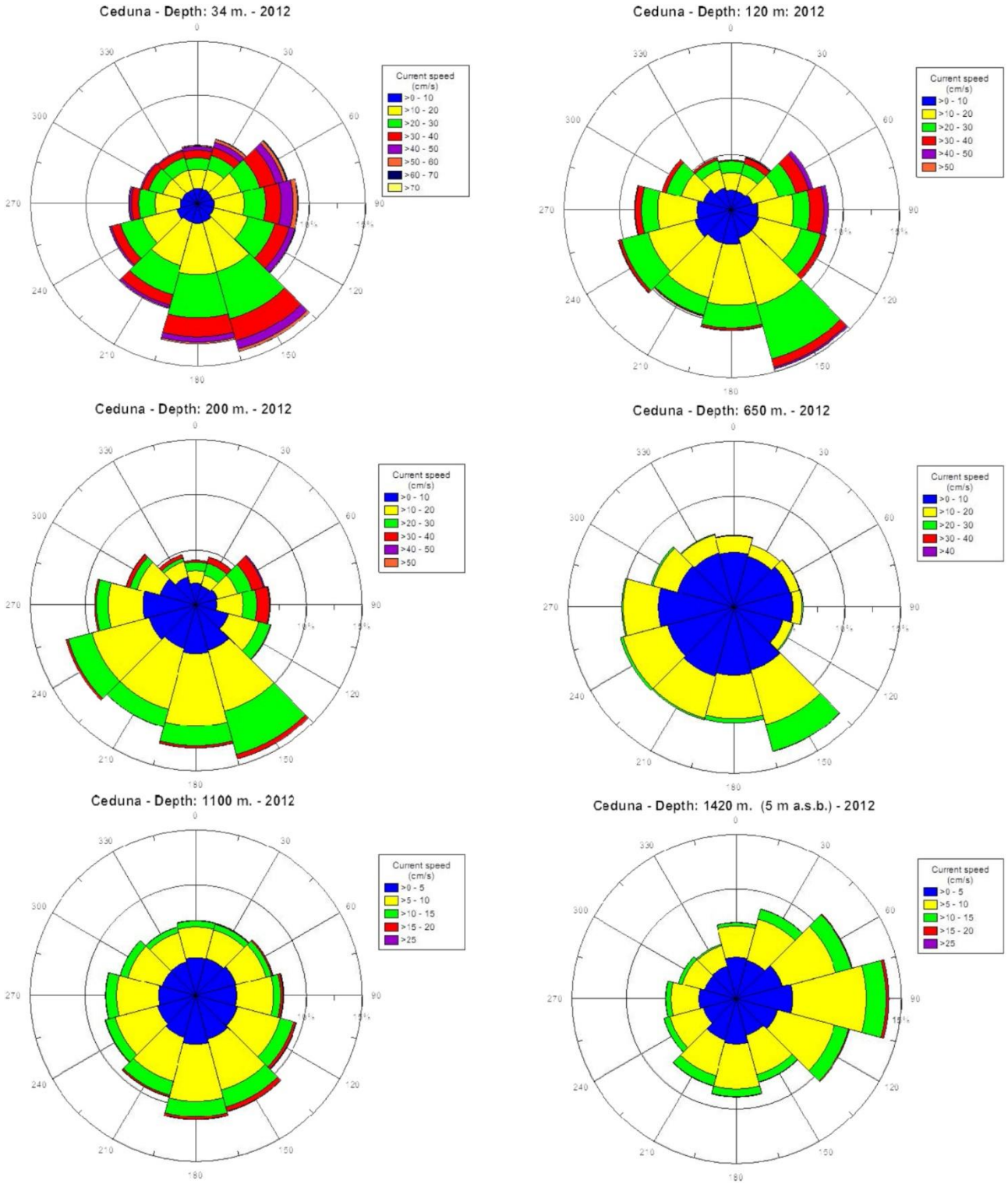
Figure 2.1 Mean winter circulation and major currents in the Great Australian Bight (LC: Leeuwin Current, FC: Flinders Current, SAC: South Australian Current, CC: Coastal Current)



Source: modified Ward et al (2017), Rogers et al. (2013)

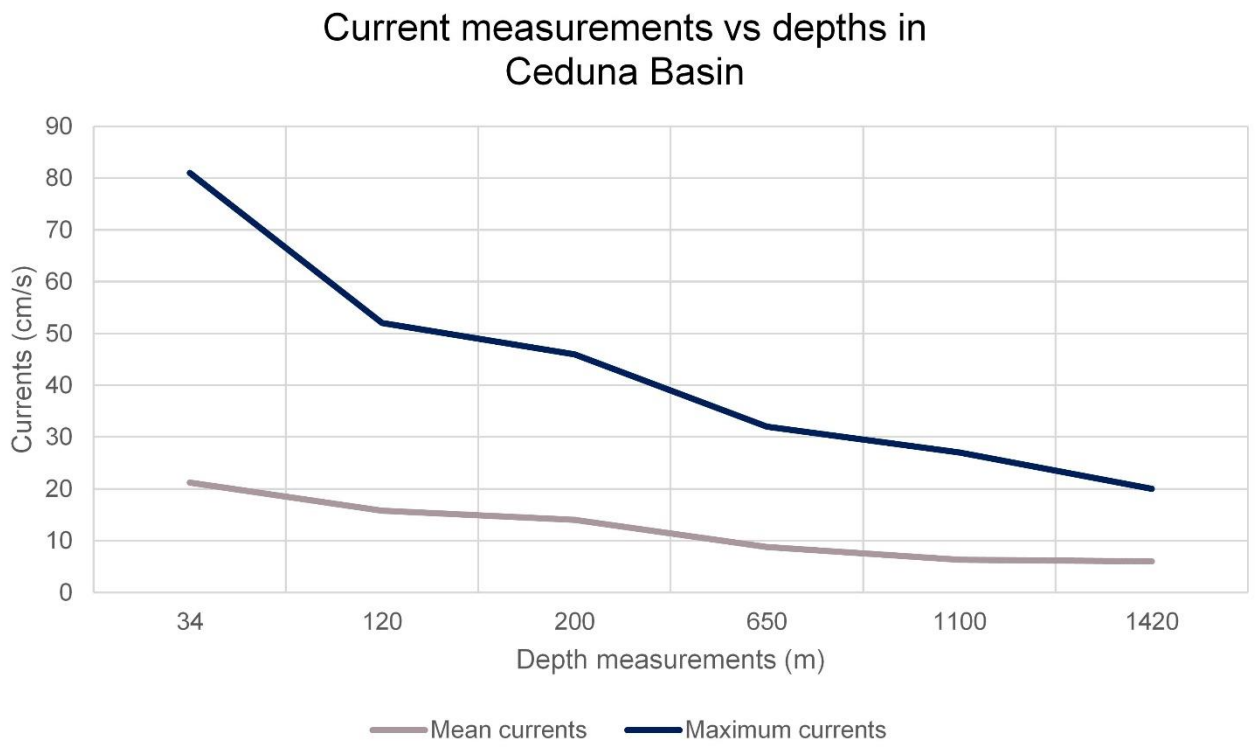
Figure 2.2 Mean summer circulation and major currents in the Great Australian Bight (FC: Flinders Current, SAC: South Australian Current, CC: Coastal Current)

Figure 2.3 shows the current roses at various depths ranging from 34 to 1420 m, as measured by current meters in the offshore Ceduna Sub-basin in 2012/2013 (Mathiesen 2017).The current roses show the prevailing directions towards which the currents flow. The currents decrease with depth; e.g. at 34 m the mean currents are 20 cm/s, decreasing to around 6 cm/s at 1420 m depth (Figure 2.4). Current speeds at the seabed below these depths are expected to be very low.



Source: Mathiesen (2017)

Figure 2.3 Current roses for measurements the Stromlo-1 well location in 2012



Source: Mathieson (2017)

Figure 2.4 Currents through the water column in the Ceduna Basin from local measurements in 2012

2.4 Climate and meteorology

Australia's size and geography gives rise to a diverse range of climate patterns across the continent and offshore islands. The southern and south-east coasts of Australia are primarily described as being a temperate climate. There is still variation present within this temperate belt, with south-western Western Australia to south-eastern South Australia typically having mild wet winters and hot dry summers compared with Victoria and New South Wales coasts, which experience year-round rainfall.

In summer, the Great Australian Bight is influenced by high pressure systems that move from west to east across the region. During winter, the land surface temperatures are cooler than the ocean, and the high pressure migrates to the north allowing for greater passage of cold fronts near the coast and primarily eastward winds (Rogers et al. 2013). Mean monthly air temperatures in Great Australian Bight (at a point 54 km from the Stromlo-1 well location) range average around 19 °C in February to 14 °C in July and August (Mathiesen 2017), with a maximum around 26 °C (January, March) to a minimum of 9 °C (August, September).

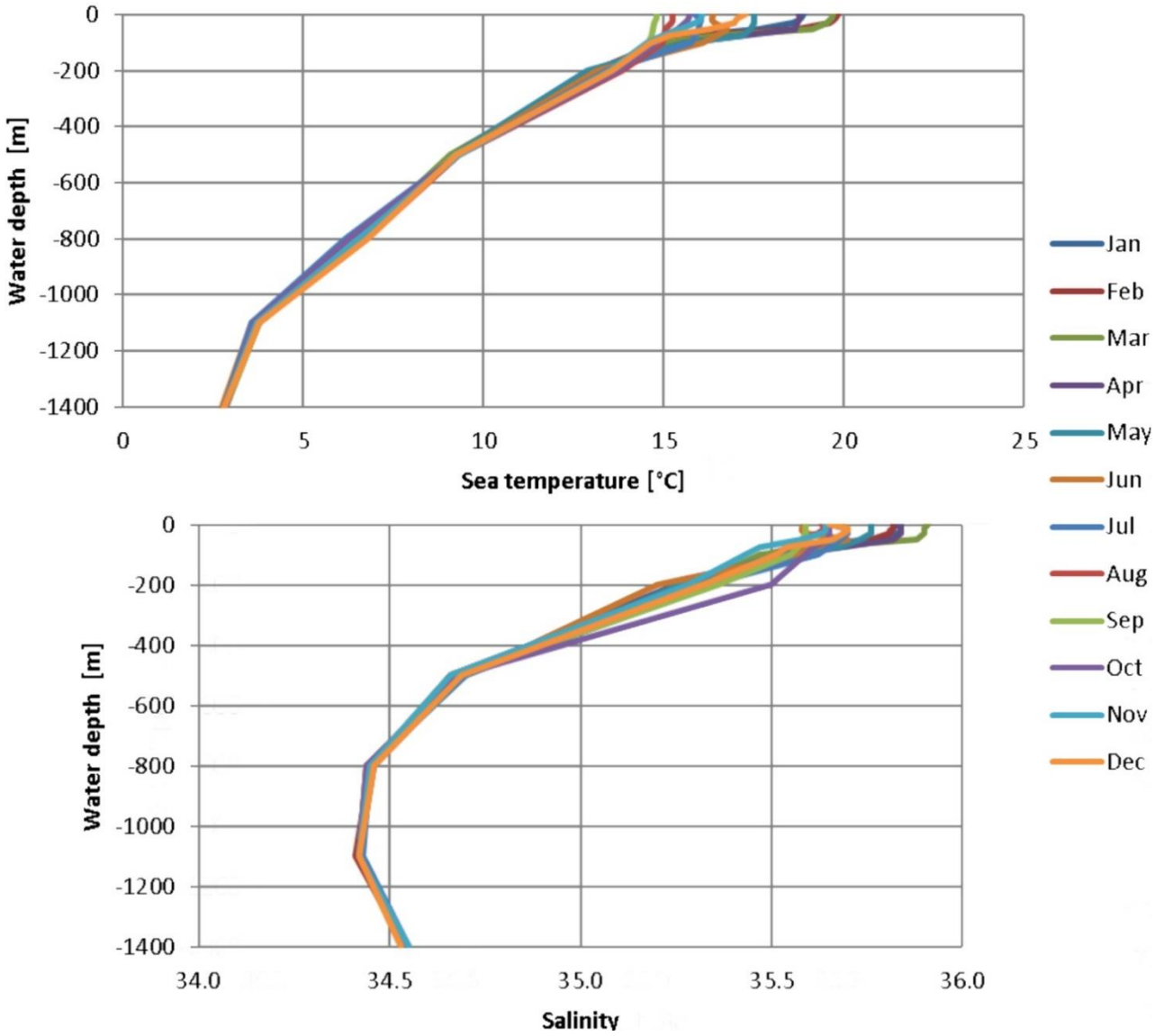
The majority of annual rainfall in the region occurs during the autumn and winter months (April to August), with an annual average of 272 mm at Eucla (90 km north-west of the Stromlo-1 well location) and 296 mm at Ceduna (415 km north-east of the Stromlo-1 well location) (BOM 2012). Rainfall increases to the west, with average annual rainfall along the Gippsland coast ranging from approximately 500 to >1000 mm. Evaporation exceeds precipitation all round and during summer; coastal waters are subject to intense heating (Rogers et al. 2013).

2.5 Temperature and salinity

Mean sea surface temperatures of the Great Australian Bight vary from 14.8 °C September to 19.8 °C in February (Figure 2.5; Mathiesen 2017), across the year. This variation is controlled by cross-shelf seawater exchange, and influenced by the combined effects of complex bathymetry, broadscale and local currents, wind and wave action and upwelling and downwelling events (Middleton et al. 2014).

During summer and autumn, upwellings produce patches of cool surface water along the coast of the southern Eyre Peninsula, in the eastern Great Australian Bight region. Year-round shelf downwelling caused by atmospheric cooling occurs in in the central Great Australian Bight. There is less seasonal variation in water temperature in depths below 200 m. From 200 m, temperatures drop from approximately 15 °C to 3 °C at 1400 m deep (Mathiesen 2017).

Salinity in the Great Australian Bight is more stable than temperature, across season, depth and distance from shore (Middleton et al. 2014). During both winter (June to August) and summer (January to March), mean salinity values range from 36.6 to 35.4 psu in water depths of 0–50 m, increasing with distance from shore. The saltiest water is found near the coast suggesting dense water formation due to evaporation. Offshore, mean values range from approximately 35.5 psu at the surface to 34.6 at 400 m deep.



Source: Mathiesen (2017)

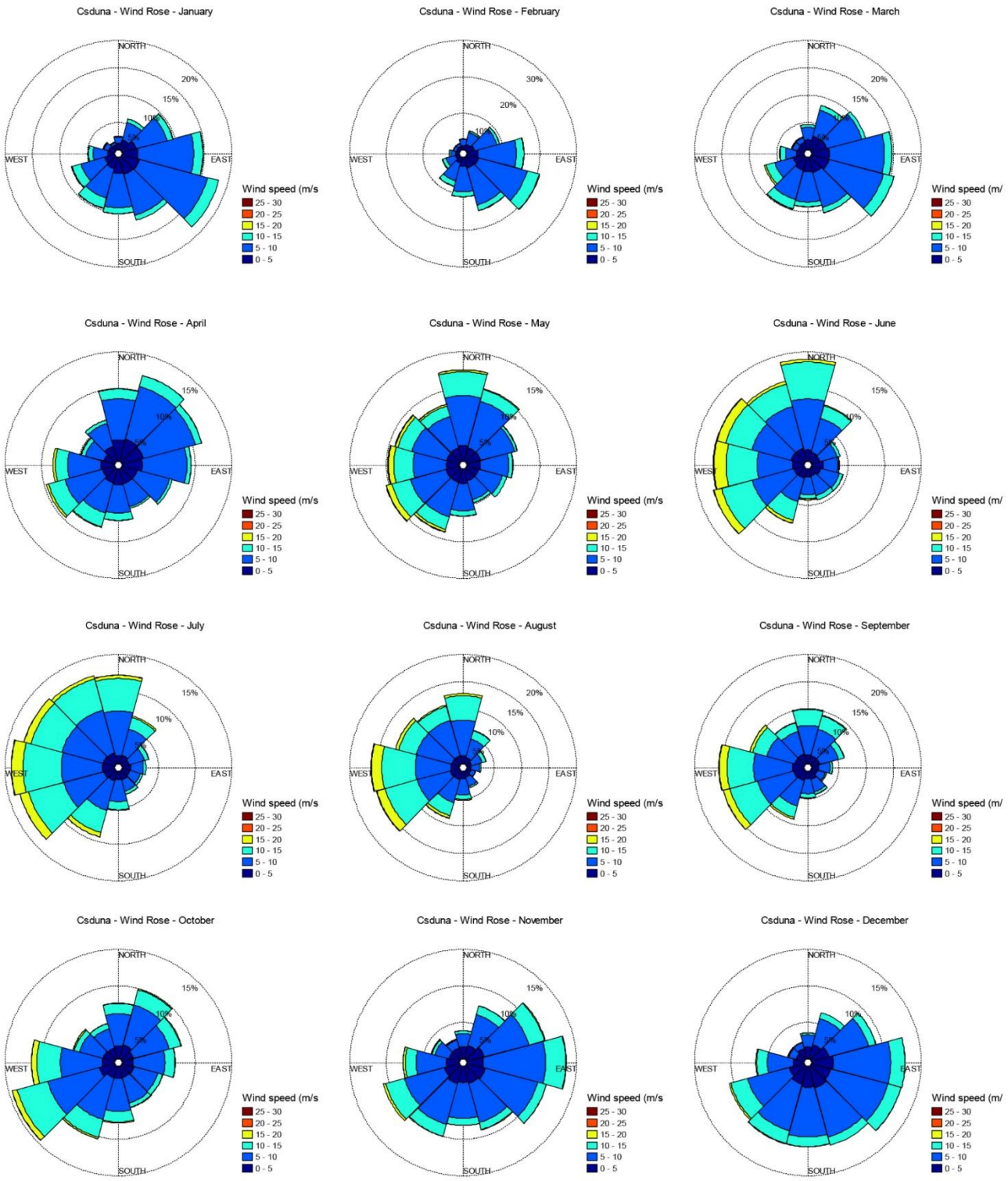
Figure 2.5 Mean monthly sea temperature and salinity profiles in the Great Australian Bight from 2005 to 2013

2.6 Winds

Wind data are available from a hindcast archive covering the period 1979–2013 with three-hour sampling. The quality of the model data has been verified by comparison with simultaneous local measurements over a period of one year within the Great Australian Bight. While wind velocities are of good quality some uncertainties related to directionality remains.

During November to March, the Great Australian Bight region is dominated by large atmospheric high pressure systems which direct winds to the west and lower coastal sea levels (Middleton et al. 2017).

In the Title Area, the strongest winds are predominantly from the west and south-west. Monthly wind roses indicate that the strongest winds (>15 m/s) are experienced between June and September (Figure 2.6). Winds are weaker in November to February, when winds from the east and south-east dominate.



Source: Mathiesen (2017)

Figure 2.6 Monthly wind roses for the title area for 1979–2013

2.7 Tides

Southern Australian waters experience a tidal cycle varying from normal semi-diurnal tidal variations at springs to almost no tidal movements at neaps. The swells are predominantly from the south-west, creating a high wave-energy regime along the eastern coastline of the region (Grzechnik 2000).

Tidal currents on the shelf and within the Great Australian Bight are generally small (<10 cm/s) and do not appear strong enough to induce any internal tides of any significance (Rogers et al. 2013).

Tides at the Stromlo-1 well location are semi-diurnal characterised by two daily high tides of different heights. Tidal elevations at the well location were estimated using the NAO.99b tidal prediction system, which predicted highest tides (HAT) of +75 cm and lowest tides (LAT; equivalent to Chart Datum) of -47 cm, relative to mean sea level (MSL)

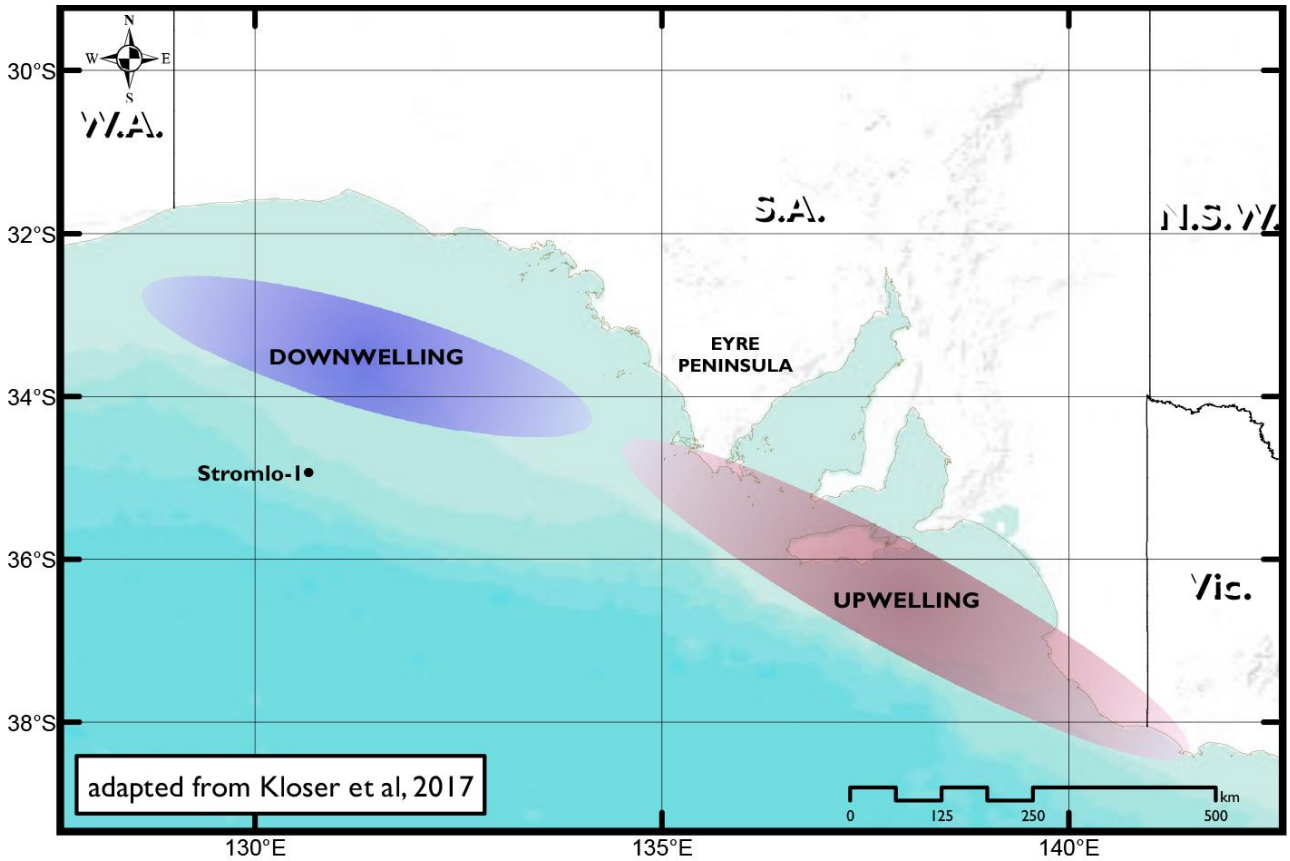
2.8 Upwelling

The dominant south-easterly winds during summer favour upwelling of deep oceanic water and assist the movement of water from the slope onto and across the shelf (McLeay et al. 2003). Summer upwelling occurs in the western and eastern Great Australian Bight regions; forced by winds and enhanced by the presence of submarine valleys and headlands (Ward et al. 2017). The eastern upwellings are thought to be linked to mesoscale eddies that form off the Eyre Peninsula, which play a role in lifting cold (14–18 °C), nutrient-rich water from depths of >150 m along the Bonney Coast and Kangaroo Island regions toward the surface and in turn enhance the productivity of plankton communities (Rogers et al. 2013, Ward et al. 2017). These seasonal upwellings may occur 4–5 times during each summer (Ward et al. 2017). Hydrodynamic models developed by Middleton et al. (2017) to describe oceanographic circulation within the Great Australian Bight demonstrated that reversal of the nearshore coastal current in summer leads to upwelling in the eastern Great Australian Bight, including the Bonney Upwelling (Figure 2.7). This is a seasonal phenomenon comprised regular cold-water upwelling plumes that occur along the Bonney Coast (between Robe, South Australia and Portland, Victoria) from November to March (CoA 2015).

2.9 Downwelling

Recent research in the Great Australian Bight has confirmed that downwelling occurs year-round in the central Great Australian Bight, driven by atmospheric cooling and evaporation in winter, and by the collision of the Sverdrup transports in summer (Ward et al. 2017) as shown in Figure 2.7. However, downwelling favourable winds are dominant from May to October (Kloser & van Ruth 2017).

Cross-shelf exchange is dominated by downwelling. The reason for this appears to be related to the summer circulation of the wide shelf region in the central Great Australian Bight. Summer westward winds driven by large high-pressure systems drive coastal upwelling and a westward CC in the central to eastern Great Australian Bight, leading to a topographic southward transport in the central Great Australian Bight region (Figure 2.7). This transport is important as it collides with the equator-ward deep ocean transport, leading to year-round downwelling at the shelf edge, and drives the S.A. Current to the east, even against prevailing westward winds (Ward et al. 2017). During summer, weak coastal currents (<10 cm/s) lead to downwelling in the central Great Australian Bight to depths of 250 m (Rogers et al. 2013). Mesoscale eddies and internal waves are expected to modulate upwelling and downwelling processes in the epipelagic zone over the Great Australian Bight (Rogers et al. 2013).



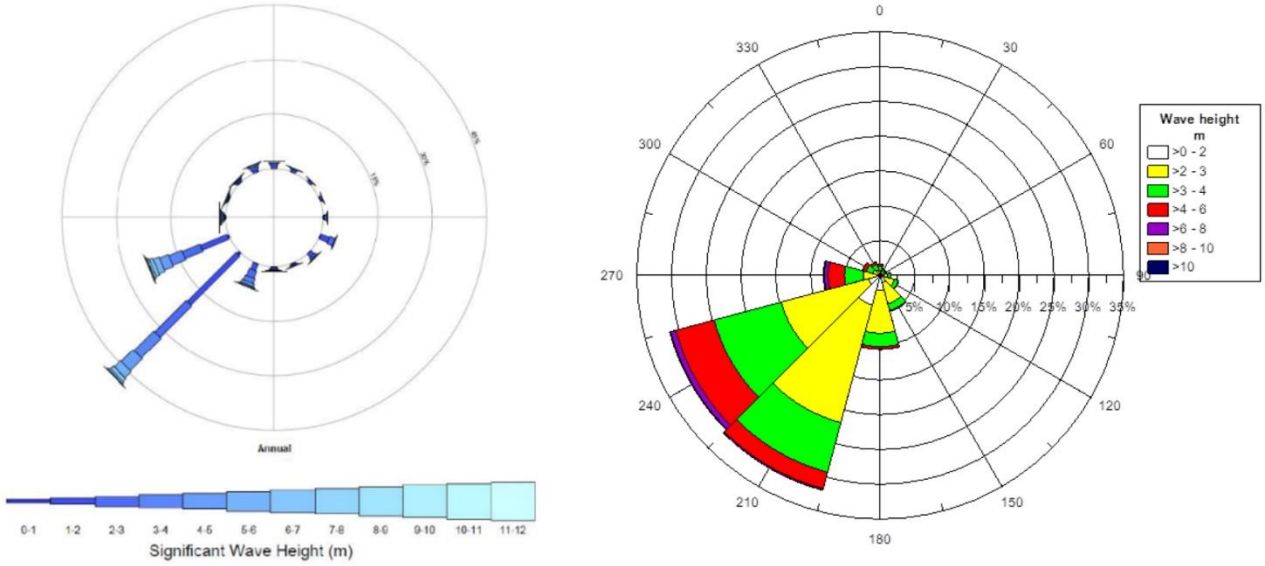
Source; Middleton et al, 2017, modified

Figure 2.7 Indicative areas of downwelling and upwelling in the Great Australian Bight region

In large oceans, there will always be presence of wind seas and swells but the wave climate in Great Australian Bight is dominated by long-period swells. The area is therefore affected by the persistent presence of swells.

Accurate information on the wave field has been collected over the past few years as a crucial step in simulating the impact of waves on ocean circulation. Equinor has access to both local recordings and long-term quality-checked model data for this region. The final wave models have also been compared with independent datasets to determine the accuracy of the model. The Great Australian Bight Research Project shows that wave models can confidently be used for the whole Great Australian Bight, including areas where there are no observations (Middleton et al. 2017).

Monthly mean and maximum significant wave heights near the Stromlo-1 well location are presented in Table 2.1 (Mathiesen 2017). The wave climate in the Great Australian Bight region is mildest in November to March and most extreme in May to October. The annualised wave roses in Figure 2.8 show the prevailing direction from which the waves originate, and the colours indicate the wave heights. The two roses show concordance between the two studies and regions in the predominance of waves from the south-west. These unimpeded south-westerly waves and swells create a high energy near-shore environment resulting in wave abrasion down to 60 m depth (Hayes et al. 2012).



Source: Mathiesen (2017), Rogers et al. (2013)

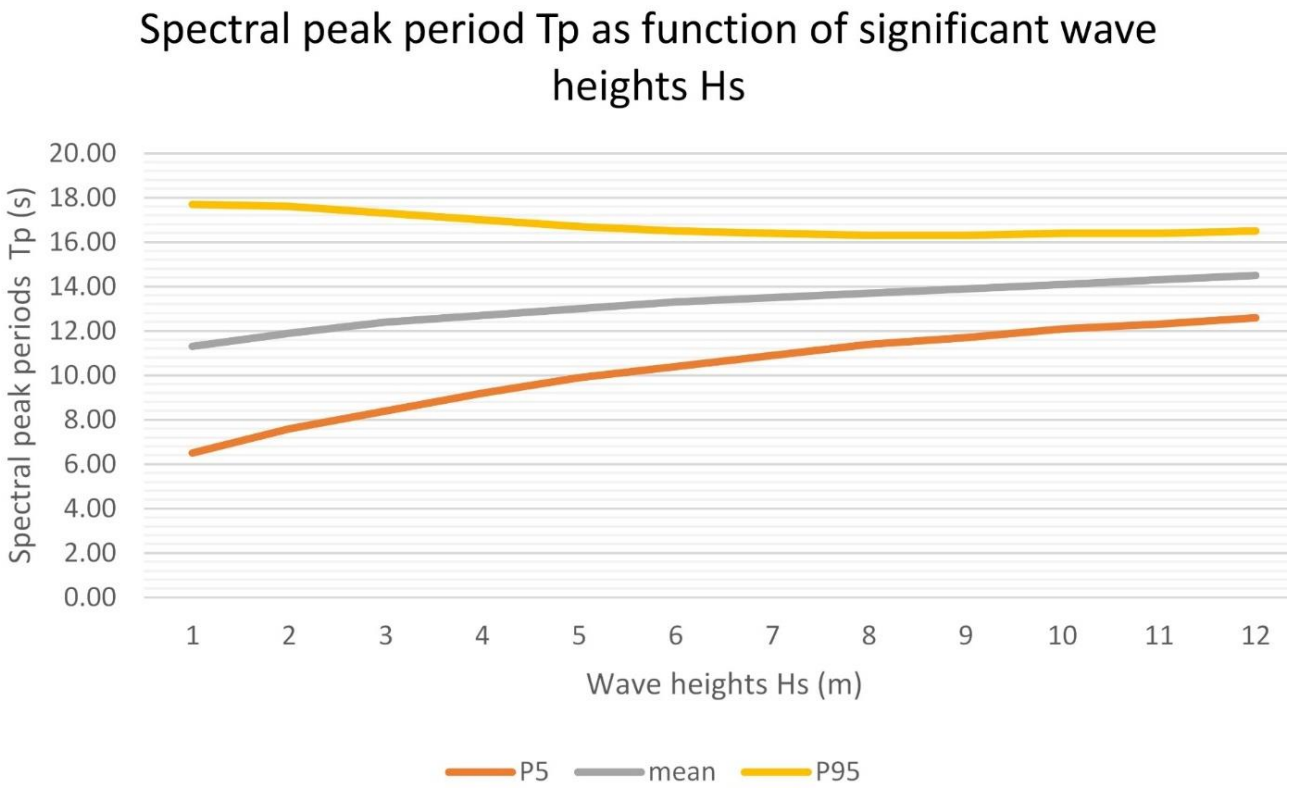
Figure 2.8 Annualised wave roses for the wider Great Australian Bight region from 1993 to 2008 (left) and for the Stromlo area (Ceduna Sub-basin) from 1979 to 2013 (right)

Table 2.1 Monthly mean and maximum wave heights for the Ceduna Basin

Significant wave height (m)*	Month												Annual
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Mean	2.5	2.5	2.6	2.8	3.1	3.5	3.6	3.7	3.6	3.1	2.7	2.6	3.0
Maximum	7.6	6.3	7.2	9.3	11.0	11.0	9.8	11.0	11.3	10.0	10.7	7.3	11.3

* This is the significant wave height, which is the average height of the top 33% of wave maxima average over a month.

The spectral peak period (time between one wave to another) shows swells with relatively long inter-peak periods (Figure 2.9). Note there are no data points from the model with wave heights below 1 m (Hs <1 m), reflecting the sea in this area is rarely flat. The mean wave periods indicate a 1–14 s periods, and wave heights between 1–12 m. Mean wave height is 3.0 m, with a corresponding wave period of 12 s (Table 2.1).



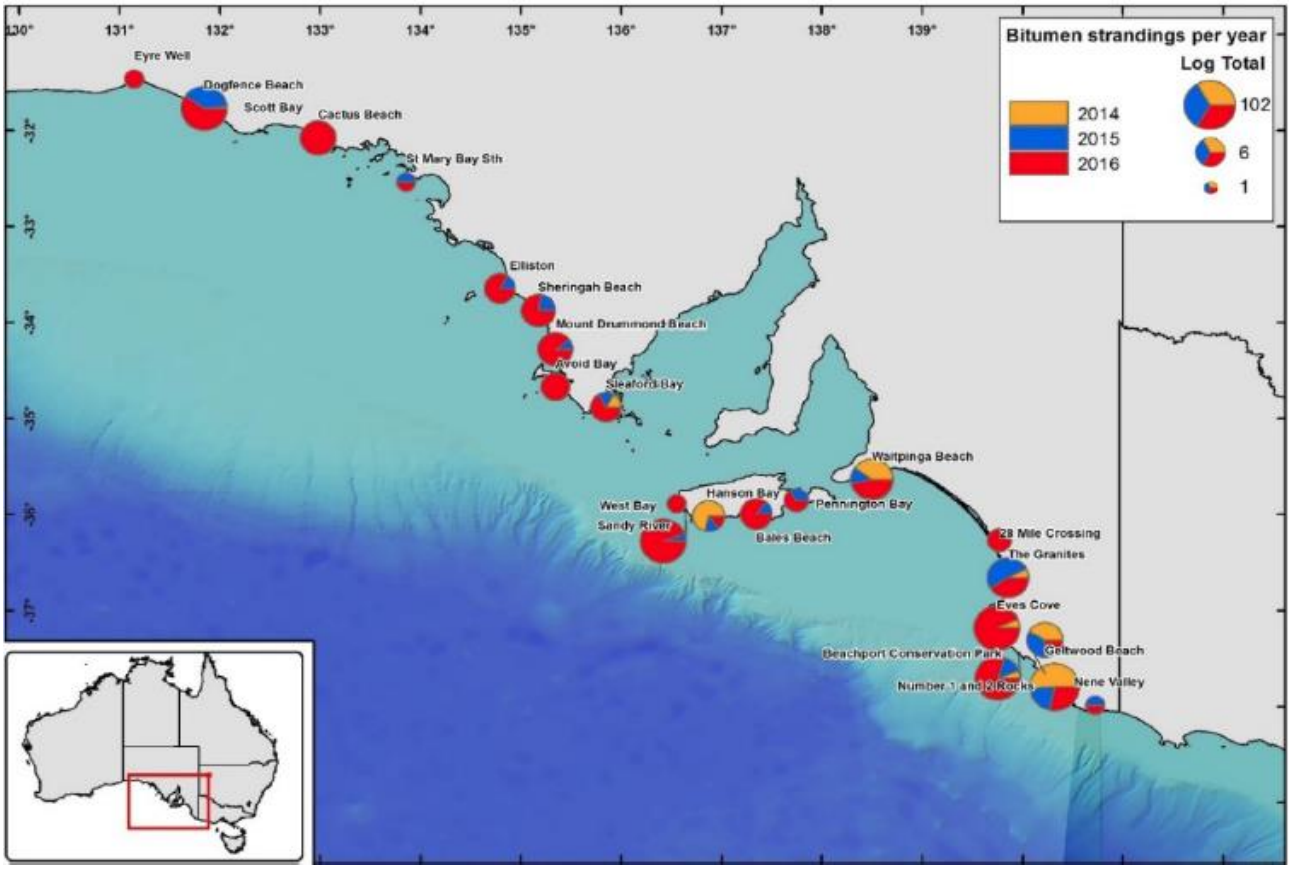
Source: Mathiesen 2017

Figure 2.9 Mean Spectral peak period for given significant wave heights with 5 and 95 per centiles in the Ceduna Basin

2.10 Natural hydrocarbons in the Great Australian Bight

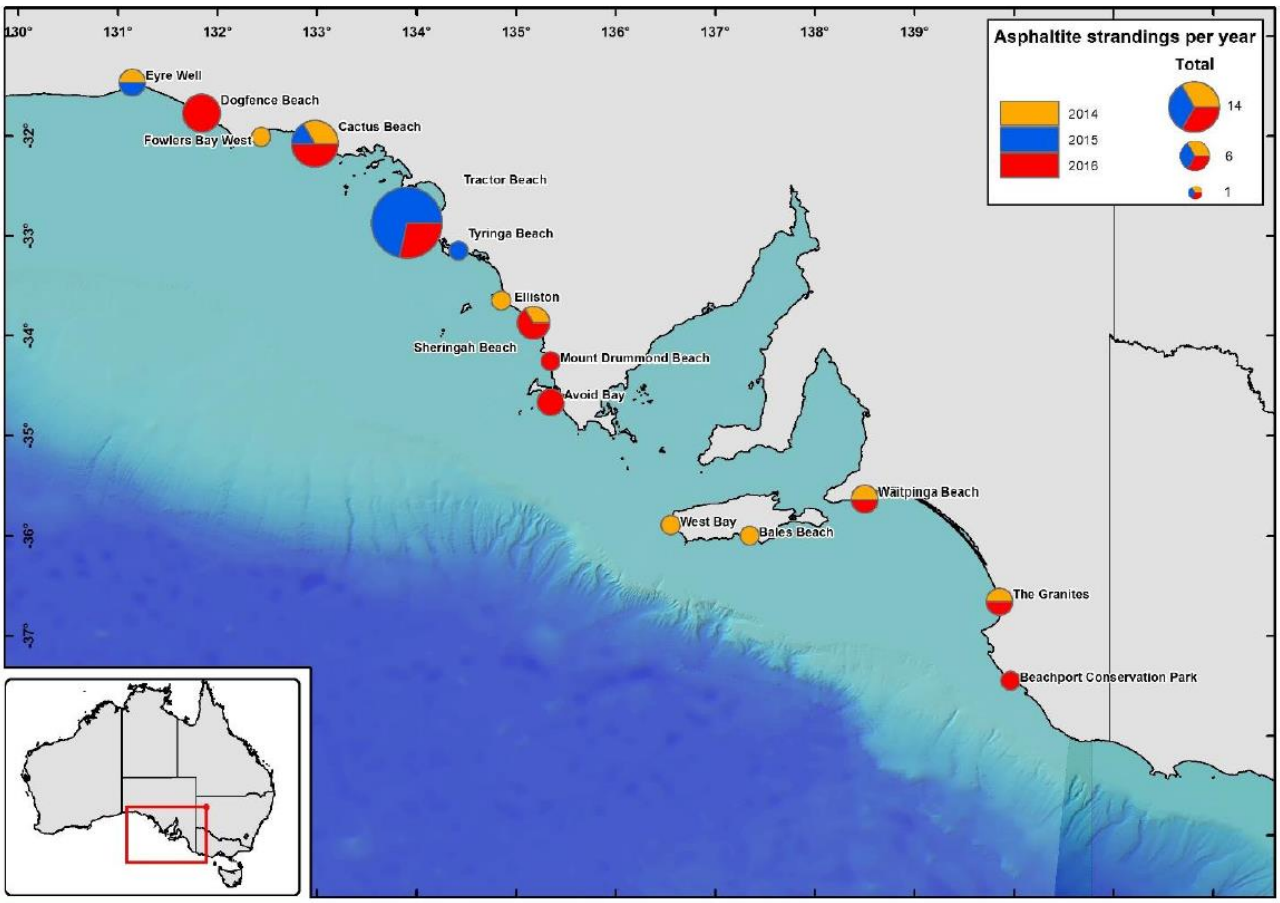
Hydrocarbons are a natural part of the Great Australian Bight environment and highly weathered forms frequently wash ashore along the southern Australian coastline. The Great Australian Bight Research Program has built on historical observations and provided a more detailed understanding of the geographical distribution of modern asphaltite strandings (a jet-black bitumen with a petroliferous odour) along the South Australian coastline, which most likely originated from natural hydrocarbon seeps (Ross et al. 2017a). Surveys for asphaltite and waxy bitumens occurred along the coastline during 2014, 2015 and 2016. Tar balls (waxy bitumens) tend to strand in the upper intertidal to supratidal zones of south-west facing ocean beaches, whereas the less common denser asphaltites tend to accumulate on beaches with a north-west aspect (Ross et al. 2017b). Waxy bitumens, possibly originating from Indonesian waters, are the most prevalent types of bitumen stranding on South Australian beaches; particularly on the limestone coast (Figure 2.10). Asphaltites are more common along the west coast of the Eyre Peninsula, which suggests a different point of origin (Figure 2.11), (Ross et al. 2017b).

Historical synthetic aperture radar (SAR) images indicate some hydrocarbon seepage (Figure 2.12), but it is difficult to determine the origin and quality of these signals. Hydrocarbons were not detected in baseline water and sediment samples in the offshore areas of the Great Australian Bight, suggesting any natural seeps would be intermittent or not expressed in the surveyed areas (Ross et al. 2017a).



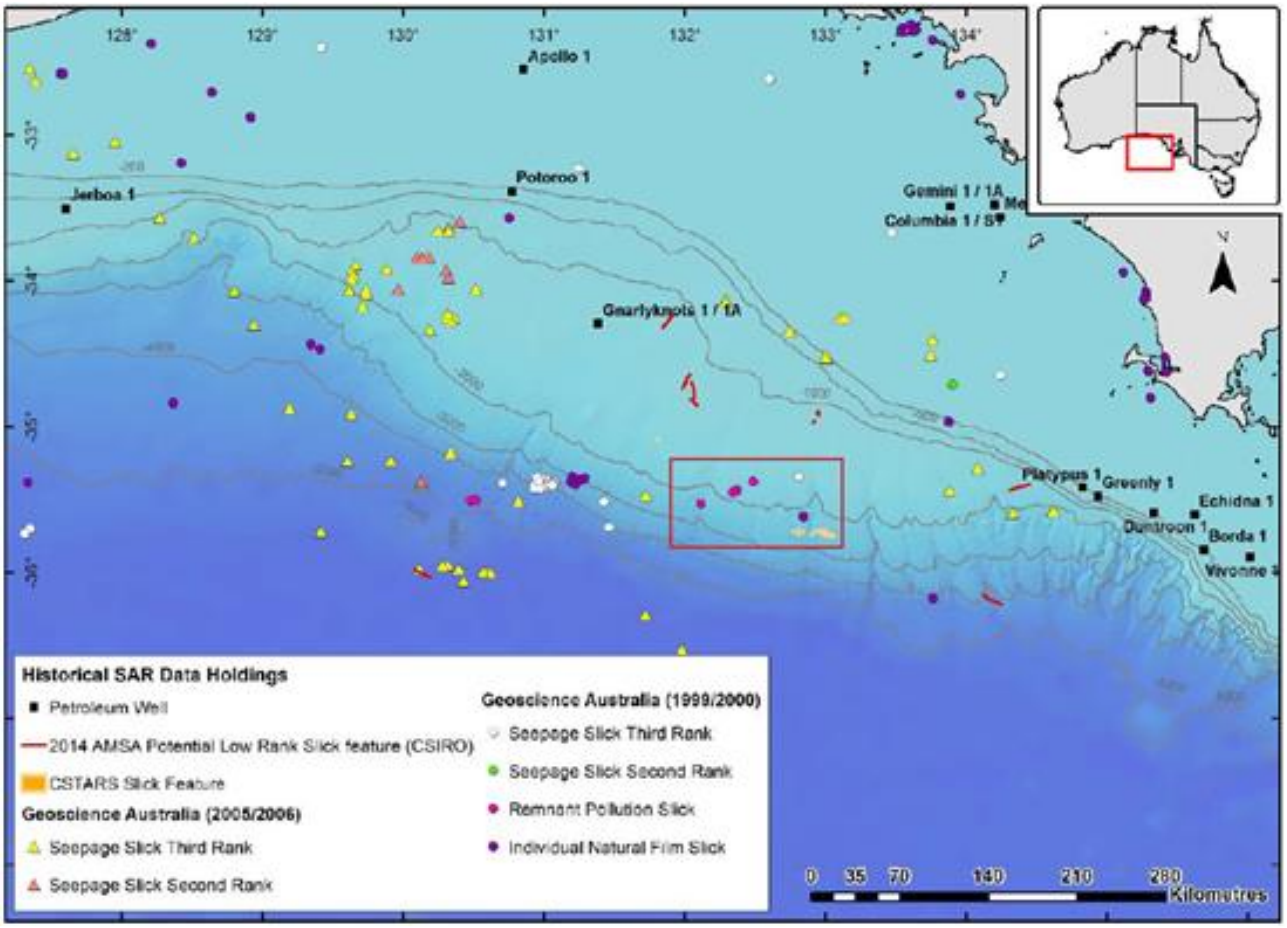
Source: Ross and Kempton (2017)

Figure 2.10 Total tarball strandings and distribution per year (on a log scale)



Source: Ross and Kempton (2017)

Figure 2.11 Total asphaltite strandings and distribution per year (on a log scale)



Source: Ross & Kempton (2017)

Figure 2.12 Synthetic Aperture Radar (SAR) seepage indications (on the sea surface)

2.11 Hydrocarbon degrading bacteria

The Great Australian Bight Research Program revealed the presence of microbial communities capable of degrading hydrocarbons in surficial deep-water sediments down to 2800 m (van de Kamp et al. in review). These oil-degrading microbes have been shown in various studies, including monitoring after the Deepwater Horizon oil spill, to bloom in the presence of elevated hydrocarbon concentrations, and play an important role in natural bioremediation of oil spills (van de Kamp et al. in review).

Water and sediment samples taken from different depths show a resident microorganism community that includes a host of known hydrocarbon biodegraders, both bacteria and archaea, which have been shown to increase in abundance in response to previous spills in other basins (Hook et al. 2016; Techtmann et al. 2015). There are several biochemical pathways for biodegradation of hydrocarbons and the key genes for such three pathways have been identified in sediment and water microbes in the Great Australian Bight (Tanner et al. 2017). This supports the assumption that hydrocarbon degrading microbes are present and, in the presence of a hydrocarbon food source, would respond with a rapid population increase to be able to biodegrade oil entrained in the water column and sedimented on the seabed.

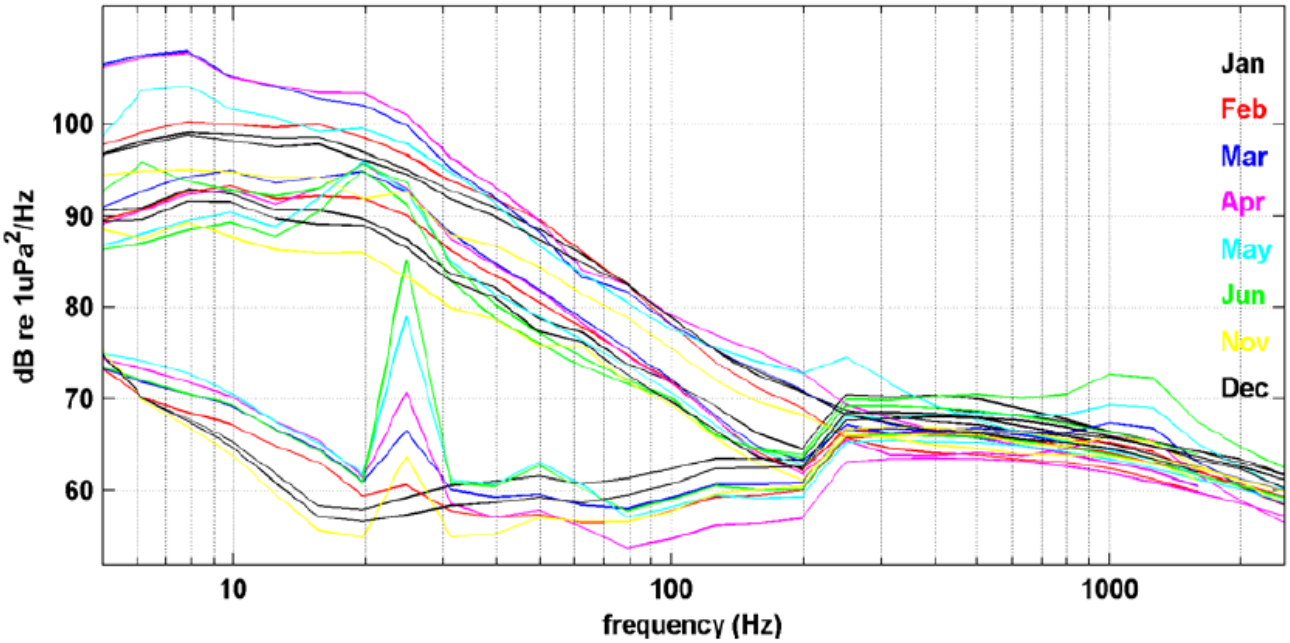
2.12 Ambient underwater sound levels

Ambient sound levels in the Great Australian Bight were recorded from late 2011 to mid-2012 by sound loggers that were deployed in the Great Australian Bight as part of BP/Equinor's efforts to investigate underwater sound characteristics of the area. Three sound loggers were deployed:

- one near the Head of Bight (approximately 335 km north of the Stromlo-1 well) in 50 m of water
- two along the shelf break (approximately 175 km north and 250 km east of the Stromlo-1 well) in water depths of approximately 190 m.

Ambient sound was higher at the shelf break sites compared with the Head of Bight, and the two shelf break sites showed a steady increase in ambient noise over summer and into early winter (McCauley et al. 2012). McCauley et al. (2012) found that ambient sound levels at the Head of Bight ranged from 73.5 to 131.9 dB re 1 µPa Root Mean Squared (SPL_{RMS}), with an average of 97.1 dB re 1 µPa (SPL_{RMS}); and at the shelf break ranged from 74.5 to 144.9 dB re 1 µPa (SPLRMS), with an average of 111.7 dB re 1 µPa (SPL_{RMS}).

Figure 2.13 illustrates the mean monthly ambient sound spectral level curves, calculated at one-third octave centre frequencies for the three sound loggers (the lower group of curves are for the Head of the Bight and the upper groups for the two shelf break sites). The Head of Bight clearly differentiates as having much lower ambient sound levels from the shelf break sites, principally below 200–300 Hz. The spikes in ambient sound in the 20–30 Hz bands at all sites were due to whale calling, either nearby as at the Head of Bight or via long-range energy reaching the receivers via the deep sound channel at the shelf sites (McCauley et al. 2012). Shelf break sites received significantly more energy from distant natural sources below 300 Hz via ducting from the deep sound channel compared to the Head of Bight (McCauley et al. 2012).



(McCauley et al. 2012)

Figure 2.13 Mean monthly ambient sound spectral level curves at three sites in the central Great Australian Bight

3.0 Biological environment – habitats and ecosystems

3.1 Shoreline and nearshore

A range of geomorphological features and biological receptors with varying levels of sensitivities occur along the coast of the Risk EMBA. The shoreline and nearshore habitats and communities (from the upper limit of the intertidal zone to a depth of approximately 40 m) are described in detail for sections of the coast across the Risk EMBA in Sections 1.5.1.1 to 1.5.1.7.

3.1.1 Western Great Australian Bight

The shoreline from Denmark to Esperance, Western Australia, generally consists of sandy beaches broken by granite outcrops, with occasional limestone reefs and eroded cliffs. A number of estuaries are also found along this 550 km stretch of the coast. These commonly feature saltmarsh communities in the upper intertidal zone and seagrass meadows dominated by *Posidonia* complexes, with "*australis*" group complexes (*P. australis, P. angustifolia* and *P. sinuosa*, with some *Amphibolis* spp. or other species such as *HeteroZostera* spp. and *Halophila* spp. growing where there are gaps) found in protected areas and "ostenfeldii" group complexes (*P. robertsoniae*, *P. kirkmanii*, *P. coriacea* and *P. denhartogii*) with their deeper rhizomes and stronger leaves found offshore to depths around 30 m (Edmund P. Green 2003; Kirkman 1997). Temperate reef communities occur across the coast, with kelp forests dominated by *Ecklonia radiata* featuring an understorey of brown, green and red seaweeds and an abundance of invertebrates typically found wherever suitable substrate is available (Bennett et al. 2015). There is a degree of variation in the composition of biota on the temperate reef communities along the coast, but in general most species are widely represented in nearshore waters throughout the South-west Marine Bioregion. Shoreline infrastructure is scarce along this stretch of coast other than around the port at Albany, which is located outside of the Risk EMBA.

The shoreline along the coast between Esperance and Point Culver (~150 km east of Israelite Bay), Western Australia, is largely similar to the above but lacks estuaries (and associated saltmarsh communities) and features the granitic islands of the Recherche Archipelago, which occur from 5–50 km offshore. These provide shelter to nearshore waters allowing large areas of seagrasses to occur along the coast to depths of more than 40 m. Seagrass meadows of *Halophila* spp. and *HeteroZostera* spp. are generally found nearshore with species distribution changing offshore from *Posidonia* meadows dominated by "*australis*" complexes in sheltered areas to *Posidonia* meadows dominated by "*ostenfeldii*" complexes in swell exposed areas (Carruthers et al. 2007). Temperate reef communities are found across the coast, with kelp forests dominated by *E. radiata* likely to be found to depths of at least 40 m where suitable reef substrate is available. Infrastructure is scarce other than around the Esperance Port, which is located outside of the Risk EMBA.

The limestone cliffs of the southern end of Nullarbor Plain meet the sea near Point Culver and generally remain along the shoreline until Cocklebiddy, Western Australia. Nearshore habitats are exposed to oceanic swells along the ~175 km stretch until the western margin of the central Great Australian Bight. Reef substrates are bare in nearshore areas where breaking waves occur, but temperate reef kelp forests dominated by *E. radiata* may be found further offshore to depths up to 40 m (Bennett et al. 2015). No significant coastal infrastructure is present along the shoreline.

3.1.2 Central Great Australian Bight

A narrow coastal plain exists between Cocklebiddy and the Western Australia–South Australia border, delimited to the north by the limestone cliffs of the Nullarbor Plain. For almost 300 km, a series of offshore reefs protect sandy beaches and high foreshore sand dunes from oceanic swell, producing a calmer habitat between the reefs and the shore, suitable for seagrass growth (Edmund P. Green 2003). Extensive seagrass meadows are found in sandy areas within the lagoons to a depth of ~30 m, including communities of *Amphibolis* spp., *Halophila* spp., *HeteroZostera* spp. and *Posidonia* spp. Nearshore reef substrates within the lagoons typically consist of kelp forest communities. No significant coastal infrastructure is present along the shoreline.

The vertical limestone cliffs of the southern end of Nullarbor Plain meet the sea again at the Western Australia–South Australia border and follow the coast until the Head of the Bight, South Australia. The sheer cliffs, known locally as the Bunda Cliffs, range from 60 to 120 m in height and extend for around 200 km, forming the longest

uninterrupted line of sea cliffs in the world. This section of the coast is totally exposed to oceanic swells with water depths increasing relatively rapidly away in the nearshore area, generally reaching 40 m within ~1 km from the cliffs. As a result, nearshore sediments and reef substrates are generally bare.

The shoreline from the Head of the Bight until near Cape Adieu consists of sandy shores and a more gradually sloping nearshore area (relative to the area to its west) but it is similarly exposed to strong south-westerly swells. The nearshore habitats reflect this with most of the seabed here composed of bare sand with occasional patches of reef supporting macroalgal communities (mainly kelp *E. radiata* and the fucoid *Scytothalia dorycarpa*) (Rogers et al. 2013).

The coast between Cape Adieu and Coffin Bay (the eastern margin of the central Great Australian Bight), South Australia, predominantly comprises hard rocky shores but is variable in nature and also offers a variety of habitats. Offshore reefs and shield islands (including those of the Nuyts Archipelago) protect the mainland coast from south-westerly swells and aid the development of several large sheltered sandy embayments. Many of these sandy bays support seagrasses with Fowlers Bay, Smoky Bay and Streaky Bay featuring extensive meadows (consisting of *P. sinuosa*, *P. angustifolia*, *Amphibolis* spp., *Halophila* spp., and *HeteroZostera* tasmanica). Seagrass distribution along the rest of exposed western coast of the Eyre Peninsula is generally patchy and restricted to the leeside of reefs and islands, although the Sir Joseph Banks and Investigator groups provide sheltered conditions and supports dense seagrasses in excellent condition. Coastal saltmarshes and mangrove (*Avicennia marina*) communities occur scattered amongst sheltered intertidal bays near Ceduna between Tourville Bay and Smoky Bay, with additional isolated patches found in intertidal areas within Streaky Bay, Anxious Bay and Coffin Bay (Edyvane & Baker 1996a; cited in Rogers et al. 2013). Temperate reefs in this area have strong floral affinities with those further west but are typically more diverse, particularly in the lee of offshore islands where cool-temperate macroalgal taxa not found on reefs to the west begin to occur (Edyvane & Baker 1996a; cited in Rogers et al. 2013). Coastal infrastructure in the central Great Australian Bight region is limited and predominantly located around Port Thevenard (near Ceduna).

3.1.3 Eastern Great Australian Bight

Exposed wave-cut rocky cliffs, bedrock platforms and offshore islands are the dominant features along the entrances to the Spencer Gulf and Gulf St Vincent; from Coffin Bay to Port Neil along the Eyre Peninsula, Port Victoria to Port Vincent on the Yorke Peninsula and Adelaide to Victor Harbour on the Fleurieu Peninsula. The shores along the mid-regions of both gulfs mainly consist of intertidal sandflats backed by long sandy beaches, interspersed with small rocky headlands and shore platforms. The northern parts of the two gulfs (north of Arno Bay and Port Broughton within the Spencer Gulf, and Androssan and Two Wells within the Gulf St Vincent) are low-energy environments that have a low gradient and mostly consist of extensive intertidal and supratidal flats. The top parts of the northern Spencer Gulf are dominated by wide expanses of coastal saltmarsh communities including samphires (typified by the samphire *Sarcocornia quinqueflora* and other succulents), salt-tolerant grasses (e.g. *Sporobolus virginicus*), sedges (e.g. the genus Gahnia) and herbfields (e.g. *Selleria radicans*). Extensive areas of mangroves (*Avicennia marina*) also occur along the intertidal zone in muddy, sheltered coastal areas. The most extensive areas of mangroves in the Spencer Gulf are in Franklin Harbour, Tumby Bay, and around Port Augusta. The most extensive areas of mangroves in Gulf St Vincent within the Risk EMBA are around Price River near Port Clinton to Sandy Point south of Port Wakefield (South Australia EPA 2013). Significant areas of shoreline infrastructure around the Gulfs is mostly associated with the ports at Adelaide, Port Lincoln, Klein Point, Port Giles, and Cape Jervis. Sea pens used for aquaculture are located nearshore around Port Lincoln.

The clear waters along the western shore of Spencer Gulf allow plants to grow to depths of 25–30 m at the base of the exposed cliffs of the eastern Eyre Peninsula, where they are unaffected by swell (Kirkman 1997). Dense monospecific meadows of seagrass occur in the warm, shallow upper reaches of Spencer Gulf, including *A. antarctica*, *P. australis* and *P. sinuosa* generally in waters to 10 m deep (Kirkman 1997). At 4215 km^2 (50% of the state's total seagrass coverage), this is the largest area of seagrass meadows recorded in South Australia, and one of the largest areas of temperate seagrass meadows in Australia (Scientific Working Group 2011). Along sheltered bays and inlets on the eastern coast of Spencer Gulf *Posidonia* spp. can extend to 20 m depth, with *P. sinuosa* growing in depths up to 15 m (Kirkman 1997). Seagrass meadows are similarly well developed in nearshore habitats along the margins of the Gulf St Vincent although those on the western side of the gulf are more fragmented and less dense than on the eastern side. Seagrass meadows also dominate the shallow, low-energy environment at the top of Gulf St Vincent but this is outside of the Risk EMBA. Seagrass beds along the Adelaide metropolitan coastline characterised by the loss of an area in excess of 5000 ha (South Australia EPA 2013). Temperate algal forest habitats dominated by *E. radiata* and other large brown algae (e.g. *Cystophora* spp. and *Sargassum* spp.) are found on subtidal rocky reefs nearshore along most of the coastline, except in the upper Gulfs (South Australia EPA 2013).

The Kangaroo Island coastline predominantly consists of hard rock coastal cliffs and rocky intertidal shores, although sandy and gravel beaches also occur, mainly along the east coast. Intertidal reefs (rocky shores) are a common feature of the coastline of Kangaroo Island and have high invertebrate and algal diversity (South Australia EPA 2013). Parts of the west and south coast of Kangaroo Island support diverse, dense macroalgal assemblages. The northern coast of Kangaroo Island is dominated by seagrass-filled embayments punctuated by rocky headlands. D'Estrees Bay supports the only seagrass meadow on the south coast of Kangaroo Island, but it is extensive and considered to be in very good condition (South Australia EPA 2013). There is a low level of coastal development around most of Kangaroo Island. The majority of shoreline infrastructure is focussed around the ports at Penneshaw and Kingscote.

The shoreline from Victor Harbor to Cape Jaffa, South Australia, is a large, sandy barrier coast and one of Australia's longest continual sandy beaches (194 km from the Murray mouth to Cape Jaffa). This section of the coast lies in the transition between the South-west and South-east marine bioregions. The transition is maintained by the presence of a reef-free "dead zone" of sand-mud substratum originating from Murray River outflow (via Lake Alexandria) and is evident across the series of parallel rocky reefs that stretch offshore at either end of the beach. The fringing granite reefs of Encounter Bay, south-west of Victor Harbor, predominantly feature species of macroalgae with warmer-water affinities typical of southern Western Australia, such as *Sargassum* spp., *Myriodesma* spp. and *Scytothalia dorycarpa*. Conversely, Margaret Brock Reef, a calcareous reef platform near Cape Jaffa, is dominated by cold-water reef macroalgal species (e.g. *Phyllospora comosa* and *Durvillaea potatorum*) and represents the most westerly extent of *Macrocystis pyrifera* (giant kelp) (South Australia EPA 2013). High-energy sandy beaches remain along the shore east of Cape Jaffa to Portland, Victoria, although much of nearshore area is dominated by flat, shallow limestone reefs with occasional rocky intertidal areas (South Australia EPA 2013). The shores between Portland and Cape Otway, Victoria (the eastern limit of Great Australian Bight), are dominated by rugged rocky cliffs dotted with pockets of sandy beaches. There is a degree of variation in the composition of temperate reef communities along the coast east of Cape Jaffa, but similar species are generally represented.

The composition and distribution of seagrasses also changes markedly along the Great Australian Bight coast east of Victor Harbor. Seagrass distribution across the rest of the eastern Great Australian Bight is patchy and limited by exposure to swell, with the exception of a dense and extensive *P. angustifolia* seagrass meadow (25,062 ha) in the more sheltered waters of Lacepede Bay (South Australia EPA 2013). Warm temperate seagrasses species decline in number from west to east due to the declining water temperatures, high wave energy and active sand movement. Encounter Bay is the eastern limit of *A. griffithii*; Lacepede Bay of *P. sinuosa*; Rivoli Bay of *P. coriacea* and *P. denhartogii*; and Port MacDonnell of *P. angustifolia* and *P. australis*. The cool temperate species *Halophila* australis is distributed throughout this region, as are *A. antarctica*, *HeteroZostera tasmanica*, *Zostera muelleri* and *Zostera mucronata* (South Australia EPA 2013).

A considerable amount of coastal infrastructure occurs within the Risk EMBA along this section of the coast, predominantly found around the ports Victor Harbor, Kingston SE, Robe in South Australia and Portland, Port Fairy and Warrnambool in Victoria.

3.1.4 Victorian central and west coasts

The Victoria coastline from Cape Otway to Wilsons Promontory is dominated by coastal cliffs, rocky headlands and shore platforms, often with narrow sandy intertidal areas and low-lying reefs nearshore. East of Wilsons Promontory to the New South Wales border the shoreline primarily consists of extensive stretches of long sandy beaches (e.g. Ninety Mile Beach) backed by dunes, with few ribbons of reef not covered by sand found nearshore.

Numerous estuaries are found along this stretch of the Victoria coast, including major wetland systems such as Port Philip Bay, Western Port, Corner Inlet and Gippsland Lakes. The sheltered shores and shallow inland waters of these estuaries feature sensitive receptors including intertidal flats with saltmarsh and mangroves communities, extensive seagrass meadows (dominated by *Zostera* spp.), and major development areas with significant amounts of shoreline infrastructure (e.g. around Geelong, Melbourne and the Mornington Peninsula). The inland waters and shores of the estuaries are located outside of the Risk EMBA.

Shoreline and nearshore habitats along the Victoria coast within the Risk EMBA include large expanses of exposed sandy substrate, relatively small areas of seagrass meadows (*Zostera* spp.) scattered amongst sheltered marine shallows, and nearshore temperate reef communities characterised by an abundance of brown kelps, with a diverse understorey of red, green and brown seaweeds, sea squirts, sponges, bryozoans, crustaceans and molluscs. Giant kelp (*M. pyrifera*) plants dominate the temperate reef communities along restricted sections of the coast between Cape Otway and Wilsons Promontory but are largely absent between Wilsons Promontory and the New South Wales border.

Limited shoreline infrastructure occurs within the Risk EMBA between Cape Otway and the New South Wales border. The little that exists is found around coastal settlements such as Apollo Bay, Lorne and Torquay.

3.1.5 Bass Strait Islands

The main islands in the Bass Strait include King Island, Three Hummock Island, Hunter Island and Robbins Island (western portion); Kent Group, Deal Island, Hogan Island and Curtis Island (north-eastern section); and the Furneaux Group, Flinders Island, Cape Barren Island, Clarke Island and the Sister Islands Group (south-east section). The islands comprise a range of hard and soft rock features, sandy dunes and various types of coastal landforms. Numerous smaller islands and offshore reefs surround the main islands. Many of the islands and rocks are sheer-sided sunken peaks that rise up from deep water. The western sides of islands in the Bass Strait are generally exposed and very rocky whereas the eastern sides tend to be sheltered and predominantly composed of sandy sediments. The rocky exposed shores are dominated by kelp forests down to depths of 25 m. Seagrass distribution in the Bass Strait is patchy and limited by exposure to swell, with most seagrass found in sheltered bays or in the lee of reefs and islands.

Very little shoreline infrastructure is present along parts of Bass Strait islands within the Risk EMBA. It is mostly associated with ports at King Island and Flinders Islands (Tasmania).

3.1.6 Tasmanian coast

The Tasmanian north coast predominantly consists of sandy shores interspersed by rocky headlands. The west coast is dominated by hard rocky shores although stretches of sandy shores occur north of Macquarie Harbour. The Tasmanian east coast and the eastern half of the north coast are sediment dominated. Seagrass typically occurs in shallow subtidal and intertidal environments of estuaries and sheltered bays. Seagrass meadows are scattered along the northern and south-east coasts where ocean currents and wave action are not as great. Most extensive seagrass meadow areas found along the coast are located outside of the Risk EMBA. The Giant Kelp Marine Forests of South East Australia TEC occurs along the southern portion of the west and east coasts, as well as the along the eastern portion of the north coast and in areas south-east of Flinders Island. Ports along the Tasmanian north coast include Stanley, Latta, Burnie and Devonport. Very little infrastructure exists along the coast of western Tasmania. Ports along the Tasmania east coast include Spring Bay and Hobart.

3.1.7 New South Wales coast

The southern and central New South Wales coastal areas within the Risk EMBA include a variety of forms of sand-dominated beaches and rocky shores. Sandy beaches interspersed by rocky headlands tend to be most common, with rocky shores predominantly found along the far south coast. Numerous estuaries are found along the New South Wales coast adjacent to the Risk EMBA; the soft sediments in the shallow parts of estuaries may support seagrasses (*P. australis*), mangroves (e.g. *Avicennia marina* and *Aegiceras corniculatum*), saltmarshes (e.g. *Sarcocornia quinqueflora* and *Sporobolus virginicus*) and considerable amounts of shoreline infrastructure, but the estuaries along the New South Wales coast are outside the Risk EMBA. Shallow rocky reefs are present nearshore along the length of the New South Wales coast within the Risk EMBA. These generally support kelp forests and mixed macroalgal communities, although urchin barrens are an increasingly dominant habitat type on New South Wales nearshore reefs (Andrew & O'Neill 2000). Major coastal infrastructure along this section of the coast within the Risk EMBA includes the ports at Wollongong, Sydney and Newcastle.

3.2 Benthos

The Great Australian Bight (GAB) is a dominant feature of the longest south-facing east–west coastline in the world, and one of the largest temperate water carbonate factories (James et al. 2001; James & Bone 2011). The ancient coastline Key Ecological Feature (KEF), which can be found in the 90–120 m depth range, supports dominant sponge communities of significant biodiversity and structural complexity where it forms a prominent escarpment (e.g. in the western Great Australian Bight). On the outer shelf (150–200 m), summer upwellings occur in the western and eastern Great Australian Bight and such upwelling is thought to promote the growth of bryozoan communities and other filter feeders due to increased phytoplankton production, except in the central Great Australian Bight where year-round downwellings are thought to account for their absence (James et al. 2001; James & Bone 2011).

The continental shelf waters of southern Australia are known for high levels of diversity and endemism (e.g. Wilson & Allen 1987; Womersley 1990), as a result of a lack of disturbance from glaciation (McGowran et al. 1997), and 80 million years of isolation from other land masses (Phillips 2001; Veevers 1991).

Particulate substrate habitats can be separated into consolidated and unconsolidated habitats. Consolidated habitats are mixed sediment habitats, usually dominated by larger particle size classes (i.e. pebbles, cobbles and/or boulders) that have formed a stable and immobile habitat (e.g. through compaction and/or chemical or biological accretion). These larger particles may comprise components of geogenic (e.g. broken bedrock) or biogenic (e.g. hard coral fragments, shell) origin. These habitats tend to be characterised by increased diversity and biomass of epibiota and may form a transition habitat between bedrock habitats and adjacent mobile soft substrates (though not in all cases). They may have a veneer of smaller particle sizes (e.g. sand/silt) or endure periods of soft sediment inundation that may impact their biological communities.

Unconsolidated habitats are that are dominated by smaller particle sizes (i.e. silt/sand) that have a greater potential for mobility (e.g. sand ripples, waves). In deep waters, where current speeds are insufficient to mobilise sediments, relic seabed features (e.g. sand waves) that were created when sea levels were lower may still be evident. These habitats tend to be dominated by infaunal biota, with burrows, tubes, mounds and tracks being evident at the sediment surface. Some epibiota may also be evident, depending on the presence of larger particle sizes (e.g. such as sponges, ascidians, hydroids, or bryozons growing on shell, gravel, pebbles, etc.) or species that have part of their body buried below the sediment surface (e.g. sea pens, sea cucumbers, burrowing anemones).

Biota in unconsolidated habitats perform a number of important ecosystem functions that may be relevant to biota in benthic, demersal and pelagic environments, including (but not limited to):

- nutrient cycling – benthic biota take up nutrients from the water column or sediments, providing nutrients in accessible forms as increased biomass (e.g. filter feeders, detritus feeders, deposit feeders, grazers, predators or scavengers)
- sediment stabilisation and habitat modification – organisms that colonise these habitats often have an effect on the stability of sediments, i.e. reduced sediment mobility through consolidation or physical presence (acting as an analogue of larger particle sizes, or modification of local-scale hydrodynamics at the sediment–water interface). Examples include large infaunal bivalves (e.g. *Glycymerids*, *Mytilids* or *Arcticids*), tube-forming polychaetes (e.g. *Chaetopterids*, *Pectinids*, *Sabellariids* and *Terrebellids*), and sea pens (*Pennatulacea*)
- sediment oxidation – burrowing organisms introduce oxygenated sea water into the sediment. This process is increased where organisms generate a respiratory current (e.g. *Nereid polychaetes*)
- increased sea bed structural heterogeneity and availability of ecological niches – epibiota, including sponges, soft corals, hard corals, hydroids, bryozoa (e.g. lace corals) increase the structural complexity and heterogeneity of sea bed habitats. This provides refugia from predation, or additional habitat area for colonisation (e.g. ascidians and pea crabs in bivalve shells, species of goby inhabiting crustacean burrows).

Benthic fauna inhabits three main zones of the vertical seabed profile, namely:

i. The sediment–water interface. Organisms are sessile (live fixed to or in the seabed and grow upwards into the water column) or motile (including both those forms that move across the surface of the seabed, and those that swim but rest or remain closely associated with the seabed, such as demersal fish). A wide range of feeding types are represented, though filter feeders represent comprise a greater proportion of communities/assemblages than in subsurface habitats. Organisms inhabiting the sediment–water interface are likely to have the greatest risk of exposure to in-water hydrocarbons, either directly (exposure to dissolved or entrained hydrocarbons) or indirectly though feeding (e.g. filter feeders, surface detritus

feeders, surface deposit feeders, herbivores, scavengers and carnivores) due to oil on external surface or within the feed item (absorbed, bioaccumulated or in the gut). Ventilation of respiratory surfaces will also be a method of uptake of hydrocarbons.

ii. The bioturbation zone, considered to be the upper ~10 cm of particulate (soft) sediment habitats (Boudreau 1998), is a refuge for infaunal biota (i.e. organisms that actively burrow into sediments). The transition from a well-oxygenated environment to an anoxic environment generally occurs in this zone. Many infaunal species have adapted to this environment by having specialist methods to either irrigate their burrow, or to siphon oxygenated water from the sediment surface. Organisms in this environment are generally surface deposit feeders, subsurface deposit feeders, scavengers or carnivores, though a number of species can adopt multiple methods for obtaining food. Such as Nereid polychaete worms which are active hunters but can also filter feed by producing a mucus net that they hold in their burrow, which catches particles drawn down by the irrigation current. The worm then eats the mucus net with the items caught on it. Organisms drawing water from the sediment surface or feeding on organic material in the upper sediments would be at risk of exposure from spill hydrocarbons.

iii. Deep sediments (>10 cm below the sediment surface). This zone is generally anoxic, and organisms have adapted to living here by either building deep burrows (e.g. scampi can build burrows >1 m deep), have modified appendages to draw down oxygen from oxygenated sediments (e.g. some sea potato species (infaunal sea urchins) have modified tube feet that they can extend like snorkels into the oxygenated layer), move between the oxic (oxygenated) and anoxic layers, or have adapted to low-oxygen conditions. Taxa that draw down oxygenated water from the surface are at potential risk of hydrocarbon exposure from a spill in this zone.

Currie et al. (2007) documented three infaunal assemblages correlated with depth on the Great Australian Bight shelf. They found that sessile filter feeders dominated the inner shelf, while motile deposit feeders dominated the shelf break. Currie et al. only documented 240 taxa that they found in 65 grab samples in 2007. Due to the remoteness and generally inaccessible nature of the fauna of deeper waters in the Great Australian Bight, they previously had not been subject to any systematic sampling despite the extent and uniqueness of this region.

Currie & Sorokin (2011) had collected samples at two sites (1000 and 2000 m depth) in the Central Great Australian Bight, and Conlan et al. (2015) reported on one study undertaken in the eastern Great Australian Bight, focussing on canyon infauna).

The Great Australian Bight Research Program included infaunal investigations of deep-sea benthic habitats in depths of 200 to 3000 m (Rogers et al. 2013; Tanner et al. 2017; Walker & Tanner 2017). The Great Australian Bight Research Program sampling sites were arranged along five transects running east to west, with sampling at multiple depths (200, 400, 1000, 1500, 2000 and 3000 m) and transects 1 to 3 running adjacent to or through Permit Area EPP39 (where the Stromlo-1 drilling location is located). Infaunal densities in the Great Australian Bight over a depth range of 200–2800 m sampled (268–1320 ind/m^2) were relatively low compared to densities documented elsewhere (Tanner et al. 2018). The two Great Australian Bight Research Program studies examining infauna densities reported considerably lower densities: 50–450 ind/m^2 at 500–2000 m (Currie & Sorokin 2011). There was a clear peak in abundance of infauna at intermediate depth (400 m) and very low abundance in deep waters, although the Great Australian Bight appears to have relatively low infaunal abundance compared to other areas in this depth range (Tanner et al. 2017). Most species were represented in only a few samples. Assemblage level patterns were less distinct, although shallow sites (200 and 400 m) differed from deeper sites (1000–2800 m). No effects due to differences in upwelling/downwelling regimes between the easternmost and westernmost transects could be detected in the infauna but were present in the sediment physical characteristics, with shallow eastern sediments being coarser than their western counterparts (Tanner et al. 2017).

Several factors contribute to variability in biodiversity and endemism in the Great Australian Bight. These include a long period of geological isolation, a persistent high wind and wave energy environment, warm water intrusion via the Leeuwin Current from Western Australia, and cold water, nutrient-rich upwellings in the east (DSEWPaC 2012a). Taxonomic groups with exceptional diversity in this area include red algae (shallow waters), ascidians (sea squirts), bryozoans (including lace corals), molluscs (shellfish) and echinoderms (such as sea urchins and sea stars).

Rogers et al. (2013) stated that about 70% of the seabed in the Great Australian Bight is soft unconsolidated sediments. Due to large variations in bathymetry, however, there are marked differences in sedimentary composition and benthic assemblage structure across the region (Rogers et al. 2013). The inner coastal regions of the Great Australian Bight support a diverse range of seagrasses, macroalgal habitats and sponge-dominated communities but the autotrophic habitats (such as seagrass and macroalgae) are restricted by light penetration and therefore are generally limited to water depths less than 100 m (DEWHA 2007; McLeay et al. 2003).

While corals are generally associated with tropical waters, some species are known to occur in the Great Australian Bight, including three reef-building species in shallow waters and more than 50 non-reef-building species in waters up to 900 m deep from the phylum Cnidaria (DEH 2005d). Reef-forming stony corals from the phylum Bryozoa, such as *Solenosmilia variabilis*, have been collected from seamounts in the western Great Australian Bight and seamounts in the Huon and Tasman fracture AMPs, so it may be expected that they will occur in suitable habitats in the central and eastern Great Australian Bight (Thresher et al. 2012; Williams 2015).

Seamounts are considered potential biodiversity hot spots, as they are islands of emergent hard substrate in otherwise particulate (soft) seabed regions and affect the local hydrodynamics. The closest known seamounts to the Stromlo-1 well location are known as Anna's Pimple and Murray's Mount. During the Great Australian Bight Deepwater Marine Program, CSIRO surveyed the pinnacles to the north of the Stromlo-1 location using a towed camera system and recorded images of the seabed that show clearly the habitat types in these areas. Both seamounts are characterised by exposed hard volcanic materials variably overlain by a veneer of mud that supports low densities of epifauna. These two seamounts do not appear to represent regionally significant biodiversity hotspots unlike some other seamounts in the Risk EMBA (e.g. Thresher et al. 2012) but they provide locally important hard substrate in an otherwise barren muddy plain.

Figure 3.1 and Figure 3.2 show the bathymetric character of Anna's Pimple and Murray's Mount. The figures also show the towed camera transects flown at these sites and typical benthic habitat photographs along these transects. These data were sourced by personal communication from CSIRO in 2018.

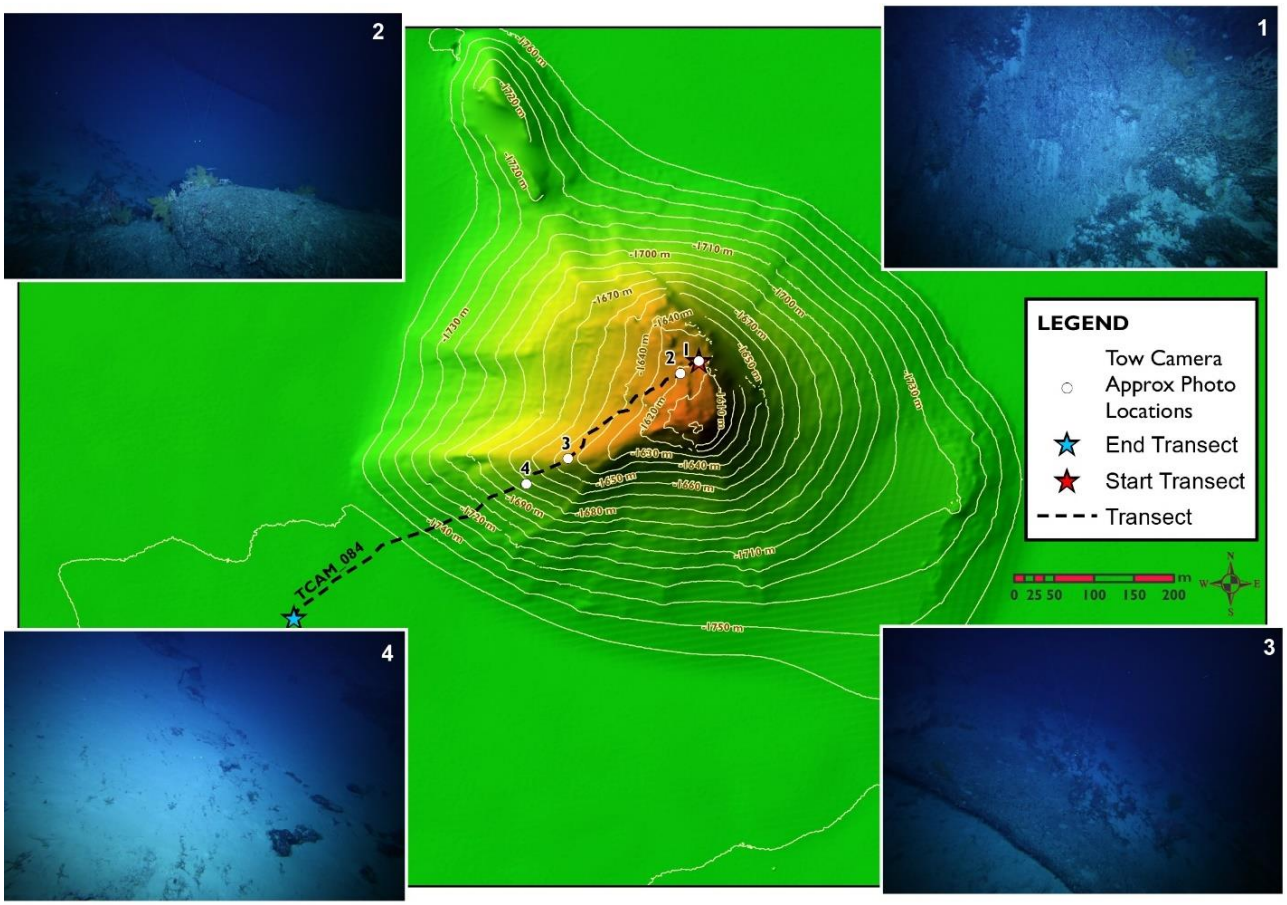


Figure 3.1 Bathymetry and towed camera photographs of the seabed at Anna's Pimple

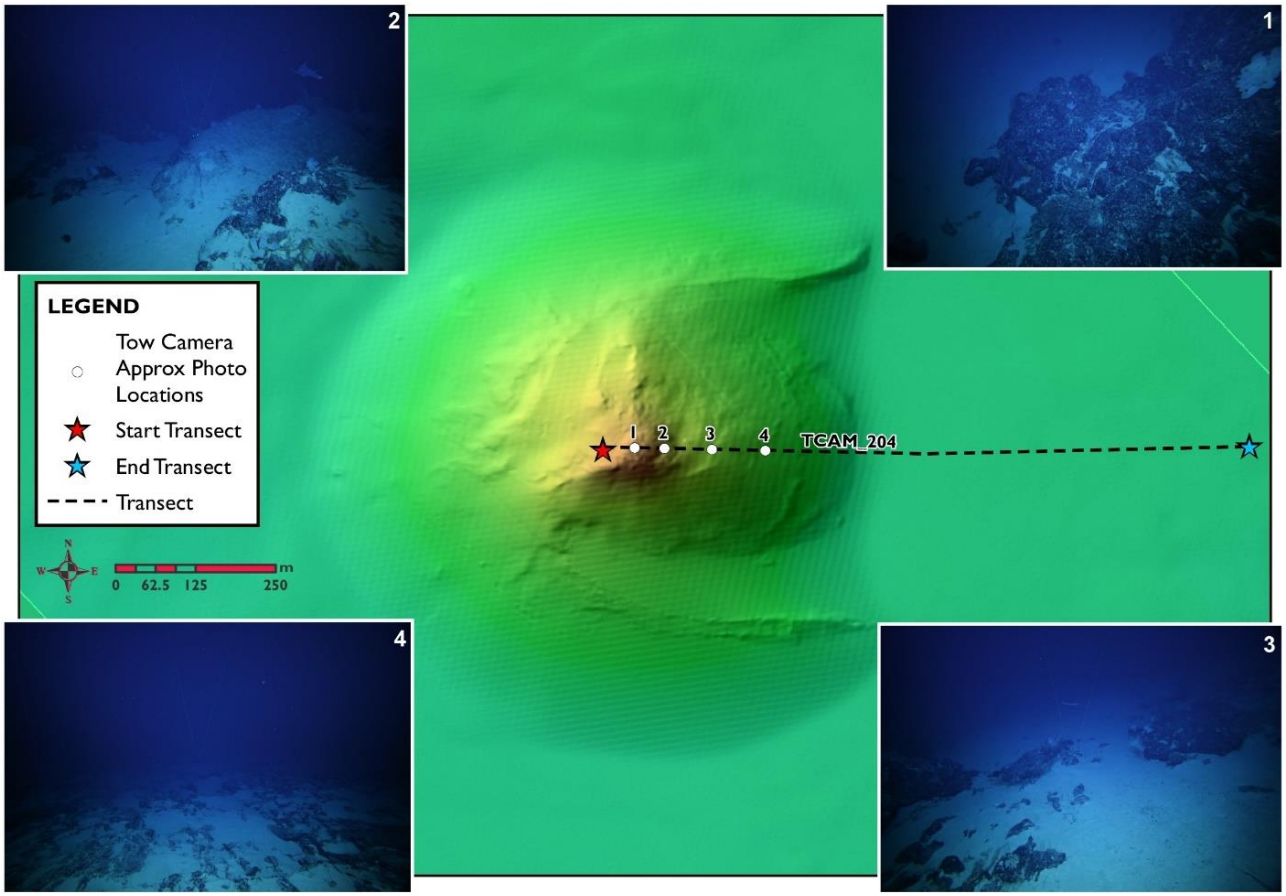


Figure 3.2 Bathymetry and towed camera photographs of the seabed at Murray's Mount

4.0 Biological environment – species and communities

4.1 Plankton

Phytoplankton (photosynthetic microalgae) comprise 13 divisions of mainly microscopic algae, including diatoms, dinoflagellates, gold-brown flagellates, green flagellates and cyanobacteria and prochlorophytes (McLeay et al. 2003). Phytoplankton drift with the currents, though some species have the ability to migrate short distances through the water column using ciliary hairs. Zooplankton is the faunal component of plankton, consisting of small crustaceans (such as krill) and fish larvae that feed on zooplankton. Zooplankton includes species that drift with the currents and those that are motile.

Kloser et al. (2017) noted that prior to the Great Australian Bight Research Program study, the only known survey focussing on the microbial food web (picophytoplankton, bacteria and viruses) in the central Great Australian Bight showed enhanced picophyton biomass in slope waters; and decreasing picophyton mass and cell abundances with distance from the shelf to offshore waters (SARDI unpublished data). Contributions of each of pico-, nano and micro-phytoplankton fractions and further details of the phytoplankton community composition are not known in the central Great Australian Bight beyond large scale satelite derived estimates (Rogers et al, 2013).

The central Great Australian Bight slope and offshore waters were sampled during the Great Australian Bight Research Program in April 2013 and again in 2015. Highest concentrations of chlorophyll-a (used as an indicator of phytoplankton abundance) occurred at depths of 60 m (0.43 ug/L) at the 200 m and 400 m isobaths. Chlorophyll-a declined with distance from the shelf edge to low concentrations (0.19 ug/L) at stations at the 1000 m and 2000 m isobaths. Dinoflagellates generally dominated the phytoplankton community (typically >40%), followed by flagellates.

The central Great Australian Bight surface waters are oligotrophic and downwelling conditions are present possibly year round (Figure 2.7) (Kloser et al. 2017). The 2015 survey for the Great Australian Bight Research Program investigated the importance of upwelling events in the central and eastern Great Australian Bight. The survey results indicated that the upwelled water mass, and therefore significant enrichment of waters in the euphotic zone, was restricted to the eastern Great Australian Bight (where the upwelling is intermittent and variable) and that there was no evidence of upwelled water on the central Great Australian Bight shelf (van Ruth & Redriguez 2017). In the central Great Australian Bight, there is a stronger influence of biological processes (nitrification), with only intermittent input from turbulent fluxes at the shelf edge, resulting in a more constant but moderate enrichment. Productivity is highest at the base of the euphotic zone which makes a minimal contribution to total primary productivity in the euphotic zone. Total chlorophyll-a was 1.7-fold higher in the eastern Great Australian Bight than in the central Great Australian Bight, with the highest concentrations approximately 70–90 m below the surface in the central Great Australian Bight (Kloser et al. 2017). A study of the western Great Australian Bight during summer found that zooplankton biomass was only 2% of that in the Gulf of Carpentaria, with other research indicating that the zooplankton assemblage is dominated by small copepods, meroplanktonic larvae and cladocerans (McLeay et al. 2003).

Data on plankton distributions were collected from the Great Australian Bight during a voyage in April 2013 by CSIRO and SARDI (Williams et al. 2013). Depth-integrated and duplicate larger surface water samples of mesozooplankton were taken at each station and a range of crustaceans, siphonophores, jellyfish and larval fish were collected (Williams et al. 2013). Deeper water zooplankton sampling was also undertaken to collect zooplankton and micronekton from the surface to 1000 m water depth during the downcast, and then in five discrete depth intervals (1000–800 m, 800–600 m, 600–400 m, 400–200 m, and between 200 m and the surface) during the upcast (Williams et al. 2013).

Copepods were found to be the dominant taxonomic group in surface waters of the eastern Great Australian Bight whereas copepods and *Appendicularia* and thaliaceans were dominant in shelf and offshore waters in the central Great Australian Bight (Kloser et al. 2017). The density of copepods was marginally greater in the central Great Australian Bight compared to the eastern Great Australian Bight (Kloser et al. 2017). The density of copepods was marginally greater in the eastern (mean 14.25 individuals/m^3) Great Australian Bight compared to the central (mean 3.44 individuals/m^3) Great Australian Bight (Kloser et al. 2017). The MIDOC samples showed that copepod were the dominant taxonomic group at all depths in the central and eastern Great Australian Bight (Kloser et al 2015). The mean body volume of the copepods increased with depth in both the eastern and central Great Australian Bight (Kloser et al. 2017).

4.2 Marine invertebrates

Highly diverse soft-sediment benthic invertebrate communities occur intermittently along the majority of the Great Australian Bight shelf, amongst vast expanses of bare sandy sediments (Currie et al. 2008; DSEWPaC 2012d; Williams et al. 2017). These communities are recognised as a KEF of the South-west Marine Region (see Section 1.3.4) (DSEWPaC 2012c). The high levels of biodiversity are attributed to the unusual width of the continental shelf, the high degree of geographic isolation from similar habitats, and the opportunities for incursions by tropical species in the Leeuwin Current (DSEWPaC 2012c). Community structure changes progressively across the shelf with depth. The species that make up these communities decrease in abundance moving away from the coast. The largest shift in community composition is a significant decline in species richness and biomass that occurs between the inner (0–65 m depth) and mid-shelf (65–200 m) (Currie et al. 2008).

In 2002 and 2006 SARDI surveyed the shelf within and around the Great Australian Bight Marine Park to a depth of 200 m (Figure 4.1) and sampled a total of 661 kg of living benthos, including a total of 735 benthic invertebrate species (Currie et al. 2008). Sessile suspension feeding organisms dominated the samples, comprising over 98% of the biomass and 85% of the species collected. The shelf communities sampled included 360 species of sponge, 138 ascidians and 93 bryozoans, many of which were new to science. The most common free-living organisms were echinoderms and molluscs, which comprised only 2% of the biomass and 12% of the species collected (Currie et al. 2008).

In southern Australia, about 1000 species of sponges have been described (McLeay et al. 2003). During the 2002 survey by SARDI sponges found at every site and comprising more than 38% (284 taxa) of the species collected (Currie et al. 2008).

Ascidian species have been recorded in water depths to 600 m off southern Australia, with about 300 species recorded from southern Australian waters (DEWR 2006). Over 200 described species are recorded from offshore islands of the Great Australian Bight and the limestone reefs of the western Eyre Peninsula (Rogers et al. 2013). Many ascidian species in the northern Great Australian Bight are endemic (Rogers et al. 2013).

There are over 500 species of bryozoans in southern Australian waters, with over 100 potentially undescribed species from the Great Australian Bight (DEWR 2006; Rogers et al. 2013). The 2006 SARDI survey of the Great Australian Bight shelf by SARDI found that bryozoans (*Lunularia* spp.) occurred at extremely high densities at several sites on the mid-shelf. Bryozoans provide structure to seabed habitats, contribute to carbonate sediments and are thought to play an important role in sustaining fish populations (DEH 2005d; DEWR 2006).

Towed underwater camera footage collected in the Great Australian Bight Marine Park during the 2006 SARDI survey found that the >90% of the shelf bedforms surveyed were bare, unconsolidated sand with emergent epibenthos covering <10% of the seabed (Currie et al. 2008). While (predominantly motile) epibiota may occur only at low densities in these areas of bare sand, it is known that a high diversity of infaunal organisms (fauna living within the sediment profile) exists (Currie et al. 2008), including polychaete worms, bivalves, amphipods, decapods and echinoderms (Rogers et al. 2013).

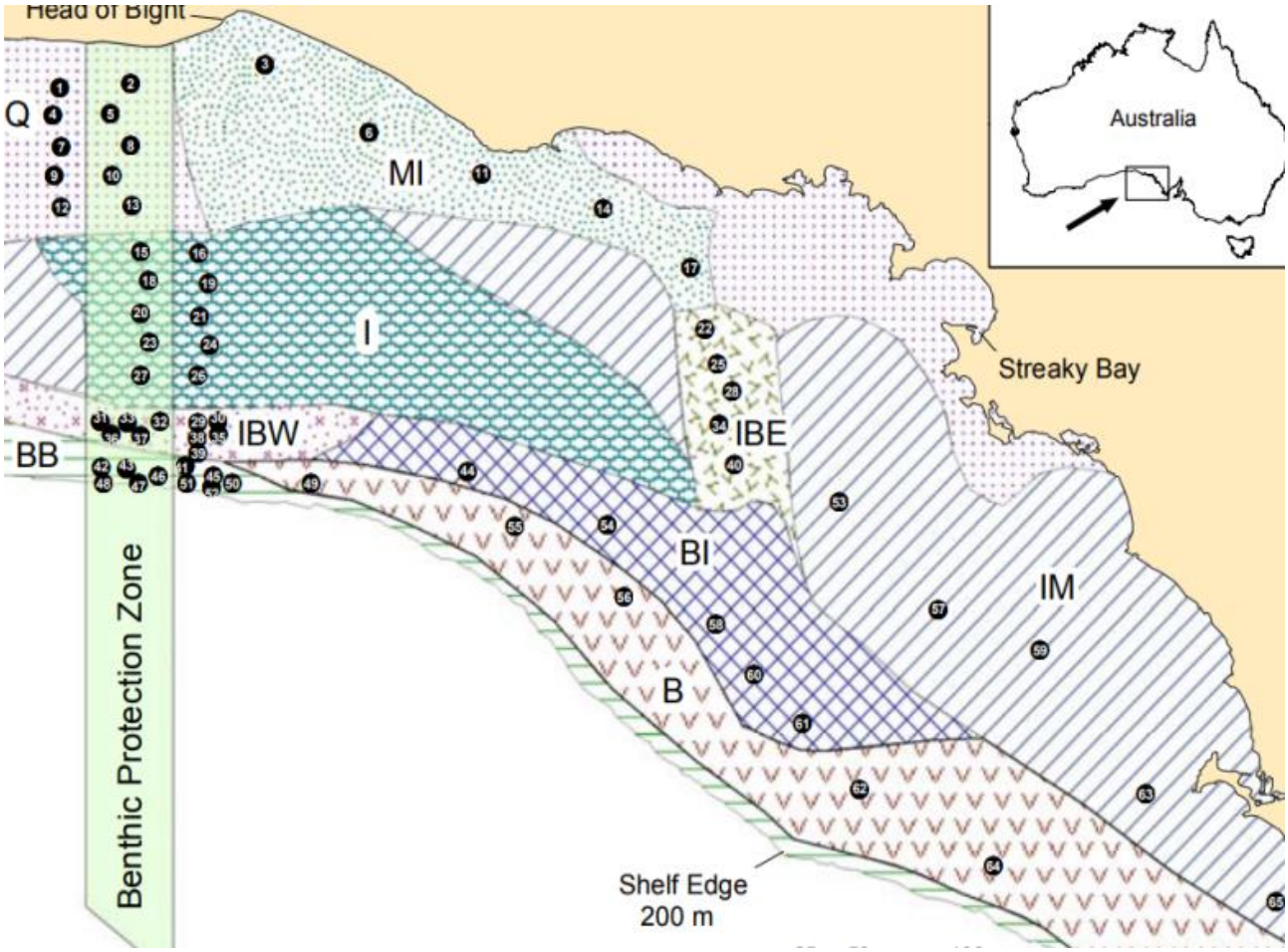
Benthic fauna were sampled as part of both the Great Australian Bight Research Program and Great Australian Bight Deepwater Marine Program between the 200-5000 m water depth contours during multiple surveys (2002, 2006, 2013, 2015 and 2017) (Figure 4.2, Figure 4.3 & Figure 4.4).

Data from the 2015 survey indicate a diverse assemblage of fauna, including deep-water coral-associated communities on some of the volcanic seamounts (Williams et al. 2017). A total of 376 species of invertebrates and 54 species of fish were collected (Williams et al. 2017). This included at least 124 likely new species, although further taxonomic work is required. Epifaunal samples were dominated by ophiuroids (brittle stars), holothurians (sea cucumbers) and stony coral, and were typically small (Williams et al. 2017). The rate of accumulation of different species with additional samples indicated the total benthic diversity was only partly characterised (Williams et al. 2017).

Initial analysis from the April 2017 survey indicates that over 200 taxa of benthic megafauna (invertebrates and fishes) were collected from ten successful beam trawls in depths from 2750 to 5030 m. In addition, seabed video imagery was collected along three transects over two volcanic seamounts in the Great Australian Bight Commonwealth Marine Reserve.

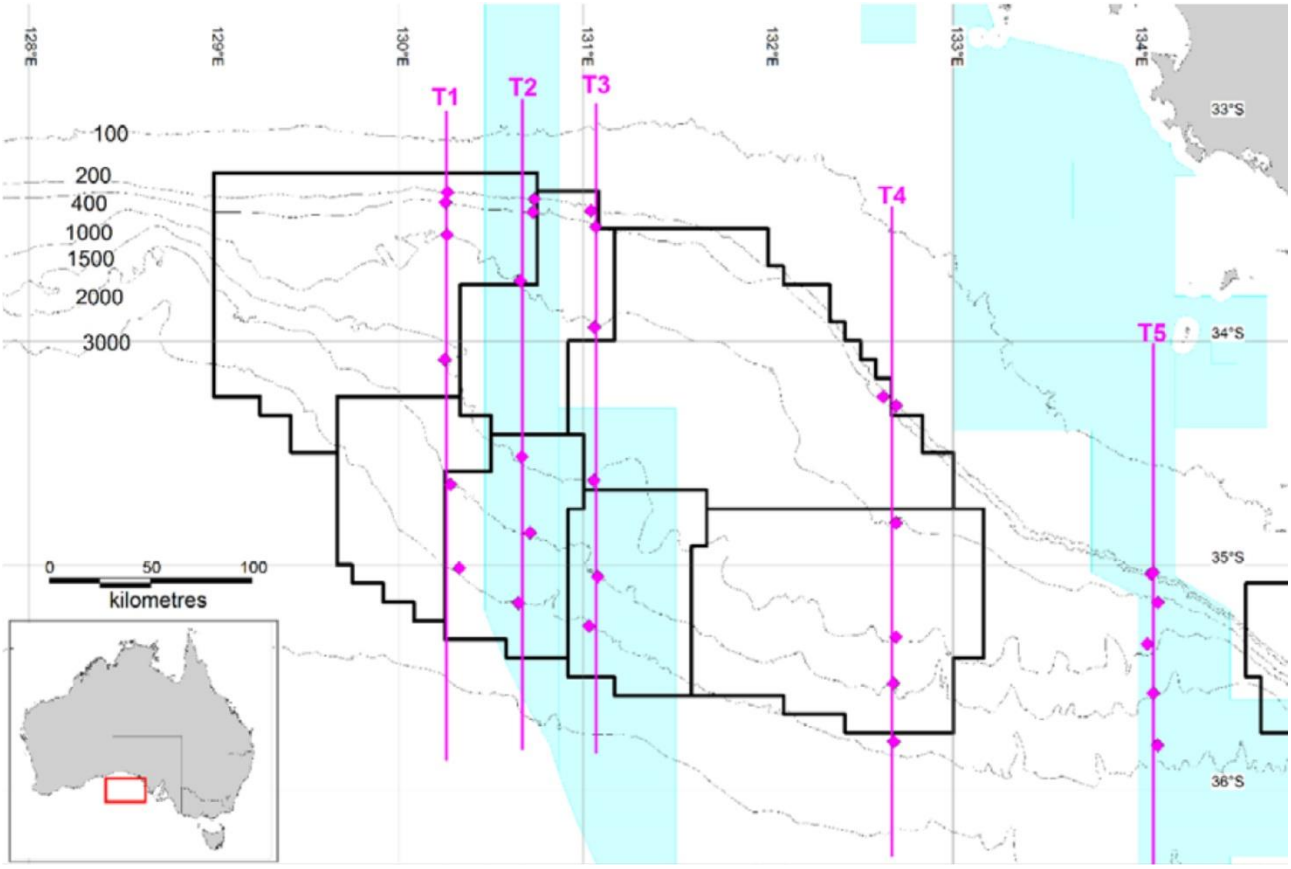
More than 600 species of megafaunal invertebrate epibiota were collected at 30 locations during the 2013 and 2015 survey (Figure 4.4) by the RV *Investigator* (Williams et al. 2017), with around one quarter being previously undescribed and 77 previously unrecorded in Australian waters. All represented families and genera known to occur in temperate deep-water areas. Diversity was greatest within the *Demospongiae*, *Decapoda*,

Gastropoda and *Echinodermata*. Assemblage structure was found to change with depth, with sponges dominating at shallower depths (with respect to biomass and density), whereas both sponges and echinoderms were dominant overall. No longitudinal change in assemblages were noted (in composition, biomass or density), inferring a single provincial-scale Great Australian Bight bioregion for megafaunal invertebrate epibiota. Endemism was low however; with only two species the crab *Choniognathus granulosus* and barnacle *Arcoscalpellum inum* known only in the Great Australian Bight. Analysis showed that the deep waters of the Great Australian Bight are not an equal mixing zone with respect to fauna in adjacent oceans to the east and west. More than twice the number of species found in the Great Australian Bight that were also found in the southern Pacific Ocean in comparison to those also found in the Indian Ocean (149 and 64 species, respectively). Potential endemism is low in this assemblage type, with only two species of crustacean recorded that are known only from the Great Australian Bight (the majid crab *Choniognathus granulosus* and the pedunculate barnacle *Arcoscalpellum inum*).



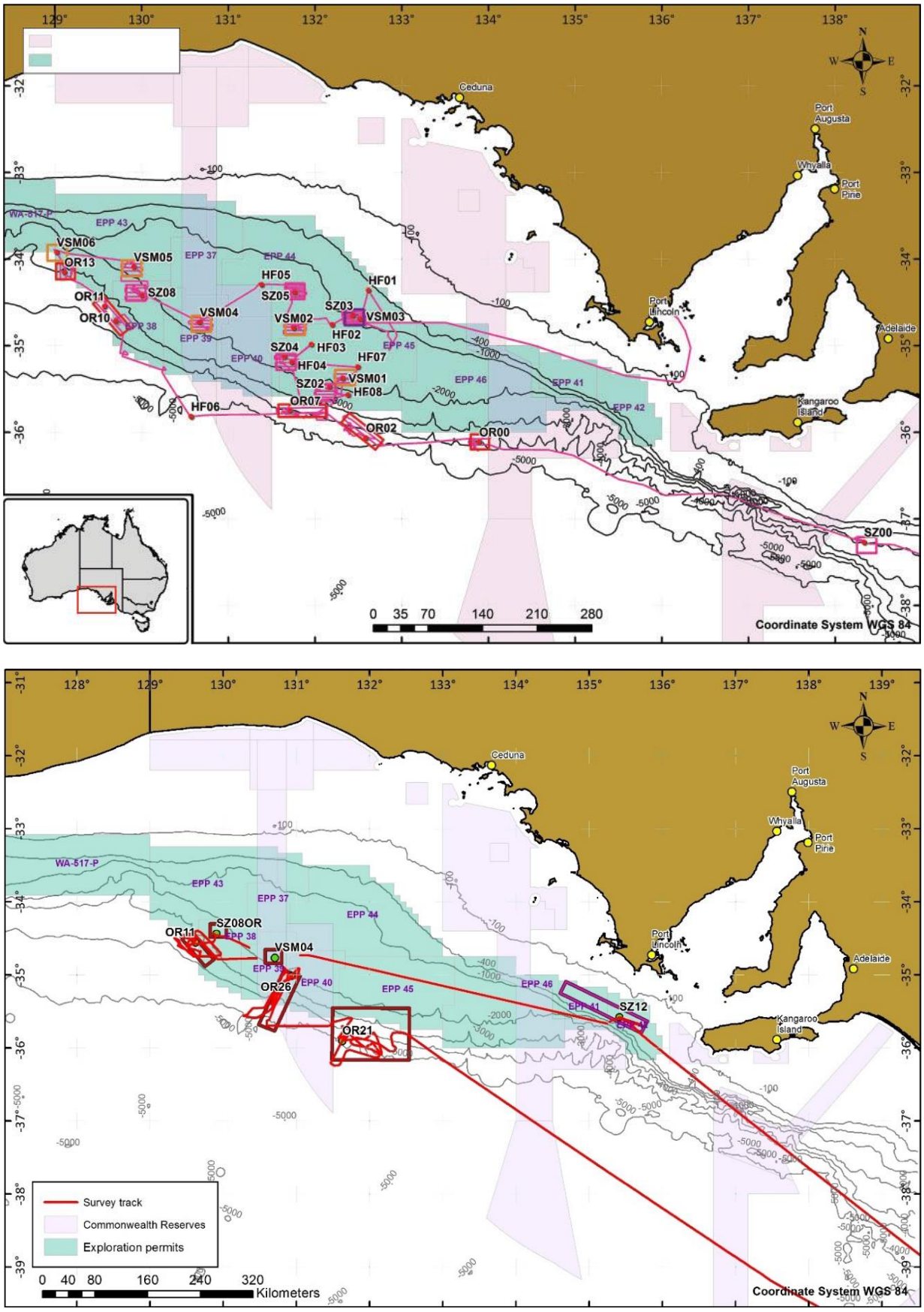
B: Bryozoan, BB: Branching Bryozoan, BI: Bryozoan Intraclast, IBE: Intraclast Bryozoan East, IBW: Intraclast Bryozoan West, IM: Intraclast Mollusc, MI: Molusc Intraclast, Q: Quartzose SkeletalSource: Currie et al. (2008)

Figure 4.1 Location of Great Australian Bight shelf areas surveyed in 2002 and 2006 by SARDI



Source: Tanner et al. 2018

Figure 4.2 Location of Great Australian Bight sampling sites at 200, 400, 1000, 1500, 2000 and 3000m (GABRP and Great Australian Bight Marine Deepwater Program, 2015)



Source: Ross et al. (2017a, 2018)

Figure 4.3 Great Australian Bight deep-water geological and benthic ecology research program voyage tracks surveyed by the RV *Investigator* in Nov–Dec 2015 (top) and April 2017 (bottom)

4.2.1 Benthic infauna

During October 2006, quantitative samples of infauna were collected from 65 sites spanning the eastern Great Australian Bight shelf, comprising the most comprehensive collection of infauna in the Great Australian Bight (Figure 4.1, Tanner et al. 2018). A total of 240 taxa were identified, with most of these found to be uncommon (Currie et al. 2008). As with the epifauna (described below), infauna was most diverse near the Head of Bight and inner-shelf waters (Currie et al. 2008).

As part of the Great Australian Bight Research Program, the first systematic and wide-ranging collection of benthic macroinfauna from the deep Great Australian Bight was made during a major field survey aboard the RV *Southern Surveyor* in 2013.Sampling of infauna during the 2013 field survey (25 sampling stations on five transects in water depths of 200, 400, 1000, 1500 and 2000 m in the eastern and central Great Australian Bight, of which three transects intersected BP/Equinor's permits, Figure 4.2) found that total species richness is not correlated with depth, though species composition changes were partially explained by changes in depth (Williams et al. 2017) . Information from the preliminary results obtained during this sampling program is provided below (Williams et al. 2017).

This survey was the first systematic collection and detailed identification of macroinfauna from the deep waters of the Great Australian Bight and has uncovered a diverse set of benthic invertebrates, with 128 distinct species across 72 families in eight major taxonomic groups. Roughly half of all confidently identifiable species were new to science and suggest a new and endemic fauna in the region. However, the large number of new species uncovered was unsurprising, given there have been relatively few surveys of deep-water infauna in Australia. It was noted that the proportion of undescribed species in the deep waters of the Great Australian Bight was consistent with data from similar depths along the Western Australia shelf (Poore et al. 2014), suggesting these species may be abundant and widespread throughout similar depth environments of the Great Australian Bight.

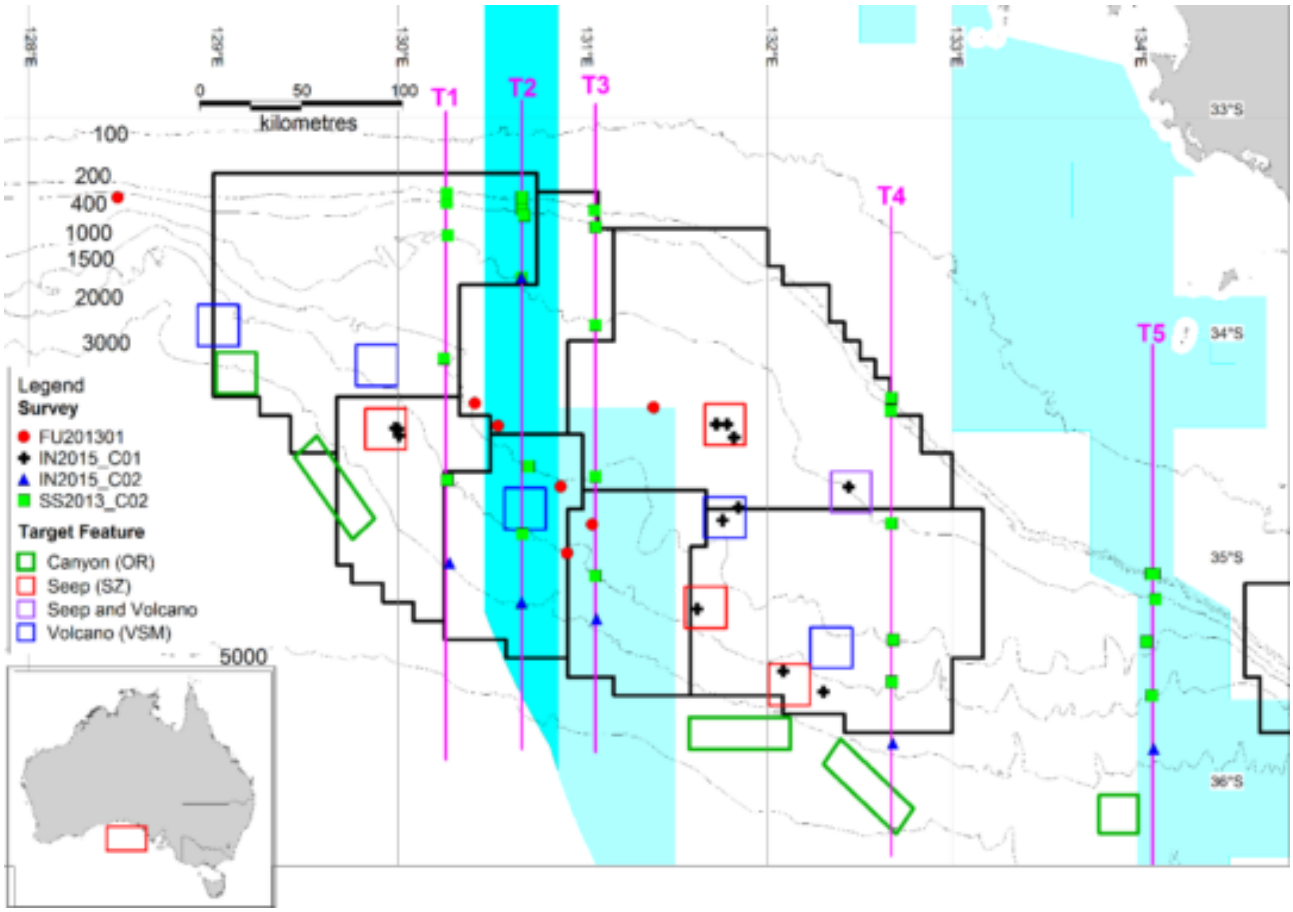
The overall structure of the macrofaunal assemblage was largely consistent with previous deep-water sampling from Australia (Poore et al. 2014), with composition and diversity dominated by large numbers of polychaetes and infaunal crustaceans, but generally low abundance. Invertebrate fauna comprises predominantly Crustacea (marine fauna with discreet body segments; head, thorax and abdomen) and Annelida (e.g. polychaete worms), accounting for 94% of all species and 96% of identified specimens:

- Crustacea
  - Amphipoda (crustaceans with no carapace) comprised the majority (~60%) of the diversity. Within the Amphipoda 37 different taxa were identified, including 13 undescribed species
  - Isopoda (crustaceans with segmented exoskeletons, such as sea slaters) were less abundant but still diverse (16 species), with 15 of these species being undescribed
  - Decapods (crustaceans with ten legs that are mostly scavengers, such as crayfish, crabs, prawns and shrimps) were less diverse, with only ten specimens collected, with only two new species uncovered by the survey
  - Nebaliacea (small benthic invertebrates, the most primitive members of the Malacostraca) were represented by only one undescribed species (which had been recorded elsewhere in southern Australia)
- Echinodermata (fauna with spiny skin and radial symmetry) were mostly represented by ophiuroids (brittle stars), with three species collected
- Annelida
  - 59 species from 31 families, with 58 species being polychaetes (marine worms) and one belonging to the oligochaete (marine worms) class (Williams 2015). 29 species were new to science.

The most abundant amphipod and isopod families are known to be associated with the deep sea and their compositions were generally consistent with surveys in other regions (Brandt et al. 2012; Knox et al. 2012). The composition of the polychaete fauna is typical of studies elsewhere at comparable depths (Alalikinya 2013; Shields & Blanco-Perez 2013), with most abundant families including *Cirratulidae*, *Spionidae*, *Glyceridae* and *Opheliidae*. Only 26% of species identified in this survey have been recorded elsewhere, with little species overlap found between the Great Australian Bight and other temperate regions of Australia. This suggests that the deep waters of the Great Australian Bight host an invertebrate fauna that is regionally endemic (Williams et al. 2017).

The majority of species/Operational Taxonomic Units were rare, known only from single individuals (59–100%), and across the whole study 73% of species were recorded only from one site. A rarefaction curve showed steady accumulation of species with continued sampling and little evidence of any asymptote, indicating that the rate of macrofaunal species accumulation will remain high in further sampling of sediments in the deep Great Australian Bight (Williams 2015).

A second benthic survey was conducted by the RV *Investigator* in December 2015 (Williams et al. 2018a; Williams et al. 2017). A total of 1303 macroinfaunal invertebrates representing 258 species were collected from 200 multi-corer samples from 30 stations equally distributed between five transects over a 200–3000 m depth range. A depth-related pattern in infaunal assemblage structure was identified. Analysis of taxa accumulation curves indicated that a low proportion of the species likely to be present in the region were sampled, indicating that future sampling is likely to result in a high proportion of additional taxa.



Source: Tanner et al. 2018

Figure 4.4 Location of infaunal and meiofaunal sites sampled within the Great Australian Bight in 2013 (indicated by red circles and green squares) and 2015 (indicated by black crosses and blue triangles). Seamounts ('volcanoes') are indicated by blue squares

4.2.2 Benthic epifauna

Benthic fauna inhabiting deep-water sediments between 200 and 5000 m water depth across the Ceduna Basin were sampled as part of the as part of the CSIRO led Great Australian Bight DMP aboard the RV *Investigator* during November– December 2015 and a follow-up survey was completed in April 2017. The full description and analysis of the results of these surveys are currently in review prior to publication in scientific journals and a special Great Australian Bight edition of Deep Sea Research II (Williams et al. 2017).

Initial analysis from the late-2015 survey indicates a diverse assemblage of fauna, including deep-water coral-associated communities on some of the volcanic seamounts (Williams et al. 2017). A total of 376 species of invertebrates and 54 species of fish were collected (Williams et al. 2017). This included at least 124 likely new species, although further taxonomic work is required. The epifauna assemblage (fauna living on sediments) was dominated by ophiuroids (brittle stars), holothurians (sea cucumbers) and stony coral, and individuals were typically small (Williams et al. 2017). The rate of accumulation of different species with additional samples indicated the total benthic diversity was only partly characterised (Williams et al. 2017).

In the April 2017 survey, over 200 benthic megafauna taxa (invertebrates and fishes) were collected from ten beam trawls in depths from 2750 to 5030 m. In addition, seabed video imagery was collected along three transects over two volcanic seamounts in the Great Australian Bight Commonwealth Marine Reserve.

More than 600 species of megafaunal invertebrate epibiota were collected from core samples collected at 30 locations during the 2015 survey by the RV *Investigator* (Williams & Tanner 2017; Williams et al. 2017). Approximately 25% of these were previously undescribed taxa and 77 were previously unrecorded in Australian waters. All represented families and genera are known to occur in temperate deep-water areas. Diversity was greatest within the *Demospongiae*, *Decapoda*, *Gastropoda* and *Echinodermata*. Assemblage structure was found to change with depth, with sponges dominating at shallower depths (with respect to biomass and density), whereas both sponges and echinoderms were dominant overall. No longitudinal change in assemblages were noted (in composition, biomass or density), inferring a single provincial-scale Great Australian Bight bioregion for megafaunal invertebrate epibiota.

Examples of deep-water benthic biota from the Great Australian Bight, including epifauna (living freely on, or attached to, the sea floor – including demersal fishes), macrofauna (exist within or closely associated with marine sediments) and microfauna (e.g. microbes), are shown in Figure 4.5 (Williams & Tanner 2017). While cnidarian corals are generally associated with tropical waters three reef-building species can be found in the shallow waters of the Great Australian Bight in shallow waters and more than 50 non-reef-building species in waters up to 1400 m deep (Montagna et al. 2005; Parks 2005). Hard corals can also be found in deep, dark, cold waters worldwide, including species such as *Solenosmilia variabilis*, which has a worldwide distribution and may form dense aggregations in depths of 1000–1400 m in waters of southern Australia (Freiwald et al. 2004). These deep-water hard coral species lack symbiotic microalgae (zooxanthellae) and therefore must live at water depths where environmental conditions (such as water pressure) mean that the deposition of the coral skeleton requires a lower energetic cost.

Deep-water corals have been collected from seamounts in the western Great Australian Bight so may occur in suitable habitats in the central Great Australian Bight (Williams 2015). Information available on the NOAA DSCRTP National Deep-Sea Coral and Sponge Database 1842–Present (NOAA 2015) shows that the location of deep-water black and gorgonian corals (subclass Octocorallia) are scattered across the Great Australian Bight (Figure 4.6). Thresher et al. (2015) also note that extensive coral reefs dominated by the scleractinian coral *Solenosmilia variabilis* are found on seamounts at depths ranging from 1000 to 1300 m in the Southeast Commonwealth Marine Reserve.

Rogers et al. (2013) noted that volcanic seamount features off southern Tasmania and New Zealand may be similar to those in the Great Australian Bight where according to Tanner et al.(2017) at least five other seamounts have been noted (as shown in Figure 4.4).These may support diverse and abundant benthic faunas (Althaus et al. 2009, Clark & Rowden 2009) similar in composition to those adjacent to continental margin reef habitats, but more abundant overall (Rowden et al. 2010). It is likely that deep-water reefs in the Great Australian Bight make up relatively small fractions of the deep offshore seabed. However, those that occur are expected to support a diverse collection of faunal elements and/or species that may be unique to reef habitat, e.g. stony corals, black corals and octocorals (Rogers et al. 2013).

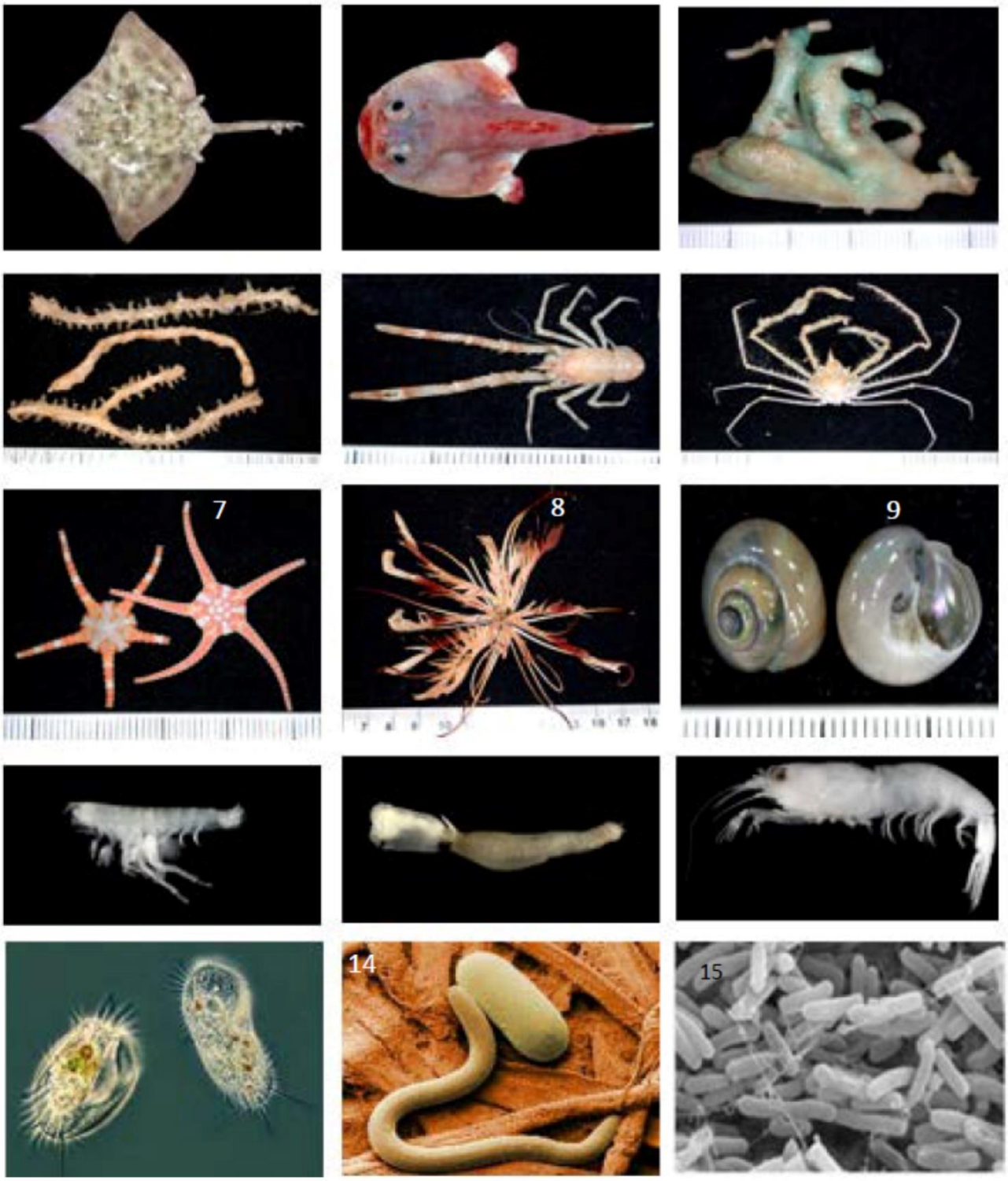
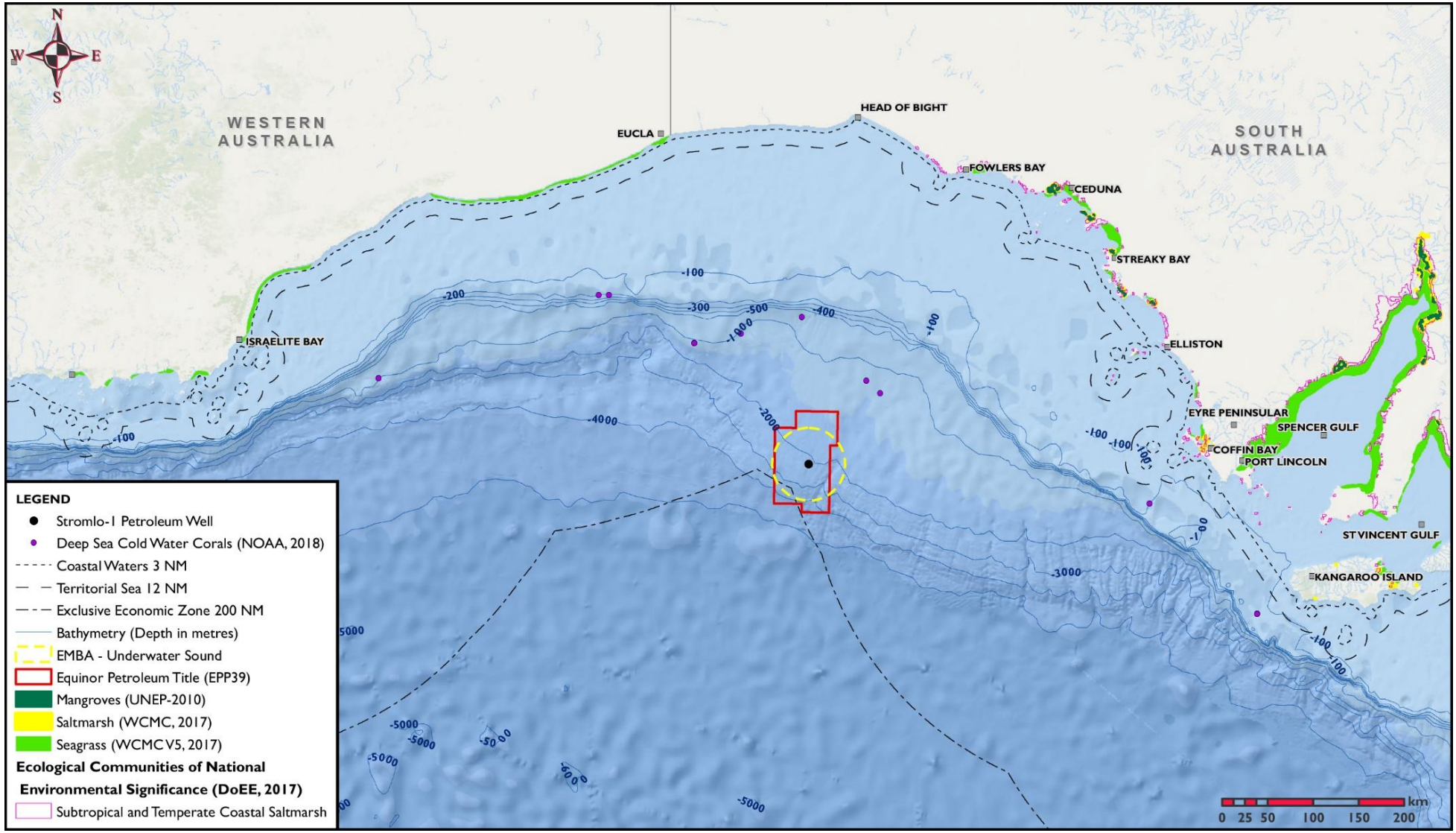


Figure 4.5 Deepwater benthic biota from the Great Australian Bight, including epifauna, macrofauna and microfauna



Source: NOAA (2018)

Figure 4.6 Nominal distribution of deep-water black and gorgonian corals in the Great Australian Bight region

4.2.2.1 Tasmanian live-bearing seastar

The Tasmanian live-bearing seastar (*Parvulastra vivipara*), listed as Vulnerable under the EPBC Act, was the only Threatened marine invertebrate species identified in the PMST report for the Risk EMBA (Appendix 7-2). This is a small species (<15 mm diameter) that is endemic to south-east Tasmania (TSSC 2009a). Its distribution covers approximately 2600 km^2 in sheltered waters from D'Entrecasteaux Channel to Norfolk Bay, although much of this area is considered unsuitable for the species due to inappropriate substrate and depth of water (deeper than 1.2 m) (TSSC 2009a). The actual area of occupancy is estimated to be 1000–2000 m^2, with an estimated population size of at least 350,000 individuals in 13 isolated populations (TSSC 2009a). The restricted geographic distribution is precarious for the survival of the species and is the reason it was added to the list of threatened species protected under the EPBC Act. Conservation advice for the Tasmanian live-bearing seastar identifies habitat loss, disturbance and modification, and animal predation and competition as key threats and provides guidance on priority threat abatement actions to support the species recovery (TSSC 2009a).

4.2.2.2 Scallops

Scallops are marine bivalves that inhabit all oceans of the world (Shumway & Parsons 2016). At least 50 species of scallop have been described from Australian coastal waters (Dredge et al. 2016). Nearly all scallop species inhabit soft sediments ranging from mud to coarse sand. Scallops are generally observed aggregated into beds, with many species capable of swimming short to moderate distances across the ocean floor (Shumway & Parsons 2016). Spawning occurs over an extended period during winter and summer, and recruitment to benthic populations is sporadic, intermittent and poorly understood (Dredge et al. 2016).

One scallop species supports targeted commercial fisheries within the Risk EMBA; the commercial scallop (*Pecten fumatus*), a large scallop that occurs along the southern and eastern Australian coastline between western South Australia (133°E) and central New South Wales (30°S), with populations found in Port Phillip Bay (Victoria), Jervis Bay (New South Wales) and Coffin Bay (South Australia) as well as more exposed coastal waters (Dredge et al. 2006). Doughboy (*Mimachlamys asperrima*) and queen scallops (*Equichlamys bifrons*) are also widely distributed and are taken as bycatch, forming a minor component of fisheries landings (Dredge et al. 2006). These commercially valuable species are mainly found within the Risk EMBA at depths of 10–20 m but may also occur down to 120 m (AFMA 2017).

4.2.2.3 Abalone

Abalone are marine gastropods that are widely distributed throughout tropical to warm temperate regions of the world, with larger species tending to occur in cooler regions (Shepard et al. 1992). In Australian waters, abalone occur on exposed coasts from the intertidal zone to depths of approximately 80–90 m, usually at depths of less than 40 m (Freeman 2001). They are predominantly found on granite and limestone substrates, but newly settled abalone prefer to live on encrusting coralline algae (Freeman 2001).

Numerous abalone species occur within the Risk EMBA, four of which support important commercial fisheries (wild-catch and aquaculture) within the Risk EMBA (see Section 1.5.2), namely blacklip (*Haliotis rubra*), greenlip (*H. laevigata*), brownlip (*H. conicopora*) and Roe's (*H. roei*) abalone (Freeman 2001). Blacklip abalone occur from northern New South Wales to eastern South Australia, including Tasmania, and account for nearly all wild-catch abalone production across their range (FRDC 2017a). Greenlip abalone are found along the coast from eastern Victoria to Cape Naturalist (Western Australia) and are responsible for the majority of abalone production in South Australia and Western Australia (FRDC 2017a). Brownlip abalone, found from central South Australia to Perth, and Roe's abalone, found from eastern Victoria to Shark Bay (Western Australia), account for a minor portion of abalone fisheries production in South Australia and southern Western Australia (Freeman 2001).

4.2.2.4 Rock lobster

Rock lobsters (family Palinuridae) occur in almost all tropical and temperate seas (Phillips & Kittaka 2000). Thirteen species of rock lobsters are found in Australian waters (Poore 2004). Three key species are commonly caught in parts of the Risk EMBA; the southern (*Jasus edwardsii*), western (*Panulirus cygnus*) and eastern (*Sagmariasus verreauxi*) rock lobsters. Each supports highly valuable state-managed commercial and recreational fisheries across their range (see Section 1.6). The size, abundance, life cycle and position in the food web of these rock lobster species also makes them ecologically important.

The southern rock lobster is distributed throughout southern Australia and New Zealand (Phillips & Kittaka 2000). The population within Australian waters predominantly occurs along the South Australia, Tasmania and Victoria coasts, with southern rock lobsters being the most common rock lobster throughout the Great Australian Bight and most of south-eastern Australia. Southern rock lobsters inhabit crevices in rocky reef habitats from the intertidal zone to water depths of 200 m, usually remaining shallower than 90 m. Higher densities occur on limestone compared to granite reefs (DEWR 2006). Adult southern rock lobsters feed on a range of other benthic invertebrates (e.g. crabs, sea urchins, molluscs and algae) and are preyed upon by a variety of predators (e.g. octopus, finfish and sharks). Mating occurs from April to July and larvae hatch in early spring over the continental shelf, with the associated strong currents facilitating dispersal. Planktonic phyllosoma larva develop over a period of 12–23 months, travelling hundreds of kilometres (mostly east) through pelagic environments, before metamorphosing into the puerulus stage and swimming across the continental shelf to settle in shallow inshore reef areas.

Western rock lobster is recognised as a KEF of the South-west Marine Region (DSEWPaC 2012a) and are Australia's most valuable fish stock (Mumme & Webster 2017). They are endemic to Western Australia, distributed along the Western Australia coast from Albany north to the North West Cape (Phillips & Kittaka 2000). Adults live under limestone reef ledges and are generally found in depths >60 m but have been recorded to 200 m (DEWR 2006; Poore 2004). Juvenile recruits occupy limestone reefs surrounded by seagrass beds in waters generally 10–30 m deep. Development of the western rock lobster is largely similar to that of the southern rock lobster, as are their feeding habits. At about four years of age, they change from their normal red shell colour to a paler colour and begin a migratory phase during which individuals move from their coastal waters to reef spawning grounds in deeper water and may travel in excess of 100 km (DEWR 2006). Only a minor overlap exists between the extent of the Risk EMBA and the area where western rock lobsters are known to occur along Western Australia's south coast. The extent and levels of recruitment of western rock lobster puerulus fluctuates considerably, depending on the strength of the Leeuwin Current and the frequency and intensity of low-pressure weather systems that generate westerly winds (DEWR 2006). The variation in levels of recruitment is expected to be most evident along the south coast of Western Australia. Western rock lobsters are therefore likely to occur in relatively low numbers where their range intersects the Risk EMBA.

Eastern rock lobsters are an endemic species distributed from southern Queensland to eastern South Australia (around Port MacDonnell), including northern Tasmania (Phillips & Kittaka 2000). They occur on rocky reef and soft sediment substrates in depths from 1–200 m, usually remaining between 20–100 m (Poore 2004). The spawning stock of eastern rock lobster in Australia is restricted to the north coast of New South Wales outside of the Risk EMBA (Poore 2004). Following spawning and a nine-month pelagic phyllosoma larval stage, puerulus recruit to shallow inshore reefs, mostly along the New South Wales coast. Eastern rock lobsters are rare over most of their range within the Risk EMBA other than in southern New South Wales, it is more common than the southern rock lobster only in these warmer waters.

4.2.2.5 Prawns

Fifteen prawn (suborder Dendrobranchiata) species occur within shallow (0–100 m) marine waters off southern Australia (O'Hara & Poore 2000). Prawns predominantly feed on small benthic fauna and decayed organic matter, and in turn are preyed upon by fish and molluscs (Poore 2004). Most of commercially valuable Australian prawns are tropical species found across northern Australia, although two major prawn stocks are commercially harvested in estuarine and inshore waters within the Risk EMBA (Poore 2004). These are western king prawns (*Melicertus latisulcatus*), found in the Gulfs of South Australia and nearshore waters along the west coast of Eyre Peninsula and which are targeted by large South Australia prawn fisheries (FRDC 2017b), and eastern school prawns (*Metapenaeus macleayi*), found in estuarine and inshore waters east of Corner Inlet and which are the primary target of a large New South Wales fishery and a developing Victoria fishery (FRDC 2017c) (see Section 1.6.2 for further information on fisheries).

Western king prawns are distributed throughout the Indo-West Pacific region with adult inhabiting marine waters up to 100 m in depth with seabed composed of sand, mud or gravels (Poore 2004). Juveniles inhabit shallow, sand/mudflat and estuarine habitats that are normally associated with mangroves (FRDC 2017b). The timing of juvenile recruitment to adult stocks in South Australia varies according to the time of settlement. Adult females spawn on multiple occasions during months of elevated water temperatures (November to March), meaning that commercial quantities of western king prawn are generally associated with hypersaline marine embayments (DEWR 2006).

Eastern school prawns are endemic to estuarine and inshore waters along the east coast of Australia between Corner Inlet in Victoria and Tin Can Bay, Queensland (FRDC 2017c). They are generally found as juveniles and sub-adults in estuaries and as adults in inshore waters (Poore 2004). Within estuaries they prefer soft muddy substrates and areas of seagrass and can be found well upstream in brackish to fresh waters (FRDC 2017c). Little is known about the biological stock structure of school prawns in Victoria, but it is assumed that they are part of a broader stock extending up with east coast of Australia (FRDC 2017c).

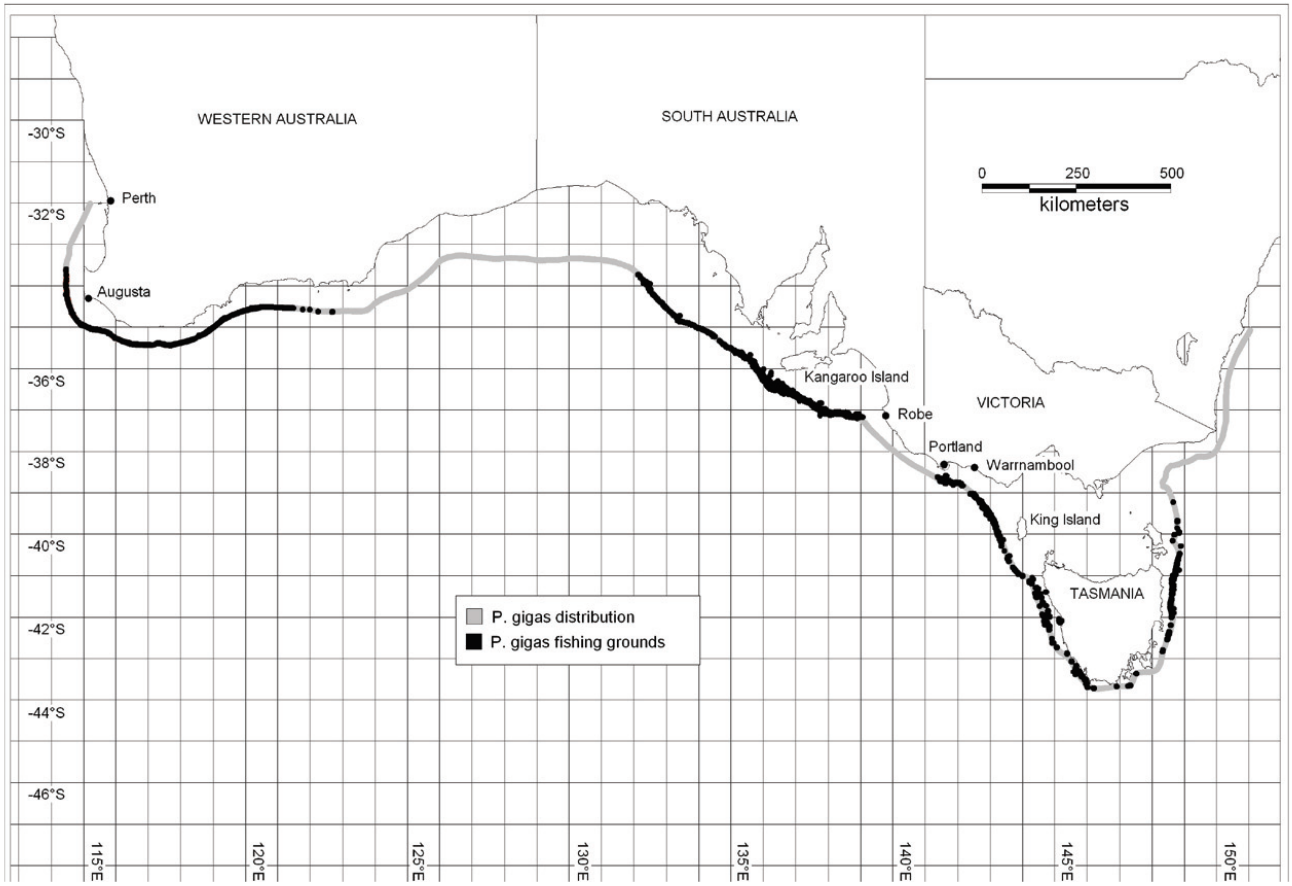
4.2.2.6 Crabs

More than 190 crab (infraorder Brachyura) species occur within shallow (0–100 m) marine waters off southern Australia (O'Hara and Poore 2000). Blue swimmer (*Portunus pelagicus*) and sand (*Ovalipes australiensis*) crabs are the key shallow water crab species contributing to state-managed commercial and recreational fisheries production across the Risk EMBA. Information on deep-water crab species is comparatively limited other than for the giant crab (*Pseudocarcinus gigas*), a very large deep-water crab species harvested by commercial fishers from all states adjacent to the Risk EMBA bar New South Wales.

Blue swimmer crabs are widespread across the Indo-West Pacific, Australia and New Zealand (Poore 2004). They are present throughout Australian coastal waters to a depth of 65 m but are generally rare in southern Western Australia, South Australia (excluding the gulfs), Victoria, Tasmania and southern New South Wales waters (Poore 2004). Blue swimmer crabs prefer muddy or sandy bottoms but can be found with seagrass (Poore 2004). Their life cycle is dependent on estuaries as the larvae and early juveniles use these habitats for growth and development (Poore 2004). Prior to hatching, the female moves into shallow marine habitats, releases her eggs and the newly hatched zoea larvae move into estuaries (Poore 2004). Juvenile crabs move offshore as they grow, reaching maturity in about one year. They return to shallow nearshore habitats during summer, becoming abundant for fishers (Poore 2004). Blue swimmer crabs are the most broadly commercially caught crab in Australia; the majority of harvesting within the Risk EMBA is from the Gulfs, western South Australia and along New South Wales.

Sand crabs are an endemic species found across southern Australia from Western Australia to Queensland, including Tasmania, in sandy beach habitats to a depth of 60 m (Poore 2004). They are the most commonly encountered large crab in southern Australia and are abundant throughout many ocean beaches and the southern areas of Gulf St Vincent and Spencer Gulf. The sand crab is from same family as the blue swimmer crab, Portunidae, better known as the swimming crabs. Both species have a rear pair of legs of both species are broad paddles, which are used for swimming (Poore 2004). This ability, together with their strong, sharp claws, allows them to be fast and aggressive predators (Poore 2004). However, both generally remain burrowed in sandy or muddy sediments during the daytime (Poore 2004). Shallow trawls in marine bays catch many individuals (Poore 2004). The species is fished both commercially and recreationally, although it is not as important as the blue swimmer crab.

Giant crabs are an endemic species that is occurs along the southern coast of Australia. Individuals have been recorded at depths of 18–800 m but most of the population occurs on the outer continental shelf and upper slope at depths of 140–400 m (Figure 4.7). Distribution appears to be limited by temperature, with the species only found at temperatures between 10–18 °C. Migration into deeper water takes place in autumn, especially among more mature individuals (Levings & Gill 2011). It is most abundant at 110–180 m in the summer and 190–400 m in the winter (Levings & Gill 2011). Giant crabs appear to be continuously distributed on the continental shelf between 140–270 m, indicating that a single biological stock likely exists (FRDC 2017d). Due to its slow growth and longevity, the giant crab is particularly susceptible to disturbances such as recruitment overfishing (FRDC 2017d). Giant crab stocks in waters under Tasmanian jurisdiction are considered overfished (due to continuously decreasing catch per unit effort), whereas the Western Australia stock is considered sustainable (South Australia and Victoria fisheries are data deficient) (FRDC 2017d).



Source: Levings and Gill (2011)

Figure 4.7 Giant crab distribution and commercial crab fishing grounds

4.2.2.7 Cuttlefish

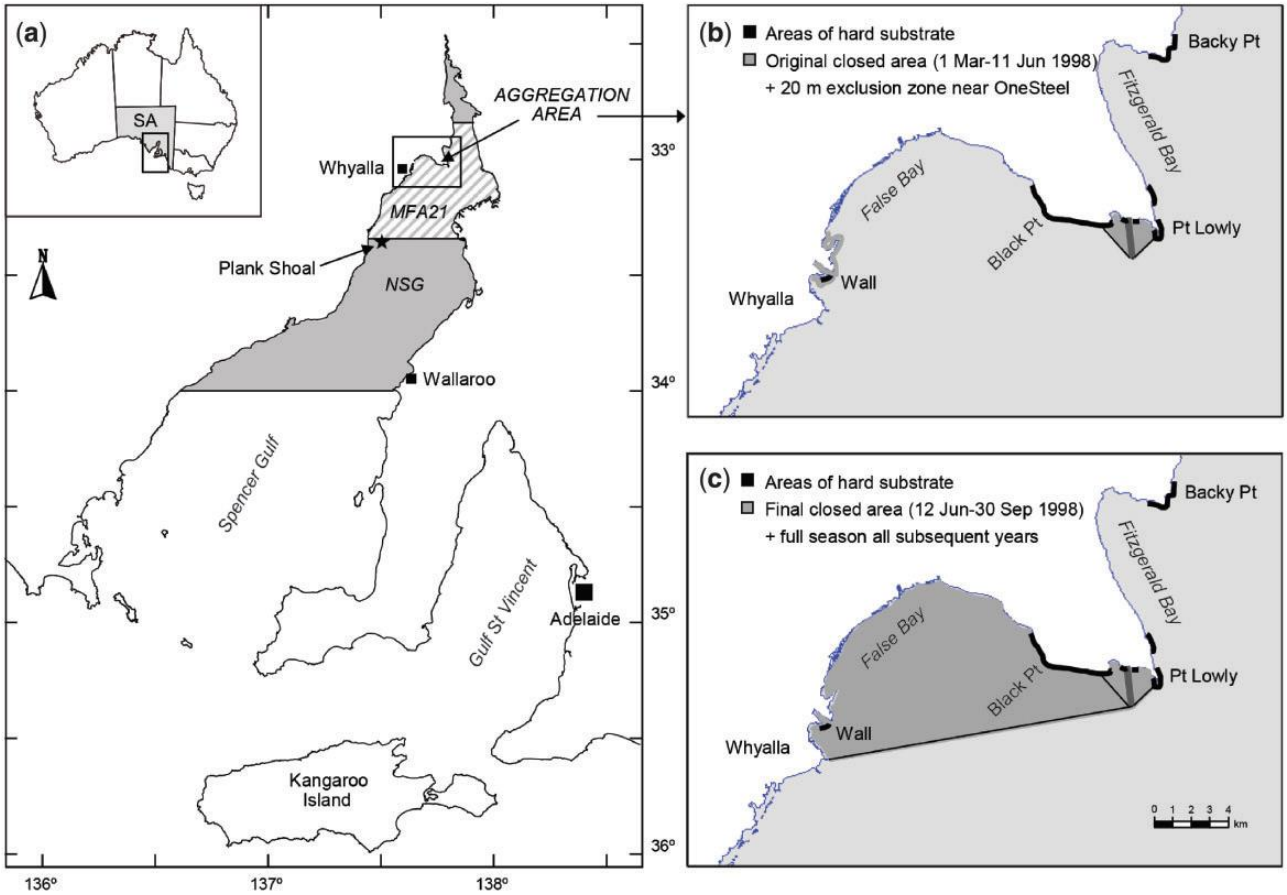
The giant Australian cuttlefish (Sepia apama) is the world's largest species of cuttlefish, growing to 50 cm in mantle length and over 10 kg in weight (FAO 2005). The species is endemic to Australia with a range that extends across temperate southern Australia from north-west Western Australia (Point Cloates) to central Queensland (Shoalwater Bay) and along northern Tasmania at depths of 1–100 m (TSSC 2011). Giant Australian cuttlefish occur in a variety of nearshore demersal habitats over their range including coral reefs, rocky reefs, seagrass beds and muddy and sandy areas. They are carnivorous, opportunistic and voracious predators that feed predominantly on crustaceans and fish (FAO 2005). Death occurs after 1–2 years, shortly after a single mating cycle and laying of eggs (TSSC 2011). Breeding takes place over winter, during which time abundance increases over inshore reefs as cuttlefish come together (Hall et al. 2017). In addition, a single massive annual spawning event occurs within the northern Spencer Gulf, which is unique for cuttlefish species worldwide and has become a minor ecotourism attraction for the region (TSSC 2011).

Despite their wide distribution, giant Australian cuttlefish are only known to form a dense spawning aggregation at one location; a very shallow (to 8 m depth), subtidal rocky reef area along 8 km of coastline near Whyalla, South Australia, where more than 100 cuttlefish per 100 m^2 are found (Figure 4.8) (Hall et al. 2017). Cuttlefish arrive in late April and densities rapidly increase and peak around the end of May–early June, before gradually decreasing until the end of August (Hall et al. 2017). Outside of this period cuttlefish numbers in the area are very low (<1 cuttlefish per 100 m^2), indicating that they move into the area from elsewhere (Hall et al. 2017). It is thought that the event comprises individuals from a distinct Spencer Gulf population that may constitute a separate species (TSSC 2011). Giant Australian cuttlefish exclusively use hard substrates for egg-laying and this likely accounts for the stretch of rocky reefs utilised within the northern Spencer Gulf, which elsewhere is predominantly soft sediment habitats (Hall et al. 2017). Because the upper Spencer Gulf spawning aggregation is highly localised both spatially and temporally it is likely to be vulnerable to overexploitation in the absence of adequate protection (Hall et al. 2017).

Giant Australian cuttlefish are not listed under the EPBC Act, but the IUCN Red List of Threatened Species listed the species as “near threatened” in 2012 following a trend of declining abundance (almost 90%) since population estimates began in 1999 by SARDI researchers (Barrat & Allcock 2012). Following a record low estimate of 13,492 individuals in 2013, the number of cuttlefish has increased each year. The factors responsible for the changes in abundance are not known.

A small commercial hand-jig fishery that targeted the aggregation from 1993–1998 was identified as having the potential to cause massive population decline, and cephalopod fishing closures were put in place to protect the aggregation area (Hall et al. 2017). The closure (Figure 4.8) remains on a permanent basis and a much larger temporary cuttlefish fishing exclusion area (identified in Figure 4.8 as “NSG”) will remain in place until at least February 2019 (PIRSA 2017a).

The Spencer Gulf aggregation area is within the Risk EMBA and giant Australian cuttlefish are present throughout most nearshore habitats within the Risk EMBA (other than in southern Tasmania) but do not occur in the vicinity of the well location.



Source: Hall et al. (2017)

Figure 4.8 Location of a) the giant Australian cuttlefish aggregation area, b) the original and c) the final cephalopod fishing closure in upper Spencer Gulf, South Australia

4.3 Fish

A diverse array of fish (classes Actinopterygii and Elasmobranchii) inhabit the range of environments within the Risk EMBA. This includes an estimated 1444 bony fish species (284 families; 32% endemic), 101 shark species (27 families; 30% endemic), and 58 species of skates and rays (15 families; 71% endemic) (CSIRO 2013a). Most are widely distributed throughout south-western and/or south-eastern Australian waters, with the majority of bony species having pelagic larvae, which drift or swim in the water for weeks to several months, facilitating dispersal over tens to hundreds of kilometres. Centres of species endemism occur in south-west and south-east Australia and many fish species have expanded from these regions to different extents until they reach some barrier to dispersal (Rogers et al. 2013).

The south coast of Australia features high fish species diversity and endemism overall as it includes transitional warm to cool temperate demersal species found off southern Western Australia and South Australia, as well and the typical cold temperate biota of Tasmania, Victoria and southern New South Wales (Edgar 2013). The wide-ranging distribution of demersal fish species along the Western Australia coast into the western Great Australian Bight is facilitated by the Leeuwin Current extending southwards from the tropical waters of Western Australia. Within this region there is an extensive network of shallow limestone and granite reefs where fish aggregate. By contrast there is relatively little shallow reef habitat in the central Great Australian Bight. Migration of demersal teleost species to south-eastern Australia is inhibited by a combination of poorly understood biological, oceanographic and bathymetric processes. A reef-free "dead zone" of sand-mud substratum at the Murray River outflow between Kangaroo Island and Robe further maintains a biogeographic barrier between species found in the Great Australian Bight and south-eastern Australia (Rogers et al. 2013).

There have been few systematic surveys of fish communities beyond the continental shelf, with knowledge of fish communities decreasing rapidly with depth because of the inherent difficulties associated with sampling the deep ocean. Evidence indicates that at least 400 species belonging to 126 families are represented on the continental shelf (<200 m depth), with shallow coastal regions exhibiting greater species richness and diversity highest within the families Labridae (wrasse), Syngnathidae (syngnathids), Gobiesocidae (clingfish), Gobiidae (gobies), Clinidae (blennies) and Monacanthidae (filefish/leatherjackets) (Gomon et al. 1994; cited in Rogers et al. 2013).

Fish species characteristic of environments in the Great Australian Bight are shown in Table 4.1.

Table 4.1 Common fish species representative of Great Australian Bight environments

Environment	Fish
Bony fish	
Shallow demersal	Invertivores: Deep velvet fish, scarlet cardinal, smooth cardinal fish, southern crested weed fish, old wife, four-spine leather jacket, smoothspine leather jacket, pygmy leatherjacket, gulf gurnard perch, little gurnard perch, rainbow cale, sculptured seamoth, common bullseye, slender bullseye, spotted grubfish, wavy grubfish, Derwent flounder, spotted flounder, barber perch, many banded sole, orange barred puffer fish, prickly toadfish, smooth toadfish, soldier fish, southern shortfin gurnard, spiny gurnard, southern school whiting, toothbrush leatherjacket, striped perch, ornate cowfish, Shaw's cowfish, rough bullseye, leatherjackets (bridled, mosaic, velvet, Gunn's, Degens and rough), crested flounder, squareback butterflyfish, goblin fish, syngnathids, ocean perch and latchet
Shelf demersal	Piscivores: stargazers, red cod, small tooth flounder, perch, butterfly fish, boarfish, cobblerfish, red mullet, goatfishes, silverbelly, silver trevally, john dory, trumpeter, stargazers and john dory
Shelf pelagic	Piscivores: Australian salmon, herring, barracouta, longfin pike, tommy rough, tailor, snook, mackerel tuna, teraglin, dolphinfish, mulloway, yellowtail kingfish, oilfish, short sunfish, trevallas and rudderfish Invertivores: Oreos, dories and pink ling Herbivores: Silver drummer, rock blackfish, luderick, dusky morwong, marblefish, fantail mullet, sea mullet and sand mullet Planktivores: Australian sardine, round herring, sandy sprat, blue sprat, Australian anchovy, jack mackerel, yellowtail scad, blue mackerel, redbait and the saury
Offshore pelagic	Piscivores: Ray's bream, moonfish, southern bluefin tuna, frigate mackerel or tuna, skipjack tuna, albacore tuna, yellowfin tuna, bonito, bigeye tuna, billfish, striped marlin, black marlin, blue marlin, swordfish and diel vertical migrating mesopelagic fishes e.g. lanternfishes Invertivores: Blue warehou, silver warehou, blue-eye trevalla and large butterfish
Deep demersal	Piscivores: Southern roughy, sandpaper fish, mirror dory, New Zealand dory, king dory, gemfish, long-finned gemfish, blue grenadier, hapuku, cucumberfish, painted gurnard, silverside, whiptails, imperador, redfish, cardinalfish and ribaldo
Deep benthic	Rattail, basketwork eel, oreo dorie, morid cod, halosaur and cusk eel

Environment	Fish
Sharks, skates and rays	
Demersal sharks (shelf and deep)	Whiskery shark, broadnose shark, Port Jackson shark, carpet shark, wobbegong, saw shark and cat shark
Pelagic sharks (inshore and offshore)	Great white shark, blue shark, shortfin mako, smooth hammerhead, bronze and dusky whaler sharks
Demersal skates and rays (shelf and deep)	Melbourne skate, southern fiddler ray, southern shovelnose ray, smooth stingray, coastal stingaree, sparsely-spotted stingaree, western shovelnose stingaree and white spotted skate

Source: CSIRO (2013), Fulton et al. (2017), Rogers et al. (2013), Williams et al. (2017).

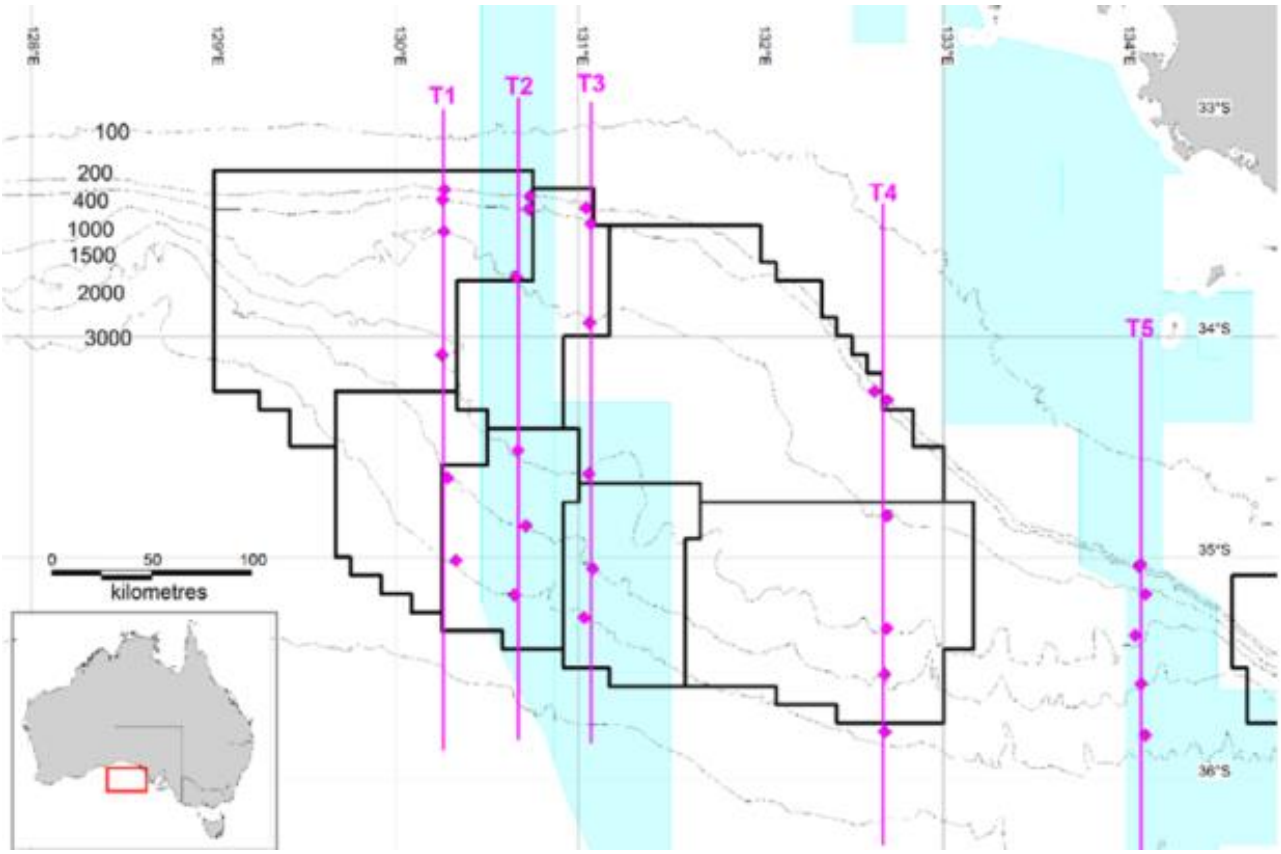
Demersal fishes utilise a wide range of habitats associated with different substrate types. In the Great Australian Bight they are found in shallow coastal embayments (<20 m) dominated by seagrass, sand and reef, and midwater depths (50–100 m) where they live among sediments (Rogers et al. 2013). Many species, such as those from the families Monocanthidae, Berycidae (Alfonsinos) and Sparidae (breams), form large aggregations on rocky granite and limestone reefs out to depths of >100 m (Rogers et al. 2013).

Pelagic fish occur throughout the Great Australian Bight in low to moderate densities. During summer coastal upwelling and enhanced primary productivity in shelf waters of the eastern Great Australian Bight supports large populations of small pelagic fish and Australia's largest and most valuable pelagic fish stock, the southern bluefin tuna (*Thunnus maccoyii*; Section 1.5.5.4.6) (Gomon et al. 2008; Rogers et al. 2013). Species for which information is available is generally limited to those that are commercially or recreationally caught and therefore the focus of dedicated research efforts.

The assemblage of small pelagic fishes that occurs in the Great Australian Bight are relatively diverse compared to other bioregions with at least ten species belonging to six families common in the region (Rogers et al. 2013). Clupeids (Family Clupeidae) including Australia sardine (*Sardinops sagax*), round herring (*Etrumeus teres*), sandy sprat (*Sprattus novaehollandiae*), and blue sprat (*Spratelloides robustus*) are all relatively abundant in shelf waters (Rogers et al. 2013). Other species that are also relatively common include Australian anchovy (*Sardinops sagax*), jack mackerel and yellowtail scad (*Trachurus declivis* and *T. novaezelandiae*), blue mackerel (*Scomber australasicus*), redbait (*Emmelichthys nitidus*) and the saury (*Scomberesox saurus*) (Rogers et al. 2013). Sprats and Australian anchovy are mainly found in the South Australia Gulfs and coastal embayments in the eastern Great Australian Bight (Rogers et al. 2013). Shelf waters of the eastern Great Australian Bight also support significant populations of Australian sardines, blue mackerel, jack mackerel and saury, but patterns of relative abundance appear to vary substantially among years and knowledge of the processes underpinning these fluctuations is limited (Rogers et al. 2013). Despite small pelagic fishes being a KEF of the South West Marine Bioregion (Section 1.3.4) minimal information is available on their population size/dynamics offshore or inshore for the western and central Great Australian Bight.

Numerous large pelagic fish species (>50 cm total length) throughout in the Risk EMBA as well as within Great Australian Bight. Seasonal pulses of high productivity in the Great Australian Bight underpin food webs supporting a range of predatory fishes and low productivity but economically important fisheries (Section 1.6). Relatively little is known of the population dynamics and distribution of the large pelagic species found offshore in the Great Australian Bight in low densities, such as include skipjack tuna (*Katsuwonus pelamis*), Australian bonito (*Sarda australis*), albacore (*Thunnus alalunga*), bigeye tuna (*Thunnus obesus*) or broad-bill swordfish (*Xiphias gladius*) (Rogers et al. 2013). Virtually no data have been collected on pelagic fishes beyond the continental shelf in any part of the Great Australian Bight (Rogers et al. 2013).

The composition, diversity and biogeographic affinities of the deep-sea benthic fish assemblages in the Great Australian Bight was studied by Williams et al. (2018b) as part of the Great Australian Bight Research Program and Great Australian Bight Deepwater Marine Program (Section 1.2.1.2). This involved the deepest systematic collection of benthic fishes in Australian waters, undertaken across depths ranging from 200 to 3000 m using a beam trawl. Samples were collected from soft substrate habitats (with some sites in close proximity to emergent features) at six depth horizons along five north-south transects. These were positioned to achieve a relatively high density of sampling in the Great Australian Bight Marine Park and the oil and gas permit areas, including EPP39 (Figure 4.9).



Source: Williams et al. (2018b)

Figure 4.9 Benthic fish transects (T1 to T5) sampled in the GABRP Benthic Theme study area

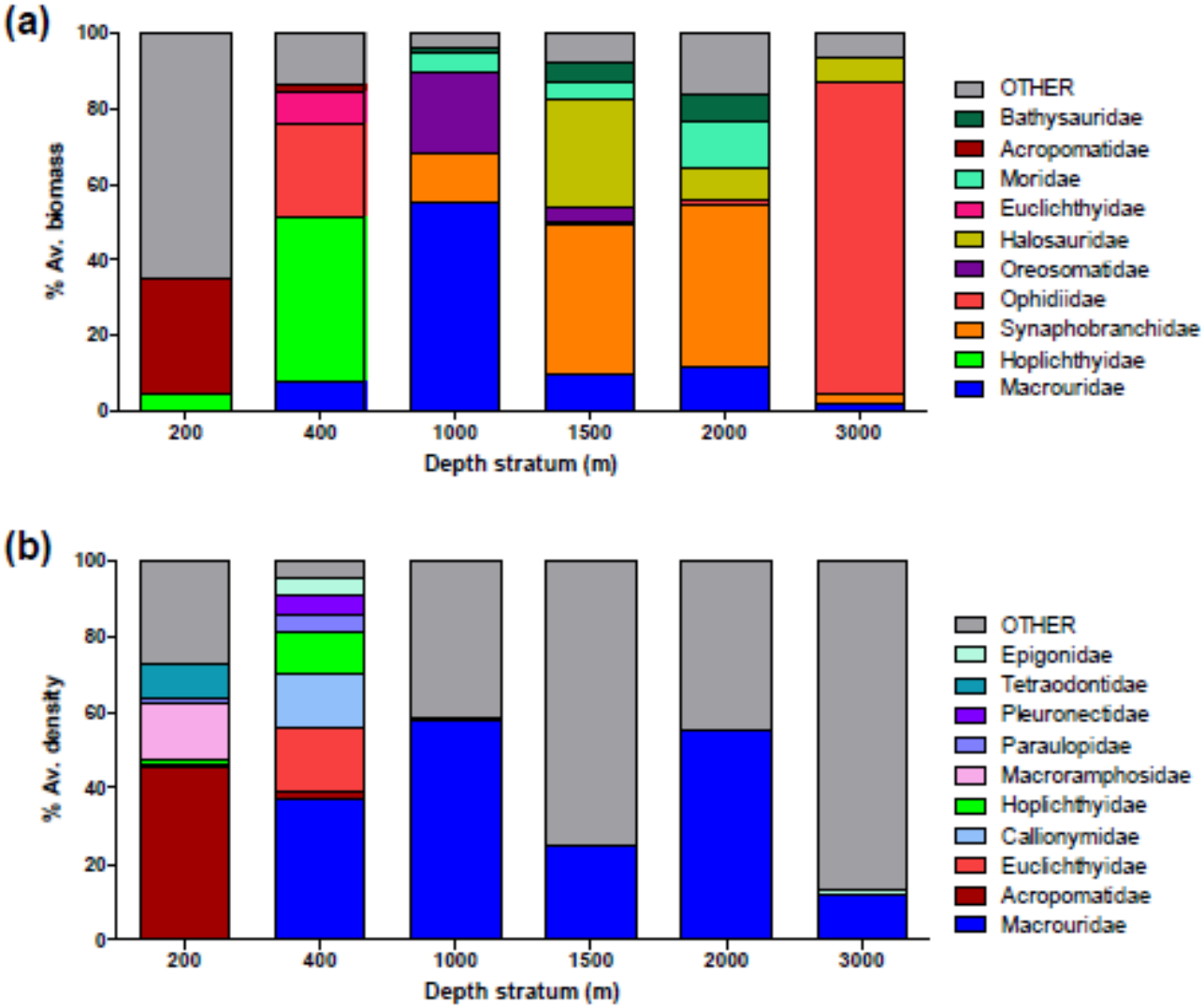
Spatial patterns in fish assemblages were evident with species richness, abundance and biomass changing markedly with depth, including across the deeper strata (1500–3000 m; Figure 4.9; Wiliams et al. 2018b). However, no consistent pattern in fish assemblages within depth strata was evident between the longitudinally separated transects (Williams et al. 2018b).

Catches were dominated by deep-sea families, including Macrouridae (rattails), Synaphobranchidae (cut-throat eels), Moridae (morid cods), Oreosomatidae (oreo dories), Alepocephalidae (slickheads), Ophidiidae (cusk eels) and Halosauridae (halosaurs). Greatest species diversity was recorded within the Macrouridae, which was also the most frequently recorded family. Macrouridae were found abundantly at water depths of ≥400 m (ranked highest by biomass and density when data were standardised by area). Species that were considered to be endemic to the Great Australian Bight were most commonly recorded at depths associated with the shelf break and upper to mid slope, declining with increased depth. Fish biomass increased between 200 and 400 m water depth (from approximately 0.5 to 3.4 g/m^2, respectively), then declined with increasing depth to ~0.4 g/m^2 at 3000 m. There was little difference in fish assemblage structure noted between 1500, 2000 and 3000 m water depths. The proximity of emergent hard substrates (e.g. volcanic seamounts, rocky outcroppings in submarine canyons) did not appear to affect the structure of fish assemblages sampled, though seasonal upwellings in the eastern part of the survey area may have increased productivity at eastern survey locations.

Family-level composition at the shelf break (200 m) sites stood out from all other depths in having the majority of biomass and density made up by “Other” families, i.e. relatively high diversity, and only two conspicuously dominant families: temperate seabasses (Acropomatidae) (biomass and density), and bellowfishes (Macroramphosidae) (density). In contrast, the dominant families in the upper slope (400 m) stratum, where biomass and density were highest overall, were ghost flatheads (Hoplichthyidae) (biomass) and Macrouridae (mostly species of Coelorinchus) (density). Two other families were also prominent at 400 m depth: cusk eels (Ophidiidae) (biomass, based on two large specimens) and Eucla cod (Euclichthyidae) (density). There were similarities in dominance at the mid-continental slope sites (1000, 1500 and 2000 m depths) where rattails (Macrouridae) (biomass and density) and basketwork eels (Synaphobranchidae) (biomass) were dominant. In this depth range, oreo dories (Oreosomatidae), morid cods (Moridae) and halosaurs (Halosauridae) were all prominent (biomass); the latter two families more so in 1500–2000 m depths. At 3000 m deep the cusk eels (Ophidiidae) were the overwhelmingly dominant family by biomass. Density was relatively very low at all sites

>1000 m and entirely dominated by rattails (Macrouridae) and a mix of "other" species. The pattern of relatively lower density than biomass in depths >1000 m indicated a generally larger body size of individuals compared to the upper slope and shelf break, especially for cusk eels (Ophidiidae). The overall trend was for species ranked highly by density to be small-bodied fishes and relatively shallow (<400 m depth) and for species ranked highly by biomass to be larger-bodied and deeper (>1000 m) (Figure 4.10).

Most fishes collected were previously recorded from Australian waters (90%) and the Great Australian Bight (75%) (Williams et al. 2018b). The proportions of recorded species were broadly similar between shelf break (~200–240 m depths), upper slope (280–600 m) and mid-slope depths (950–1550 m): (91–100% in Australian waters, 86–89% in Great Australian Bight waters).



Conservation significant fish data shown for the ten highest ranked families making up >88% of the standardised biomass the remaining families summed into "others"

Source: Williams et al. (2018b)

Figure 4.10 Per centage of (a) biomass and (b) density distribution in the transect samples of the ten top-ranked fish families by depth stratum

4.3.1 Conservation significant fish

The PMST report (Appendix 7-2) identified 10 Threatened fish species as potentially occurring within the Risk EMBA (Table 4.2). The PMST report also identified 51 listed species of syngnathids (Family Syngnathidae) as potentially occurring in the Risk EMBA (Section 1.5.5.7). In addition, all seven fish species listed as "Conservation Dependent" under Section 178 of the EPBC Act were identified as potentially occurring within the Risk EMBA (Section 1.5.5.5). These species are described further below.

Table 4.2 Protected fish species which may occur in the Risk EMBA

Scientific name	Common name	EPBC Act status		BIA within Risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory marine species[2]		
Brachionichthys hirsutus	Spotted handfish	Critically endangered	–	–	Recovery Plan for Three Handfish Species: Spotted handfish (*Brachionichthys hirsutus*), Red handfish (*Thymichthys politus*) and Ziebell's handfish (*Brachiopsilus ziebelli*) (DEE 2015)
Brachiopsilus ziebelli	Ziebell's handfish	Vulnerable	–	–	
Epinephelus daemelii	Black rockcod	Vulnerable	–	–	Black Rockcod (*Epinephelus daemelii*) Recovery Plan (DPI 2012)
Prototroctes maraena	Australian grayling	Vulnerable	–	–	National Recovery Plan for the Australian Grayling (*Prototroctes maraena*) (DSE 2008)
Thymichthys politus	Red handfish	Critically endangered	–	–	Recovery Plan for Three Handfish Species: Spotted handfish (*Brachionichthys hirsutus*), Red handfish (*Thymichthys politus*) and Ziebell's handfish (*Brachiopsilus ziebelli*) (DEE 2015)
Carcharodon carcharias	Great white shark	Vulnerable	Yes	Yes	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC 2013c)
Carcharias taurus (east coast population)	Grey nurse shark (east coast population)	Critically endangered	–	Yes	Recovery Plan for the Grey Nurse Shark (*Carcharias taurus*) ((DoE 2014a)
Carcharias taurus (west coast population)	Grey nurse shark (west coast population)	Vulnerable	–	Yes	
Isurus oxyrinchus	Shortfin mako shark	–	Yes	–	–
Lamna nasus	Porbeagle	–	Yes	–	–
Manta alfredi	Reef manta ray	–	Yes	–	–
Manta birostris	Oceanic manta ray	–	Yes	–	–
Rhincodon typus	Whale shark	Vulnerable	Yes	No	Whale shark recovery plan 2005–2010
Zearaja maugeana	Maugean skate	Endangered	–	–	–

1 Listed threatened species: A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.
2 Listed migratory species: A native species that from time to time are included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.

4.3.1.1 Handfish

Handfish are small (<150 mm) benthic fish found only in Australian waters that move slowly using their hand-like fins to crawl across the sea floor (DEE 2015). The spotted handfish (*Brachionichthys hirsutus*), Ziebell's handfish (*Brachiopsilus ziebelli*), and red handfish (*Thymichthys politus*), are listed as Critically Endangered,

Vulnerable and Critically Endangered, respectively, under the EPBC Act. The distribution of each species is restricted to limited areas of shallow, soft-sediment sheltered environments (e.g. inshore and within macroalgal beds) in southern and eastern Tasmania (DEE 2015). Given that there has been a drastic reduction in the number of mature individuals observed in recent decades and the extremely limited distribution of each handfish species, all areas in which they are found represent habitat critical to the survival of the species (DEE 2015). A recovery plan (DEE 2015) has been developed that sets out the research and management actions necessary to support the recovery and long-term survival of the three threatened handfish species.

Spotted handfish occur in the lower Derwent Estuary and adjoining bays and channels. They inhabit benthic environments in association with coarse to fine sand and shell grit or silt, with a depth distribution ranging from 2 to 30 m (DEE 2015). All sites where spotted handfish are known to occur (n = 9) have been monitored infrequently between 1998 and 2016. Comparison of density estimates show inter-site variability suggesting that the populations persist at each site (Wong & Lynch 2016), although there is no evidence of consistent temporal trends are demonstrated across sites over the survey period (Wong & Lynch 2016).

Ziebell's handfish historically occurred in widely disjunct populations across eastern and southern Tasmania, though the species current distribution is unknown. They inhabit a variety of locations, such as soft bottomed habitat with patches of rock that support sponge and algal communities, rocky-bottomed sea floor, on rock ledges and in cracks on open walls and in caves and on the edge of giant kelp forests, with a depth distribution ranging from 3 to 20 m (DEE 2015). Very limited data are available to track the conservation trajectory of the Ziebell's handfish.

Red handfish occur in Frederick Henry Bay and were historically recorded from sites off Port Arthur and the Forestier Peninsula. They inhabit a variety of locations, such as on top of rocks, among macroalgae, in sandy areas between rocks and the reef–sand interface and on sediments with weed clumps near reefs, with a depth distribution ranging from 1 to 20 m (DEE 2015). Very limited data are available to track the conservation trajectory of the red handfish.

These species are unlikely to be encountered within the vicinity of the well location but may occur in the Risk EMBA.

4.3.1.2 Black rockcod

The black rockcod (*Epinephelus daemelii*), listed as Vulnerable under the EPBC Act, is a slow-moving territorial fish that grows to 2 m in length and more than 80 kg in weight (DPI 2012). Black rockcod generally inhabit nearshore rocky and offshore coral reefs at depths down to 50 m but have occasionally been recorded from deeper waters (DPI 2012). The historic range of black rockcod in Australian waters extended from southern Queensland to Kangaroo Island, South Australia (DPI 2012). Fishing has depleted the species to a level where it is now rare to find black rockcod in areas other than along the New South Wales coastline, with large numbers found in northern New South Wales coastal waters only (DPI 2012). Conservation advice (TSSC 2012) has been developed that provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species. A recovery plan (DPI 2012) is in place that sets out the research and management actions necessary to support the recovery and long-term survival of species in New South Wales waters.

This species is unlikely to be encountered within the vicinity of the well location but may occur in the Risk EMBA.

4.3.1.3 Australian grayling

The Australian grayling (*Prototroctes maraena*), listed as Vulnerable under the EPBC Act, is a medium-sized (commonly 20 cm in length) diadromous fish that lives around three years (DSE 2008). Most of their life cycle is spent in freshwater but at least part of the larval and/or juvenile stages is spent in estuarine waters and coastal seas (DSE 2008). Historically, the Australian grayling occurred in coastal rivers and streams from Shoalhaven River in New South Wales to Ewan Ponds in South Australia and throughout Tasmania (including King Island) (DEE 2017b). Declines in abundance in many areas have resulted in the species becoming patchily distributed throughout its range (DSE 2008). A recovery plan (DSE 2008) has been developed that sets out the research and management actions necessary to support the recovery and long-term survival of the Australian grayling in Victorian waters.

This species is unlikely to be encountered within the vicinity of the well location but may occur in the Risk EMBA.

4.3.2 Conservation-dependent species

The EPBC Act includes a “Conservation Dependent” category for the listing of commercially over-exploited marine fish not listed as threatened or migratory species. “Conservation Dependent” fish species do not receive special protection and are not considered MNES. However, commercial fishing may only continue subject to the implementation of sound management plans that provide for the recovery of the species.

4.3.2.1 Harrisson’s dogfish and southern dogfish

The Harrisson’s dogfish (*Centrophorus harrissoni*) is a small shark known from only along the east coast of Australia and isolated spots north and west of New Zealand (TSSC 2013a). The species typically occurs on the upper-slope between 200 and 650 m. Within Australian waters, Harrisson’s dogfish is found along a narrow strip of continental slope off eastern Australia from north of Evans Head in New South Wales through to Cape Hauy, Tasmania and remote seamounts in the Tasman Sea (AFMA 2012).

The southern dogfish (*Centrophorus zeehaani*) is a small, endemic shark found along the majority of the continental shelf upper-slope between Mandurah in Western Australia to Newcastle, New South Wales, at depths between 180 and 900 m (TSSC 2013b).

Upper-slope dogfish species within the family Centrophoridae, including the Harrisson’s dogfish and southern dogfish, have a slow growth rate, late onset of sexual maturity and low fecundity. These life history characteristics make them vulnerable to rapid stock depletion and their recovery protracted once depleted (AFMA 2012). Historic overfishing from the 1960s to 1990s resulted in significant declines of Harrisson’s and southern dogfish stocks, with these species each considered eligible for listing as endangered under the EPBC Act (TSSC 2013a,b). However, both species were listed as conservation dependent on the basis that their recovery is being managed under the under the Upper Slope Dogfish Management Strategy (AFMA 2012)

The Harrisson’s dogfish is not known to occur in the Great Australian Bight but the southern dogfish may be encountered in the vicinity of the well location. Both species are found within the Risk EMBA.

4.3.2.2 School shark

The school shark (*Galeorhinus galeus*) is a small shark that is widespread in temperate waters offshore of the eastern United States, Hawaii, South America, South Africa, Europe, Australia and New Zealand. The species is widely distributed across southern Australia in waters up to 800 m deep (TSSC 2009b). Despite school sharks undertaking migrations of up to 1400 km in southern Australia (DEWHA 2009) the populations from Australia and New Zealand are generally regarded as separate (TSSC 2009b).

School sharks are a demersal species that inhabit the continental and insular shelves but are also recorded on the upper slopes to deep water offshore (Last & Stevens 2009). This species uses shallow sheltered bays, estuaries and inlets as nursery areas (DEWHA 2009). Known pupping areas of significance are found around Tasmania (particularly in the south-east) and off Victoria.

The life history characteristics of school shark include having a low reproductive rate and slow growth making the species vulnerable to overexploitation. As a result of historic overfishing in the eastern part of its range, the Australian school shark population declined by almost 90% between 1927 and at least 1999. The species is considered eligible for listing as endangered under the EPBC Act (TSSC 2009b) but the stock was listed as conservation dependent on the basis that its recovery is being managed according to the School Shark Stock Rebuilding Strategy (AFMA 2018).

This species is unlikely to be encountered within the vicinity of the well location but is known to occur within the Risk EMBA.

4.3.2.3 Orange roughy

The orange roughy (*Hoplostethus atlanticus*) is a deep-sea fish occurring throughout the waters of the Atlantic, Pacific and Indian oceans. Orange roughy are found in waters 700–1200 m deep (usually at depths of 800–1000 m) over steep continental middle and lower slopes and oceanic ridges (AFMA 2014a). Orange roughy are very long-lived (>100 years), slow growing, late to reach reproductive maturity (27–32 years) and form both spawning and non-spawning (likely related to feeding) aggregations around geologic structures (AFMA 2014a). These traits make the species particularly vulnerable to overfishing.

In Australia, the orange roughy can be found in offshore waters from the New South Wales central coast through to southern Western Australia, including Tasmania (AFMA 2014a). Australian stocks experienced a significant decline during the early to mid-1990s as a result of heavy fishing pressure by demersal trawl operators. The species is believed to have declined in the Great Australian Bight, with no large aggregations reported by the Great Australian Bight Trawl Sector since 1990 (AFMA 2014a). It is thought that orange roughy may aggregate and spawn in canyons and the shelf break off Kangaroo Island during winter (for further information on spawning see Section 1.5.5.7) (DEWHA 2007).

Orange roughy stock are managed in Australian waters according to the Orange Roughy Stock Rebuilding Strategy (AFMA 2014a) under which commercial fishing is essentially closed in the Great Australian Bight, particularly in areas with a water depth greater than 700 m.

Orange roughy are found within the Risk EMBA and may occur in the vicinity of the well location.

4.3.2.4 Eastern gemfish

Eastern gemfish are the eastern Australian stock of the conventionally accepted gemfish (*Rexea solandri*). Eastern gemfish are a geographically isolated, breeding population distributed from Cape Moreton, Queensland along the east coast to Bass Strait and the waters off Tasmania (AFMA 2015). The population is genetically distinct from the western population, which extends across the Great Australian Bight to Geraldton, Western Australia (TSSC 2009c). Eastern gemfish are found in deeper continental shelf and upper slope waters from 100 to 700 m in depth and generally remain near the sea floor but may move into mid-water at times (TSSC 2009c).

Eastern gemfish were a very significant proportion of trawl landings off south-east Australia during the 1970s and 1980s. Due to overfishing eastern gemfish are thought to have declined by up to 95% between the late 1960s and 2002 but have stabilised in recent years (TSSC 2009c). The eastern gemfish is considered eligible for listing as endangered under the EPBC Act (TSSC 2009c) but was listed as conservation dependent on the basis that its recovery is being appropriately managed under the Eastern Gemfish (*Rexea soandri*) Stock Rebuilding Strategy – Revised 2015 (AFMA 2015).

Eastern gemfish are found within the Risk EMBA but are unlikely to be encountered within the vicinity of the well location.

4.3.2.5 Blue warehou

The blue warehou (*Seriolella brama*) is a medium-sized, migratory fish that is confined to Australian and New Zealand waters, predominantly in coastal shelf, upper continental slope and seamount waters offshore of New South Wales, Tasmania, Victoria, South Australia and south-east Western Australia. The species is found at depths between 3 and 550 m, although they are more abundant in waters shallower than 200 m (TSSC 2015a).

The species undertakes major seasonal migrations to feed and spawn and in response to changes in water temperature. The species shows preference for relatively warmer waters of between 10 and 15 °C when compared with other trevallas. Larval blue warehou have been observed in surface waters to depths of 100 m, with the highest abundances in the upper 50 m. Older larvae and small juveniles are commonly found under drifting jellyfish or larger inanimate objects, with larger juveniles congregating in bays and estuaries. Once individuals have attained lengths greater than 30 cm, they are most abundant in the continental slope waters further offshore (TSSC 2015a).

There is evidence that blue warehou display diurnal movements in the water column, with individuals moving upwards and away from the seabed on the approach of sunset, before dispersing through the water column at night. The reverse occurs at sunrise, when the fish move downwards before forming schools that become fully formed at between 10 and 30 m above the seabed (TSSC 2015a).

Historically, the blue warehou was taken as a by-product in gillnet fisheries and as a target and non-target species in demersal trawl fisheries in southern Australia (TSSC 2015a). Fishing pressure is thought to have resulted in a decline in the abundance of blue warehou throughout its entire Australian distribution of at least 80%. Blue warehou are considered eligible for listing as critically endangered under the EPBC Act (TSSC 2015a) but were listed as conservation dependent on the basis that its recovery is being appropriately managed under the Blue Warehou Stock Rebuilding Strategy – Revised 2014 (AFMA 2014b).

Blue warehou are unlikely to be encountered within the vicinity of the well location but are known to occur in the Risk EMBA.

4.3.2.6 Southern bluefin tuna

The southern bluefin tuna (SBT) (*Thunnus maccoyii*) is a large pelagic fish species that occurs throughout the southern hemisphere in waters between 30°S and 50°S but is mainly found in the eastern Indian Ocean and in the south-western Pacific Ocean (TSSC 2010). The SBT off southern Australia is part of a single, highly migratory biological stock that spawns in the north-east Indian Ocean from September to April and migrates throughout the temperate southern oceans, supporting a number of international, Commonwealth and state-managed fisheries (Ellis & Kiessling 2016; Honda et al. 2010). The southern bluefin tuna is listed as conservation dependent and is managed in Australian waters according to the Commonwealth Listing Advice on *Thunnus maccoyii* (Southern Bluefin Tuna) (TSSC 2010b).

The SBT is a long-lived species (maximum age ~40 years) and is highly fecund. SBT feed rapaciously in the epipelagic layers of oceans, opportunistically targeting fish, crustaceans, cephalopods, salps and other marine animals (Ellis & Kiessling 2016). Within Australian waters, SBT range from northern Western Australia, around the southern region of the continent, to northern New South Wales.

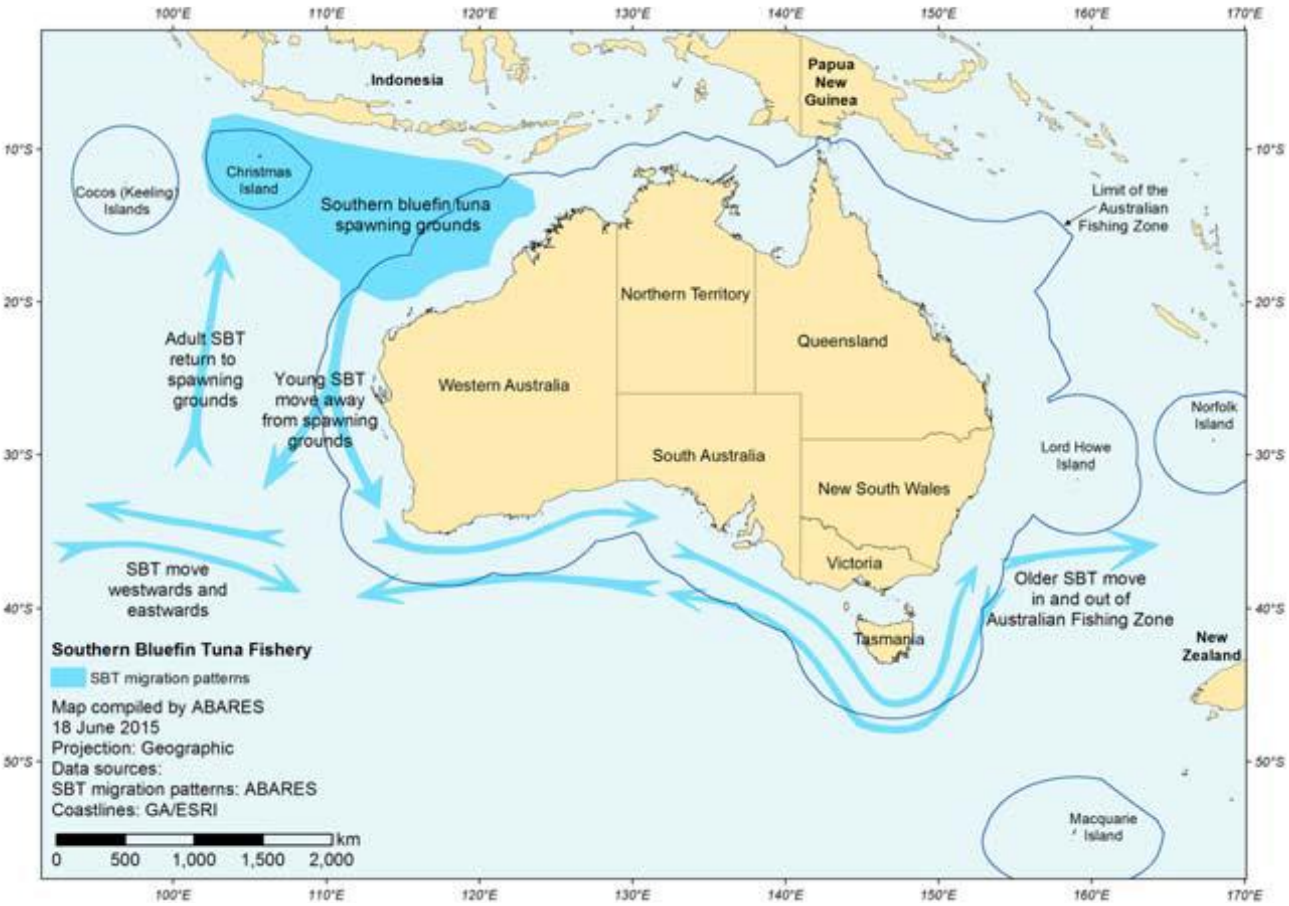
The migratory movements of SBT are complex and vary among life history stages (Figure 4.11). It is thought that larvae follow the Leeuwin Current south from the spawning grounds shortly after hatching in the spring months, reaching the waters off south-west Australia in early summer (Rogers et al. 2013). Most of these young-of-the-year SBT are thought to move into the continental shelf waters off southern Western Australia and gradually move eastwards into the Great Australian Bight. An unknown proportion of this age class remains in the Great Australian Bight throughout the winter while others move into the Indian Ocean (Rogers et al. 2013).

Juvenile SBT (1–4 years old) undertake seasonal large-scale migrations, typically departing from the Great Australian Bight between March and July once seasonal upwelling and associated enhanced productivity declines (Evans et al. 2017a). They then move to major feeding grounds either west and into the central Indian Ocean or east into the Tasman Sea, before returning between November and March to use the Great Australian Bight during the summer and autumn (e.g. Figure 4.13), highlighting the global importance of the region for this species (Evans et al. 2017a; Rogers et al. 2013).

In summer the Great Australian Bight is one of the few locations where SBT form aggregated schools near the sea surface (<200 m deep) during the day. From December to February juvenile SBT largely concentrate in inshore shelf waters or around the shelf break in the western and central Great Australian Bight and tend to shift towards the eastern Great Australian Bight from March to May (Evans et al. 2017b). A large proportion of the annual growth increment of SBT is achieved during this summer and autumn period, with juvenile SBT frequently feeding on relatively small prey, predominantly sardines (Evans et al. 2017b). Increased time spent in warm surface waters over summer may be a form of behavioural thermoregulation, allowing them to increase their body temperature, increasing digestion and growth rates above levels that could be achieved in other coastal or oceanic environments (Evans et al. 2017b). Outside the summer and autumn period, juvenile SBT do not appear to have preferred depth or temperature habitats, instead demonstrating highly plastic behaviours in response to their environment; consequently, feeding is more sporadic and consists of larger prey such as fish, squid and krill. The limited number of SBT that remain in the Great Australian Bight during winter tend to concentrate around the shelf break (Evans et al. 2017b).

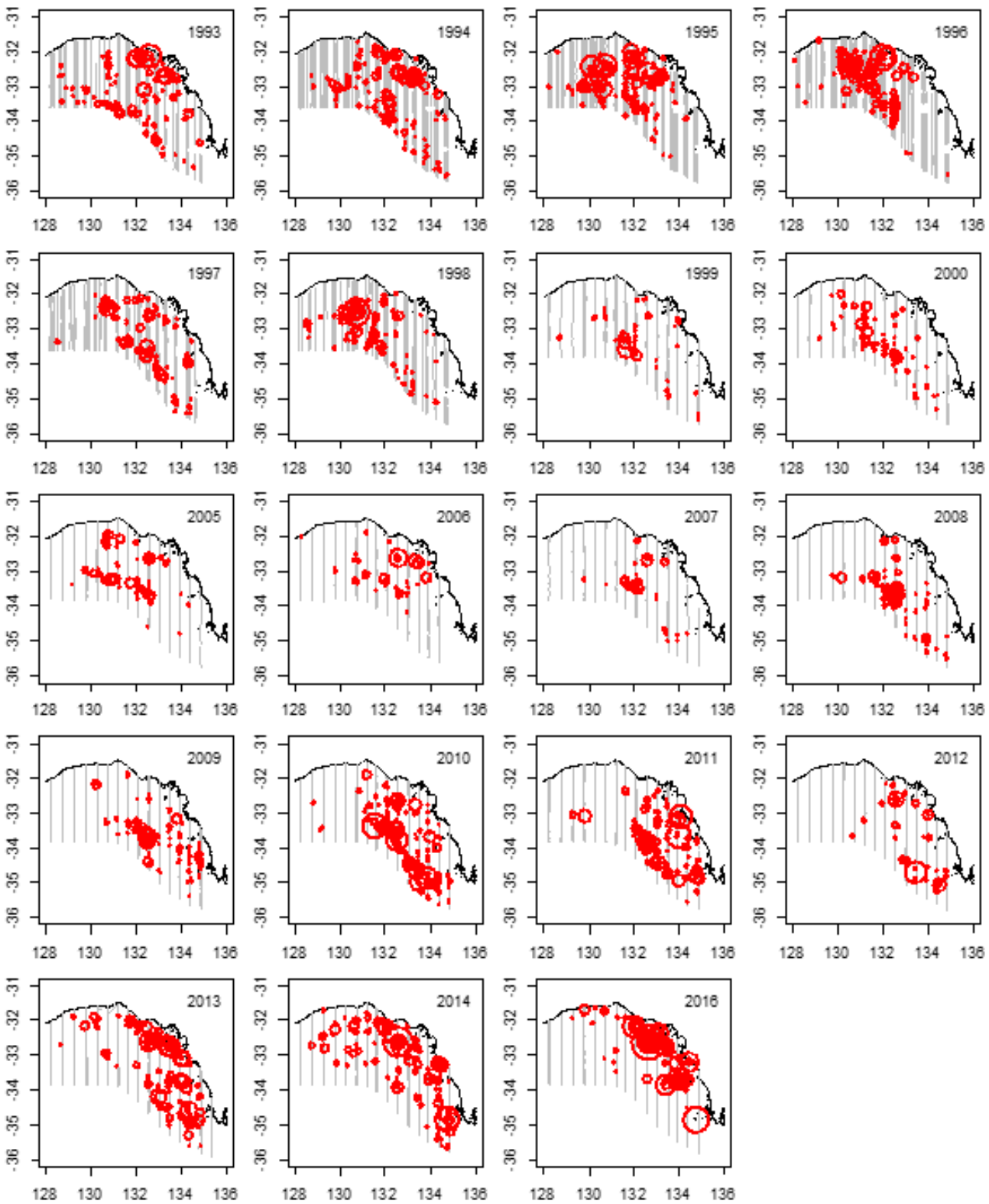
Little is known of the movement patterns of sub-adult SBT (>5 years old) but commercial catch data suggest these animals disperse throughout southern temperate waters. Figure 4.13 shows the tracks of over 120 tagged juvenile SBT which dispersed widely across the Great Australian Bight region. Both sub-adult and adult SBT occur seasonally during the winter throughout the Tasman Sea. Adults migrate south around Tasmania towards the end of spring–beginning of summer, moving across the south of Australia and then north along the western coastline of Australia to the spawning ground in the north-east Indian Ocean (Patterson et al. 2008). Similar to juveniles, migration schedules are highly variable with individuals departing the Tasman Sea from September to December (Patterson et al. 2008). Adults demonstrate temperature preferences for waters of 18–20 °C and waters <250 m, although spend time at depths >600 m, and demonstrate diel variation in diving behaviour for periods of time (Patterson et al. 2008).Fishery independent aerial surveys have previously been used to estimate an annual index of relative abundance of 2–4-year-old SBT in the Great Australian Bight between January and March for most years from 1992 to 2016 (Everson & Farley 2016). This data shows a temporal contraction in the distribution of juveniles within the Great Australian Bight to shelf waters and away from the western Great Australian Bight (Figure 4.12; Evans et al. 2017a). Electronic tagging of juvenile SBT contributes to current understanding of SBT dynamics and abundance (CSIRO 2018). Current estimates of absolute abundance of juvenile SBT are conducted using genetic mark-recapture (gene-tagging) methods (Preece et al. 2014).

SBT will be present within the Risk EMBA (Evans et al. 2017a; Goldsworthy et al. 2017), particularly along the continental shelf and areas nearer the shelf break and upwelling areas (Figures 4.13 and 4.14).



Source: ABARES in Ellis & Kiessling (2016)

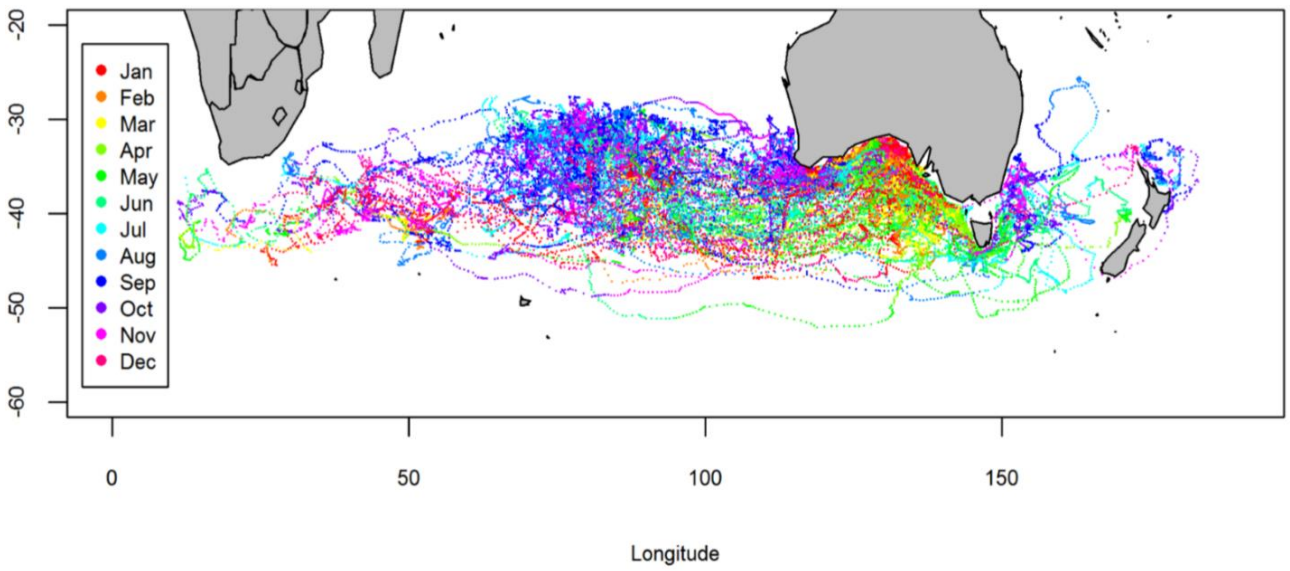
Figure 4.11 Generalised southern bluefin tuna migration patterns



Red circles show the locations of SBT sightings, with the size of the circle proportional to the size of the sighting

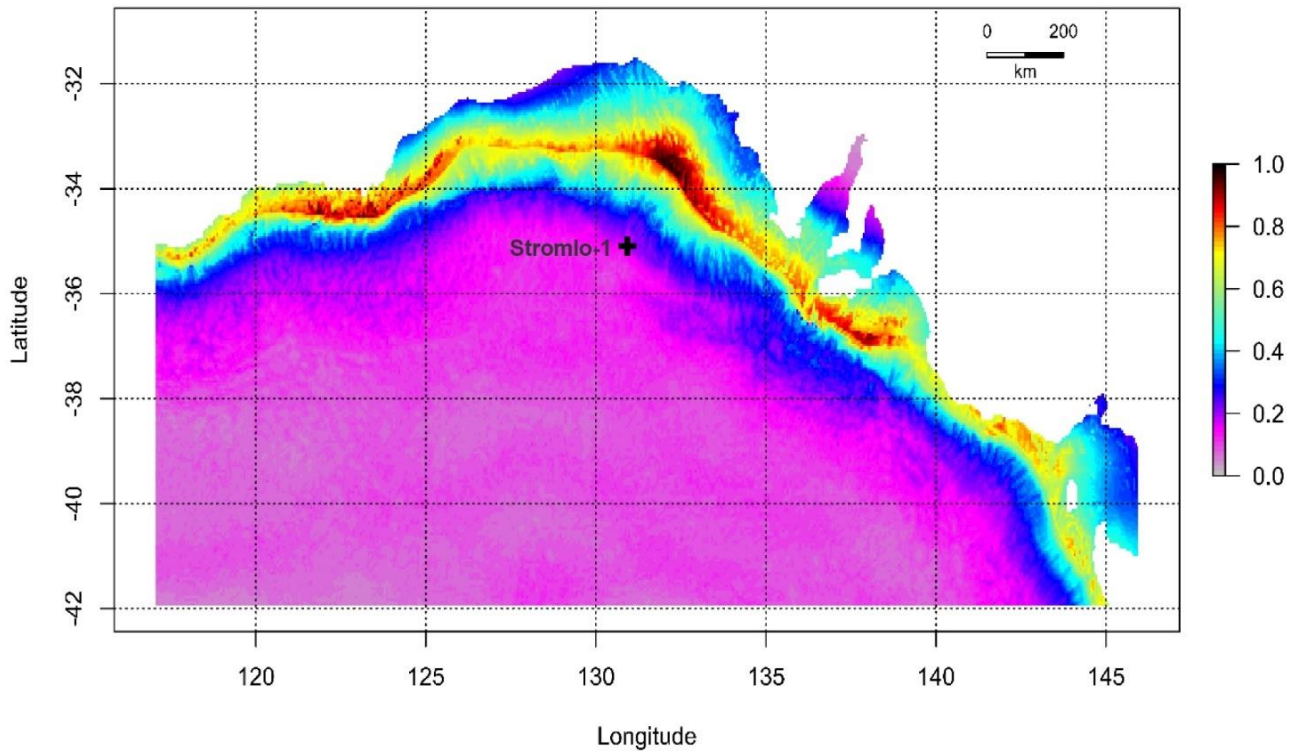
Source: Evans et al. (2017)

Figure 4.12 Distribution of SBT sightings in the Great Australian Bight during areal census surveys 1992-2016



Source: Evans et al. (2017)

Figure 4.13 Movements of juvenile SBT derived from archival tag deployments 1998–2011



Source: Bailleul et al. 2017

Figure 4.14 Standardised probability of potential occurrence of foraging habitats of southern bluefin tuna

The PMST report (Appendix 7-2) identified five threatened and seven migratory shark species as potentially occurring within the Risk EMBA (Table 4.2). These are described below. Biologically Important Areas (BIAs) of EPBC-listed shark species that are located within the Risk EMBA are provided in Figure 4.15.

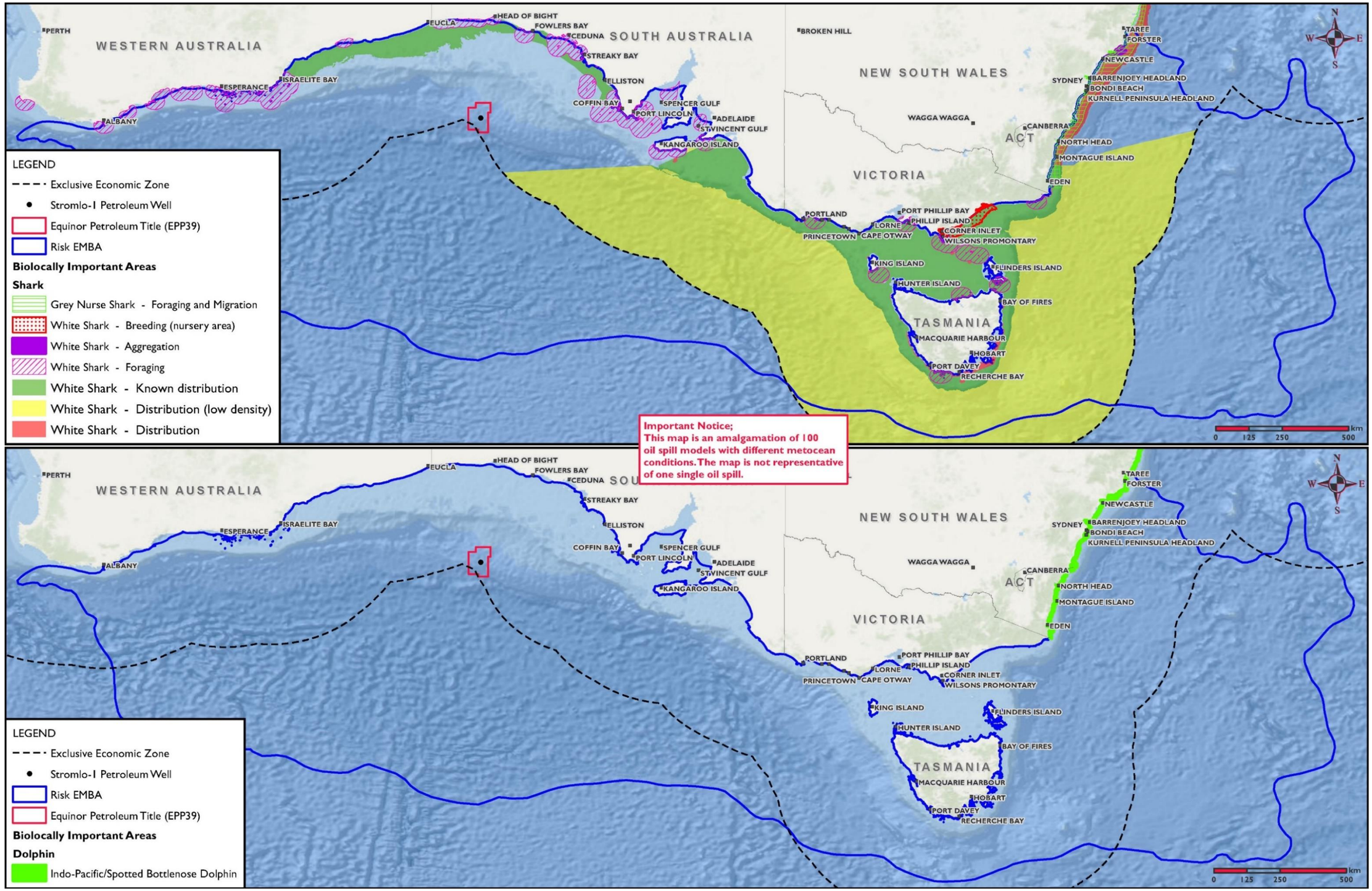


Figure 4.15 Biologically important areas for EPBC - listed sharks and dolphins occurring within the Risk EMBA

4.3.2.7 Great white shark

The great white shark (*Carcharodon carcharias*), listed as a Vulnerable and Migratory species under the EPBC Act, is widely but sparsely distributed throughout temperate and sub-tropical regions of the world (DSEWPaC 2013c). In Australia, great white sharks occur from close inshore rocky reefs, surf beaches and shallow coastal bays to the outer continental shelf and slope waters out to 1000 m depth with a range that extends from north-western Western Australia around the southern coastline (including Tasmanian waters) to central Queensland (DSEWPaC 2013c). Figure 4.16 shows the broad distribution of great white shark foraging areas across the Risk EMBA, including higher density areas south of Western Australia and South Australia that have been identified as foraging sites, and juvenile nursery areas in central New South Wales and eastern Victorian waters. Distribution, foraging, breeding and aggregation BIAs for this species are shown in Figure 4.15.

Genetic evidence suggests that this distribution includes two separate populations: a western population that ranges from north-western Western Australia to western Victorian and an eastern population that ranges along the east coast from Tasmania to central Queensland (Blower et al. 2012). There is currently no reliable estimate of the total size of the Australian great white shark populations and therefore no robust measure of population trends or status (DSEWPaC 2013d). However, there is clear evidence from a range of sources of a decline in the relative abundance of the great white sharks in Australian waters over the last 60 years (DSEWPaC 2013d). Preliminary results of a CSIRO study of great white shark numbers undertaken under the National Environmental Science Program estimates that the western population comprises between 750 and 2250 adults, with a 90% survival rate year to year (Hillary et al. 2018). The preliminary results suggest that there are considerably fewer adults in the eastern population, although it has a slightly improved survival rate of 93% year to year. A recovery plan (DSEWPaC 2013c) has been developed that sets out the research and management actions necessary to support the recovery and long-term survival of great white sharks in Australian waters.

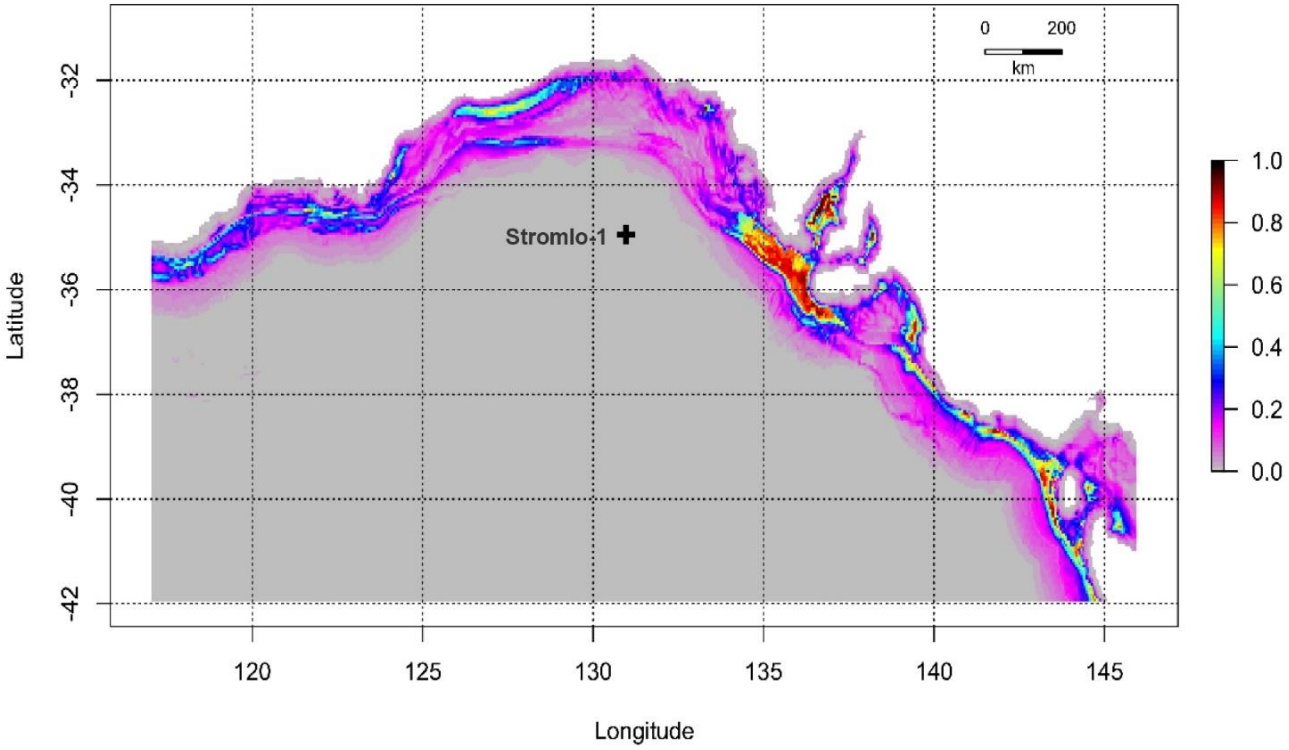
Adult and sub-adult great white sharks are most commonly observed in Australian waters foraging in coastal waters off pinniped colonies at several locations throughout the South-west Marine Region (DSEWPaC 2013c). This includes the Recherche Archipelago and other islands off the lower west coast of Western Australia, in central South Australia around Fowlers Bay, off the Eyre Peninsula, the Neptune Islands, the southern and eastern coasts of Kangaroo Island, and within Spencer Gulf. Males are observed in these waters year-round in relatively consistent numbers, with data collected at the Neptune Islands over 14 years demonstrating that the abundance of great white sharks is greatest overall from winter to spring, when the occurrence of females is focussed (Bruce & Bradford 2015). Observations of sex-specific patterns in seasonal occurrence (Bruce & Bradford 2015), as well as acoustic telemetry (McAuley et al. 2017) and satellite tracking data (Rogers et al. 2016), show that great white sharks only visit these foraging areas temporarily. Great white shark movements indicate a pattern of temporary residency at favoured sites intermixed with periods of long-distance travel between these sites, undertaking large-scale migrations where they spend the majority of their time in continental shelf habitats often travelling at depths between 400 and 700 m (Rogers et al. 2016). Individual great white sharks may, however, also show a high diversity of movement strategies and there is limited evidence of predictable return behaviour, seasonal movement patterns or coordination of the direction and timing of individual shark's movements. The observed diversity of movement patterns is hypothesised to relate to patterns of distribution and abundance of suitable prey, reproductive cycling and oceanographic clues, yet the relative importance of each of these drivers is unknown.

Juvenile great white sharks spend a considerable amount of time in the nearshore environment where they feed on finfish, rays and other sharks until they reach approximately 3.4 m in length (generally at around five years of age) and shift to include marine mammals in their diet (Estrada, J.A, Rice, A.N, Natanson, L.J, Skomal 2006). Satellite and acoustic tracking of great white sharks in eastern Australia have shown that juveniles also intersperse broad-scale movements with periods of temporary residency (both generally occurring shoreward of the 120 m depth contour). However, individual juveniles have shown preferred habitat areas and annual patterns of residency in two discrete coastal nursery areas in waters surrounding Port Stephens in central New South Wales (around the northern margin of the Risk EMBA) and the southern section of 90 Mile Beach (Corner Inlet) in south-east Victoria (within the Risk EMBA) (Bruce & Bradford 2012). A recent study (Harasti et al. 2017) using acoustic telemetry demonstrated that juvenile great white sharks use also use the large estuarine systems adjoining the known nursery areas in eastern Australia (Harasti et al. 2017). No juvenile nursery sites have been identified in the south-west region and pupping locations for white sharks remain unknown (DSEWPaC 2013d).

Habitat modelling undertaken by Bailleul et al. (2017) based on tracking data collected from pop-up archival tags deployed on five great white sharks by Rogers et al. (2016) as part of the Great Australian Bight Research Program (Section 1.2.2) indicates that habitats where great white sharks have a high probability of potential occurrence are located on the continental shelf and shelf break in the eastern and western Great Australian

Bight and in Spencer and St Vincent Gulfs. No habitat suitable for the occurrence of great white great white sharks was found to exist within 50 km of the well location (Figure 4.16).

This species is likely to occur in the Risk EMBA and is unlikely to be encountered within the vicinity of the well location.



Source: Bailleul et al. (2017)

Figure 4.16 Standardised probability of potential occurrence of foraging habitats of great white sharks

4.3.2.8 Grey nurse shark

Distinct populations of the grey nurse shark (*Carcharias taurus*) inhabit inshore sub-tropical to cool temperate waters around continental land masses (DoE 2014b). Significant declines have occurred throughout the species' range, resulting in grey nurse shark populations now being restricted to the east and west coasts of Australia, South Africa and the east coasts of North and South America (DoE 2014a). The populations in Australian waters are genetically distinct and listed separately under the EPBC Act; the east coast population is listed as critically endangered and the west coast population is listed as Vulnerable. A recovery plan (DoE 2014a) has been developed that sets out the research and management actions necessary to support the recovery and long-term survival of both populations in Australian waters.

Grey nurse sharks are found on the continental shelf to a depth of at least 230 m but are most commonly observed in caves or sandy gutters close to the mainland or around islands (DoE 2014a). Adults and juveniles are both generally solitary and thought to migrate throughout much of their populations range, although aggregations of five or more individuals gather on a recurrent basis are known to occur at certain locations around inshore rocky reefs and sandy bottom gutters in depths of 10–40 m (DoE 2017). Aggregation sites are considered habitat critical to the survival of the species as they may play an important role in pupping and/or mating (DoE 2014a).

The Australian east coast population covers a range of approximately 2700 km with sightings extending from central Queensland (Capricornia coast) to as far south the New South Wales–Victorian border (DoE 2014a). The typical distribution of the east coast population has been identified as a BIA for grey nurse sharks (Figure 4.15). Aggregation sites identified for the east coast population include four sites identified in Queensland waters, 13 sites located in New South Wales waters and two off New South Wales in Commonwealth waters (DoE 2014a). These only occur within a minor portion of the Risk EMBA around Sydney.

The Australian west coast population is predominantly found in coastal waters in the south-west of Western Australia (Chidlow et al. 2006). Records indicate that its range is approximately 2900 km with sighting widely distributed from the North West Shelf (including coastal waters), south to coastal waters in the eastern Great

Australian Bight (around Cocklebiddy, Western Australia) (DoE 2014a). Only one aggregation site, at the Point Murat Navy Pier in Exmouth, has been confirmed for the west coast grey nurse shark population (Chidlow et al. 2006; Hoschke & Whisson 2016). No potential aggregation sites have been identified within the Risk EMBA (Chidlow et al. 2006).

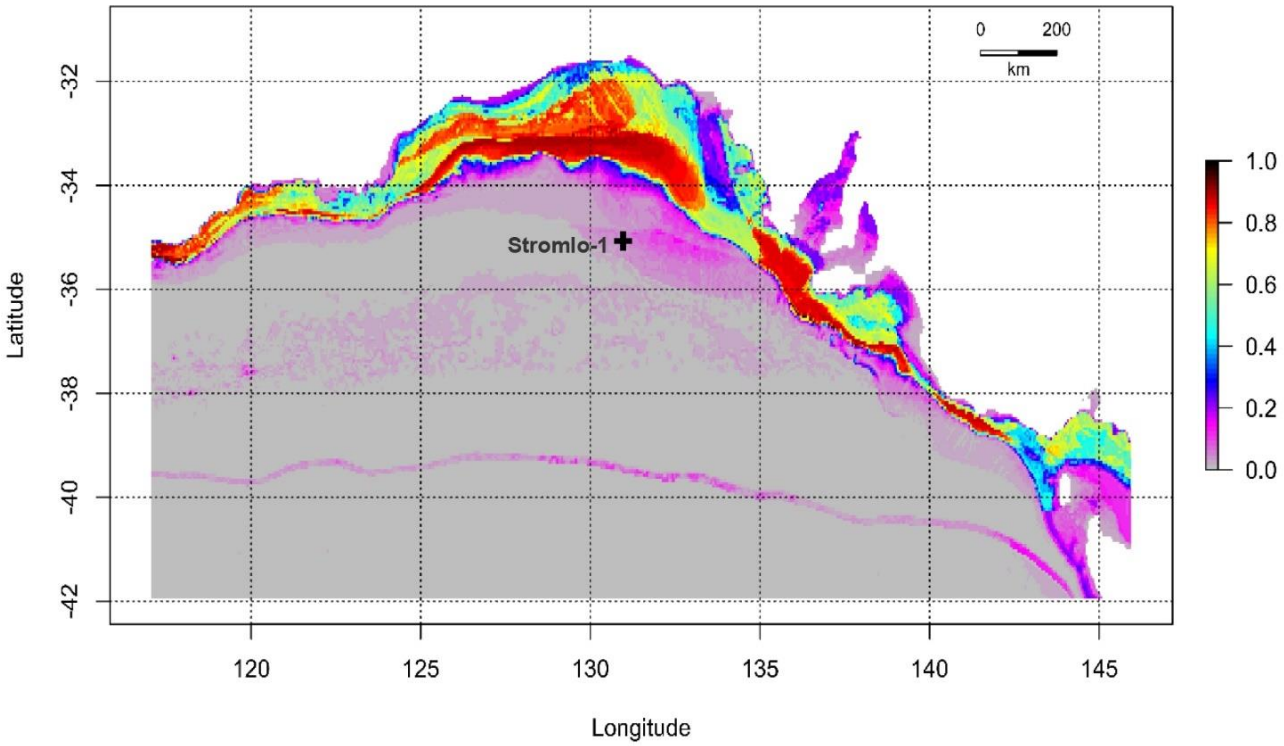
This species may occur in the Risk EMBA but is unlikely to be encountered within the vicinity of the well location.

4.3.2.9 Shortfin mako

The shortfin mako (*Isurus oxyrinchus*), listed as a migratory species under the EPBC Act, is a pelagic shark with a circumglobal oceanic distribution in tropical and temperate seas that grows to maximum length of 4 m (TSSC 2014). The species is widespread in offshore waters around most of Australia (other than the Arafura Sea, Gulf of Carpentaria and Torres Strait) and is known to travel large distances to areas well beyond the EEZ (TSSC 2014). Shortfin mako generally inhabit depths from the surface to 600 m, often spending the majority of the night in shallower water and the days in deeper water.

Habitat modelling undertaken by (Bailleul et al. 2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data collected from pop-up archival tags deployed on 18 mako sharks demonstrates that suitable habitats in the Great Australian Bight are located over the continental shelf and shelf break (Figure 4.17).

Given the widespread distribution the shortfin mako, the species is likely to be encountered within the Risk EMBA and may be present in the vicinity of the well location.



Source: Bailleul et al. (2017)

Figure 4.17 Standardised probability of potential occurrence of foraging habitats of shortfin mako sharks

4.3.2.10 Porbeagle shark

The porbeagle shark (*Lamna nasus*), listed as a migratory species under the EPBC Act, is widely distributed through temperate and cold-temperate waters of the North Atlantic and Southern Hemisphere (Cavanaugh et al. 2003; IUCN 2010). In Australia, porbeagle sharks are typically found in oceanic waters on the continental shelf and are distributed from south-western Australia throughout the South-east Marine Region to southern Queensland (DoE 2015a). The species preys on bony fishes and cephalopods and is an opportunistic hunter that regularly moves up and down in the water column, catching prey in mid-water as well as at the sea floor. It is most commonly found over food-rich banks on the outer continental shelf but does make occasional forays close to shore or into the open ocean, down to depths of approximately 1300 m (Evanset al. 2017). It also undertakes long-distance seasonal migrations, although the timing and details of migratory movements are not well understood for Australian populations (DEE 2017c).

This species may be encountered near the well location and the Risk EMBA.

4.3.2.11 Reef manta ray

The reef manta ray (*Manta alfredi*), listed as a migratory species under the EPBC Act, is circumglobally distributed in tropical and subtropical waters (IUCN 2011a). The reef manta ray is the smaller of the two recognised manta species (the giant manta ray is described in Section 1.5.5.5.6), with a maximum disc width of 5 m and weight of up to 1350 kg (IUCN 2011a). Reef manta rays predominantly reside in productive coastal and continental shelf waters off northern Australia where they feed on a variety of zooplankton. They are most frequently encountered around Ningaloo Reef and the Great Barrier Reef, but individuals have been recorded as far south as Albany on the west coast and Sydney on the east coast (DEE 2017d). Reef manta rays are capable of travelling almost 70 km in a day and have been documented moving up to 500 km along the east coast of Australia (IUCN 2011a).

The reef manta ray is unlikely to be encountered within the Risk EMBA given that there is only minimal overlap with the maximum extent of the species known distribution.

4.3.2.12 Giant manta ray

The giant manta ray (*Manta birostris*), listed as a migratory species under the EPBC Act, has a global distribution in tropical, sub-tropical and temperate marine waters (IUCN 2011b). The manta genus was re-evaluated and split into two distinct species in 2009; the giant manta ray, which has been recorded with a disc width up to 7 m and weight of 2400 kg (IUCN 2011b), and the smaller, more commonly encountered reef manta ray (described in Section 1.5.5.5.5). Relatively little is currently known about the giant manta ray except that it is mostly oceanic and potentially highly migratory. The southern extent of the species typical distribution in Australia is thought to be the south-west corner of Western Australia on the west coast and the Victorian–New South Wales border on the east coast (DoE 2015a). The species was recorded off the north-east corner of Tasmania in 2014, extending the species known distribution range to 40°S but this was attributed to irregular oceanographic conditions and is likely a rare occurrence (Couturier et al. 2015).

This species is unlikely to be encountered within the vicinity of the well location but may occur in the Risk EMBA.

4.3.2.13 Whale shark

The whale shark (*Rhincodon typus*), listed as a Vulnerable and Migratory species under the EPBC Act, is the world's largest species of fish (growing up to 20 m in length and 34 tonnes in weight), and one of only three filter-feeding sharks (DoE 2015c). Whale sharks are highly migratory pelagic species that have global distribution in all tropical and warm temperate seas, generally from 30°N to 30°S (Rowat & Brooks 2012). In Australia, whale sharks occur mainly off the NT, Queensland, and northern Western Australia (DoE 2015c) although there have been isolated records of whale sharks off New South Wales, Victoria and South Australia (DoE 2015c). Whale sharks form seasonal aggregations in coastal waters at several sites around the world, which have been linked to localised seasonal pulses of food productivity (Rowat & Brooks 2012). These are considered BIAs and within Australian waters include Ningaloo Reef, Western Australia (from March to July), off the coastal waters off Christmas Island (during December and January), and in the Coral Sea (during November and December) (DoE 2015c).

This species is unlikely to be encountered within the vicinity of the well location but may occur in the Risk EMBA.

4.3.2.14 Maugean skate

The maugean skate (*Zearaja maugeana*), listed as endangered under the EPBC Act, is only known from two estuaries in Tasmania; Bathurst and Macquarie Harbours (DEWHA 2008a). This species has an extremely restricted habitat and range within these estuaries, being only found in the shallow, low saline, naturally low-nutrient waters of the upper reaches (DEWHA 2008a). Conservation advice has been developed to provide guidance on the recovery of the maugean skate.

This species is unlikely to be encountered within the Risk EMBA.

4.3.3 Fish spawning

Commercially important fish species that occur within the Risk EMBA are largely broadcast spawners (i.e. species that release vast numbers of sperm and eggs into the water column, or in some cases scatter them on the substratum), with several species forming spawning aggregations on the continental shelf, shelf break and slope. Commercially important crustacean species such as southern rock lobster and giant crab also spawn eggs but hold them under their abdomen where they incubate until hatching. Spawning species may aggregate at locations and spawn all their eggs and sperm at a specific time within a certain period (e.g. on a lunar cycle for blue grenadier), batch spawn across a region multiple times during certain seasons (e.g. pink ling and Australian sardine) or spawn continuously throughout the year (e.g. Gould's squid).

Information regarding spawning in offshore regions of the Great Australian Bight is generally limited. Spawning aggregation areas are not known to occur in the vicinity of the Stromlo-1well location and consultation with relevant fishing industry authorities (i.e. AFMA (2017) and PIRSA) and commercial fishing associations (i.e. GABA, WFSA) for fisheries permitted to operate in the survey area did not identify concerns over fish spawning in the vicinity of the well location.

Spawning periods for key species of Commonwealth and South Australia fisheries with a jurisdictional area that includes the well location are shown in Table 4.3. Some commercially important species able to be fished in the vicinity of the well location are not shown in Table 4.3 as they spawn outside of the Risk EMBA, most notedly southern bluefin tuna (Section 1.5.5.4). The spread of fish spawning periods throughout the year (Table 4.3) indicates that there are no specific periods of higher sensitivity with respect to fish spawning for key fisheries species likely to spawn within the Risk EMBA.

Table 4.3 Spawning periods occurring within the Risk EMBA for key species of Commonwealth and South Australia fisheries with a jurisdictional area that includes the Stromlo-1 well location

Fishery		Key species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Additional information
Commonwealth managed fisheries	Western Tuna and Billfish Fishery	Yellowfin tuna													Spawn throughout the tropical and equatorial waters of the major oceans. Spawning is seasonal at higher latitudes with peaks in summer
		Bigeye tuna													Spawning occurs throughout the year in tropical waters, mostly occurring in the eastern Pacific Ocean. Peak spawning periods in the southern hemisphere are between summer and autumn
		Skipjack tuna													Spawn throughout the year in tropical waters and during summer and early autumn in subtropical waters. The spawning season becomes shorter as distance from the equator increases
		Albacore													Spawning occurs in small aggregations during the summer. The peak spawning period in the southern hemisphere occurs in summer
		Broadbill swordfish													Spawning appears to occur throughout the year in tropical waters but is restricted to spring and summer at higher latitudes
	Southern and Eastern Scalefish and Shark Fishery (SESSF)	SESSF – Commonwealth trawl sector													
		Blue grenadier													Spawning occurs in winter and early spring. The main spawning ground for blue grenadier is on the west coast of Tasmania (AFMA 2017)
		Tiger flathead													Spawning occurs over an extended period from spring to autumn, with some variation on the timing of spawning depending on location
		Silver warehou													Spawning occurs in late winter-early spring, with some variation in timing depending on location
		Pink ling													Spawning occurs over an extended period during late winter and spring. May move into deeper water to spawn
		SESSF – Gillnet, hook and trap sector													
		Blue-eye trevalla													Thought to move into shallower waters and aggregate over specific areas for spawning. Most spawning activity occurs in waters from central New South Wales to north-eastern Tasmania
		Pink ling	See above												See above

Fishery		Key species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Additional information
		SESSF – Great Australian Bight trawl sector													
		Deepwater flathead													Spawning activity in the western central Great Australian Bight peaks in late summer
		Bight redfish													Form spawning aggregations above “lumps” on the seabed during summer and early autumn
		Orange roughy													Migrate to form dense spawning aggregations usually associated with submerged hills or seamounts generally at depths of 700–1000 m
	Small Pelagic Fishery	Jack mackerel													Spawning begins off the south-east coast of Australia and moves progressively southwards over the summer. Eggs and sperm are released among schooling fish, possibly deep in the water column near the edge of the continental shelf
		Redbait													Spawning occurs over 2–3 months during spring
		Australian sardine													Spawning occurs during spring-summer in the southern part of the species range, and in summer-autumn in the northern part
	Southern Squid Jig Fishery	Gould’s squid													Spawn continuously throughout the year, possibly with 2–3 peaks in spawning activity
South Australian managed fisheries	Sardine (pilchard) Fishery	Australian sardine	See above												See above
	Rock Lobster Fishery	Southern rock lobster													Hatching occurs in early spring, phyllosoma then spend 8–23 months at sea during which time they become widely distributed in the Southern Ocean
	Marine Scalefish Fishery	King George whiting													Spawn in offshore waters from late summer to winter
		Southern garfish													Spawning occurs in close association to seagrass beds with peak spawning activity occurring from Oct to Nov
		Australasian snapper													Aggregate outside harbours, bays and estuaries to spawn, usually from Nov to Dec. South Australia state-wide snapper spawning closure between midday 1 Nov and midday 15 Dec each year. Additional closure areas are in place in the gulfs from 15 Dec to 31 Jan
		Southern calamari													Spawning occurs in shallow inshore waters, with egg mass deposits attached to seagrass, macroalgae and reef substrates
	Miscellaneous Fishery (specialised fisheries)	Scallop													Spawning occurs over an extended period during winter and spring
		Giant crab													Closures previously existed in South Australia waters from May to Oct

Source: AFMA (2017); Collette & Nauen (1983); DEWR (2006); Dredge et al. (2016); Ewing & Lyle JM(2009); FAO (2005); Kailola et al. (1993); Marshall et al. (1993); Pecl (2000); PIRSA (2007, 2017); Poisson & Fauvel (2009); ild (1994)

4.3.4 Syngnathids

The PMST report identified 51 syngnathids (family Syngnathidae) including pipefishes, seahorses, pipehorses and the three known species of seadragons. Syngnathids are found in temperate and tropical seas across the world. Limited information has been published on syngnathids as they are generally well-camouflaged. Most species inhabit shallow, sheltered coastal waters where they typically are associated with seagrass meadows, macroalgal habitats, rocky reefs and sponge gardens located in shallow, inshore waters (e.g. protected coastal bays, harbours and jetties) less than 50 m deep (Bray 2017). The Gulf of St Vincent and Spencer Gulf contain important syngnathid habitat (Brown et al. 2008). The DEE's (2017m) online SPRAT Database indicates that the syngnathid species listed in the Risk EMBA are widely distributed throughout southern, south-eastern and south-western Australian waters.

4.3.4.1 Seadragons

Seadragons are endemic to southern Australia and are a focal point for conservation across the region. The common seadragon (*Phyllopteryx taeniolatus*) is the marine faunal emblem of Victoria and the leafy seadragon (*Phycodurus eques*) is the marine faunal emblem of South Australia. The ruby seadragon (*Phyllopteryx dewysea*) was first described in 2015 and has only been recorded in Western Australia waters (Rouse et al. 2017). Common and leafy seadragons are mostly found over sandy substrates in waters up to 50 m deep, around kelp-covered rocks and in seagrasses. The range of the common seadragon spans the entire southern coast from Western Australia to New South Wales and Tasmania, whereas the leafy seadragon has a more restricted distribution from Western Australia to South Australia (Gomon et al. 2008). Ruby seadragons are known from three specimens collected near Perth (one beach-washed and the other two trawled in 72 m) and from the Recherche Archipelago (~50 m depth from one live sighting and one trawled specimen carrying a brood of eggs) (Rouse et al. 2017). Although limited, the available evidence suggests that the ruby seadragon may have a widespread nearshore distribution in Western Australia but occur at depths >30 m (Rouse et al. 2017).

Syngnathids are found within the Risk EMBA but are not known to occur in the vicinity of the well location.

4.4 Marine reptiles

Five species of marine turtles listed as MNES under the EPBC Act were identified in the PMST Report as potentially occurring in the Risk EMBA (Appendix 7-2). These are identified in Table 4.4 and described in further detail in Sections 1.5.6.1.1 to 1.5.6.1.5. All five marine turtle species are listed as both threatened and migratory with foraging, feeding or related behaviour known to occur within area. No marine turtle BIAs are recognised within the Risk EMBA (http://www.environment.gov.au/webgis-framework/apps/ncva/ncva.jsf; accessed 13 Sept 2018). All species of marine turtles in Australian waters are managed under the Recovery Plan for Marine Turtles in Australia (DEE 2017e).

Table 4.4 MNES listed marine reptile species or species habitat and marine reptiles with BIAs within the Risk EMBA

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory marine species[2]	Type of presence		
Caretta caretta	Loggerhead turtle	Endangered	Yes	Foraging, feeding or related behaviour known to occur within area	No	Recovery Plan for Marine Turtles in Australia (DEE 2017e)
Chelonia mydas	Green turtle	Vulnerable	Yes	Foraging, feeding or related behaviour known to occur within area	No	
Dermochelys coriacea	Leatherback turtle	Endangered	Yes	Foraging, feeding or related behaviour known to occur within area	No	

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory marine species[2]	Type of presence		
Eretmochelys imbricate	Hawksbill turtle	Vulnerable	Yes	Foraging, feeding or related behaviour known to occur within area	No	
Natator depressus	Flatback turtle	Vulnerable	Yes	Foraging, feeding or related behaviour known to occur within area	No	

1 Listed threatened species: A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.
2 Listed migratory species: A native species that from time to time are included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.

4.4.1 Loggerhead turtle

The endangered loggerhead turtle (*Caretta caretta*) is globally distributed in tropical, sub-tropical waters and temperate waters (Limpus 2008a). Loggerhead turtles show a strong fidelity to their breeding and feeding areas (Limpus 2008a).

The main Australian breeding areas for loggerhead turtles are generally confined to the southern Queensland and north-western Western Australia coasts (Limpus 2008a). Hatchlings disperse into oceanic currents and gyres and remain in pelagic environments until large enough to settle in coastal feeding habitats (DEE 2017e). Pelagic juveniles from eastern Australian rookeries are known to travel as far as South America (DEE 2017e). Following this, loggerhead turtles take up residency nearshore and forage in depths up to 55 m, feeding primarily on benthic invertebrates such as molluscs and crabs (DEE 2017e). Loggerhead turtles forage in the waters of all coastal states and the Northern Territory (NT), but are uncommon in South Australia, Tasmania and Victoria (DEE 2017e). Most migrate less than 1000 km between their feeding and breeding areas (Limpus 2008a), although individuals have been infrequently recorded in waters north-east of Kangaroo Island and as far as Spencer Gulf (DENR 2004).

The loggerhead turtle is expected to only be an occasional visitor to the Risk EMBA and is unlikely to be encountered in the vicinity of the well location.

4.4.2 Green turtle

The Vulnerable green turtle (*Chelonia mydas*) is distributed in subtropical and tropical waters around the world (Limpus 2008b). Green turtles show a strong fidelity to their breeding and feeding areas (Limpus 2008b). Nine genetically distinct Australian green turtle stocks are recognised with breeding areas across northern Australian waters including the Cocos Keeling, North West Shelf, Ashmore Reef, Scott Reef-Browse Island, Cobourg, Gulf of Carpentaria, northern Great Barrier Reef and Torres Strait, Coral Sea and southern Great Barrier Reef (DEE 2017e). Green turtle hatchlings spend their first 5–10 years drifting on ocean currents until they settle in tidal and subtidal coastal habitats such as reefs, bays and seagrass beds where they feed on seagrass and algae (Limpus 2008c; DEE 2017e). Green turtles are predominantly found in Australian waters off the NT, Queensland and Western Australia coastlines, with limited numbers in New South Wales, Victoria and South Australia (DEE 2017e). Most migrate less than 1000 km between feeding and breeding areas (Limpus 2008b), although individuals have been infrequently recorded in waters north-east of Kangaroo Island and as far as Spencer Gulf (DENR 2004).

Green turtles are expected to only be an occasional visitor to the Risk EMBA and are unlikely to be encountered in the vicinity of the well location.

4.4.3 Leatherback turtle

The Endangered leatherback turtle (*Dermochelys coriacea*) is distributed throughout tropical, sub-tropical and temperate waters around the world (Limpus 2009a). Unlike other marine turtles, leatherback turtles do not take up residency in continental shelf waters but instead spend most of their life travelling vast distances and foraging in temperate coastal and open ocean areas. As the species is largely pelagic, leatherback turtles also

differ in that they remain planktivorous throughout their life, feeding on jellyfish and large planktonic ascidians in the upper 300 m of the water column (Limpus 2009a). Within Australia, the species is most commonly reported from coastal waters in central-eastern Australia (southern Queensland to central New South Wales), south-east Australia (from Tasmania, Victoria and eastern South Australia) and in south-western Western Australia (Limpus 2009a). The central-eastern and south-eastern Australian region is one of five identified foraging sites (where area restricted behaviour is known to occur) for the leatherback turtles (Bailey et al. 2012; DEE 2017e). Tracks from individuals fitted with satellite tags indicate that they forage in warmer waters further north in autumn and spring and only forage at higher southerly latitudes in south-east Australian waters during summer (November to February) (Bailey et al. 2012). This is consistent with reports that the species has often been observed in the Bass Strait during summer (Limpus 2009a). Away from their feeding grounds leatherback turtles are rarely found nearshore (DEE 2017e). Records available from the Atlas of Living Australia (CSIRO 2017) suggest that the species is a rare but occasional visitor to the Great Australian Bight; between 2006 and 2016 there were eight sightings (including strandings) recorded in the Great Australian Bight and ten in the Bass Strait, compared to over 40 in waters off the coast of New South Wales.

No major leatherback turtle rookeries have been recorded in Australia. Most leatherback turtles in Australian waters migrate to breed in neighbouring countries including Indonesia, north-west Papua, northern Papua New Guinea, the Solomon Islands and Vanuatu. However, nesting is known to occur in the NT during December-January as well as occasionally along parts of southern Queensland and northern New South Wales (last reported in 1996) (DEE 2017e). Nesting has not been recorded along any beaches within the Risk EMBA.

The leatherback turtle is expected to occasionally visit the Risk EMBA but is unlikely to occur in the vicinity of the well location, particularly during the winter months.

4.4.4 Hawksbill turtle

The Vulnerable hawksbill turtle (*Eretmochelys imbricata*) is found in tropical and sub-tropical waters in all the oceans of the world (Limpus 2009b). Major nesting of hawksbill turtles in Australia occurs on beaches at Varanus Island and Rosemary Island in Western Australia, off Arnhem Land in the NT, and along the northern Great Barrier Reef and Torres Strait in Queensland (DEE 2017e). Hawksbill turtle hatchlings spend from one to three years drifting on ocean currents until they settle in tidal and subtidal coral and rocky reef habitats (DEE 2017e). Adult hawksbill turtles are omnivorous and predominantly forage in nearshore waters where a variety of animals and plants can be found (DEE 2017e). In Australia, hawksbill turtles are most frequently encountered throughout tropical and warm temperate areas to as far south along the east coast as northern New South Wales and Exmouth Gulf in Western Australia (Limpus 2009b). Hawksbill turtles foraging along Australia's east are known to migrate up to 2400 km to the breeding areas of neighbouring South Pacific countries, while those off Western Australia remain within around 450 km from their nesting beaches (DEE 2017e). It is not known from which stock hawksbill turtles foraging in New South Wales originate (DEE 2017e).

This species is unlikely to be present in the vicinity of the well location but may occur within the Risk EMBA.

4.4.5 Flatback turtle

The Vulnerable flatback turtle (*Natator depressus*) is found only in the tropical waters of northern Australia, Papua New Guinea and Irian Jaya, and is one of only two species of marine turtle without a global distribution (Limpus 2008c). Flatback turtle nesting is confined to Australia and typically occurs from north-west Western Australia to southern Queensland (DEE 2017e). Adults display a high degree of fidelity and migrate to their breeding areas over distances in excess of 1300 km (Limpus 2008c). Unlike other marine turtles flatback turtles do not have a post-hatchling juvenile pelagic life stage (DEE 2017e). Instead flatback turtles are thought to spend their entire sub-adult life phase within northern Australian continental shelf waters (DEE 2017e). Adults typically inhabit soft bottom habitat over the continental shelf but forage widely into continental waters off Papua New Guinea and Indonesia (DEE 2017e).

This species is unlikely to occur within the Risk EMBA.

4.5 Marine mammals

The Risk EMBA supports internationally significant populations of numerous marine mammals. The PMST report (Appendix 7-2) identified 45 marine mammals species listed as threatened and/or migratory MNES under the EPBC Act that may potentially occur within the Risk EMBA. This included 40 cetaceans, four pinnipeds and one sirenian species. These are identified in Table 4.5 and described in further detail in the following sections. The National Conservation Values Atlas (DoEE 2015) showed that five of these species have BIAs defined within the Risk EMBA. Regionally significant species identified from Marine Bioregional Plans are also described.

4.5.1 Cetaceans

Thirty-five cetacean species have been recorded in the Great Australian Bight, including 11 baleen (mysticete) whales and 24 toothed (odontocete) whale species (Fulton et al. 2017). Information on cetaceans in the Great Australian Bight is largely restricted to sightings or stranding records and so the population status, population dynamics, foraging ecology and habitat utilisation of most species are poorly understood (Rogers et al. 2013). The Great Australian Bight Research Program has improved the understanding of spatial distribution of key cetacean species across the Great Australian Bight by tracking and habitat modelling including historical records. BIAs for the Indo-Pacific/spotted bottlenose dolphin (Figure 4.15) and a number of whale species (Figure 4.18) overlap the Risk EMBA

Table 4.5 Marine mammal species (threatened, migratory and/or with a BIA) or species habitat within the Risk EMBA

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species	Listed migratory marine species	Type of presence		
Cetaceans (whales and dolphins)						
Balaenoptera acutorostrata	Minke whale	–	–	Species or species habitat may occur within area	–	–
Balaenoptera bonaerensis	Antarctic minke whale	–	Yes	Species or species habitat likely to occur within area	–	–
Balaenoptera borealis	Sei whale	Vulnerable	Yes	Foraging, feeding or related behaviour known to occur within area	–	*Balaenoptera borealis* (sei whale) conservation advice (TSSC 2015b)
Balaenoptera edeni	Bryde's whale	–	Yes	Species or species habitat likely to occur within area	–	–
Balaenoptera musculus	Blue whale	Endangered	Yes	Foraging, feeding or related behaviour known to occur within area	Yes	Blue Whale Conservation Management Plan (DoE 2015d)
Balaenoptera physalus	Fin whale	Vulnerable	Yes	Foraging, feeding or related behaviour known to occur within area	–	*Balaenoptera physalus* (fin whale) conservation advice (TSSC 2015c)
Beradius arnuxii	Arnoux's beaked whale	–	–	Species or species habitat may occur within area	–	–
Caperea marginata	Pygmy right whale	–	Yes	Foraging, feeding or related behaviour likely to occur within area	–	–
Delphinus delphis	Common dolphin	–	–	Species or species habitat may occur within area	–	–
Eubalaena australis	Southern right whale	Endangered	Yes	Breeding known to occur within area	Yes	Conservation Management Plan for the Southern Right Whale (DSEWPAC 2012)
Feresa attenuata	Pygmy killer whale	–	–	Species or species habitat may occur within area	–	–
Globicephala macrorhynchus	Short-finned pilot whale	–	–	Species or species habitat may occur within area	–	–
Globicephala melas	Long-finned pilot whale	–	–	Species or species habitat may occur within area	–	–
Grampus griseus	Risso's dolphin	–	–	Species or species habitat may occur within area	–	–

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species	Listed migratory marine species	Type of presence		
Hyperoodon planifrons	Southern bottlenose whale	–	–	Species or species habitat may occur within area	–	–
Kogia breviceps	Pygmy sperm whale	–	–	Species or species habitat may occur within area	–	–
Kogia simus	Dwarf sperm whale	–	–	Species or species habitat may occur within area	–	–
Lagenorhynchus obscurus	Dusky dolphin	–	Yes	Species or species habitat likely to occur within area	–	–
Lissodelphis peronii	Southern right whale dolphin	–	–	Species or species habitat may occur within area	–	–
Megaptera novaeangliae	Humpback whale	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	*Megaptera novaeangliae* (humpback whale) Conservation Advice (TSSC 2015d)
Mesoplodon bowdoini	Andrew's beaked whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon densirostris	Blainville's beaked whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon ginkgodens	Gingko-toothed beaked whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon grayi	Gray's beaked whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon hectori	Hector's beaked whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon layardii	Strap-toothed whale	–	–	Species or species habitat may occur within area	–	–
Mesoplodon mirus	True's beaked whale	–	–	Species or species habitat may occur within area	–	–
Orcinus orca	Killer whale	–	Yes	Species or species habitat likely to occur within area	–	–
Pseudorca crassidens	False killer whale	–	–	Species or species habitat likely to occur within area	–	–
Physeter macrocephalus	Sperm whale	–	Yes	Foraging, feeding or related behaviour known to occur within area	Yes	–

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species	Listed migratory marine species	Type of presence		
Sousa chinensis	Indo-Pacific humpback dolphin	–	Yes	Species or species habitat may occur within area	No	–
Stenella attenuata	Spotted dolphin	–	–	Species or species habitat may occur within area	–	–
Stenella coeruleoalba	Striped dolphin	–	–	Species or species habitat may occur within area	–	–
Stenella longirostris	Long-snouted spinner dolphin	–	–	Species or species habitat may occur within area	–	–
Steno bredanensis	Rough-toothed dolphin	–	–	Species or species habitat may occur within area	–	–
Tasmacetus shepherdi	Shepherd's beaked whale	–	–	Species or species habitat may occur within area	–	–
Tursiops aduncus	Indian Ocean bottlenose dolphin	–	–	Species or species habitat likely occur within area	–	–
Tursiops truncatus s. str.	Bottlenose dolphin	–	–	Species or species habitat may occur within area	–	–
Ziphius cavirostris	Cuvier's beaked whale	–	–	Species or species habitat may occur within area	–	–
Pinnipeds (fur seals, seals and sea lions)						
Mirounga leonina	Southern elephant seal	Vulnerable	–	Breeding may occur within area	–	Conservation Advice *Mirounga leonina* southern elephant seal (TSSC 2016i)
Neophoca cinerea	Australian sea lion	Vulnerable	–	Breeding known to occur within area	Yes	Recovery Plan for the Australian Sea Lion (*Neophoca cinerea*) (DSEWPaC 2013e)
Arctocephalus forsteri	New-Zealand fur seal	–	–	Breeding known to occur within area	–	–
Arctocephalus forsteri	Australian fur seal	–	–	Breeding known to occur within area	–	–
Sirenians (sea cows)						
Dugong dugon	Dugong	–	Yes	Species or species habitat may occur within area	No	–

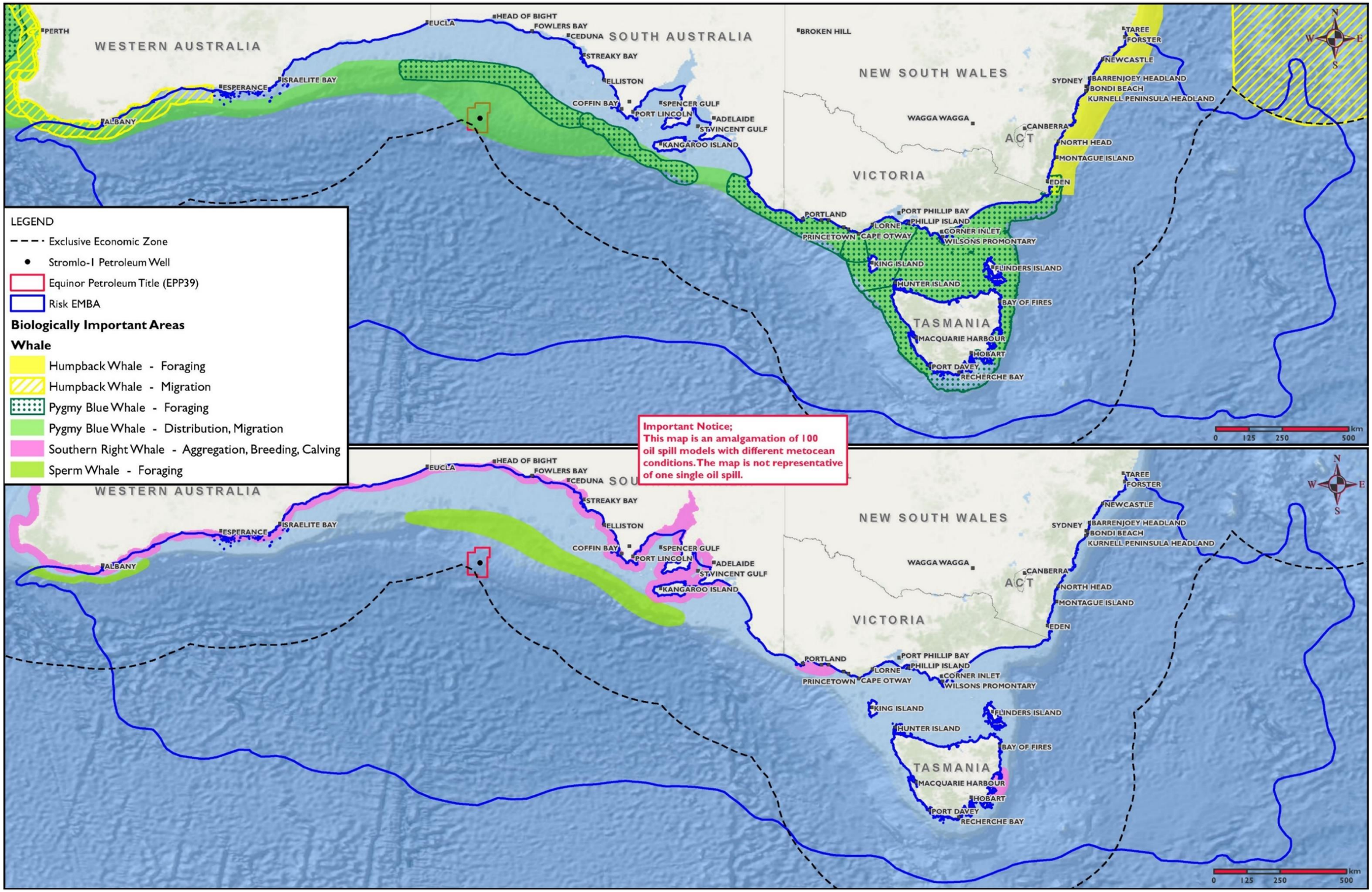


Figure 4.18 Biologically important areas for EPBC-listed cetaceans that overlap the Risk EMBA

4.5.1.1 Antarctic minke whale

Antarctic minke whales (*Balaenoptera bonaerensis*), listed as migratory under the EPBC Act, have been recorded from all Australian states except the NT (Bannister et al. 1996) though population estimates in Australia are not available (DoE 2017). This species is known to occur north to 21°S off the east coast, with distribution along the west coast of Australia unknown. The southern distribution of Antarctic minke whales extends south to approximately 65°S in the Australian Antarctic Territory (DoE 2018). Antarctic minke whales are known to feed on Antarctic krill (*Euphausia superba*) and other smaller krill species. In the high latitudinal winter breeding grounds in other regions, Antarctic minke whales appear to be distributed off the continental shelf edge, suggesting a similar winter distribution could be expected for Australian Antarctic waters (DoE 2017). Extensive migration occurs between their summer feeding grounds in Antarctic waters and winter subtropical or tropical breeding grounds (DoE 2017). Mating occurs from June to December, with calving peaking during late May–early June in warmer waters north of the Antarctic convergence, with a 14-month calving cycle (DoE 2018).

Aerial surveys for inshore cetaceans undertaken across coastal waters (<100 m water depth) of the Great Australian Bight between Ceduna and Coffin Bay during July and August 2013 detected one Antarctic minke whale (Bilgmann et al. 2014). No Antarctic minke whale were observed during 2011–2012 Ceduna 3D seismic survey of the Ceduna sub-basin (inclusive of the EPP39 permit area) in depths ranging from approximately 1000 to 3000 m (BP 2016) or the offshore aerial cetacean survey undertaken during December 2015 and April 2016 as part of the Great Australian Bight Research Program from south-west Kangaroo Island to south of the Head of the Bight between the 100 and 200 m depth contours (Gill 2016).

Due to the uncertainties associated with the exact migratory paths, foraging and breeding areas, there is the potential that the Antarctic minke may be encountered in the vicinity of the well location and within the Risk EMBA.

4.5.1.2 Sei whale

The sei whale (*Balaenoptera borealis*), listed as Vulnerable and Migratory under the EPBC Act, is a wide-ranging baleen whale species with a global distribution that primarily resides in deep-water oceanic habitats (TSSC 2015b). The distribution, abundance and latitudinal migrations of sei whales are thought to be largely determined by seasonal feeding and breeding cycles, although the spatial and temporal distribution of sei whales and areas where biologically important behaviour are displayed (BIAs) are poorly defined in the Australian region (TSSC 2015b). The majority of sightings occur within Australian Antarctic Territory waters but sei whales have infrequently been recorded in Commonwealth waters off all states as well as the NT (TSSC 2015b).

The main factor that is the cause of the species being eligible for listing in the Vulnerable category is its small population size due to being severely impacted by whaling last century and most of this decline occurred in the southern hemisphere (TSSC 2015b). The global population of mature sei whales is estimated to have declined by about 80% over the previous three generation period (= 70 years), with no direct evidence of a recent increase in the population (TSSC 2015b). Conservation advice has been developed to provide guidance on the recovery of sei whale populations using Australian waters.

It is thought that the sei whale has a similar migration pattern to other baleen whale species, completing long annual seasonal migrations from sub-polar summer feeding grounds to lower latitude winter breeding grounds, but details of this migration, and whether it involves the entire population, are unknown (TSSC 2015b).

Recent sightings of sei whales within the Risk EMBA include the Bonney Upwelling region off South Australia (Miller et al. 2012) where opportunistic feeding has been observed between November and May (Gill et al. 2015), as well as a small number of females and calves sighted about 40 km south of Hobart, Tasmania (Ensor et al. 2002; cited in TSSC 2015b). No sei whales were observed during 2011–2012 Ceduna 3D seismic survey of the Ceduna sub-basin (inclusive of the EPP39 permit area) in depths ranging from approximately 1000 to 3000 m (BP 2016).

This species is likely to be present within the Risk EMBA infrequently and is unlikely to be present in the vicinity of the well location.

4.5.1.3 Bryde's whale

Bryde's whale (*Balaenoptera edeni*), listed as Migratory under the EPBC Act, is restricted to tropical and temperate waters (generally found between latitudes of about 40°N and 40°S) and has been recorded off all Australian states (Bannister et al. 1996). Bryde's whales can be found in both oceanic and inshore waters with the only key localities recognised in Australia being in the northern parts of the continent (DEE 2018b).

Population estimates are not available for Bryde's whales, globally or in Australia, and no migration patterns have been documented in Australian waters (DEE 2018b). Offshore populations have been recorded in depths of between 500 and 1000 m.

Due to the uncertainties associated with the exact migratory paths, foraging and breeding areas, there is the potential that the Bryde's whale may be encountered in the vicinity of the well location and within the Risk EMBA.

4.5.1.4 Blue whale

Blue whales (*Balaenoptera musculus*), listed as Endangered and Migratory under the EPBC Act, reach a length of over 30 m, weigh up to 180 tonnes and live up to 90 years (DEH 2005b). The blue whale is a cosmopolitan species, found in all oceans except the Arctic, but is absent from some regional seas such as the Mediterranean, Okhotsk and Bering seas. There are two recognised subspecies of blue whale in Australian waters; the Antarctic blue whale (*B. m. intermedia*) and the pygmy blue whale (*B. m. brevicauda*) (DoE 2015f). Both subspecies are found in all Australian waters, with the Antarctic blue whale primarily found in waters south of 60°S and pygmy blues found in waters north of 55°S (DSEWPC 2012c). Given that both species may be found in Australian waters reference to blue whale unless otherwise specified is synonymous to both species.

The Antarctic blue whale subspecies remains severely depleted from historic whaling and its numbers are recovering slowly. Approximately 341,830 blue whales were recorded as taken by whaling in the Antarctic and sub-Antarctic (IWC 2006) in the 20th century, of which 12,618 were identified as pygmy blue whales or are assumed to have been so from their location (Branch et al. 2004). The current global population of blue whales is uncertain but is plausibly in the range of 10,000 to 25,000, corresponding to about 3–11% of the 1911 population size. For the pygmy blue whale there is uncertainty of their numbers pre-exploitation and their current numbers are not known. Pygmy blue whale reaches sexual maturity between the ages of 5 – 15 with a blue whale life span of 70-90 years (https://www.whalefacts.org).

The blue whale is included in the Conservation Management Plan for the Blue Whale identifies threats and establishes actions for assisting the recovery of blue whale populations using Australian waters (DoE 2015d).

BIAs for the pygmy blue whale have been identified around Australia and a number overlap the Risk EMBA (Figure 4.18). These include a distribution BIA that extends along the south coast and up the west coast of Australia and foraging areas. The nearest foraging pygmy blue whale BIA is located north of the Stromlo-1 well, and along the shelf break to the west and south of Kangaroo Island, extending north-west along the 200 m isobath (DEWHA 2007; DSEWPaC 2012c,:Morrice et al. 2004).

Both subspecies feed on krill (euphausiids, *Nyctiphane australis*). The predominant foraging baleen whale that occurs in the Great Australian Bight is the pygmy blue whale. The area between Cape Otway and Robe, which includes the Bonney Upwelling, has been identified as having high annual use due to an abundance of food (DoE 2015a). The total number of blue whales that forage in Great Australian Bight waters is unknown but based on estimates of sightability from aerial surveys they may number 150 and are thought to remain in the upwelling system for approximately six months of the year (P. Gill pers. comm.; cited in Fulton et al. 2017). Antarctic blue whales feed mainly during summer–autumn, while pygmy blues feed during November to May in a regional upwelling system of temperate latitudes (Gill et al. 2011), this being the Eastern Great Australian Bight Upwelling/Kangaroo Island canyons (DSEWPaC 2012a, 2012b), approximately 350 km south-east of the well location.

Most sightings that occur between late spring to autumn to the east of the well location are believed to be pygmy blue whales (DEWHA 2007; DoE 2015a), though aerial surveys indicate that their abundance in the eastern Great Australian Bight is highly variable between and within seasons (DSEWPaC 2012a).

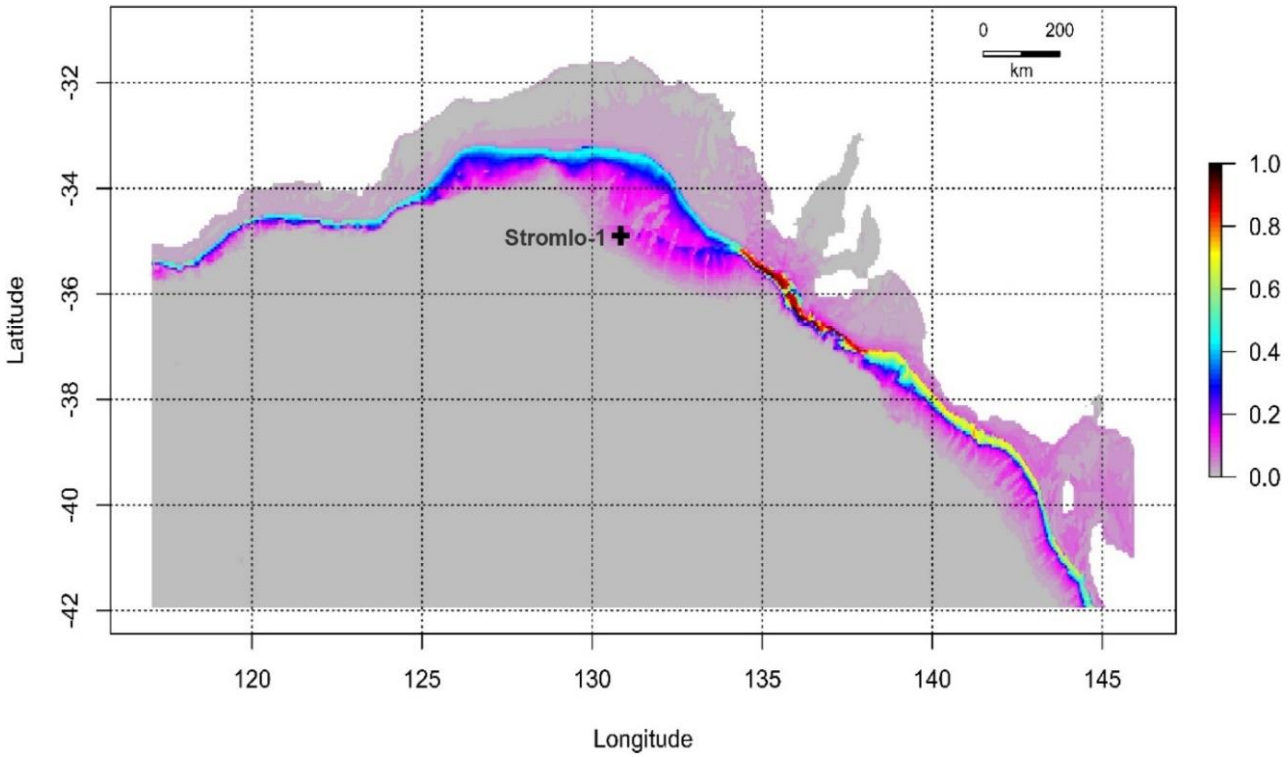
Noise logging studies undertaken by McCauley et al. (2012) for BP/Equinor's Ceduna 3D seismic survey indicate that pygmy blue whale signals were received at the shelf break and at the Head of Bight in late 2011. Antarctic blue whales were detected from the shelf break and at the Head of Bight in late 2011. Antarctic blue whales were detected from the shelf break during winter, likely to be coming from deeper southern waters (McCauley et al. 2012).

The pygmy blue whale species migrates twice a year along the coast off Western Australia between the Bonney Upwelling system in the Great Australian Bight and Indonesia. Pygmy blue whales are known to migrate between warm water (low latitude) breeding grounds near Indonesia and cold water (high latitude) feeding grounds off the south-west of Australia. Blue whale migration patterns are similar to those of the humpback whale, with the species feeding in mid to high latitudes (south of Australia) during the summer months and moving to temperate/tropical waters in the winter for breeding and calving. Blue whale migration is oceanic and no specific migration routes have been identified in the Australasian region (DEWHA 2007).

Up to 40 photo-identified individuals have been recorded in the Great Australian Bight, but no formal assessments of abundance have been undertaken in Australia (Rogers et al. 2013). During the 2011–2012 Ceduna 3D seismic survey of the Ceduna sub-basin (inclusive of the EPP39 permit area) in depths ranging from approximately 1000 to 3000 m, a total of 12 blue whales were observed; ten within the vicinity of the well location and two during transit. Ten of these sightings occurred during November. Pygmy blue whales were also detected at the Head of Bight by sound loggers deployed from November 2011 to June 2012, with no detection of pygmy blue whales from late January to May 2012 at the Head of Bight (McCauley et al. 2012). An offshore aerial cetacean survey (between 100 and 200 m depth contours) was undertaken between south-west Kangaroo Island to south of the Head of the Bight, during December 2015 and April 2016 and recorded six blue whales (Gill 2016).

Habitat modelling undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) identified that pygmy blue whales are most likely to occur within the Great Australian Bight over the continental shelf break between 134°E and 138°E but may be encountered along the entire continental shelf break (Figure 4.19). The well location includes habitat with a low suitability for pygmy blue whales with the nearest areas with a moderate probability of occurrence suitability for the species approximately 150 km away.

Given the proximity of the foraging and migration BIA to the well location, it is likely that pygmy blue whales will be present within the Risk EMBA (peak activity November–May) and may occur in the vicinity of the well location but will be more common in upwelling areas outside the Risk EMBA.



Source: Bailleul et al. (2017)

Figure 4.19 Standardised probability of potential occurrence at-sea of pygmy blue whales

4.5.1.5 Fin whale

The fin whale (*B. physalus*), listed as Vulnerable and Migratory under the EPBC Act, is considered a cosmopolitan species and occurs from polar to tropical waters, and rarely in inshore waters (TSSC 2015c). The extent of their distribution in Australian waters is uncertain but they occur withi4n Commonwealth waters and have been recorded in most state waters and from Australian Antarctic Territory waters (Bannister 2008a; Bannister et al. 1996; Thiele et al. 2000).

The fin whale's inclusion on the EPBC Act threatened species list is primarily due to its small population size (TSSC 2015c). The species was very abundant prior to commercial whaling last century, with an estimated global population of about 400,000 whales in the 1920s, of which about 325,000 occurred in the southern hemisphere (Rielly et al. 2008j). The global population is estimated to have declined by more than 70% over three generations between 1929–2007 (TSSC 2015c).

The total abundance and population trends of fin whales in Australian waters is unknown. Estimated population numbers given by Aguilar (2009) in global locations included 15,200 fin whales in the Antarctic, south of 30°S. Conservation advice (TSSC 2015c) has been developed to provide guidance on the recovery of fin whale populations using Australian waters.

These whales are generally thought to undertake long annual migrations from higher latitude summer feeding grounds to lower latitude winter breeding grounds (Aguilar 2009). It is likely that fin whales migrate between Australian waters and external waters including Antarctic feeding areas (the Southern Ocean), subantarctic feeding areas (the Southern Subtropical Front), and tropical breeding areas (Indonesia, the northern Indian Ocean and south-west South Pacific Ocean waters) (D. Thiele 2004, pers. comm.; cited in TSSC 2015c). Their oceanic migratory routes and dispersal to winter breeding grounds are largely unknown (TSSC 2015c).

Fin whales are generalist feeders, preying on schooling krill, fish and squid (TSSC 2015c). Fin whales have been sighted inshore over the southern Australian continental shelf and slope between western Bass Strait and the eastern Great Australian Bight, corresponding to the known extent of the broad-scale upwelling system (which includes the predictable and intense Bonney Upwelling), multiple times (n = 7) during the upwelling season between November and May (Gill et al. 2015). This includes one of the first documented records of these whales feeding in Australian waters, suggesting that the southern Australian coastal upwelling zone may be used as an opportunistic foraging ground (Gill et al. 2015).

The sighting of a fin whale cow and calf in the Bonney Upwelling in April 2000 and the stranding of two fin whale calves in South Australia suggest that the area could potentially play a role in the species' breeding, perhaps as a provisioning area for cows with calves (TSSC 2015c). However, there are no defined mating or calving areas in Australia waters.

During the 2011–2012 Ceduna 3D seismic survey, a total of nine fin whales were observed (in the central Great Australian Bight over the shelf break and slope) during November, April and May. An offshore aerial cetacean survey (between 100 and 200 m depth contours) was undertaken between south-west Kangaroo Island to south of the Head of the Bight, during December 2015 and April 2016 and recorded one fin whale over the upper slope in the eastern Great Australian Bight (Gill 2016).

The species is likely to occur within the Risk EMBA but as the Stromlo-1 well location is more than 500 km west of the nearest upwelling zone south of Kangaroo Island, transient individuals may pass through the area but it is unlikely that the species will be encountered in the vicinity of the well location in large numbers.

4.5.1.6 Pygmy right whale

The pygmy right whale (*Caperea marginata*), listed as Migratory under the EPBC Act, is a baleen whale found in temperate and sub-Antarctic waters in oceanic and inshore locations. The species, which has never been hunted commercially, is thought to have a circumpolar distribution in the southern hemisphere between about 30°S and 55°S. Distribution appears limited by the surface water temperature as they are almost always found in waters with temperatures ranging from 5 °C to 20 °C (Baker 1985). There are few confirmed sightings of pygmy right whales at sea (Reilly et al. 2008a). The largest reported group sighted (100+) occurred near Portland in June 2007 (Gill et al. 2008).

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.5.1.7 Southern right whale

The southern right whale (*Eubalaena australis*), listed as Endangered and Migratory under the EPBC Act, is a baleen whale species that reaches a maximum length of approximately 17.5 m and a weight of around 80 tonnes (DSEWPaC 2012e). The species only occurs in the southern hemisphere where it has a circumpolar distribution between latitudes of 16°S and 65°S (DSEWPaC 2012e). The Australian southern right whale population migrates annually from southern feeding grounds (below 40°S) to breed, calve and rest in coastal waters (mostly within 2 km of the shoreline) between Perth and Sydney (including off Tasmania) between May and November (Charlton et al. 2014; DSEWPaC 2012e).

The southern right whale is listed as endangered because the species undergone a severe reduction in numbers as a result of commercial whaling in the 19th century and 20th century. The estimated overall number of southern right whales was between 55,000 and 70,000 in the late 1700s (DSEWPaC 2012e) but by the 1920s there may have been fewer than 300 individuals remaining throughout the southern hemisphere (DSEWPaC 2012e). The population is thought to have begun to recover following protection in 1935, but illegal Soviet whaling in the 1960s is estimated to have removed over half the remaining population and delayed recovery (DSEWPaC 2012e). The Australian population is thought to have been reduced from approximately 15,000 individuals to as few as 300 (Bannister 1990) although other reports suggest the number of individuals in Australia was reduced to 1500 (Charlon et al. 2014). The Australian population is recovering slowly and is currently estimated at 2500 individuals in 2017 (Charlton 2017).

Two genetically differentiated sub-populations of southern right whales are suggested to exist within the Australian population, the western sub-population and the eastern sub-population (Mackay & Goldsworthy 2015). The western Australian sub-population, which includes ~2195 individuals according to the latest estimates, occupies areas between Cape Leeuwin in Western Australia and Ceduna, South Australia (Bannister 2017). The eastern sub-population consists of fewer than 300 individuals and can be found along the south-eastern coast, including Tasmania, but rarely further north than Sydney. The western population is showing signs of recovery at the suggested species maximum biological rate of recovery of approximately 7% per year while the eastern subpopulation is not showing signs of recovery (Mackay & Goldsworthy 2015).

Critical habitat has not been identified for the southern right whale under the EPBC Act; however, the Conservation Management Plan for the Southern Right Whale 2011–2021 (DSEWPC 2012a) provides information on BIAs necessary for maintaining essential life functions (Figure 4.20). The majority of southern right whales aggregate in a relatively small range, compared with suitable habitat. In Australia, wintering and calving/nursery grounds are primarily found off southern Western Australia and off the far west of South Australia (Figure 4.20) (DSEWPaC 2012e). Key large established calving areas in South Australia include Head of Bight, Fowlers Bay and Encounter Bay. Western Australia sites include Flinders Bay, Hassel Beach, Doubtful Island Bay, Bremer Bay, Israelite Bay Twilight Cove and Yokinup Bay. Victorian sites include Port Fairy, Warrnambool, Port Campbell and Peterborough.

Less than 10% of reproductively mature females calving along the Australian coast in any one year appear to use the coast off Tasmania, Victoria, New South Wales and eastern South Australia.

The National Conservation Values Atlas (DoEE 2015) identifies BIAs for southern right whales in coastal waters throughout the South-east Marine Region and the South-west Marine Region below Perth, including the Bass Straight (Figure 4.20). The nearest BIA is the southern right whale calving habitat, which is runs along the coast east of Kangaroo Island and is approximately 320 km north of the well location at the nearest point.

The breeding area BIA for southern right whale illustrated in Figure 4.20 may be considered critical habitat given that female southern right whales show calving site fidelity, which combined with their low and slow reproductive rate (DSEWPaC 2012b) make calving sites of critical importance to the species recovery.

The closest aggregation area to the well location is the Head of Bight, approximately 375 km to the north (Figure 4.20). This is a significant aggregation area, where 25-40% of the south-western population gathers between May and October to calve in waters less than 20 m deep (Charlton 2017). Female mother-calf pairs generally stay within the calving grounds for 2–3 months (DSEWPaC 2012b), peaking from mid to late July to mid-late August at the Head of Bight.

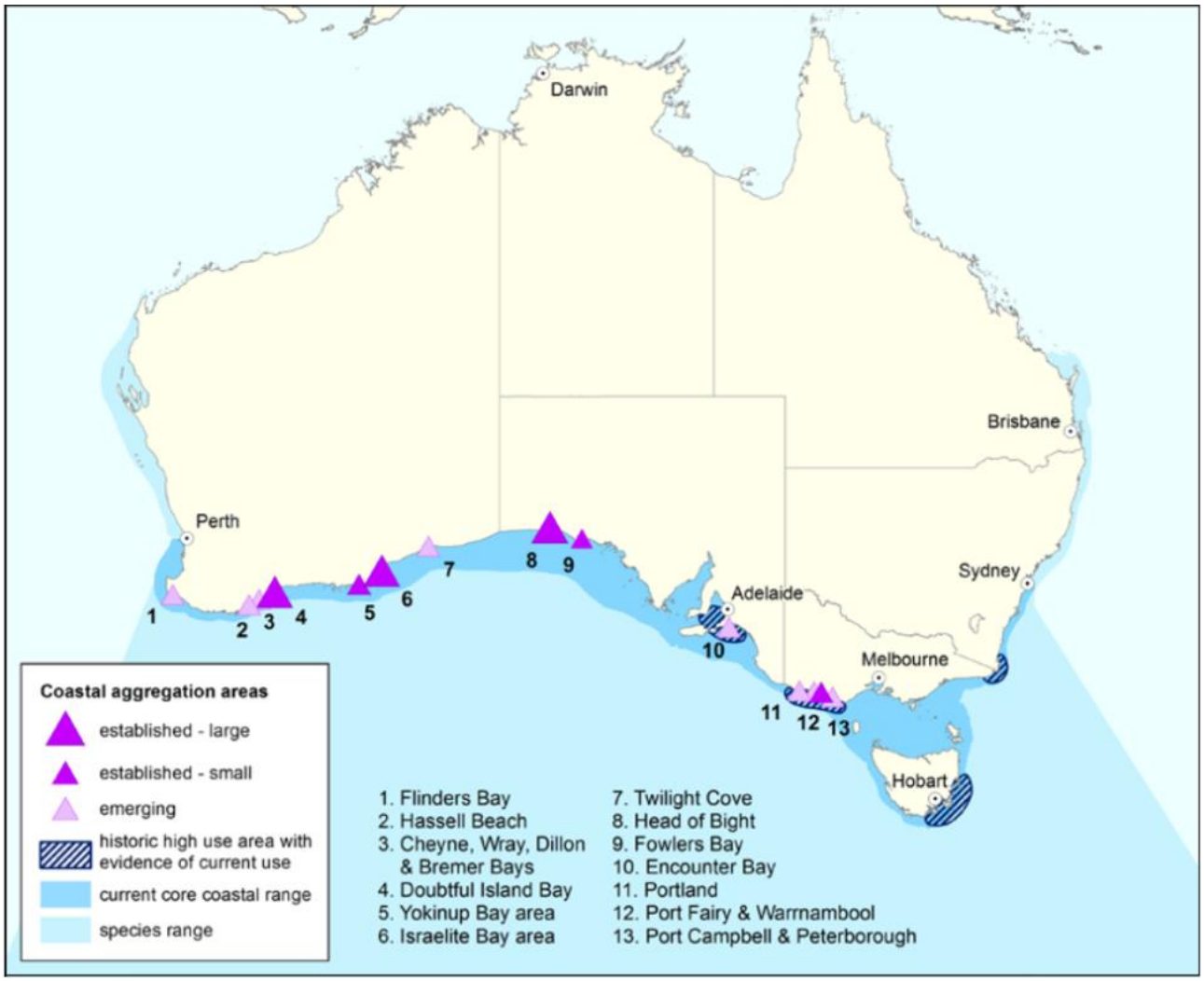
The southern right whale photo identification and population census study has been continuously maintained at the Head of Bight since 1991. The study collects daily census and photo identification data (during the peak period of coastal residence in August) from cliff-top vantage points along a 15 km stretch of the Bunda Cliffs and provides an unbroken data series on abundance trends and life history data (Charlton et al. 2014). Long-term abundance data suggests there are triennial peaks in abundance representing cohort structured breeding cycles, with indications that the Australian population is recovering at approximately 7% per annum (with the Head of Bight population growth rate being 5.5% for 1991–2013) (Charlton et al. 2014).

Monitoring of population dynamics of “western right whales” has also been conducted through an annual series of aerial surveys off the southern Australian coast between Cape Leeuwin Western Australia and Ceduna South Australia since 1993. The 2017 count, while still being finalised, is likely to total more than 800 southern right whales, the highest tally since the count began (ABC/Bannister 2017; Bannister 2016)

Southern right whales move offshore from the Great Australian Bight to higher latitude areas, including the Antarctic ice edge, to feed on crustaceans in the spring months (September to November) (Rogers et al. 2013). Limited information is available on migration paths away from the coast. A defined nearshore coastal migration corridor is considered unlikely given the absence of any predictable directional movement of southern right whales along the coast (DSEWPaC 2012a). The entire coastline from Kangaroo Island west to the Perth Canyon may be part of the migratory pathway for the southern right whale (DSEWPC 2012e). From photo identification data, it is thought that relatively direct approaches and departures to the coast are likely, and there is a seasonal westward movement (DSEWPC 2012e). Information obtained from sound loggers deployed in the Great Australian Bight indicates that southern right whales move to the Head of Bight from the south and possibly from the west (McCauley et al. 2012). Satellite tracking of three adult female southern right whales (each accompanied by a calf) undertaken by SARDI in September 2014 at the Head of Bight showed that when they departed (approximately a month later) two of the whales immediately travelled south-west across the shelf without following the coastline (Figure 4.21) (Mackay & Goldsworthy 2015). The tag on the other southern right whale did not function as intended and only began to transmit data 30 days after it was deployed, however the data that were eventually received showed that the whale followed the coast west before departing to the south-west (Mackay & Goldsworthy 2015). Therefore, it is possible that southern right whales will travel within the vicinity of the well location.

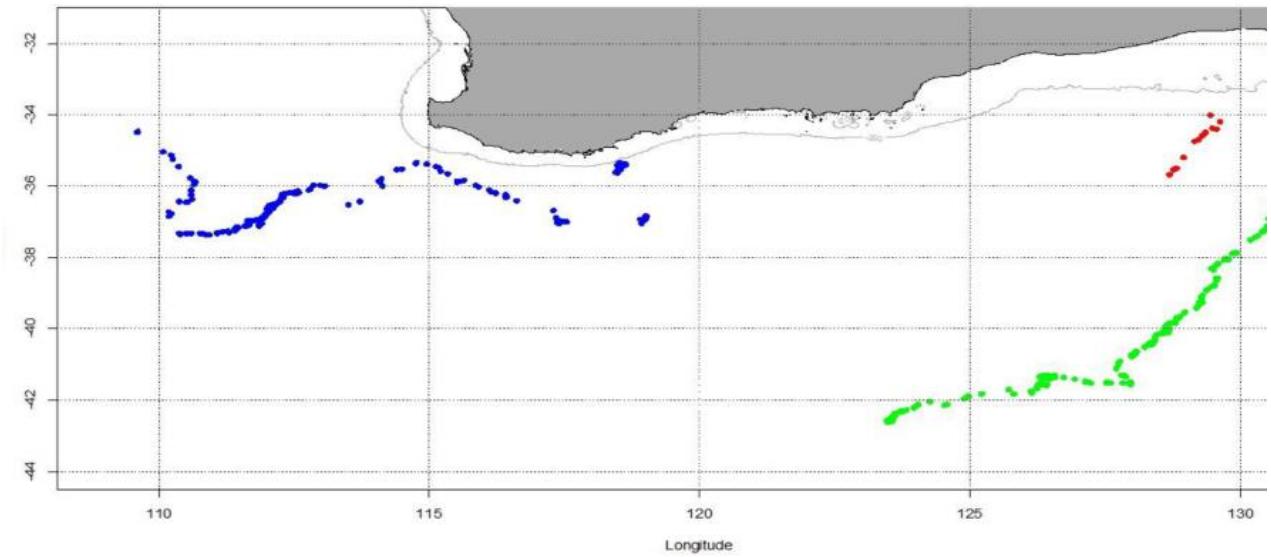
Aerial surveys for inshore cetaceans undertaken across coastal waters (<100 m water depth) of the Great Australian Bight between Ceduna and Coffin Bay during July and August 2013 detected seven southern right whales (Bilgmann et al. 2014). No southern right whales were observed in the vicinity of the well location during the Ceduna 3D seismic survey undertaken between November 2011 and May 2012.

This species is likely to be present within the Risk EMBA during the period of May to November, when the Australian population is migrating to and from the south coast of Australia to breed. Given that the Head of Bight is a particularly important calving area, individuals may traverse the survey area as they move to or from breeding areas, but the lack of defined migration pathways and survey observations indicate that large numbers of individuals are unlikely to be present.



Source: DSEWPAC (2012)

Figure 4.20 Coastal aggregation areas for southern right whales



Note that the tag with a blue track only began to transmit data 30 days after it was deployed

Source: (Mackay et al. 2015)

Figure 4.21 Tracks from satellite tags attached to three southern right whales (adult females accompanied by a calf) at the Head of Bight aggregation site in Sept–Oct 2014

4.5.1.8 Killer whale

The killer whale (*Orcinus orca*), listed as Migratory under the EPBC Act, is the most cosmopolitan of all cetaceans and may be seen in any marine region. The species is most numerous in coastal waters and cooler regions where productivity is high (DEE 2017f). Killer whales are most abundant in the Antarctic south of 60°S and are regularly reported from Australian waters surrounding the Territory of Heard Island and McDonald Islands, which appears to be a key locality (DEE 2017f). The species has been recorded around the Australian continent, with sightings concentrated off southern Western Australia, Victoria and around Tasmania (DEE 2017f).

The widespread nature of killer whale distribution does not enable a global estimate of population. There has been limited study of the total number of killer whales in Australian waters with most of the information on their distribution and occurrence within Australian waters obtained from incidental sightings. As a result the population size of killer whales in Australian waters have not been established (DEE 2017f) although populations estimates on a regional basis suggest that at least 80,000 killer whales occupy Antarctic waters (south of 60°S) (Kasamatsu & Joyce 1995) and it has been suggested that the total number of mature animals that visit Australian waters is less than 10,000 (DEE 2017f).

Killer whales tend to live in pods of fewer than ten animals, built around a stable core of two to three generations of related females. They are known to make seasonal movements and probably follow regular migratory routes. The breeding season is variable with observed species movements thought to be related to foraging opportunities (Bannister et al. 1996; Morrice et al. 2004). No important breeding or resting grounds have been identified in Australia (DEE 2017f).

Killer whales are the dominant oceanic apex predator and generally feed on a variety of vertebrate and invertebrate species. The diet of Australian killer whales is not well known but there are reports of attacks on dolphins, young humpback whales, blue whales, sperm whales, beaked whales, dugongs, Australian sea lions and sun fish (Bannisteret al. 1996; Wellard et al. 2016).

Within the last decade, large numbers of killer whales have been discovered to congregate in the area of a group of canyons on the slope of the continental shelf (Bremer Sub-basin) 70 km south-east of the Bremer Bay, Western Australia, from January to March each year (Totterdell 2014). This seasonal concentration of killer whales in the area is unprecedented, with more than 100 individuals and several distinct groups identified from the local population, many of which are routinely sighted (Meeuwig & Turner 2017; Totterdell 2014). Other pelagic megafauna (including various squid, sharks, cetaceans and seabirds) also aggregate in the area and the biodiversity hot spot, which is within the area designated as the Bremer Canyon AMP, supports a seasonal ecotourism industry (ABC 2016). There is evidence of killer whales foraging on prey including giant squid (Architeuthis sp.) and beaked whales (Mesoplodon spp.) across multiple years (Totterdell 2014; Meeuwig & Turner 2017; Wellard et al. 2016) suggesting that they likely visit the area to forage on a variety of locally abundant prey.

Ongoing research based out of the Bremer Bay sub-basin by scientists from the Centre for Marine Science and Technology (CMST) at Curtin University is investigating the distribution, abundance, bioacoustics and population dynamics of killer whales in Australian waters. Results published from the Bremer Canyon area to date include tracking data from a satellite telemetry tag attached to a mature female killer whale in March 2014 that showed that the tagged individual undertook dives of 8 minute durations to depths of up to 900 m and that her group largely travelled east and west along the continental slope and remained beyond the shelf break in water depths around 1000 m, supporting the existence of a high density foraging area around the canyons (Totterdell 2014).

Seven killer whale encounters with group sizes varying from one to upwards of 30 individuals were recorded during a one week aerial survey of the Bremer Sub-basin region in March 2017 (Meeuwig & Turner 2017). An offshore aerial cetacean survey (between the 100 and 200 m depth contours) from south-west Kangaroo Island to south of the Head of the Bight during December 2015 and April 2016 recorded ten killer whales including a calf (Gill 2016). This species may be encountered in the vicinity of the well location and within the Risk EMBA.

4.5.1.9 Sperm whale

The sperm whale (*Physeter macrocephalus*), listed as Migratory under the EPBC Act, is the largest of the toothed whales. The species is found in all oceans and confluent seas but tends to inhabit offshore areas more than 600 m deep and is uncommon in waters less than 300 m deep (DEE 2017g). Sperm whales have been recorded off all Australian states with a portion of the population present in Australian waters year-round (DEE 2017g). Female and young male sperm whales remain in tropical and sub-tropical waters year-round, whereas

older males are usually found in waters from 45°S to the Antarctic but travel to lower latitudes occasionally (DotE 2015d). Both sexes are gregarious, tending to live in groups of up to 50 individuals. Sperm whales are deep divers and forage for oceanic cephalopods (frequently at depth for prolonged periods), as well as medium and large demersal fish including rays, sharks and teleosts (DotE 2015d). Females and juveniles feed on cephalopods only and forage at greater depths. In southern Australia, there is evidence that the diet of sperm whales is dominated by oceanic, sub-tropical cephalopod species (Evans & Hindell 2004).

Sperm whales were hunted commercially in Australia until 1978 and the only systematic survey for these whales was conducted in the late 1960s. Consequently, the current population status is not known but it is likely that the total number of mature animals within Australian waters is less than 10,000 (DEE 2017g).

The submarine canyons (steep-sided valleys on the continental slope) off south-western and south-eastern Australia have been identified as a key ecological feature as they are linked to localised, periodic upwellings that enhance productivity and attract aggregations of marine life including cetaceans. Their higher productivity leads to marine megafauna often inhabiting and/or feeding in them, thereby making them important areas to consider in systematic conservation planning (Hooker et al. 1999; Moors-Murphy 2014). Submarine canyons have been identified as preferred habitat for sperm whales in south-west Australia, specifically in the Albany Canyon group and the Perth Canyon.

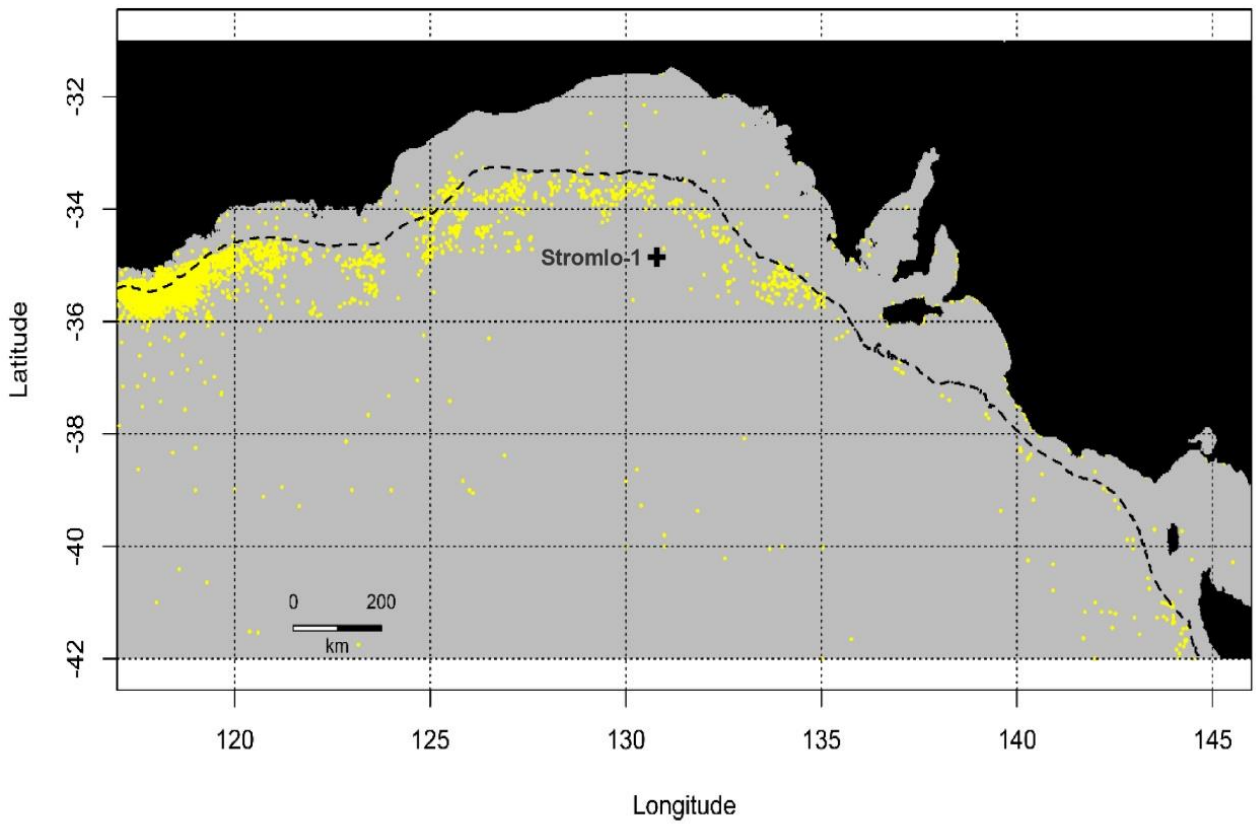
Key locations for sperm whales include the area between Cape Leeuwin and Esperance, Western Australia, close to edge of continental shelf; south-west of Kangaroo Island, South Australia; off the Tasmania west and south coasts; off New South Wales, including Wollongong; and off Stradbroke Island, Queensland (Bannister et al. 1996). The National Conservation Values Atlas (DoEE 2015) identifies a BIA for sperm whale foraging along the shelf break of the Great Australian Bight and waters south of Kangaroo Island (Figure 4.18). Another foraging BIA is identified within the Risk EMBA and is associated with the Albany Canyons (DoEE 2015).

Aerial surveys of the Bremer Sub-basin region off the south coast of Western Australia in March 2017 recorded 25 sperm whales across the two transects flown (Meeuwig & Turner 2017). During the 26 days offshore on a vessel in the Bremer Sub-basin region in late February to early April 2017, sperm whales were observed on 15 days (57.7%); the individuals recorded were mostly solitary adult males but larger groups of around ten individuals were recorded and on one occasion up to 40 individuals were observed (Meeuwig & Turner 2017).

Deep, long diving odontocete cetaceans such as sperm whales may be under-represented in aerial survey data as they are unavailable for sighting during feeding dives that may last 40 minutes or more (Whitehead 2003). Sperm whales were often detected acoustically but not sighted during a vessel-based cetacean acoustic survey west of Kangaroo Island during autumn 2013 (IFAW 2013). No sperm whale sound signals were detected by sound loggers deployed from November 2011 to June 2012 at three locations in the Great Australian Bight (McCauley et al. 2012). During the 2011–12 Ceduna 3D seismic survey over the central Great Australian Bight area, a total of 25 sperm whales were observed in December, April and May (Figure 4.22).

Habitat modelling undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on more than 15,500 records of the locations of sperm whales demonstrates the importance of the continental shelf break, more specifically sub-marine canyons, for sperm whales in the Great Australian Bight (Figure 4.23).

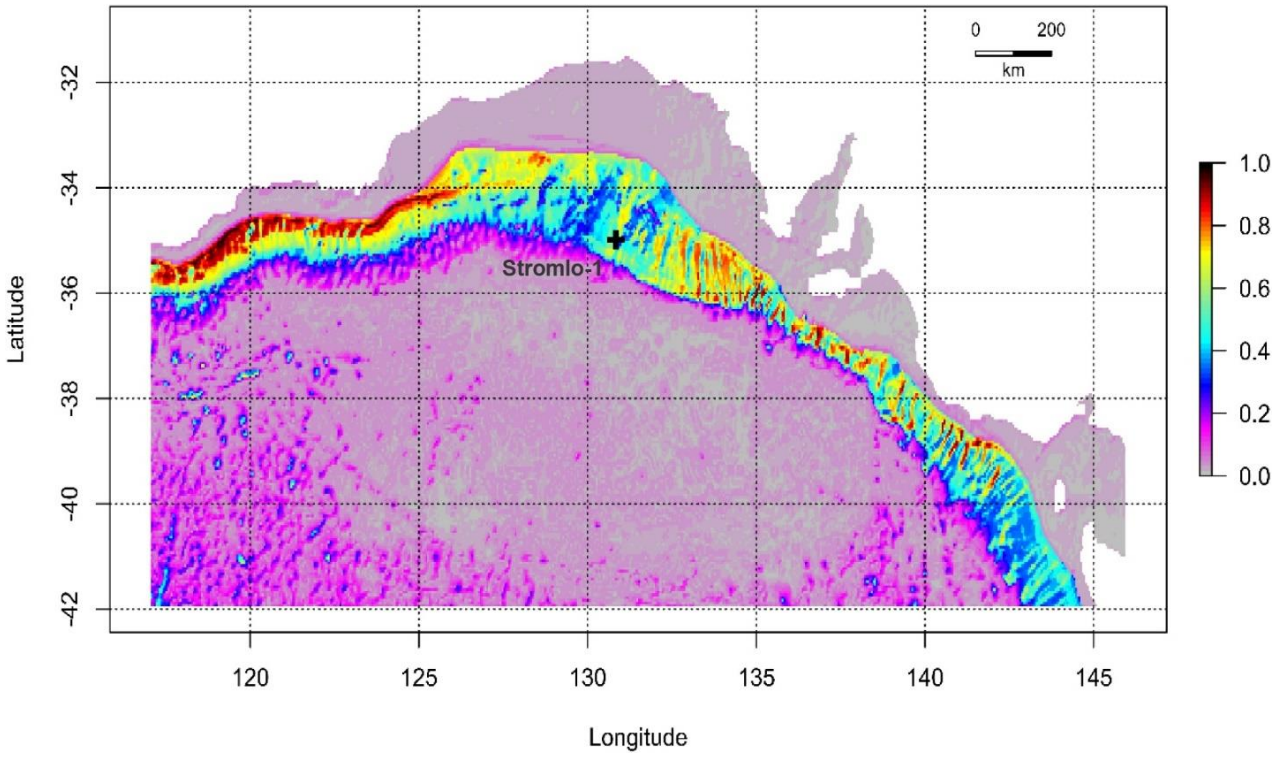
Sperm whales may occur within the Risk EMBA but other than transient individuals are likely to be present in BIAs rather than in the vicinity of the well location.



The 250 m isobath is indicated by the dashed line

Source: Bailleul et al. (2017)

Figure 4.22 Location of observations of sperm whales from aerial surveys and historic whaling data showing the importance of the continental shelf break



Source: Bailleul et al. (2017)

Figure 4.23 Standardised probability of potential occurrence at-sea of sperm whales showing the importance of sub-marine canyons in the Great Australian Bight

4.5.1.10 Humpback whale

The humpback whale (*Megaptera novaeangliae*), listed as Migratory and Vulnerable under the EPBC Act, is a baleen whale that has a global distribution (TSSC 2015d). Humpback whales are found in Australian offshore and Antarctic waters, undertaking an annual migration between summer feeding grounds in Antarctic waters and winter breeding and calving grounds in sub-tropical and tropical inshore waters on both the east and west coast of Australia (Jenner et al. 2001). They primarily feed on krill in Antarctic waters south of 55°S.

In the 19th and 20th centuries, humpback whales were hunted extensively throughout the world's oceans and as a result it is estimated that 95% of the population was eliminated. In Australia, it is estimated that humpback whales were reduced to between 3.5% and 5% of pre-whaling abundance. The International Whaling Commission imposed a ban on humpback whaling in the southern hemisphere in 1963 and an international moratorium on commercial whaling came into effect in 1985–1986 (DEH 2005c). Both the west coast and east coast Australian populations are reported to be recovering after near population collapse caused by whaling in the 1950s and 1960s. The rate of population increase for these two populations is thought to be the highest in the world at a rate of 10.9–11% per year for the east coast population and 9.7–13% for the west coast population. The available estimates for the global population total more than 60,000 animals, and global population is categorised on the IUCN Red List as Least Concern.

Humpback whales migrate up the eastern and western coasts of Australia and do not often travel into the Great Australian Bight (DEH 2005c; Vang 2002). The northern migration of the south-east coast starts in April and May, while on the west coast it occurs towards early June. The west coast southern migration then peaks around November and December, while the east coast southern migration peaks in October and November.

BIAs for the humpback whale have been identified around Australia and overlap the Risk EMBA on eastern and western sides of the continent (Figure 4.18). The nearest known humpback whale resting area within the Risk EMBA is in Flinders Bay on the south coast of Western Australia, approximately 1400 km west of the well location. Small numbers of humpback whales have been observed at the Head of Bight and near Kangaroo Island in early winter. Aerial surveys for inshore cetaceans undertaken across coastal waters (<100 m water depth) of the Great Australian Bight between Ceduna and Coffin Bay during July and August 2013 detected three humpback whales (Bilgmann et al. 2014). No humpback whales were observed during the 2011–2012 Ceduna 3D seismic survey nor were they detected by sound loggers deployed from November 2011 to June 2012 at three locations in the Great Australian Bight (McCauley et al. 2012).

Given this species known feeding and breeding areas and migration routes, it is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.5.1.11 Dolphins

Many dolphins are cosmopolitan species that are generally restricted to continental shelf environments. None of the ten dolphins listed in Table 4.5 that may inhabit the Risk EMBA are listed as threatened and the dusky and Indo-Pacific humpback dolphins are the only two migratory species.

The dusky dolphin (*Lagenorhynchus obscurus*) is primarily found from approximately 55°S to 26°S, though sometimes further north associated with cold currents. They are considered to be primarily an inshore species but can also be oceanic when cold currents are present (Gill et al. 2000; Ross 2006). Only 13 reports of the dusky dolphin have been made in Australia since 1828 and key locations are yet to be identified (Bannister et al. 1996). They occur across southern Australia from Western Australia to Tasmania, with unconfirmed sightings south of continental Australia but confirmed sightings near Kangaroo Island and off Tasmania. Given the lack of sightings in Australian waters, it is unlikely that significant numbers of dusky dolphins would be present in the Risk EMBA.

The Indo-Pacific humpback dolphin (*Sousa chinensis*) is primarily found along the northern Australian coast from Exmouth Gulf (Western Australia) to the Queensland/New South Wales border and their Australian distribution is linked to the warm eastern boundary current. This species inhabits shallow coastal, estuarine, and occasionally riverine habitats, in tropical and sub-tropical regions; usually occurring close to the coast, in depths of <20 m. Given its typical distribution, this species is unlikely to be encountered in the vicinity of the well location or within the Risk EMBA.

Bottlenose dolphins (*Tursiops* spp.) are distributed continuously around the Australian mainland but the status of many populations is unknown due to the taxonomy of the genus having undergone considerable revision in recent years (DEE 2017h). Based on morphological evidence and mitochondrial DNA data three species are presently recognised; the common bottlenose dolphin (*T. truncates*), the Indo-Pacific bottlenose dolphin (*T. aduncus*) and the Burrunan dolphin (*T. australis*) (Charlton-Robb et al. 2014). All three species are likely to

occur within the Risk EMBA. The common bottlenose dolphin is widespread in all temperate and tropical waters around the world, in both coastal (inshore and nearshore) and offshore waters (DEE 2017h). Indo-Pacific bottlenose dolphins are found in tropical and sub-tropical coastal and shallow offshore waters of the Indian Ocean, Indo-Pacific region and the western Pacific Ocean and have been confirmed to occur in estuarine and coastal waters of eastern, western and northern Australia where they are restricted to inshore and shallow offshore habitats. A BIA for Indo-Pacific bottlenose dolphin breeding and calving exists within the Risk EMBA in waters adjacent to New South Wales to a depth of 20 m (DEE 2017h; Figure 4.15). The Burrunan dolphin, only recognised as a distinct species in 2011 (Charlton-Robb et al. 2011), was not identified in the PMST report but is only known to occur in inshore waters of southern Australia (Victoria, Tasmania and South Australia) (Monk et al. 2014). Sufficient data do not currently exist for the Burrunan dolphin to be classified according to the EBPC Act but the species has been listed as threatened under the Victoria Flora and Fauna Guarantee Act 1988. Two small, genetically distinct resident populations of the Burrunan dolphin have been identified; one in Port Phillip Bay and the other in the Gippsland Lakes (both are Ramsar sites and each is described in Section 1.1.1), with approximately 100 and 50 individuals, respectively (Charlton-Robb et al. 2014). This pattern of small, isolated populations with low levels of genetic diversity heightens extinction risks.

Comparison of bottlenose dolphin (*Tursiops* spp.) photo-identification catalogues from Kangaroo Island and the South Australia mainland (i.e. from the Fleurieu Peninsula and the Adelaide Dolphin Sanctuary) suggests that limited mixing also occurs between bottlenose dolphin populations in South Australia waters and that certain populations may use specific migration routes (Cribb et al. 2018). No latitudinal connectivity has been identified between the bottlenose dolphin populations of the north (i.e. Adelaide Dolphin Sanctuary) and south (Kangaroo Island and southern Fleurieu Peninsula) waters of Gulf St Vincent but regular longitudinal crossovers have been documented between Kangaroo Island and the southern Fleurieu Peninsula through Backstairs Passage (Cribb et al. 2018). The spatial coverage of South Australia bottlenose dolphin photo-identification catalogues has recently expanded to include the Yorke Peninsula; evidence for the migratory pathways used suggests that the coastal waters surrounding King Island across to the bottom part of Yorke Peninsula and the Fleurieu Peninsula should all be considered a bottlenose dolphin hot spot (T. Bartram pers. comm.).

An inshore aerial cetacean survey (from the coast to the 100 m isobath) was undertaken between Ceduna and Coffin Bay in South Australia during late July and early August 2013 as part of the Great Australian Bight Research Program. This survey found the common dolphin (*Delphinus delphis*) to be the most commonly sighted species (722 records), with bottlenose dolphins (*Tursiops* spp., suggested to consist entirely of Burrunan dolphins) being the next most common (107 records) (Bilgmann et al. 2017). The abundance of common dolphins throughout the survey area was estimated to be 20,000–22,000 using distance sampling methods (sightings of other species were insufficient for abundance estimates) (Bilgmann et al. 2017). Comparisons of common dolphin densities off the western Eyre Peninsula in the central Great Australian Bight with other regions around the world show that shelf waters off the central Great Australian Bight represent an important habitat for common dolphins (Bilgmann et al. 2017).

An offshore aerial cetacean survey (between the 100 and 200 m depth contours) from south-west Kangaroo Island to south of the Head of the Bight during December 2015 and April 2016 sighted Risso's dolphin (60 records), common dolphins (three records) and bottlenose dolphins (*Tursiops* spp.) (262 records) (Gill 2016).

4.5.1.12 Beaked whales

Beaked whales (family Ziphiidae) are one of the most widespread families of cetaceans, ranging from the ice edges at both the north and south poles to the equator in all the oceans. Beaked whales are one of the least known groups of mammals because of their deep-sea habitat, mysterious habits, and apparent low abundance.

Shepherd's beaked whale (*Tasmacetus shepherdi*) is amongst the most poorly understood of all mammals and is one of the least known cetaceans globally. Prior to 2006, there had been no validated vessel-based at-sea sightings of this species and subsequently there has been a paucity of detailed descriptive data on the external morphology of live specimens. Offshore vessel-based surveys between May 2008 and February 2017, in the region of southern Australia and New Zealand, presented rare opportunistic sightings of free-swimming Shepherd's beaked whale (Donnelly et al. 2018).

4.5.1.13 Pilot whales

Pilot whales are cetaceans belonging to the genus Globicephala. The two extant species are the long-finned pilot whale (G. melas) and the short-finned pilot whale (*G. macrorhynchus*). Pilot whales are not well-surveyed within Australian waters and their distribution is primarily assumed from incidental sightings and beach-cast

animals, for all areas. Albeit from limited data, these methods are believed to result in reliable distributional information for the species. Although no global population estimates exist for either species of pilot whale, they are considered relatively abundant globally (Reeves et al. 2003). Pilot whales are not protected as Threatened or Migratory species under the EPBC Act and no BIAs have been identified.

Short-finned pilot whales occur in tropical and warm-temperate waters worldwide between approximately 41°S and 45°N, with their distribution extending into cold–temperate waters in the North Pacific (Bernard & Reilly 1999). In the Australian region, short-finned pilot whales occur in tropical to temperate (10–32 °C) oceanic waters, generally occurring at the edge of the continental shelf and over deep submarine canyons, although they may also approach coastal seas (Culik 2003). This species is socially cohesive, forming small groups of between ten to 30 individuals but also commonly seen in groups of several hundred animals, often accompanied by dolphins, especially bottlenose dolphins (Bannister et al. 1996). Short-finned pilot whales appear to be generally nomadic, with no known migration patterns.

The long-finned pilot whale appears to be distributed in two distinct locations: the southern subspecies (*G. m. edwardii*) occupies the southern hemisphere, with a circum-global distribution generally between 27°S and 62°S (Bannister et al. 1996; Leatherwood & Reeves 1983; Ross 2006; Sylvestre 1993). The long-finned pilot whale is widely recorded in waters off southern Australia and has been documented across all states but not the NT, near all the major land masses and in oceanic waters. Long-finned pilot whales inhabit temperate (10–20 °C) and subantarctic (1–8 °C) deep oceanic waters and zones of higher productivity along the continental slope, apparently venturing into the shallower waters of the shelf (<200 m) in pursuit of favoured prey species (Lewinson et al. 2004; Ross 2006). The long-finned pilot whale is highly gregarious, usually travelling in small, socially cohesive groups of around 10–50 individuals but is also encountered in large herds of several hundred and occasionally of over 1000 individuals (Bloch 1998; Zachariassen 1993). Some long-finned pilot whales appear to live permanently either offshore or inshore, while others make seasonal migrations, moving inshore in summer and autumn and offshore in winter and spring (Culik 2003). No information is available for long-finned pilot whales off Australia but it is plausible they may make extensive movements similar to those in the Northwest Atlantic (Mate 1989). Mass strandings on Australian coasts certainly suggest seasonal occurrence, with all but three events historically occurring from September to March and 60% occurring from December to March (Bannister et al. 1996). Pilot whales are known to occur within the Risk EMBA and may be within the vicinity of the well location.

4.5.2 Pinnipeds

Two threatened pinniped species listed as Vulnerable under the EPBC Act were identified as potentially occurring within the Risk EMBA (Table 4.5); the southern elephant seal (*Mirounga leonina*) and the Australian sea lion (*Neophoca cinerea*). Although not protected under the EPBC Act as Threatened or Migratory species, the New Zealand fur seal (*Arctocephalus forsteri*) and the Australian fur seal (*Arctocephalus pusillus* doriferus) are the most abundant pinnipeds throughout the Risk EMBA, with the Great Australian Bight containing more than 90% of their populations within Australian waters. Biologically important areas and other ecologically important areas (e.g. haul out and breeding sites) for the Australian sea lion, Australian fur seal and New Zealand fur seal are shown in Figure 4.24, Figure 4.25 and Figure 4.26.

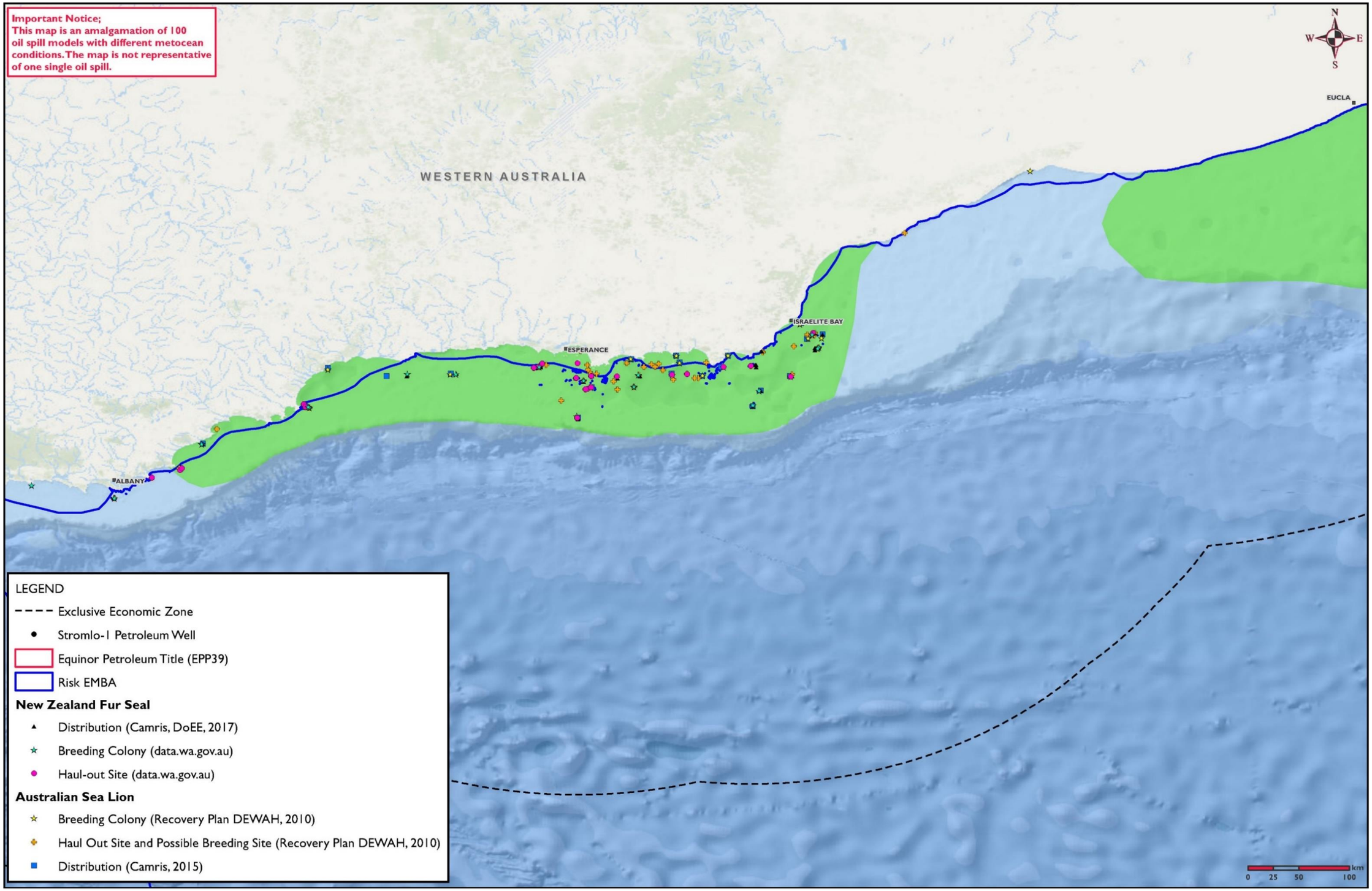


Figure 4.24 Biologically and ecologically important areas for Australian sea lion and New Zealand fur seal (Western Australia)

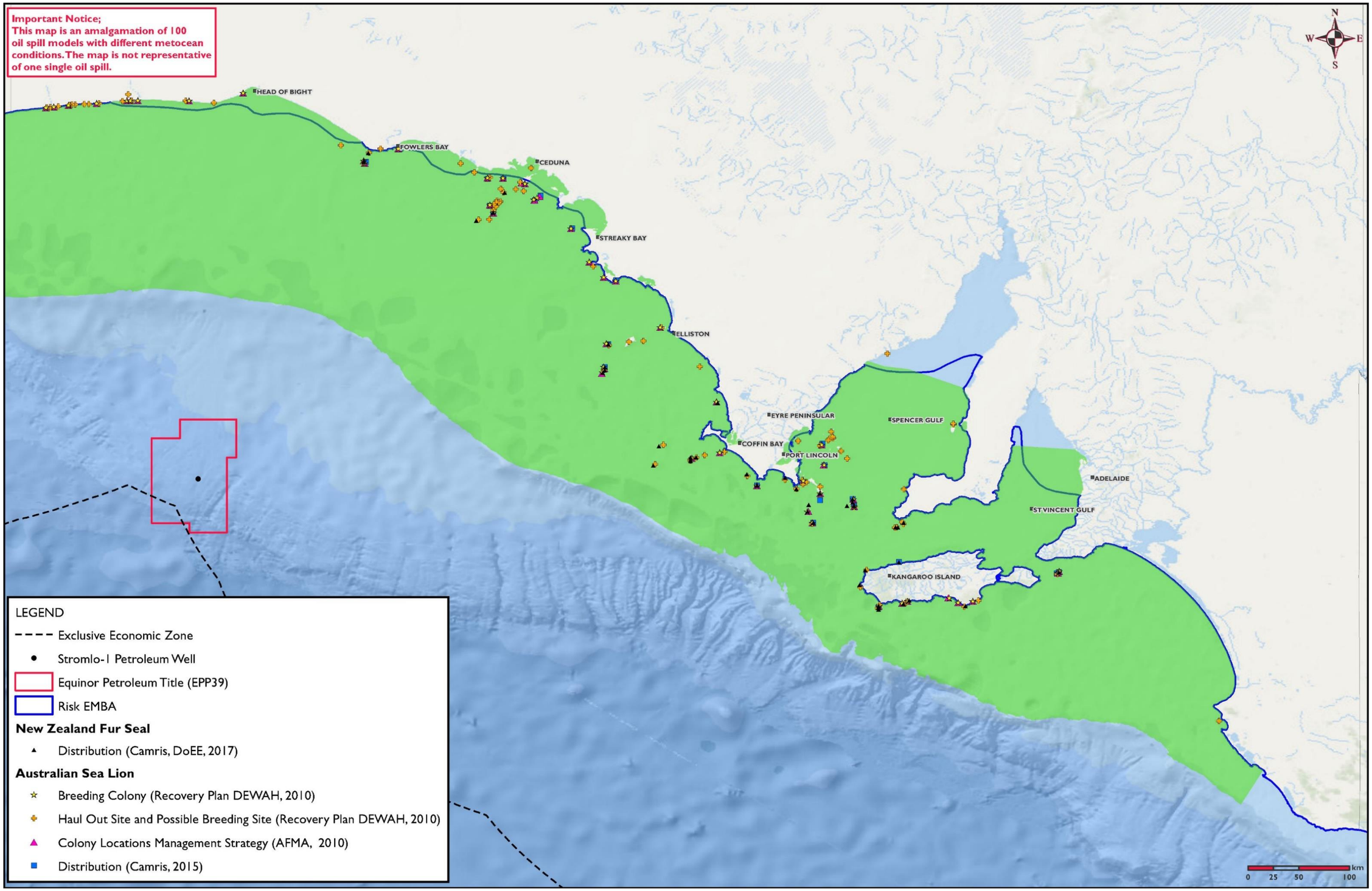


Figure 4.25 Biologically and ecologically important areas for Australian sea lion and New Zealand fur seal (South Australia)

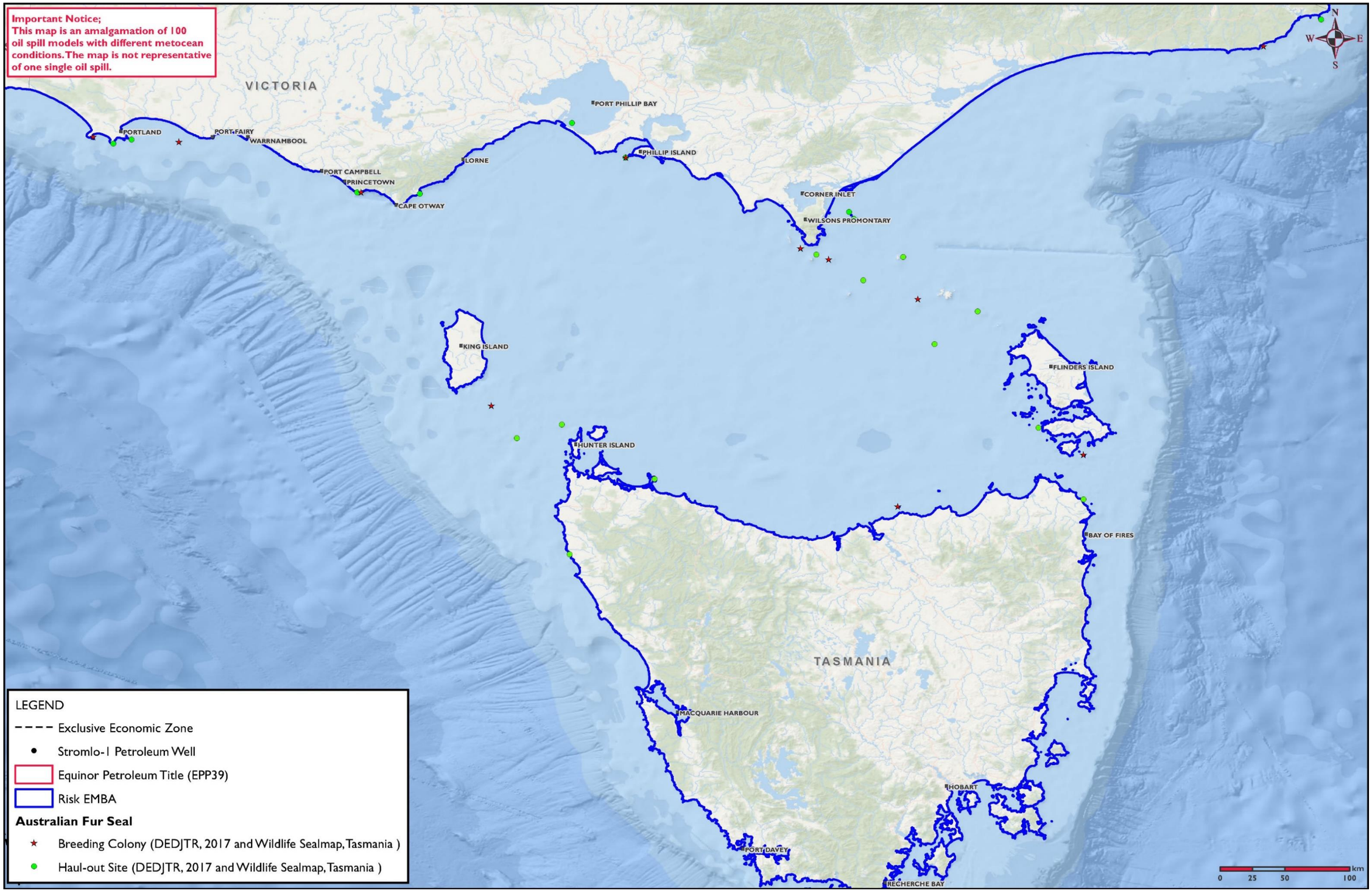


Figure 4.26 Biologically and ecologically important areas for Australian fur seal (Victoria, Tasmania)

4.5.2.1 Southern elephant seal

The southern elephant seal (*M. leonina*) is listed as Vulnerable under the EPBC Act. It is the largest pinniped species and has a nearly circumpolar southern hemisphere distribution, with a range that extends throughout most of the Southern Ocean down to high latitude sites on the Antarctic continent (TSSC 2016a). Southern elephant seals spend most of their lives at sea with most breeding colonies and haul-out areas occurring on subantarctic islands north of the seasonal pack ice zone (TSSC 2016a). Most adults foraging on or near the continental shelf of Antarctica, where they feed mainly on cephalopods (marine molluscs, including squid and octopus) and fish (TSSC 2016a).

In the Australian jurisdiction, the species breeds and hauls-out mainly on Macquarie Island approximately 1500 km south-south-east of Australia and Heard Island approximately 4000 km south-west of Australia (TSSC 2016a). Historically, large colonies of southern elephant seals occurred on islands within the Risk EMBA in the western Bass Strait and around north-west Tasmania before these were extirpated by European sealers in the early 1800s (TSSC 2016a). Individuals have been recorded in coastal habitats from Tasmania and southern Australia with mainland records extending from the New South Wales south coast, to Victoria, South Australia and south-west Western Australia (TSSC 2016a). Occasional pupping is seen on Maatsuyker Island (southern Tasmania) where there have been semi-regular surveys conducted and the last count in 2015 recorded 12, mostly sub-adult, males (Alderman pers. comm. 2016; cited in TSSC 2016a).

Conservation advice (TSSC 2016a) has been developed that provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.5.2.2 Australian sea lion

The Australian sea lion (*N. cinerea*), listed as Vulnerable under the EPBC Act, is endemic to Australia and found only in waters off Western Australia and South Australia (Gillanders et al. 2013). The species' current distribution extends from the Houtman Abrolhos Islands on the west coast of Western Australia through to the Pages Islands to the east of Kangaroo Island, South Australia (DSEWPaC 2013e).

The Australian sea lion now only breeds in the coastal and offshore waters of South Australia and Western Australia. While the original range for the species is unknown, it was thought to extend into Bass Strait. The breeding colonies in Bass Strait were likely to have been eliminated due to seal harvesting during the late 18th, 19th and early 20th centuries (DSEWPaC 2013e). Unlike other pinnipeds that were harvested during that time, Australian sea lion populations have not recovered across their range and there is evidence certain populations are still in decline (DSEWPaC 2013e; Goldsworthy et al. 2015). A recovery plan (DSEWPaC 2013e) has been developed to halt the decline of Australian sea lion populations and to ensure that anthropogenic activities do not hinder recovery across their range.

The most comprehensive assessment of the species status and trends in abundance in the Great Australian Bight region is provided by Goldsworthy et al. (2017). In South Australia there are 42 breeding sites with total pup abundance in 2014–2015 estimated to be 2500 while in the Great Australian Bight region off the south coast of Western Australia there are 16 known breeding sites with a total estimated pup abundance of 301, giving a total Great Australian Bight region estimate of 2801 pups from 58 sites (Goldsworthy et al. 2017). Pup abundance is presently declining by 2.9% per year in South Australia, and 2.1% off the south coast of Western Australia (Goldsworthy et al. 2017). Based on these values, total pup abundance in the Great Australian Bight region was estimated to be 3509 in 2007 and 2721 in 2016 (Goldsworthy et al. 2017).

The species generally hauls out (rests) and breeds on rocks and sandy beaches on sheltered sides of islands, although some small colonies exist on the mainland. While pups have been recorded at 76 sites, only 58 of these are classified as breeding sites (DSEWPC 2012a). Most (42) of the known breeding colonies are small, producing <25 pups per breeding season. Only eight sites produce >100 pups per season: North and South Page islands, Seal Bay on Kangaroo Island, Dangerous Reef (supports the third-largest breeding population in the world), Lewis Island, West Waldegrave Island, Olive Island and Purdie Island, all of which are in South Australia (DSEWPC 2012a, Edyvane 1999; Rogers et al. 2013). All eight of these large breeding colonies are within the Risk EMBA.

Breeding occurs at different times of the year in different colonies, with pups generally nursed for 15–18 months (DSEWPC 2013e). Pup abundance surveys indicate that 3119 pups per breeding cycle were born in South Australia, with 503 pups per breeding cycle born in Western Australia (DSEWPC 2013e), while the 2014–2015 census found a pup production of 3074 (83% in South Australia) (Goldsworthy et al. 2015). Goldsworthy et al. (2015) also reports that over the last three generations (38 years), there has been a 78% decline in Australian sea lion pup production (a rate of ~3% per year), with declines greatest in the west and least in the east.

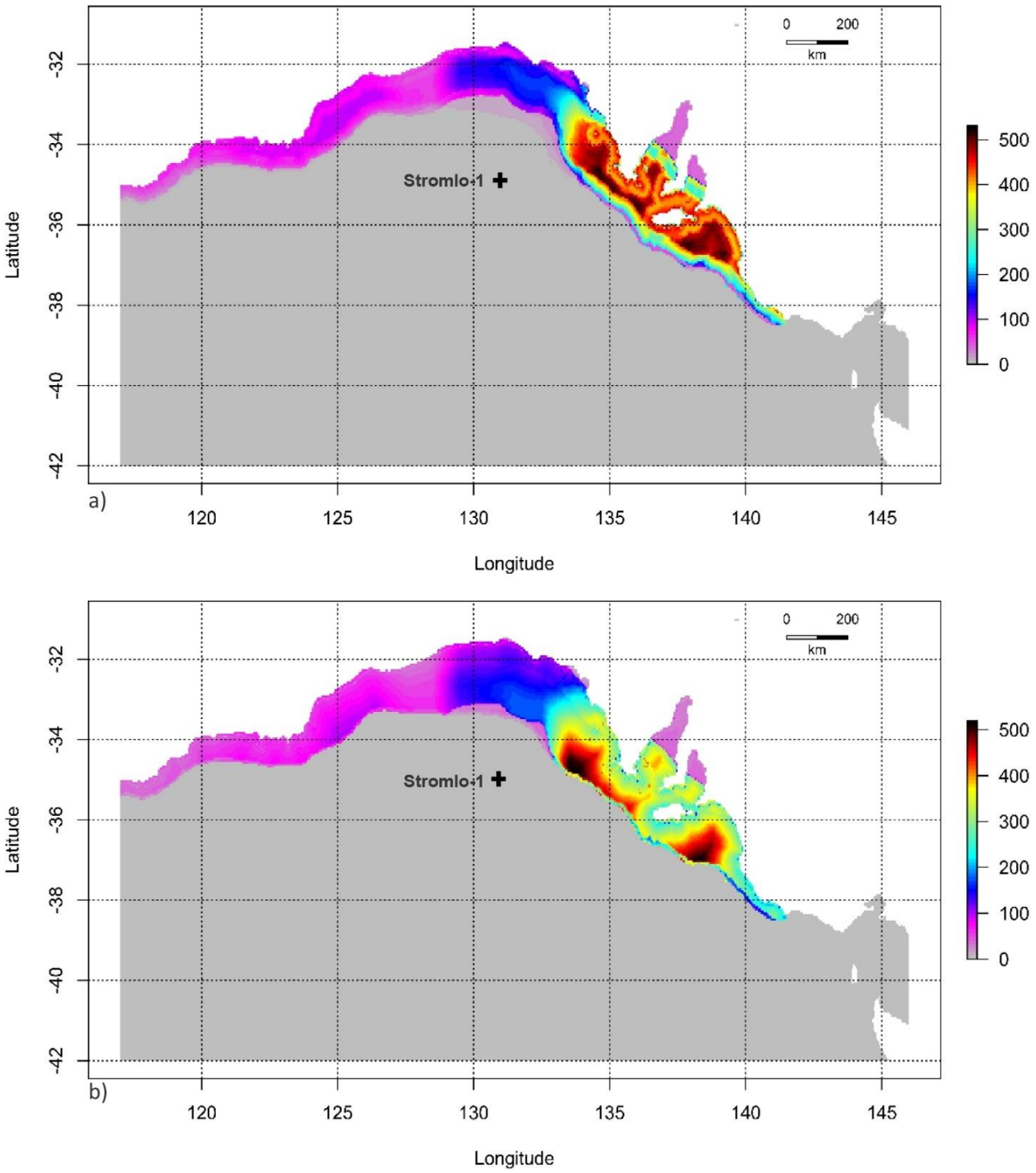
Other aggregation areas for this species include Kangaroo Island and Point Labatt, both well east of the well location, as well as the Head of Bight (385 km north of the well location) and Nuyts Archipelago (360 km and 300 km north-east of the well location) (DEWHA 2007). A large number of haul-out and basking sites (151) have been identified for the species, with 90 in South Australia and 61 in Western Australia.

Recent telemetry data from tagged Australian sea lions recorded foraging ranges with a broad use of coastal shelf waters, including coastal areas to the shelf's edge (Campbell 2008). Foraging behaviour varied among different Australian sea lion populations and different cohorts within each population. Female Australian sea lions travel up to 130 km on foraging trips and dive to depths of 130 m, while males travel up to 300 km and dive to at least 200 m (Rogers et al. 2013). Satellite tracking data analysed by SARDI (Goldsworthy 2015) validates this, with movements of Australian sea lions limited to shelf waters. DSEWPaC (2013e) report that the utilisation of shelf waters in South Australia is likely to be extensive (although variable depending on environmental conditions), with at-sea foraging behaviours likely to vary between breeding colonies. They eat a wide range of prey including fish, small sharks, invertebrates, cephalopods and occasionally seabirds (Rogers et al. 2013), with DSEWPaC (2013e) reporting that 35% of time is spent at or close to the seabed, with benthic species comprising the majority of the diet. The well location is approximately 65 km south of the nearest foraging BIA for the species.

No Australian sea lions were observed during 2011–2012 Ceduna 3D seismic survey of the Ceduna sub-basin (inclusive of the EPP39 permit area) in depths ranging from approximately 1000 to 3000 m (BP 2016).

Habitat mapping undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data from satellite tags deployed on 196 individuals (148 female, 48 male) from 34 sites across the Great Australian Bight demonstrated that suitable realised foraging habitats for females are located along the coast east of 133°E, south-east to Kangaroo Island, and in southern Spencer and St Vincent gulfs (Figure 4.27), while suitable foraging habitats for males are mainly located east of 132°E, further away from the coast and nearer the shelf break (Figure 4.27). No habitat suitable for the occurrence of either sex was shown to exist within more than 200 km of the well location (Bailleul et al. 2017).

This species is known to occur within the Risk EMBA. Since foraging trips are typically within 20–30 km of the coast, the likelihood of encountering foraging individuals is expected to be low.



Source: Bailleul et al. (2017)

Figure 4.27 Standardised probability of realised foraging habitats (weighted by abundance) of a) female and b) male adult Australian sea lions

4.5.2.3 Australian fur seal

The Australian fur seal (*Arctocephalus pusillus*) is considered to have two subspecies: *A. p. doriferus* (hereafter referred to as the Australian fur seal) and A. p. pusillus (hereafter referred to as the Cape fur seal). The Cape fur seal occurs along the south-western and southern coasts of Africa and thus is not considered in this EP.

The Australian fur seal is not protected under the EPBC Act as a Threatened or Migratory species and does not have any recognised BIAs within the Risk EMBA. The greater range of the Australian fur seal includes South Australia, southern Tasmania and Jervis Bay Territory, with several haul-out sites known in each state

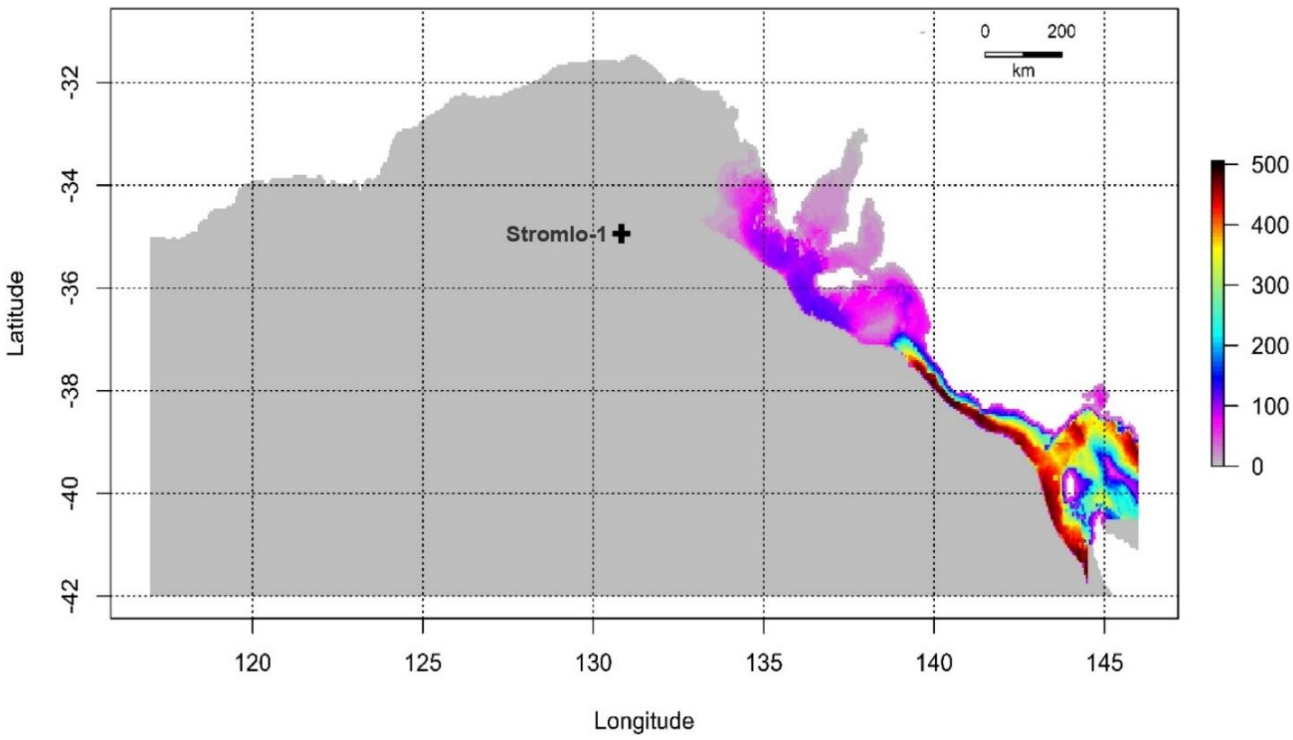
(Brothers & Pemberton 1990; Shaughnessy 2000). The Great Australian Bight supports approximately 18% of the Australian population, with populations of increasing having largely recovered following colonial sealing (Evans et al. 2017).

The distribution of Australian fur seal breeding colonies and haul-out sites is shown in Figure 4.26. There are ten established breeding colonies of the Australian fur seal, which are restricted to islands in the Bass Strait; six occurring off the coast of Victoria and four off the coast of Tasmania (Kirkwood et al. 2010; Pemberton & Kirkwood 1994; Warneke 1995). The largest of the established colonies occur at Lady Julia Percy Island (25.9% of the breeding population) and at Seal Rocks (25.5% of the breeding population), both of which are in Victoria (Kirkwood et al. 2010; Shaughnessy et al. 2002). Kirkwood and colleagues (2010) identify three additional developing breeding colonies, specifically: Wright Rocks (Tasmania), Double Island (Tasmania) and North Casuarina Island (South Australia).

Historically, Australian fur seal breeding colonies were more widespread but several islands have not been occupied since their populations were removed by early commercial sealing (Warneke & Shaughnessy 1985). In New South Wales, for example, the Australian fur seal is reported to have bred at Seal Rocks, near Port Stephens, but no longer occurs there (Shaughnessy, Testa & Warneke 1995; Warneke 1982). Pups have been born occasionally at Montague Island, on the southern New South Wales coast, and many non-breeding animals are known to congregate there (Shaughnessy et al. 2001).

Habitat mapping undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data from satellite tags deployed on 38 individuals (27 female, 11 male) from three sites in the Great Australian Bight demonstrated that suitable realised habitats for Australian fur seals are located in the far east of the Great Australian Bight over the continental shelf break, and along the mainland coast north to Tasmania (Figure 4.28).

Australian fur seals occur within the Risk EMBA but are unlikely to be encountered within the vicinity of the well location.



Source: Bailleul et al. 2017

Figure 4.28 Standardised probability of realised occurrence of foraging habitats (weighted by abundance) of Australian fur seals

4.5.2.4 New Zealand fur seal

The New Zealand fur seal (*Arctocephalus forsteri*), a listed marine species under the EPBC Act, is the most abundant pinniped in the Great Australian Bight. New Zealand fur seals are native to Australia but also occur at several other islands in the Southern Ocean and around the South Island of New Zealand, where they were first described. In Australia, they are found in the coastal waters and offshore islands off south-west Western Australia, South Australia, Victoria and New South Wales.

As part of the Great Australian Bight Research Program Goldsworthy et al. (2017) compiled a comprehensive synthesis of recent and historic surveys of pinniped populations throughout the Great Australian Bight region. This comprised individuals from 51 breeding sites, with 33 breeding colonies identified from South Australia, 16 breeding colonies identified from Western Australia and two breeding colonies identified from Victoria (Bass Strait Islands). Smaller breeding colonies are also found on remote islands off the south coast of Tasmania (DEHWA 2007). The largest breeding sites are at the Neptune Islands (at the mouth of Spencer Gulf) (with 7870 individuals estimated during the 2013–2014 breeding season (Shaughnessy et al. 2014), Kangaroo Island (southern coast) and Liguanea Island, which collectively account for 80% of the national annual pup production for the species (DEWHA 2007; Edyvane 1999; Gillanders et al. 2013). Smaller breeding populations are also found at islands off the Eyre Peninsula, the Nuyts Archipelago, Head of Bight, Recherche Archipelago and Cape Leeuwin (DEWHA 2007). Other important areas along the Great Australian Bight coast include haul-out and basking sites at Cape Rock, Rocky Islands, Curta Rocks, William Island, Low Rocks and Albatross Island (Edyvane 1999).

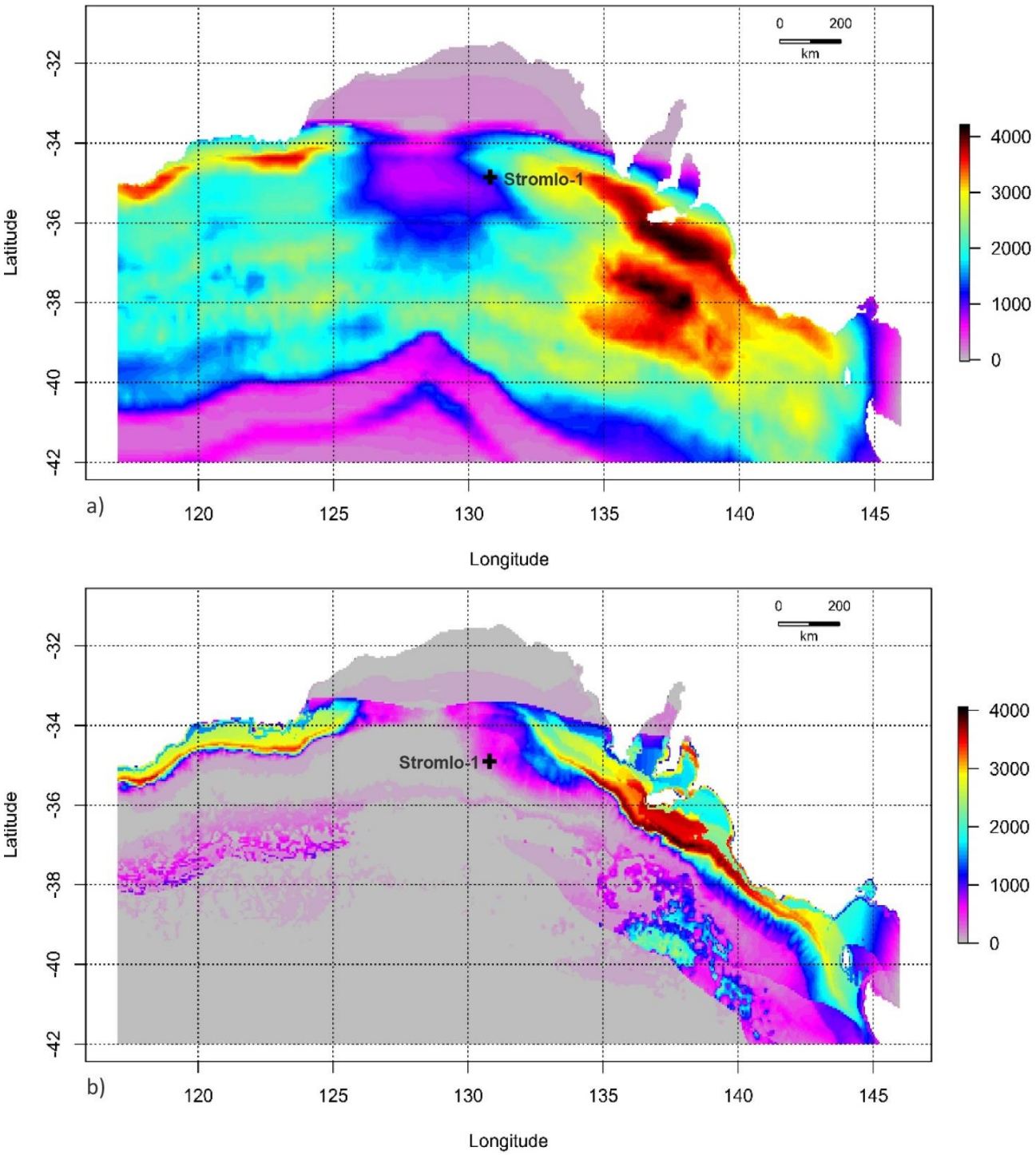
The current estimate for the total abundance of New Zealand fur seal in the Great Australian Bight region is 114,540, including 24,063 pups (Goldsworthy et al. 2017). Breeding occurs annually and is highly synchronised, commencing in late November with the bulk of births occurring over a five-week period (Rogers et al. 2013). Females give birth to a single pup and nurse it until it is about 10 months old (Rogers et al. 2013). Over 17,600 New Zealand fur seals are born annually in South Australia, representing about 85% of Australia's total population (Shaughnessy et al. 2014).

New Zealand fur seals feed on small pelagic fish such as redbait (*Emmelichthys nitidus*) and jack mackerel (*Trachurus declivis*), cephalopods, benthic fish species and seabirds, primarily little penguins (Rogers et al. 2013). Male adult New Zealand fur seals forage over the over continental shelf and continental slope (Rogers et al. 2013; Goldsworthy et al. 2017). Female adult New Zealand fur seals forage over the shelf, along the shelf break and in the oceanic waters, especially in the eastern Great Australian Bight, with lactating females tending to feed in mid-outer shelf waters (50–100 km from the colony) when their pups are small (Rogers et al. 2013). Juvenile seals feed primarily in oceanic waters beyond the continental shelf (Rogers et al. 2013).

Eight New Zealand fur seals were observed during 2011–2012 Ceduna 3D seismic survey of the Ceduna sub-basin (inclusive of the EPP39 permit area) in depths ranging from approximately 1000 to 3000 m (BP 2016), both in the vicinity of the well location and during transit.

Habitat mapping undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data from satellite tags deployed on 87 individuals (62 female, 25 male) from six sites in the Great Australian Bight demonstrated that suitable realised foraging habitats for female New Zealand fur seals are located over the shelf and shelf break and in the oceanic waters, especially in the eastern Great Australian Bight, while the suitable realised habitats for males are located over the shelf and shelf break (Figure 4.29).

New Zealand fur seals occur within the Risk EMBA and individuals may be encountered in the vicinity of the well location.



Source Bailleul et al. (2017)

Figure 4.29 Standardised probability of potential occurrence of realised foraging habitats of a) adult female and b) adult male New Zealand fur seals

4.5.2.5 Dugong

The dugong (*Dugong dugon*), listed as Migratory under the EPBC Act, is one of only four living species of the order Sirenia and the only representative in its range, which spans the coastal waters of around 40 countries throughout the Indo-West Pacific. In Australia, dugongs occur in coastal waters from Shark Bay (Western Australia) across the northern coastline to Moreton Bay (Queensland), with some recorded sightings as far south as the Newcastle, New South Wales (the northern limit of the Risk EMBA). Sightings in New South Wales have been typically associated with areas of known seagrass habitat.

This species is unlikely to be encountered within the Risk EMBA.

4.6 Birds

4.6.1 Seabirds

Seabirds are those species of bird whose normal habitat and food source is derived from the sea, whether that be coastal or offshore. Continental shelf, inshore coastal waters and embayments of southern Australia provide regionally and nationally significant foraging and breeding habitats for seabirds. This includes species that have breeding colonies on inshore and offshore islands, and seasonal visitors to the region including a number of highly migratory species.

The southern and south-eastern coasts of Australia provide regionally and nationally significant foraging and/or breeding habitat for a number of seabirds. Oceanic features, such as seasonal upwellings (e.g. Eyre coastal upwellings), or regional currents (e.g. East Australian Current and Tasman Front), increase biological productivity thereby creating a significant foraging habitat for both resident and migratory species. Roosting and nesting habitats can be found on both the mainland coast and offshore islands.

All pelagic seabirds are central-place foragers during the breeding season, with foraging ranges that vary with species, reproductive or provisioning cycle stage, and distribution and density of prey. Shipboard surveys in March 1996 suggest that bridled terns ranged up to 70 km seaward when foraging during late chick-rearing, and wedge-tailed shearwaters range 80–120 km (DSEWPC 2012f). Oceanic foragers such as sooty terns are thought to have foraging ranges of several hundred kilometres during chick-rearing (DSEWPC 2012f).

The Great Australian Bight research project collected information on the abundance data of three key seabird species at some of their offshore island breeding sites; the crested tern (*Thalasseus bergii*), little penguin (*Eudyptula minor*), and flesh-footed shearwater (*Puffinus carneipes*). Crested tern breeding colonies were surveyed using aerial photography during the nesting period and the study provided the first abundance estimates for some breeding sites. Little penguins were surveyed at two breeding sites off the western Eyre Peninsula (Olive and Pearson islands) using a combination of burrow transects, census plots and direct burrow counts. Comparison of results from earlier surveys suggest potential declines of 80% and 66% at Olive and Pearson islands, respectively, since 2004. Flesh-footed shearwaters were surveyed using burrow transects and direct burrow counts at the only breeding sites that occur in South Australia, Lewis and Smith islands. The surveys estimated 928 and 5785 breeding pairs at Lewis and Smith islands, respectively, representing the first population estimates for this species in South Australia (Evans et al. 2017).

Seabird species listed as Threatened and/or Migratory in the EPBC Act PMST report (Appendix 7-2) and those with BIAs that occur within the Risk EMBA (Figure 4.30 & Figure 4.31) are described further below (according to sub-groups where appropriate). The primary focus is on threatened seabird species and those that have breeding colonies, important foraging areas or and/or a significant proportion of their global population within the Risk EMBA (e.g. Table 4.6, Table 4.7, Table 4.8).

Table 4.6 EPBC Act-listed seabird species or species habitat and seabird species with BIAs that may occur within the Risk EMBA

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory marine species[2]	Type of presence		
Albatrosses (family Diomedeidae)						
Diomedea amsterdamensis	Amsterdam albatross	Endangered	Yes	Species or species habitat may occur within area	–	National recovery plan for threatened albatrosses and giant petrels 2011–2016 (DSEWPaC 2011c)
Diomedea antipodensis	Antipodean albatross	Vulnerable	–	Foraging, feeding or related behaviour likely to occur within area	Yes	
Diomedea antipodensis gibsoni	Gibson's albatross	Vulnerable	–	Foraging, feeding or related behaviour likely to occur within area	–	
Diomedea dabbena	Tristan albatross	Endangered	–	Species or species habitat may occur within area	–	
Diomedea epomophora	Southern royal albatross	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	–	
Diomedea exulans	Wandering albatross	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	
Diomedea sanfordi	Northern royal albatross	Endangered	–	Foraging, feeding or related behaviour likely to occur within area	–	
Phoebetria fusca	Sooty albatross	Vulnerable	Yes	Species or species habitat likely to occur within area	–	
Thalassarche bulleri	Buller's albatross	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	
Thalassarche bulleri platei	Northern Buller's albatross	Vulnerable	–	Foraging, feeding or related behaviour likely to occur within area	Yes	
Thalassarche carteri	Indian yellow-nosed albatross	Vulnerable	–	Foraging, feeding or related behaviour may occur within area	Yes	
Thalassarche cauta	Shy albatross	Vulnerable	Yes	Breeding known to occur within area	Yes	
Thalassarche cauta steadi	White-capped albatross	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	
Thalassarche chrysostoma	Grey-headed albatross	Endangered	Yes	Species or species habitat likely to occur within area	–	
Thalassarche eremita	Chatham albatross	Endangered	–	Foraging, feeding or related behaviour likely to occur within area	–	
Thalassarche impavida	Campbell albatross	Vulnerable	–	Foraging, feeding or related behaviour likely to occur within area	Yes	
Thalassarche melanophris	Black-browed albatross	Vulnerable	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	
Thalassarche salvini	Salvin's albatross	Vulnerable	–	Foraging, feeding or related behaviour likely to occur within area	–	
Cormorants (family Phalacrocoracidae)						
Phalacrocorax fuscescens	Black-faced cormorant	–	–	Breeding known to occur within area	Yes	–
Frigatebirds (family Fregatidae)						
Fregata ariel	Lesser frigatebird	–	Yes	Species or species habitat likely to occur within area	No	–
Fregata minor	Greater frigatebird	–	Yes	Species or species habitat likely to occur within area	No	–
Gannets (family Sulidae)						
Morus serrator	Australasian gannet	–	–	Breeding known to occur within area	Yes	–
Gulls, noddies and terns (family Laridae)						
Anous stolidus	Common noddy	–	Yes	Species or species habitat likely to occur within area	No	–
Hydroprogne caspia	Caspian tern	–	Yes	Breeding known to occur within area	Yes	–
Larus pacificus	Pacific gull	–	–	Breeding known to occur within area	Yes	–
Onychoprion anaethetus	Bridled tern	–	Yes	Breeding known to occur within area	Yes	–
Sterna striata	White-fronted tern	–	–	Breeding known to occur within area	Yes	–
Sternula albifrons	Little tern	–	Yes	Breeding known to occur within area	Yes	–
Sternula nereis	Fairy tern	Vulnerable	–	Breeding known to occur within area	Yes	Approved Conservation Advice for Sternula nereis (Fairy Tern) (DSEWPaC 2011a)
Thalasseus bergii	Crested tern	–	Yes	Breeding known to occur within area	–	–

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory marine species[2]	Type of presence		
Osprey (family Pandionidae)						
Pandion haliaetus	Osprey	–	Yes	Breeding known to occur within area	–	–
Penguins (family Spheniscidae)						
Eudyptula minor	Little penguin	–	–	Breeding known to occur within area	Yes	–
Petrels, prions and shearwaters (family Procellariidae)						
Ardenna carneipes	Flesh-footed shearwater	–	Yes	Breeding known to occur within area	Yes	–
Ardenna grisea	Sooty shearwater	–	Yes	Breeding known to occur within area	Yes	–
Ardenna pacifica	Wedge-tailed shearwater	–	Yes	Breeding known to occur within area	Yes	–
Ardenna tenuirostris	Short-tailed shearwater	–	Yes	Breeding known to occur within area	Yes	–
Calonectris leucomelas	Streaked shearwater	–	Yes	Species or species habitat may occur within area	–	–
Fregetta grallaria	White-bellied storm-petrel	Vulnerable	–	Species or species habitat likely to occur within area	Yes	Lord Howe Island Biodiversity Management Plan (DECC 2007)
Halobaena caerulea	Blue petrel	Vulnerable	–	Species or species habitat may occur within area	–	Conservation Advice *Halobaena caerulea* blue petrel (TSSC 2015e)
Macronectes giganteus	Southern giant petrel	Endangered	Yes	Foraging, feeding or related behaviour likely to occur within area	Yes	National recovery plan for threatened albatrosses and giant petrels 2011–2016 (DSEWPaC 2011c)
Macronectes halli	Northern giant petrel	Vulnerable	Yes	Species or species habitat may occur within area	Yes	
Pachyptila turtur subantarctica	Southern fairy prion	Vulnerable	–	Species or species habitat may occur within area	–	Conservation Advice Pachyptila turtur subantarctica fairy prion (southern) (TSSC 2015f)
Pelagodroma marina	White-faced storm-petrel	-	–	Breeding known to occur within area	Yes	–
Pelecanoides urinatrix	Common diving-petrel	-	–	Breeding known to occur within area	Yes	–
Pterodroma heraldica	Herald petrel	Critically Endangered	–	Species or species habitat likely to occur within area	–	Conservation Advice Pterodroma heraldica Herald petrel (TSSC 2015g)
Pterodroma leucoptera	Gould's petrel	Endangered	–	Breeding known to occur within area	Yes	Gould's Petrel (*Pterodroma leucoptera leucoptera*) Recovery Plan (DEC 2006)
Pterodroma macroptera	Great-winged petrel	-	–	Breeding known to occur within area	Yes	–
Pterodroma mollis	Soft-plumaged petrel	Vulnerable	–	Breeding known to occur within area	Yes	Conservation Advice Pterodroma mollis soft-plumaged petrel (TSSC 2015h)
Pterodroma neglecta	Kermadec petrel (western)	Vulnerable	–	Foraging, feeding or related behaviour known to occur within area	Yes	Norfolk Island Region Threatened Species Recovery Plan (DEWHA 2010) Lord Howe Island Biodiversity Management Plan (DECC 2007)
Puffinus assimilis	Little shearwater	-	–	Breeding known to occur within area	Yes	–
Swifts (family Apodidae)						
Apus pacificus	Fork-tailed swift	-	Yes	Species or species habitat likely to occur within area	–	–

1 Listed threatened species: A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.
2 Listed migratory species: A native species that from time to time are included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.

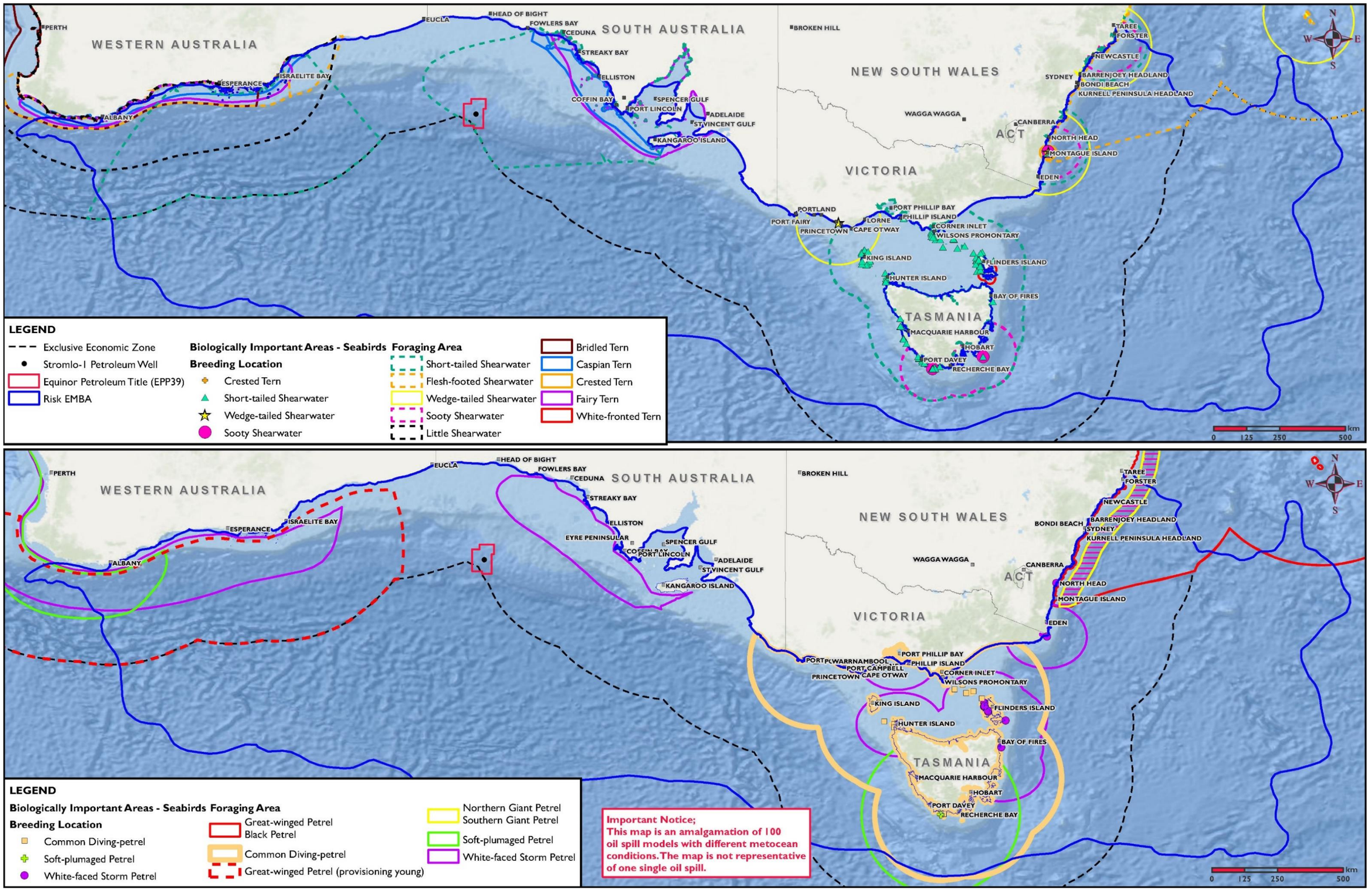


Figure 4.30 Biologically important areas for EPBC Act-listed seabirds (1)

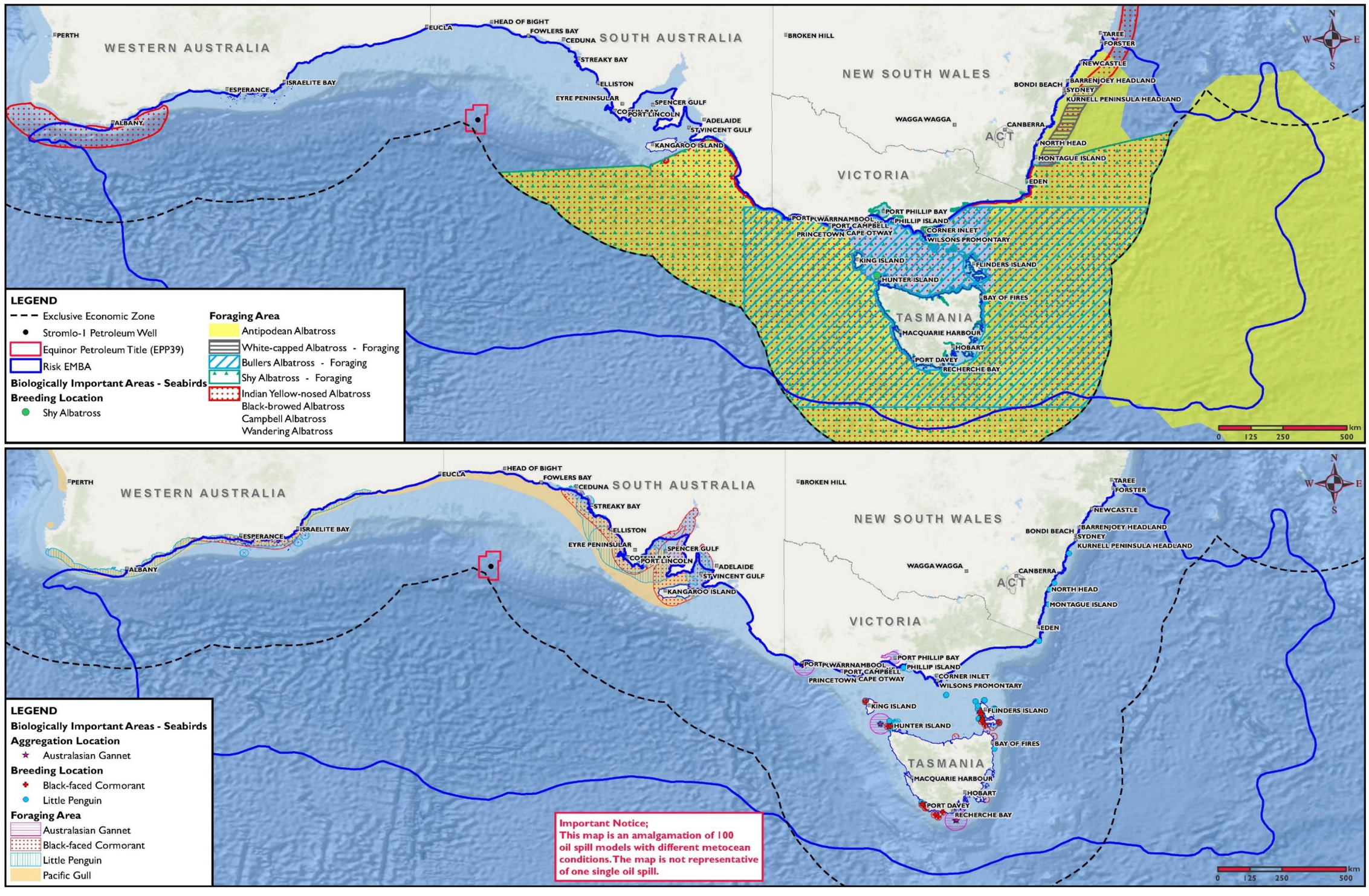


Figure 4.31 Biologically important areas for EPBC Act-listed seabirds (2)

4.6.1.1 Albatrosses

Albatrosses are among the most dispersive and oceanic of all birds, spending more than 95% of their time foraging at sea and usually only return to land to breed on remote islands. The PMST report (Appendix 7-2) identified 18 albatross species listed as threatened (five classed as Endangered and 12 as Vulnerable) under the EPBC Act which may occur within the Risk EMBA; eight of these are also listed as Migratory marine birds. All of these albatross species are widely distributed across the southern hemisphere, share oceanic foraging habits and face similar conservation threats. They require the same conservation actions, but some have unique breeding sites. Information on albatrosses below applies to all 17 species listed in the PMST report, unless otherwise specified.

Albatrosses have a broad range of diets and foraging behaviours, and hence their at-sea distributions are diverse (DSEWPaC 2011c). Combined with their ability to cover vast oceanic distances, all waters within Australian jurisdiction can be considered foraging habitat but the most critical foraging habitat is considered to be those waters south of 25°S where most species spend the majority of their foraging time (DSEWPaC 2011c). Albatrosses are usually found foraging in offshore areas under Australian jurisdiction during winter, particularly along the continental shelf edge and open waters, with cephalopods, fish and crustaceans caught while diving generally forming the basis of their diet (DSEWPaC 2011c). Foraging BIAs have been identified within the Risk EMBA for nine albatross species (Figure 4.31); their foraging areas are shown in Figure 4.32.

Albatrosses breed at only six localities under Australian jurisdiction: Macquarie Island (including Bishop and Clerk islets); Albatross Island; Pedra Branca; the Mewstone; Heard and McDonald Islands; and the Australian Antarctic Territory (Giganteus Island, Hawker Island and the Frazier Islands) (DSEWPaC 2011c). These remote islands constitute the only suitable breeding habitat under Australian jurisdiction and are regarded as habitat that is critical to the survival of albatrosses in Australian waters under the DSEWPaC (DSEWPaC 2011c) National Recovery Plan for Threatened Albatrosses and Giant Petrels 2011–2016.

Breeding colonies of the shy albatross which is endemic to Australia (*Thalassarche cauta*) occur within the Risk EMBA on Albatross Island in the Bass Strait, approximately 28 km off the north-west coast of Tasmania, as well as the Mewstone and Pedra Branca, both approximately 25 km off the south coast of Tasmania (DSEWPaC 2011c). Shy albatrosses breed only on these islands and hence the breeding habitats of this species comprise its entire breeding habitat (DSEWPaC 2011c). Albatross Island is nearest the well location (~1375 km east-south-east) and supports a breeding colony of approximately 5200 shy albatrosses (Thomson et al. 2015). Mewstone Island (9500) and Pedra Branca Island (170) are around 1675 km and 1725 km south-east from the well location, respectively. Limited data are available for these colonies, but it estimated that Mewstone Island supports a population of 9000–11,000 shy albatrosses and Pedra Branca less than 220.

Four other albatross species breed on isolated islands under Australia's jurisdiction (namely; wandering albatross *Diomedea exulans*, black-browed albatross *T. melanophris*, grey-headed albatross *T. chrysostoma* and light-mantled albatross *Phoebetria palpebrata*) but do so on islands at latitudes below 50°S (DSEWPaC 2011c) outside of the Risk EMBA. The nearest of these nesting sites is Macquarie Island at ~3100 km south-east of the well location. DSEWPaC, (2011a) notes the wandering albatross is most common off south-east Australia (especially the Tasman Sea) from October–April.

From August to April most adults black-browed albatross traverse the Antarctic and sub-Antarctic shelf-waters adjacent to their breeding grounds. They are migratory and in April they leave their colonies for the warmer coastal or shelf waters of Australia, New Zealand, South Africa and South America (DSEWPaC 2011a). Sub-adults are seen in Australian waters all year round with immature birds seen in south-east Australian waters between October and January. it is not possible to determine whether the size of the Australian breeding population has declined over the past three generations, or 65 years, as there is inadequate data available for all sub-populations over this time period (DEE https://www.environment.gov.au/node/16311). However, the population data that is available for the Macquarie Island and Heard Island sub-populations suggests that the Australian breeding population has not declined in recent years. The species has a long generation length of 21.5 years (BirdLife International 2004). Black-browed Albatrosses are one of the species most frequently captured and killed in longlines (Brothers 1991; Environment Australia 1998) It is projected that population decline will continue into the future owing to the impact of longline fishing (DEE https://www.environment.gov.au/node/16311).

Indian yellow-nosed albatrosses predominantly occur within the southern Indian Ocean (DSEWPaC 2011a). They are found over both pelagic and inshore waters between 15°S and 50°S. Even during the breeding season adults can be found foraging at subtropical latitudes. Indian yellow-nosed albatrosses are the most common albatross in the Great Australian Bight and central Bass Strait.

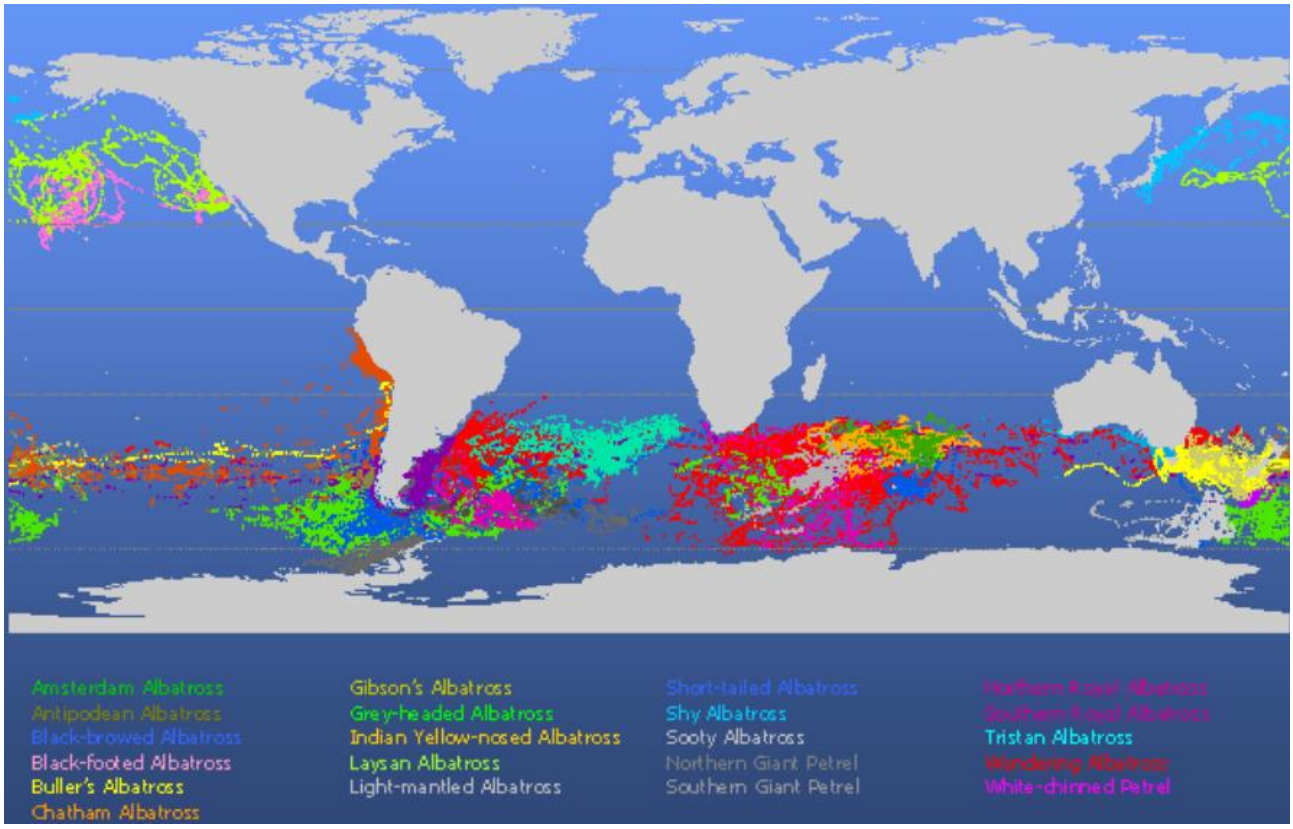
The global population sizes of these species have been estimated to be: shy albatross ~65,000; black-browed albatross ~2,100,000 and Indian yellow-nosed albatross ~160,000 (BirdLife International 2017).

The grey-headed albatross (*Diomedea chrysostoma*) is a regular visitor to Australia, especially in winter. It is seen at sea with some frequency south and west of Tasmania, occasionally in Victorian waters (DSEWPaC, 2011c), Most prey is taken by surface-seizing while the grey-headed albatrosses can dive to at least 6 m below the surface, and swim underwater for up to 11 seconds, in search of prey.

The Light-mantled Sooty albatross (*Phoebetria palpebrate*) are regular visitors to the pelagic waters of south and southeast Australia, especially in winter. (DSEWPaC, 2011c) They are commonly seen over open waters south and west of Tasmania. Many of the birds seen in mainland waters are breeding adults foraging on behalf of their offspring.

All five species of albatross breeding in Australian waters (and both species of giant petrel) are seriously threatened by longline fishing (Gales & Brothers 1996; Gales 1998; Environment Australia 2001), as are most of the species that forage within Australia's EEZ (Gales 1998). The Commonwealth Trawl Sector (CTS) of Australia's Southern and Eastern Scalefish and Shark Fishery (SESSF) reported an observed 'shy-type' albatross capture rate of 31 birds in 2006 (Phillips et al. 2010). It is likely that most or all albatross species also suffer from ingestion of fishing equipment while incidental bycatch in trawl fishing and net entanglement in trawl, gill and drift nets also pose a serious threat (DSEWPaC 2011c).

No breeding colonies or nesting areas for the listed albatross species are located within the vicinity of the well location and only one species has a breeding BIA within the Risk EMBA (Albatross Island, off north-west Tasmania). Given the large, pelagic distribution of albatross, individuals may fly over the area in transit or while foraging. These species are unlikely to be encountered in the vicinity of the well location but may occur as foraging individuals within the Risk EMBA.



Source: DSEWPaC (2011c)

Figure 4.32 Extract from Birdlife International's global procellariiform tracking database

4.6.1.2 Black-faced cormorant

The black-faced cormorant (*Phalocrocorax fuscescens*) is endemic to southern Australia and is Australia's only cormorant that does not occur in terrestrial wetlands (DoE 2015a). The species is confined to the south-eastern and south-western seaboards, where it is locally common in coastal waters and are found in flocks in

large bays, deep inlets, rocky headlands and islands. Black-faced cormorant breeding usually occurs on rocky islands but also on stacks, slopes and sea cliffs in colonies of up to 2500 individuals (DoE 2015a). There are 40 significant breeding sites (more than ten breeding pairs) known for the species, recognised as BIAs (Figure 4.31). Black-faced cormorants forage in coastal waters by pursuit-diving to depths of up to 12 m, sometimes in sheltered places such as bays, islets or river mouths but rarely along exposed beaches (Birdlife Australia 2016).

This species may occur within the Risk EMBA.

4.6.1.3 Australasian gannet

The Australasian gannet (*Morus serrator*) generally feeds over the continental shelf or inshore waters. Its diet is comprised mainly of pelagic fish, especially pilchard, anchovies and jack mackerel, but also squid and garfish. Prey is caught mainly by plunge-diving, but it is also seen regularly attending trawlers. Breeding is highly seasonal (October–May), nesting on the ground in small but dense colonies (DoE 2015a). Breeding occurs at seven sites in Australia, three of which occur in the Great Australian Bight region; Lawrence Rocks (3100 pairs) and Point Danger (600 pairs) in Victoria, and Margaret Brock Reef (~300 pairs) off Cape Jaffa in South Australia The largest colony of the species in Australia occurs adjacent to the Great Australian Bight region at Black Pyramid (12,339) in western Bass Strait, with the remaining three breeding sites occurring in Port Phillip Bay (507 pairs), and on Pedra Branca (3013 pairs) and Eddystone Rock (189 pairs) off the south coast of Tasmania (Bunce et al. 2002).

The South-east Marine Region supports breeding sites for approximately 20% of the global population and all of the Australian breeding population (DoE 2015a); important breeding locations include Pedra Branca, Eddystone and Sidmouth Rocks, Black Pyramid and Lawrence Rocks.

The National Conservation Values Atlas (DoEE 2015) indicates that foraging BIAs exist within the Risk EMBA for the Australasian gannet around the coast off Portland and in Port Phillip Bay, Victoria as well as on Black Pyramid and Pedra Branca Islands, Tasmania (Figure 4.31).

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.1.4 Common noddy

The common noddy (*Anous stolidus*), listed as a Migratory marine bird under the EPBC Act, is a widespread migratory bird found throughout tropical and subtropical seas and land masses around the world. In Australia, the common noddy is found off the west, north and east coasts of Australia, from the Abrolhos Islands in Western Australia to the islands of the Great Barrier Reef in Queensland, as well as Norfolk and Lord Howe Islands (DoE 2017).

Common noddy breed on islands, the breeding season is highly variable and depends on the location (DoE 2017). The nearest breeding site to the Risk EMBA is Lord Howe Island (~100 km east of the Risk EMBA) where breeding occurs from October to January (DoE 2015a). During the breeding season, the common noddy usually occurs on or near islands, on rocky islets or on shoals or cays of coral or sand and individuals generally remaining close to the nest (within 50 km), foraging on fish and molluscs in the surrounding waters (DoE 2017). During the non-breeding season common noddy tend to forage further offshore and may occur in groups hundreds of kilometres from breeding islands (DoE 2017).

Breeding and foraging BIAs are defined for the common noddy in the National Conservation Values Atlas (DoEE 2015) but none occur within the Risk EMBA.

The common noddy is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.1.5 Pacific gull

The Pacific gull (*Larus pacificus*), listed as a Migratory marine bird under the EPBC Act, is endemic to southern Australia and occurs mostly on the south and west coasts and in Tasmania (Birdlife Australia 2017d). Pacific gulls are the dominant large gull throughout the South-west Marine Region, breeding in small numbers (usually 1–2 pairs/island), with strongholds at the Recherche Archipelago (Western Australia) and The Brothers Islands in Coffin Bay (South Australia) (DWR 2006). They prefer sandy or rocky coasts and beaches and forages along the coasts between high-water mark and shallow water on fish birds and other marine animals.

The National Conservation Values Atlas (DoEE 2015) indicates that BIAs exist within the Risk EMBA for the Pacific gull. These have been identified for foraging in high numbers, which occurs in nearshore waters of the south-west Western Australia coast as far east as just east of the eastern Recherche Archipelago, and for foraging from this point east to Kangaroo Island.

These species are unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.1.6 Terns

Six tern species may occur within the Risk EMBA, including one species listed under the EPBC Act as Vulnerable (fairy tern *Sternula nereis nereis*) and four species listed as Migratory (Caspian tern *Hydroprogne caspia*, bridled tern *Onychoprion anaethetus*, little tern *Sternula albifrons* and crested tern *Thalasseus bergii*).

Many of the tern species are widespread and occupy beach, wetland, grassland and beach habitats. Terns rarely swim; they hunt for prey in flight, dipping to the water surface or plunge-diving for prey (Flegg 2002) usually within sight of land, for fish, squid, jellyfish and sometimes crustaceans (DEHWA 2007). The three most abundant resident (breeding) tern species that occur in the Great Australian Bight region are the crested tern, Caspian tern and fairy tern.

Fairy terns (*Sternula nereis nereis*) forage in nearshore areas of Spencer Gulf, Gulf of St Vincent, and the south-west Western Australia coast as far east as the eastern Recherche Archipelago. They are also known to breed on the offshore islands and coast of Spencer Gulf (e.g. Ward Spit) (Edyvane 1999). Flegg (2002) reports that the species is widespread on southern and western Australian coasts, breeding on coastal beaches and islands.

Bridled terns (*Onychoprion anaethetus*) forage in high numbers along the south-west Western Australia nearshore coast as far east as the eastern Recherche Archipelago, though Flegg (2002) states they are uncommon along the southern Australian coast. Their foraging range encompasses open shelf waters, the shelf edge and deep water oceanic areas, where planktonic fish and squid make up most of their diet (DSEWPC 2012f). They breed in loose colonies on islands, dispersing northwards into oceanic waters (Flegg 2000). They are also known to breed on the offshore islands and coast of Spencer Gulf (e.g. Ward Spit) (Edyvane 1999). Bridled terns migrate north to tropical seas during the April to October non-breeding season (DEWHA 2007).

The little tern (*Sternula albifrons*) is widespread, migratory and occurs around the Australian coastline from Broome, around the northern coastline to south-eastern South Australia. They inhabit sheltered coastal environments (lagoons, estuaries, river mouths and deltas, exposed sand spits or sandbanks and exposed ocean beaches (least preferred). Breeding occurs between September and February in a shallow scrape in the sand sometimes laced next to debris (driftwood, etc.) above the high-tide mark (DoE 2015a)do. The species forages in shallow waters of estuaries, coastal lagoons and lakes and frequently over channels next to spits and banks or entrances on small fish crustaceans, insects and molluscs taken by plunge diving. They forage along open coasts, less often at sea and usually within 50 m of the shore. This species may be present along sandy embayments in the Risk EMBA.

Crested terns (*Thalasseus bergii*) are very common on the Australian coastline. They show a preference for nesting on offshore islands, low-lying coral reefs, sandy or rocky coastal islets, coastal spits, lagoon mudflats within 3 km of the coast (BirdLife International 2018). Their diet consists predominantly of pelagic fish although they will also take cephalopods, crustaceans and prawns, insects and hatchling turtles. Crested terns breed in large colonies but there is limited information on their population size and ecology. The total population of crested terns in the Great Australian Bight was estimated to be approximately 49,000 breeding pairs (taking the mid-estimate of 39,000 pairs for surveyed sites and up to 59,000 pairs based including unsurveyed sites, or 148,485 individuals) (Goldsworthy et al. 2017).

The National Conservation Values Atlas (DoEE 2015) indicates that BIAs for a number of tern species intersect with the Risk EMBA; none intersect with the well location (Figure 4.30).

These species are unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.1.7 Osprey

The osprey (*Pandion haliaetus*), listed as a Migratory marine bird under the EPBC Act, is widely distributed around the world and throughout Australia (DEE 2017i). At least two sub-populations exist in Australia; one or more populations around the northern coast of Australia from Albany in south-western Western Australia to

Lake Macquarie in south-eastern New South Wales (including many offshore islands), and a geographically-isolated isolated breeding population on the coast of South Australia, extending from Head of Bight east to Cape Spencer and Kangaroo Island (DEE 2018c). The species is considered to be moderately common in Australia and is most abundant in northern Australia, where high population densities occur in remote areas (DEE 2018c). The species is rare to uncommon in southern Western Australia and occurs in low numbers in South Australia (~52 pairs in 2005), and New South Wales (~100 pairs in 1996) (DEE 2018c).

Ospreys occur in littoral and coastal habitats and terrestrial wetlands of tropical and temperate Australia and on offshore islands. They are mostly found in coastal areas but occasionally travel inland along major rivers, particularly in northern Australia (DEE 2018c). They require extensive areas of open fresh, brackish or saline water for foraging and frequent a variety of wetland habitats including inshore waters, reefs, bays, coastal cliffs, beaches, estuaries, mangrove swamps, broad rivers, reservoirs and large lakes and waterholes (DEE 2018c). Ospreys mainly feed on fish, especially mullet where available, and rarely take molluscs, crustaceans, insects, reptiles, birds and mammals (DEE 2018c).

The osprey breeds from April to February in Australia (DEE 2018c). Adult ospreys are mostly resident or sedentary around breeding territories although home ranges are poorly quantified. Young birds may disperse more than 700 km from their natal territories, but many return to their natal areas to breed (DEE 2018c).

This species is unlikely to be encountered in the vicinity of the well location as it does not occur in offshore waters (other than in association with islands) but is likely to occur within the Risk EMBA based on its preference for coastal habitats.

4.6.1.8 Little penguin

Little penguins (*Eudyptula minor*) are the smallest species of penguin in the world. The species is found inshore along the coast and on a number offshore islands around New Zealand and across southern Australia from Western Australia to New South Wales, including Bass Strait and Tasmania. The Australian population is large but thought to comprise under one million birds (DoE 2015e). Bass Strait has the largest proportion (~60%) of the known breeding colonies in Australia but breeding populations also occur within the Risk EMBA in South Australia and Western Australia. (DoEE 2015). Note that the 37 little penguin breeding BIAs within the South-east Marine Region are not mapped as BIAs, but their location is indicated in Figure 4.31.

Individuals generally exhibit strong site fidelity, returning to the same breeding colony each year to breed in the winter and spring months (Gillanders et al. 2013). Nesting occurs from late September to about late October. Two eggs are produced per clutch which both adults take turns to incubate for a period of approximately five weeks through to mid-November. Chicks are reared over subsequent summer months. The number of chicks that successfully fledge is thought reflect food availability and foraging success during the breeding season (Goldsworthy et al. 2017).

Little penguins are central-place foragers that feed on small pelagic fish and cephalopods and generally forage close (<20 km) to the colony during the breeding season, although longer foraging trips of up to 86 km from the colony have been recorded during the guard phase (Goldsworthy et al. 2017). Most little penguins stay at sea through autumn and winter, although some will return frequently to their burrows year-round (Goldsworthy et al. 2017).

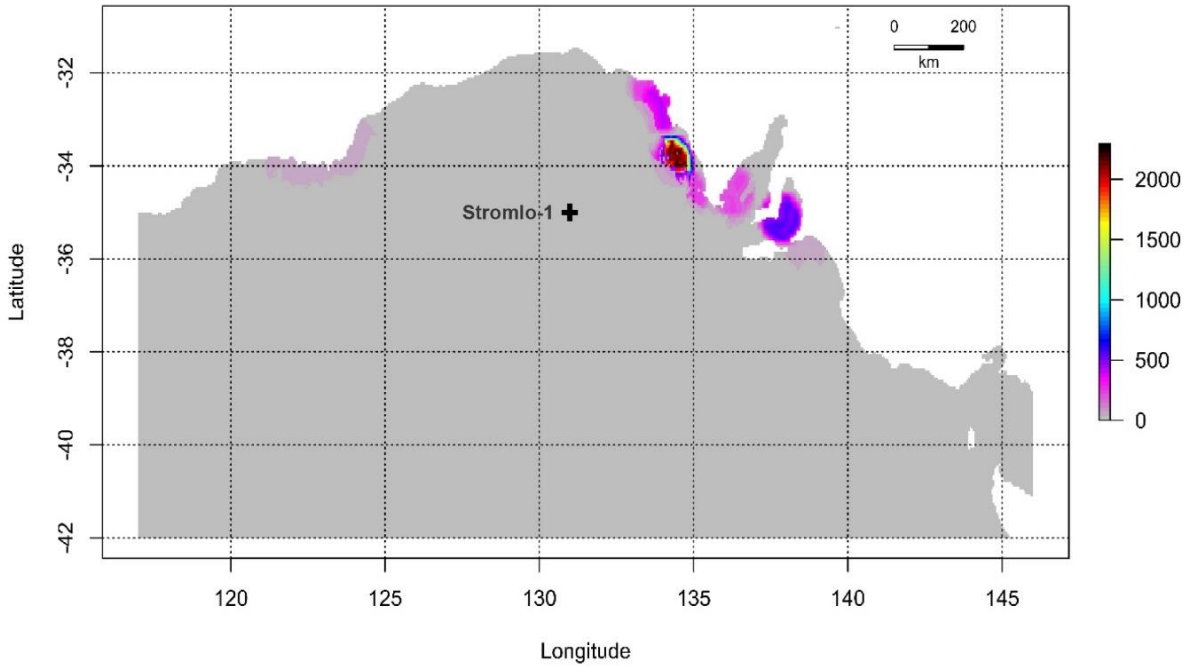
Little penguins are resident in the Great Australian Bight region and their presence has been recorded at 135 locations between the Recherche Archipelago in Western Australia and the South Australia–Victoria border (Goldsworthy et al. 2017). Breeding colonies have been recorded breeding on up to 40 islands within the Great Australian Bight region but over recent decades populations at colonies across Gulf St Vincent and Investigator Strait have undergone substantial declines. For the majority of South Australia colonies, there is limited abundance or trend data available to assess the status of little penguins. Some colonies in the Gulf St Vincent region of South Australia have undergone major declines in abundance in recent decades, while others appear to be stable (Goldsworthy et al. 2017). A synthesis of available summaries and estimates compiled as part of the Great Australian Bight Research Program provided a minimum estimate of 36,300 pairs, with an upper estimated range of 46,300 accounting for the many unsurveyed sites (Goldsworthy et al. 2017). Abundance estimates demonstrate that the largest colonies are located off the western Eyre Peninsula.

The largest breeding colony of little penguins in South Australia, at Pearson Island, was estimated to have 6000 breeding pairs (12,000 breeding individuals) during the last full burrow count in 2004, although burrow density evidence from a survey undertaken at Pearson Island in 2013 by Goldsworthy et al. (Goldsworthy et al. 2017) suggests that the breeding abundance may have declined since then by ~66%. This is supported by full burrow counts from Olive Islands completed in 2013 and 2014, which suggest a decline of ~80% in the total number of breeding individuals since the only other survey was conducted at the colony in 2006

(Goldsworthy et al. 2017). Factors that have been suggested as causes for the declines in onshore populations include predation from introduced species, disturbance and habitat loss (Wiebkin 2011) but since offshore islands like Pearson and Olive Island are not exposed these threats, further study is required to understand whether little penguin declines are occurring on these key breeding islands within the Great Australian Bight.

Habitat mapping undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data from satellite tags deployed on 94 individuals from eight sites in the Great Australian Bight demonstrated that the most suitable foraging habitats for little penguins are located along the west of the Eyre Peninsula around 134°E, 34°S (Figure 4.33).

Little penguins occur within the Risk EMBA but are not expected to be encountered in the vicinity of the well location.



Source: Bailleul et al. 2017

Figure 4.33 Standardised probability of realised occurrence of foraging habitats (weighted by abundance) of little penguins

4.6.1.9 Petrels

Eleven petrels are identified in as potentially occurring within the Risk EMBA, including eight species listed as threatened and two species also listed as migratory under the EPBC Act. Several species have breeding (3) and/or foraging (9) BIAs that intersect the Risk EMBA (Figure 4.30). Petrels range widely throughout certain regions of the Risk EMBA, foraging on small fish, cephalopods (octopus, squid and cuttlefish) and crustaceans along the edge of the continental shelf and over open waters.

The blue petrel (*Halobaena caerulea*), listed as Vulnerable under the EPBC Act, is found throughout the Southern Ocean and breeds on subantarctic islands including offshore stacks near Macquarie Island (DoE 2015a). The blue petrel breeds in colonies, laying eggs in mid to late October and fledging in January–February. The birds occur predominantly between July and September in Australian waters, including throughout the South-east Marine Region (DoE 2015a). They forage for pelagic crustaceans, fish, cephalopods and insects (DoE 2015a). Conservation advice (TSSC 2015e) has been developed for the blue petrel that provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.

The northern giant petrel (*Macronectes halli*), listed as Vulnerable and Migratory under the EPBC Act, and the southern giant petrel (*M. giganteus*, Endangered and Migratory), resemble albatrosses in that they cover vast oceanic distances throughout the southern hemisphere (and breed on isolated islands in Australian jurisdiction). All waters within Australian jurisdiction can be considered foraging habitat but the most critical foraging habitat is considered to be those waters south of 25° where most species spend the majority of their foraging time (DSEWPaC 2011c). Foraging BIAs defined in the National Conservation Values Atlas (DoEE 2015) for both species off south-eastern Australia are shown in Figure 4.30. Macquarie Island, Heard and

McDonald Islands, Giganteus Island, Hawker Island and the Frazier Islands are identified as habitat critical to the survival of giant petrels (DSEWPaC 2011c) but are all outside of the Risk EMBA in waters south of 50°S, with Macquarie Island the closest at ~3100 km south-east of the well location.

The white-faced storm-petrel (*Pelagodroma marina*) is not protected under the EPBC Act but is common throughout both the South-west Marine Region and South-east Marine Region and has breeding and foraging BIAs identified within the Risk EMBA. There are multiple large foraging BIAs along the coast across the Risk EMBA and the species are present year-round.

Similarly, the common diving petrel (*Pelecanoides urinatrix*) is not protected under the EPBC Act but is common throughout the South-east Marine Region and has and has breeding and foraging BIAs identified within the Risk EMBA. They forage mainly in the nearshore areas around their breeding colonies. There is large BIA for breeding and foraging that is a buffer around all of Tasmania and Victorian coasts and the birds are present year-round, breeding from July to January (Commonwealth of Australia 2015).

Gould's petrel (*Pterodroma leucoptera leucoptera*), listed as endangered under the EPBC Act, is Australia's rarest endemic seabird and only breeds on Cabbage Tree and Boondelbah islands, around 2 km off the coast of Port Stephens, New South Wales (within the Risk EMBA) (DEC 2006) When not breeding, the species disperses throughout the Tasman Sea and eastern Pacific Ocean, feeding primarily on cephalopods (DEC 2006) Conservation advice (DEC 2006) developed for Gould's petrel provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.

The great-winged petrel (*Pterodroma macroptera*), listed as endangered under the EPBC Act, is the only species that breeds in the South-west Marine Region, with an estimated 33,000 breeding pairs on the islands of the Recherche Archipelago in Western Australia (DSEWPaC 2012a). Outside the breeding season (October to February), great-winged petrels disperse widely and move north into subtropical waters (AAD 2008).

The Gould's petrel (*Pterodroma leucoptera leucoptera*), listed as endangered under the EPBC Act, is Australia's rarest endemic seabird and only breeds on Cabbage Tree and Boondelbah islands, around two kilometres off the coast of Port Stephens, New South Wales (within the Risk EMBA) (DEC 2006). When not breeding, the species disperses throughout the Tasman Sea and eastern Pacific Ocean, feeding primarily on cephalopods (DEC 2006). Conservation advice (DEC 2006) has been developed for the Gould petrel that provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species.

These species are unlikely to be encountered in the vicinity of the well location but are known to occur within the Risk EMBA.

4.6.1.10 Shearwaters

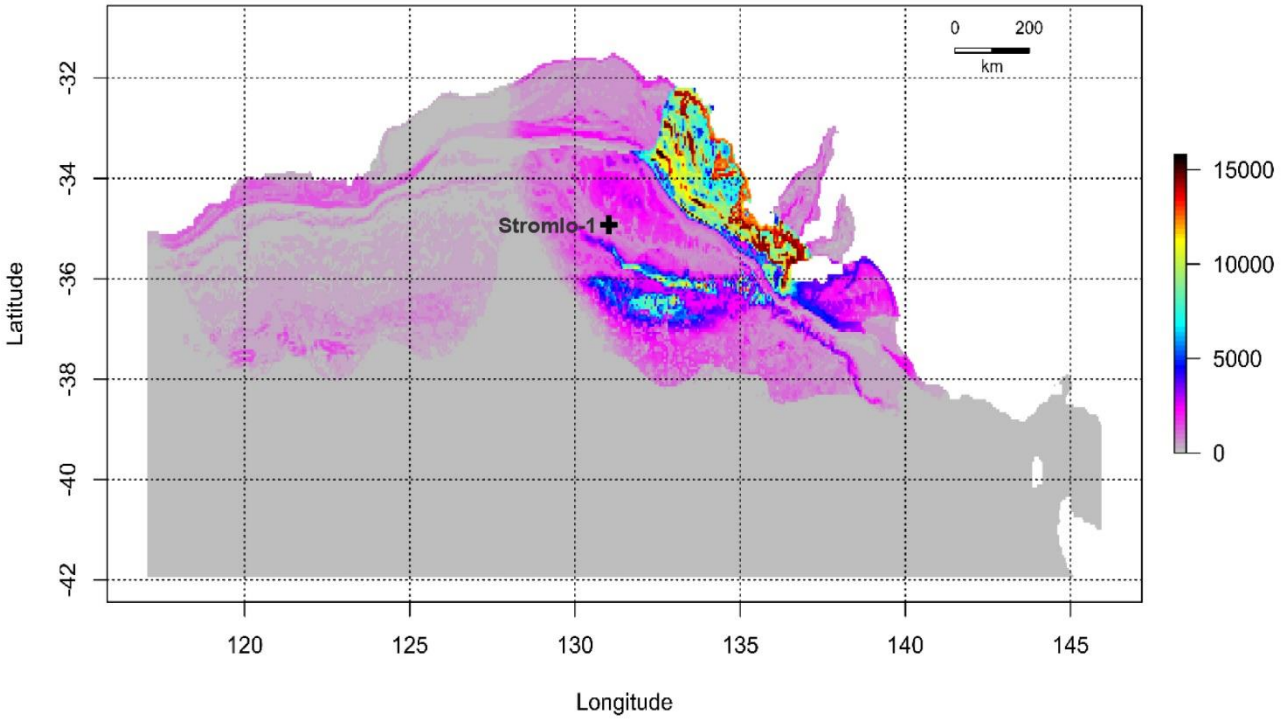
Six shearwater species are identified in Table 4.6 as potentially occurring within the Risk EMBA, including five species listed as Migratory under the EPBC Act. Shearwaters are oceanic seabirds that forage widely across the Risk EMBA but generally only during the breeding season, where they favour remote islands or headlands (Flegg 2002). Numerically, the dominant shearwater species in the Great Australian Bight region are the flesh-footed shearwater (*Ardenna carneipes*) and the short-tailed shearwater (*Puffinus tenuirostris*). The National Conservation Values Atlas (DoEE 2015) identifies BIAs for a number of shearwater species that lie within the Risk EMBA (Table 4.6). The short-tailed shearwater foraging BIA is the only one to intersect with the well location, with the next closest being the flesh-footed shearwater BIA located ~500 km east-north-east of the well location (Figure 4.30).

The flesh-footed shearwater undertakes trans-equatorial migrations between non-breeding foraging grounds and breeding colonies. The breeding range extends from St Paul Island (mid-southern Indian Ocean), across offshore islands of Western Australia and South Australia, Lord Howe Island in the Tasman Sea, and islands off the North Island of New Zealand. Flesh-footed shearwaters forage in high numbers in nearshore areas off the south-west Western Australia coast as far east as the eastern Recherche Archipelago, and in low numbers for a short distance east of the archipelago (Goldsworthy et al. 2017). They are the most abundant shearwater species in the Great Australian Bight (Goldsworthy et al. 2017). About 104,000 pairs of flesh-footed shearwaters breed on islands between Eucla and Cape Leeuwin and from early September to late May, the species forages up to 100 km offshore along the south and extreme south-west coasts (DSEWPaC 2012a). From late April to late June, and again from late August to early November, they migrate over offshore waters off the south-west coast of Western Australia (DSEWPaC 2012a). As part of the Great Australian Bight Research Program, Goldsworthy et al. (2017) surveyed flesh-footed shearwaters at their only known breeding sites in the eastern Great Australian Bight. They estimated 928 and 5785 breeding pairs at Lewis and Smith Islands, respectively, representing the first quantitative surveys for this species in South Australia.

Short-tailed shearwater forage for krill and small fish at the surface and by diving, in high numbers in offshore waters of most parts of the Great Australian Bight during autumn and summer. They breed only in Australia, from the Recherche Archipelago in Western Australia to Great Althorpe Island in South Australia, migrating to the north Pacific during the non-breeding season (DEWHA 2007). Short-tailed shearwaters forage as far afield as the subantarctic during breeding season (DEWHA 2007). Satellite tracking data analysed by SARDI shows that short-tailed shearwaters overfly the Great Australian Bight, including the waters of the surrounding the well location (PIRSA 2017).

Habitat mapping for the short-tailed shearwater undertaken by Bailleul et al. (2017) as part of the Great Australian Bight Research Program (Section 1.2.2) based on tracking data from satellite tags deployed on 33 individuals from two sites in the Great Australian Bight identified that the most suitable realised foraging habitats are located west and north-west of Kangaroo Island and Eyre Peninsula, as well as the area of oceanic waters southeast of the well location around 36°S (Figure 4.34).

Shearwater species may be encountered foraging in the vicinity of the well location (although the PMST report and SPAT database did not identify this species as a visitor likely within the Impact EMBA) and within the wider Risk EMBA.



Source: Bailleul et al. (2017)

Figure 4.34 Standardised probability of realised occurrence of foraging habitats (weighted by abundance) of short-tailed shearwaters

4.6.1.11 Swift

The fork-tailed swift (*Apus pacificus*), is the only listed swift species identified in the PMST report (and Table 4.6) as potentially occurring within the Risk EMBA. Fork-tailed swifts are listed as Migratory under the EPBC Act and travel from the north (often via the NT) to arrive in Australia between October and April (DEE 2017j). No BIAs exist for the fork-tailed swift. They mostly occur over inland plains but sometimes above foothills or in coastal areas, such as over cliffs or beaches (DEE 2017j). When present on the coast, they mostly occur in saltmarsh habitat but can also be found in sand dunes (DEE 2017j). Fork-tailed swifts forage aerially (up to hundreds of metres above ground) above open areas or over water. The species is known to be insectivorous but its food items within Australia are not well documented (DEE 2017j). No significant threats are recognised for fork-tailed swifts within Australia and no recovery plans or conservation advice exist for the species (DEE 2017j).

This species is unlikely to be encountered within the vicinity of the well location or within the Risk EMBA.

4.6.2 Shorebirds

Shorebirds, also known as waders, are members of the order Charadriiformes and inhabit intertidal areas of coastal and freshwater wetlands. Shorebirds are principally found along the shores of beaches, estuaries, rock platforms and wetlands, where they feed mainly on invertebrates taken from mud and other soft substrates. They tend to have long legs in relation to their body size, no webbing on their feet and do not swim. Fifteen species of shorebird are resident in Australia and an additional 37 species regularly and predictably visit Australia during their non-breeding season, from the Australian spring to autumn (DoE 2015a).

Shorebird species listed as Threatened and/or Migratory in the EPBC Act PMST Report (Appendix 7-2) are identified in Table 4.7. Threatened and Non-threatened ("other") shorebird species are described further below. Other migratory shorebirds are described as a group because they follow a common pathway, arrive and depart during the same seasons, have similar habitat preferences and tend to congregate at a limited number of sites, often in mixed flocks. BIAs are not defined for any shorebird species although Ramsar sites and nationally important wetlands (Section 1.3) generally represent critical shorebird habitat.

Table 4.7 EPBC Act-listed shorebird species or species habitat within the Risk EMBA

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory species[2]	Type of presence		
Charadriidae (plovers)						
Charadrius bicinctus	Double-banded plover	–	Yes	Roosting known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Charadrius leschenaultii	Greater sand plover	Vulnerable	Yes	Roosting known to occur within area	–	Conservation Advice Charadrius leschenaultii greater sand plover (TSSC 2016b)
Charadrius mongolus	Lesser sand plover	Endangered	Yes	Roosting known to occur within area	–	Conservation Advice Charadrius mongolus lesser sand plover (TSSC 2016c)
Charadrius veredus	Oriental plover	–	Yes	Roosting known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Pluvialis fulva	Pacific golden plover	–	Yes	Roosting known to occur within area	–	
Pluvialis squatarola	Grey plover	–	Yes	Roosting known to occur within area	–	
Thinornis rubicollis	Hooded plover (eastern)	Vulnerable	–	Species or species habitat known to occur within area	–	Conservation Advice *Thinornis rubricollis* hooded plover (eastern) ((DoE 2014c))
Painted snipes (family Rostratulidae)						
Rostratula australis	Australian painted snipe	Endangered	Yes	Species or species habitat likely to occur within area	–	Approved Conservation Advice for Rostratula australis (Australian painted snipe) (TSSC 2013c)
Curlew, godwits, knots, sandpipers, snipes, stints and phalaropes (family Scolopacidae)						
Actitis hypoleucos	Common sandpiper	–	Yes	Species or species habitat known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Arenaris interpres	Ruddy turnstone	–	Yes	Roosting known to occur within area	–	
Calidris acuminata	Sharp-tailed sandpiper	–	Yes	Roosting known to occur within area	–	
Calidris alba	Sanderling	–	Yes	Roosting known to occur within area	–	

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory species[2]	Type of presence		
Calidris canutus	Red knot	Endangered	Yes	Species or species habitat may occur within area	–	Conservation Advice *Calidris canutus* red knot (TSSC 2016d)
Calidris ferruginea	Curlew sandpiper	Critically Endangered	Yes	Species or species habitat may occur within area	–	Conservation Advice *Calidris ferruginea* curlew sandpiper (DoE 2015d)
Calidris melanotos	Pectoral sandpiper	–	Yes	Roosting known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Calidris ruficollis	Red-necked stint	–	Yes	Roosting known to occur within area	–	
Calidris subminuta	Long-toed stint	–	Yes	Species or species habitat known to occur within area	–	
Calidris tenuirostris	Great knot	Critically Endangered	Yes	Roosting known to occur within area	–	Conservation Advice Calidris tenuirostris great knot (TSSC 2016e)
Gallinago hardwickii	Latham's snipe	–	Yes	Species or species habitat may occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Gallinago megala	Swinhoe's snipe	–	Yes	Roosting known to occur within area	–	
Gallinago stenura	Pin-tailed snipe	–	Yes	Roosting known to occur within area	–	
Limicola falcinellus	Broad-billed sandpiper	–	Yes	Roosting known to occur within area	–	
Limnodromus semipalmatus	Asian dowitcher	–	Yes	Roosting known to occur within area	–	
Limosa lapponica baueri	Western Alaskan bar-tailed godwit	Vulnerable	Yes	Species or species habitat known to occur within area	–	Conservation Advice Limosa lapponica baueri Bar-tailed godwit (western Alaskan) (TSSC 2016f)
Limosa lapponica menzbieri	Northern Siberian bar-tailed godwit	Critically Endangered	–	Species or species habitat likely to occur within area	–	Conservation Advice Limosa lapponica menzbieri bar-tailed godwit (northern Siberian) (TSSC 2016g)
Limosa	Black-tailed godwit	–	Yes	Roosting known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory species[2]	Type of presence		
Numenius madagascariensis	Eastern curlew	Critically Endangered	Yes	Roosting known to occur within area	–	Conservation Advice *Numenius madagascariensis* eastern curlew (DoE 2015e)
Numenius minutus	Little curlew	–	Yes	Roosting known to occur within area	–	Wildlife Conservation Plan for Migratory Shorebirds (DoE 2015h)
Numenius phaeopus	Whimbrel	–	Yes	Roosting known to occur within area	–	
Phalaropus lobatus	Red-necked phalarope	–	Yes	Foraging, feeding or related behaviour known to occur within area	–	
Philomachus pugnax	Ruff	–	Yes	Roosting known to occur within area	–	
Tringa brevipes	Grey-tailed tattler	–	Yes	Roosting known to occur within area	–	
Tringa glareola	Wood sandpiper	–	Yes	Roosting known to occur within area	–	
Tringa incana	Wandering tattler	–	Yes	Roosting known to occur within area	–	
Tringa nebularia	Common greenshank	–	Yes	Species or species habitat known to occur within area	–	
Tringa stagnatilis	Marsh sandpiper	–	Yes	Roosting known to occur within area	–	
Xenus cinereus	Terek sandpiper	–	Yes	Roosting known to occur within area	–	

1 Listed threatened species: A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.
2 Listed migratory species: A native species that from time to time are included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act

Plovers

Seven plover species are identified in the PMST Report (and Table 4.7 above) as potentially occurring within the Risk EMBA. Plovers occur in beach, dune, estuary, coastal marsh, mudflat and sometimes mangrove habitats along the coast, with most of the plovers present along the southern Australian coastline having broad distributions. The identified plovers are all migratory shorebirds with the exception of the hooded plover (*Thinornis rubricollis*). This species is listed as Vulnerable under the EPBC Act. It is a resident shorebird species that inhabits sandy beaches, consuming invertebrates (such as sandhoppers, small bivalves and soldier crabs) from the sand near the water's edge and laying eggs in sand dunes or upper beach areas. While not an abundant species, they do have a widespread distribution from Jervis Bay in New South Wales through to Perth in Western Australia (DoE 2014c)

Plovers are unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

Painted snipe

The Australian painted snipe (*Rostratula benghalensis*) is listed as endangered under the EPBC Act. This species has been recorded at wetlands in all states of Australia but is most common in eastern Australia, where records throughout much of Queensland, New South Wales, Victoria and south-eastern South Australia. The Australian painted snipe generally inhabits shallow terrestrial freshwater (occasionally brackish) wetlands, including temporary and permanent lakes, swamps and claypans.

This species is unlikely to be encountered in the vicinity of the well location or within the Risk EMBA.

Red knot and great knot

Two species of knots are included in Table 4.7, the red knot (*Calidris canutus*) and great knot (*C. tenuirostris*), listed as Endangered and Critically Endangered Migratory species under the EPBC Act, respectively.

The great knot has been recorded in all states of Australia but is much less common in south-west Australia, South Australia, Victoria and Tasmania. The species typically prefers sheltered coastal habitats, with large intertidal mudflats or sandflats. The great knot does not breed in Australia. Similarly, while red knots have been recorded in all states they do not exist in significant numbers within the Great Australian Bight or New South Wales coasts where wader habitat is scarce. They typically inhabits intertidal mudflats, sandflats and sandy beaches of sheltered coasts, in estuaries, bays, inlets, lagoons and harbours. This species does not breed in Australia.

These species are unlikely to be encountered in the vicinity of the well location or the Risk EMBA.

Curlew sandpiper

The curlew sandpiper (*Calidris ferruginea*) is listed as critically endangered under the EPBC Act. In Australia, curlew sandpipers occur along the coast and are also quite widespread inland (though in smaller numbers). They have been recorded in all states and do not breed in Australia. Curlew sandpipers mainly occur on intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons; they occur in both fresh and brackish waters.

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

Eastern curlew

The eastern curlew (*Numenius madagascariensis*) is listed as critically endangered under the EPBC Act (DoE 2015h). They have a primarily coastal distribution and have been recorded in all states, particularly the north, east, and south-east regions including Tasmania. In Victoria, they are mostly found around the Gippsland Lakes, from Corner Inlet to Port Phillip Bay, and on the far west coast. Eastern curlews are found on islands in Bass Strait and the north and east coasts of Tasmania. In South Australia, the species is patchily distributed from the Coorong north-west to the Streaky Bay area. In southern Western Australia, they are recorded from Eyre and there are scattered records from Stokes Inlet to Peel Inlet. The eastern curlew is most commonly associated with sheltered coasts, especially estuaries, bays, harbours, inlets and coastal lagoons, with large intertidal mudflats or sandflats, often with beds of seagrass. The eastern curlew does not breed in Australia.

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.2.1 Other migratory shorebirds

In addition to the Threatened Migratory shore birds described above, 38 other migratory shorebirds protected under the EPBC Act are identified in the PMST Report as potentially occurring within the Risk EMBA.

Migratory shorebirds make an annual return journey of many thousands of kilometres between their breeding grounds in the northern hemisphere and their non-breeding grounds in the southern hemisphere (DoE 2015f). Around two million migratory shorebirds travel from Arctic regions during the non-breeding season to feed at Australian coastal and freshwater wetlands each year (DoE 2015f). The migratory shorebird populations that visit Australia travel along a similar pathway throughout their annual cycle, known as the East Asian–Australasian Flyway (EAAF) (Bamford et al. 2008). The EAAF extends from breeding grounds in the Russian tundra, Mongolia and Alaska southwards through east and south-east Asia, to non-breeding areas in Indonesia, Papua New Guinea, Australia and New Zealand.

Migratory shorebirds arrive in north-western Australia and the Gulf of Carpentaria in Queensland around September and disperse from Ramsar site staging areas such as Roebuck Bay and Eighty Mile Beach across Australia, reaching the south-eastern states by October. Smaller flocks, cumulatively numbering thousands of birds, take advantage of ephemeral wetlands across inland Australia, while others (including the species identified in Table 4.7) spread to wetland sites along the coastline. By March, the birds that have previously dispersed across the country return to the staging areas in northern Australia, forming large flocks and feeding constantly to accumulate energy reserves for their northward migration. Some flocks or individuals of some migratory species remain in Australia during the winter months, such as first-year birds that lack the experience or physical condition to return to their natal sites but often do so in their second year.

Migratory shorebirds are generally gregarious and congregate at Ramsar sites, gathering in mixed flocks, but also occur in single-species flocks or feed and roost with resident shorebird species such as stilts, avocets, oystercatchers and plovers. The DoE (2015h) Wildlife Conservation Plan for Migratory Shorebirds provides a framework to guide the conservation of migratory shorebirds and their habitat in Australia.

Migratory shorebird species are not expected to be present in the vicinity of the well location but are likely to be found around wetlands along the shoreline of the Risk EMBA.

4.6.3 Terrestrial birds

Terrestrial bird species listed as Threatened and/or Migratory under the EPBC Act identified in the PMST report that transit through the Risk EMBA or inhabit coastal habitats immediately adjacent to the Risk EMBA are identified in Table 4.8 and described further below.

Table 4.8 EPBC Act-listed terrestrial bird species or species habitat within the Risk EMBA

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory species[2]	Type of presence		
Anatidae (geese)						
Cereopsis novaehollandiae grisea	Cape Barron goose (south-western)	Vulnerable	–	Breeding known to occur within area	–	Approved Conservation Advice for *Cereopsis novaehollandiae grisea* (Cape Barren goose (south-western)) ((DEWHA 2008b)
Parrots (family Psittaculidae)						
Neophema chrysogaster	Orange-bellied parrot	Critically Endangered	–	Breeding known to occur within area	–	National Recovery Plan for the Orange-bellied Parrot (DELWP 2016)

Scientific name	Common name	EPBC Act status			BIA within risk EMBA	Relevant plan
		Listed threatened species[1]	Listed migratory species[2]	Type of presence		
Lathamus discolor	Swift parrot	Critically Endangered	–	Breeding known to occur within area	–	Conservation Advice *Lathamus discolor* swift parrot (TSSC 2016h) National Recovery Plan for the Swift Parrot (*Lathamus discolor*) (Birds Australia 2011)

1 Listed threatened species: A native species listed in Section 178 of the EPBC Act as either extinct, extinct in the wild, critically endangered, endangered, vulnerable or conservation dependent.
2 Listed migratory species: A native species that from time to time are included in the appendices to the Bonn Convention and the annexes of JAMBA, CAMBA and ROKAMBA, as listed in Section 209 of the EPBC Act.

4.6.3.1 Cape Barren goose

The Cape Barren goose (*Cereopsis novaehollandiae grisea*), listed as Vulnerable under the EPBC Act, is a distinct-looking grey bird that is most abundant on islands and rocks of the Recherche Archipelago, Western Australia (approximately 580 km west of the well location), and is a casual visitor to the Western Australia mainland from Bremer Bay to Cape Arid (DEWHA 2008b). It has also been introduced to Kangaroo Island (BirdLife Australia 2015c). The population is estimated at 650 individuals, which has remained reasonably stable for the last 50 years (DEWHA 2008b). This species feeds predominantly on tussock grasses, herbs and succulents, where it also lays its eggs, and rarely ventures into the water (BirdLife Australia 2015c).

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.3.2 Swift parrot

The swift parrot (*Lathamus discolor*), listed as critically endangered under the EPBC Act, is a small parrot endemic to south-eastern Australia that migrates between distinct breeding and non-breeding ranges. There are no recent estimates of the number of swift parrots in the wild but it is thought that considerably less than 2000 birds remain in the wild (TSSC 2016h). The species breeds in Tasmania during the summer and the entire population migrates to mainland Australia for the winter (TSSC 2016h).

The breeding range of the swift parrot is largely restricted to the east and south-east coast of Tasmania and closely mirrors the distribution of blue gum (Eucalyptus globulus), their main food source (TSSC 2016h). The species breeds in tree hollows in old-growth or other forest with suitable hollows between Launceston and Smithton, but the number of birds involved and frequency of these breeding events is not well understood (TSSC 2016h). Potential breeding habitat remaining in the north-west is scarce and highly fragmented (TSSC 2016h).

When on the mainland the swift parrot disperses widely to forage on flowers and psyllids in Eucalyptus species, with the majority being found in Victoria and New South Wales (TSSC 2016h). In Victoria, swift parrots are predominantly found in the dry forests and woodlands of the box-ironbark region on the inland slopes of the Great Dividing Range (TSSC 2016h). In New South Wales, swift parrots forage in forests and woodlands throughout the coastal and western slopes regions each year (TSSC 2016h). Small numbers of swift parrots are observed in the ACT and in south-eastern Queensland on a regular basis (TSSC 2016h). The species is less frequently observed in the southern Mount Lofty Ranges and the Bordertown–Naracoorte area in south-eastern South Australia (TSSC 2016h). Coastal regions tend to support larger numbers of birds when inland habitats are subjected to drought (TSSC 2016h).

Conservation advice (TSSC 2016h) developed for the swift parrot provides guidance on immediate recovery and threat abatement activities that can be undertaken to ensure the conservation of the species. A recovery plan (Birds Australia 2011) is also in place for the swift parrot and identifies actions to be taken to ensure the species long-term viability across its range.

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

4.6.3.3 Orange-bellied parrot

The orange-bellied parrot (*Neophema chrysogaster*), listed as critically endangered under the EPBC Act, is a small ground-feeding parrot endemic to south-eastern Australia that migrates between distinct breeding and non-breeding ranges. There are thought to be about 50 orange-bellied parrots remaining in the wild, as well as around 320 in captivity (DELWP 2016)dwe.

Breeding occurs in south-west Tasmania between November and March, and orange-bellied parrots overwinter on the coast of south-east mainland Australia between April and October (DELWP 2016). Breeding birds are currently restricted to an area mainly within 30 km of the coast around Melaleuca, south-west Tasmania (DELWP 2016). Non-breeding orange-bellied parrots are usually found within 3 km of the coast along mainland Australia between Goolwa, South Australia and Corner Inlet, Victoria (DELWP 2016). Throughout the non-breeding range the species requires a diversity of foraging opportunities, in saltmarshes, dunes and adjacent shrubby areas and weedy pastures, within 10 km of the coast and 200 m of coastal wetlands and waterbodies, but more than 2 km from developed areas (such as towns) In Victoria, they mostly occur in sheltered coastal habitats, such as bays, lagoons and estuaries (DELWP 2016). The non-breeding range also includes New South Wales, however sightings are now very rare, with the most recent sightings in New South Wales being two reports of single birds in 2003 (DELWP 2016). The migration route follows the west coast of Tasmania, and at least some birds stop on King Island during the northward migration in autumn (DELWP 2016). Birds depart the mainland for Tasmania from September to November (DELWP 2016).

A recovery plan (DELWP 2016) has been developed for the orange-bellied parrot and outlines the long-term strategy, and short-term objectives and actions, for the recovery of the species. The recovery plan identifies habitat critical to survival for the orange-bellied parrot including:

- eucalypt forest and rainforest and recently burnt (<8 years) moorland and sedgeland plains in south-west Tasmania, especially within 10 km of Melaleuca Lagoon, required to support breeding activity
- all historic breeding and non-breeding locations (including those that are no longer occupied)
- migratory habitat on King Island mapped by Barrow (2008) (at Bungaree Point, Peerless Point, Lake Flannigan, Yellow Rock Estuary and Sea Elephant Estuary) and on the Tasmanian west coast (yet to be identified).

This species is unlikely to be encountered in the vicinity of the well location but may occur within the Risk EMBA.

5.0 Socio-economic environment

This section describes the socio-economic environment within the Risk EMBA, including coastal aspects as relevant.

5.1 Coastal settlements

There are 104 areas defined as "Urban Centres and Localities" by the Australian Bureau of Statistics (2018) with coastal infrastructure or developments within or immediately adjacent to the Risk EMBA. The distribution of these coastal settlements and the characteristics of the resident populations varies markedly throughout the Risk EMBA. These are identified and described below for each state. It is noted that other coastal settlements may also occur along the Risk EMBA (e.g. hamlets and isolated dwellings with a population of less than 100 residents). Those not described below are considered rural areas with few services or buildings under the Australian Statistical Geography Standard (Australian Bureau of Statistics 2018).

5.1.1 Western Australian coastal settlements

None of the settlements present on the south coast of Western Australia intersect the Risk EMBA.

5.1.2 South Australian coastal settlements

There are 31 South Australia coastal settlements that intersect the Risk EMBA. Each is identified (from west to east) in Table 5.1. South Australia coastal settlements are concentrated around the Gulfs, with the density and population size of coastal settlements tending to decline with increased distance from Adelaide.

Data from the 2016 census (Australian Bureau of Statistics 2018) standardised according to hierarchal classes (Doxiadis, 1968) groups the settlements as (ordered according to resident population size):

- one metropolitan area (population >1,000,000) – Adelaide
- no large cities (population of 300,000 to 1,000,000) or cities (population of 100,000 to 300,000)
- one large town (population of 20,000 to 100,000) – Whyalla
- 15 towns (population of 1000 to 20,000) – Victor Harbor, Port Lincoln, Port Pirie, Goolwa, Moonta, Wallaroo, Normanville, Kingscote, Kingston SE, Tumby Bay, Ardrossan, Port Broughton and Robe
- 16 villages (population of 100 to 1000) – Cowell, Middleton, Port MacDonnell, Stansbury, Port Vincent, Edithburgh, Beachport, Elliston, Port Germein, Point Turton, Port Victoria, Penneshaw, Southend, Arno Bay, Coobowie and Port Neill.

South Australia coastal settlements vary considerably in terms of the per centage of residents employed in industries likely to be adversely affected in the event of inadvertent environmental damage caused by the development (i.e. fishing and tourism). Australian Bureau of Statistics census statistics for 2016 (Australian Bureau of Statistics 2018) indicate that a relatively high per centage of residents in South Australia coastal settlements are involved in agriculture, forestry & fishing (assumed to be a proxy for fishing/aquaculture industries) and accommodation & food services (assumed to be a proxy for the tourism industry).

Table 5.1 South Australian coastal settlement population and employment figures[1]

Settlement	Population	% of employment in industries relevant to potential impacts	
		Agriculture, forestry and fishing	Accommodation and food services
Elliston	324	7.72	6.79
Port Lincoln	14,062	3.93	3.05
Tumby Bay	1413	4.10	2.76
Port Neill	142	4.23	3.52

Settlement	Population	% of employment in industries relevant to potential impacts	
		Agriculture, forestry and fishing	Accommodation and food services
Arno Bay	232	9.48	5.60
Cowell	990	6.46	3.64
Whyalla	21,505	0.18	2.75
Port Germein	303	2.64	2.64
Port Pirie	13,743	0.32	2.84
Port Broughton	1033	5.13	3.29
Wallaroo	3988	2.26	2.56
Moonta	4175	2.06	2.95
Port Victoria	281	6.76	2.85
Point Turton	303	5.28	3.30
Edithburgh	458	0.66	2.40
Coobowie	207	5.31	4.35
Stansbury	569	5.10	3.87
Port Vincent	470	3.19	5.11
Ardrossan	1168	2.05	2.05
Adelaide	1,165,639	0.35	3.05
Normanville	1903	1.10	3.26
Kingscote	1785	4.59	4.71
Penneshaw	272	5.88	9.93
Victor Harbor	15,267	0.79	3.28
Middleton	930	1.29	4.62
Goolwa	7715	0.80	3.03
Kingston SE	1647	9.29	3.34
Robe	1001	5.99	9.69
Beachport	435	9.89	7.59
Southend	253	15.81	3.56
Port MacDonnell	677	7.24	2.66

1Australian Bureau of Statistics (2018) – 2016 census data for “Urban Centres and Localities (UCL)” and “Employment, Income and Education”.

5.1.3 Victorian coastal settlements

There are 29 Victoria coastal settlements that intersect the Risk EMBA. These are listed (from west to east) in Table 5.2. Victoria coastal settlements are concentrated around the major settlements within Port Phillip Bay (i.e. Melbourne and Geelong – both located outside the Risk EMBA) and occur relatively consistently to the west of this area along the Great Ocean Road. Coastal settlements also occur in relatively high density to the west around Western Port Bay but are sparse east of Wilsons Promontory.

Resident population sizes similarly tend to be higher along the western and central Victoria coast but lower to the east. When standardised according to hierarchal classes (Doxiadis 1968), the Victoria coastal settlements that intersect the Risk EMBA include (ordered according to resident population size):

- one large town (population of 20,000 to 100,000) – Warrnambool

- 15 towns (population of 1000 to 20,000) – Ocean Grove–Barwon Heads, Torquay–Jan Juc, Portland, Lakes Entrance, Inverloch, Cowes, Point Lonsdale–Queenscliff, Port Fairy, Anglesea, Balnarring–Balnarring Beach, Cape Woolamai, Apollo Bay, San Remo, Aireys Inlet–Fairhaven and Mallacoota
- 13 villages (population of 100 to 1000) – Venus Bay, Cape Paterson, Surf Beach–Sunderland Bay, Ventnor, Flinders, Lake Tyers Beach, Shoreham, Golden Beach–Paradise Beach, Kilcunda, Port Campbell, Marengo, Smiths Beach and Sandy Point.

Settlements along the western Victoria coast including Port Campbell, Warrnambool, Port Fairy and Portland provide services to the commercial and recreational fishing industries in south-west Victoria. The proportion of residents employed by the accommodation and food services industry is among the highest across all coastal settlements that intersect the Risk EMBA for settlements along Great Ocean Road, particularly for Apollo Bay, Marengo and Port Campbell (Table 5.2).

Table 5.2 Victorian coastal settlement population and employment figures[1]

Settlement	Population	% of employment in industries relevant to potential impacts	
		Agriculture, forestry and fishing	Accommodation and food services
Portland	10,059	1.59	3.45
Port Fairy	3028	1.88	5.52
Warrnambool	30,707	1.16	4.10
Port Campbell	266	1.88	16.92
Marengo	237	1.69	10.97
Apollo Bay	1363	1.03	12.69
Aireys Inlet–Fairhaven	1120	0.00	6.16
Anglesea	2543	0.20	5.19
Torquay–Jan Juc	16,942	0.43	3.55
Ocean Grove–Barwon Heads	18,208	0.46	3.19
Point Lonsdale–Queenscliff	3748	0.83	3.31
Flinders	637	1.41	3.61
Shoreham	459	0.65	1.96
Balnarring–Balnarring Beach	2319	1.34	2.63
Ventnor	646	0.00	3.25
Cowes	4944	0.49	5.66
Smiths Beach	227	0.00	3.52
Surf Beach–Sunderland Bay	764	0.65	2.88
Cape Woolamai	1675	0.84	3.88
San Remo	1209	0.83	4.88
Kilcunda	350	2.86	2.57
Cape Paterson	837	1.43	3.82
Inverloch	5066	1.18	2.23
Venus Bay	937	0.75	1.49
Sandy Point	206	0.00	4.37
Golden Beach–Paradise Beach	442	0.90	1.36
Lakes Entrance	6071	1.63	5.53
Lake Tyers Beach	592	0.84	5.41
Mallacoota	1005	2.29	5.17

1Australian Bureau of Statistics (2018) – 2016 census data for “Urban Centres and Localities (UCL)” and “Employment, Income and Education”.

5.1.4 Tasmanian coastal settlements

There are five Tasmanian coastal settlements that intersect the Risk EMBA. Each is identified in Table 5.3. These occur along parts of the northern margin of mainland Tasmania, with the exception of Currie on King Island and Scamander, which is located on an exposed part of the east coast of Tasmania.

Data from the Australian Bureau of Statistics 2016 census standardised according to hierarchal classes (Doxiadis 1968) groups Burnie–Somerset and Wynard as towns and Currie, Scamander and Stanley as Villages, although Burnie–Somerset and Wynard are only separated along the coast by approximately 5 km and could be considered a large town (Australian Bureau of Statistics 2018).

The per centage of residents employed in industries likely to be adversely affected in the event of inadvertent environmental damage caused by the development, a high proportion of the population in Currie are employed by the agriculture, forestry and fishing industry and a high proportion of the population in Stanley employed by the accommodation and food services industry. The other Tasmanian coastal settlements within the Risk EMBA have a low-moderate per centage of the population employed in both industries.

Table 5.3 Tasmanian coastal settlement population and employment figures[1]

Settlement	Population	% of employment in industries relevant to potential impacts	
		Agriculture, forestry and fishing	Accommodation and food services
Currie	667	7.65	3.30
Stanley	472	4.87	8.05
Wynyard	5167	1.86	2.40
Burnie–Somerset	19,388	1.01	3.19
Scamander	511	1.17	3.91

1Australian Bureau of Statistics (2018) – 2016 census data for “Urban Centres and Localities (UCL)” and “Employment, Income and Education”.

5.1.5 New South Wales coastal settlements

There are 39 coastal settlements along the New South Wales coast that intersect the Risk EMBA. Each is identified (from south to north) in Table 5.4. The number of settlements along the New South Wales coast generally increases with proximity to Sydney. In addition to being higher density, the central New South Wales coast region around Sydney comprises multiple coastal settlements with a population that is much larger than anywhere else in the Risk EMBA, other than Adelaide. This includes Wollongong, Sydney, the Central Coast and Newcastle, which are classified as a city, metropolitan area and large cities, respectively (based on data from the Australian Bureau of Statistics 2016 census standardised according to hierarchal classes classifies). The other coastal settlements along the New South Wales coast within the Risk EMBA have much lower resident populations and include (ordered according to resident population size):

- 21 towns (population of 1000 to 20,000) – Forster–Tuncurry, Kiama, Ulladulla, Merimbula, Anna Bay–Boat Harbour, Gerringong, Old Bar, Culburra Beach–Orient Point, Narooma, Shoalhaven Heads, Broulee–Mossy Point, Tuross Head, Malua Bay, Dalmeny, Fingal Bay, Pambula, Tathra, Bermagui, Stanwell Park, Hawks Nest and Tomakin
- 14 villages (population of 1000 to 20,000) – Hallidays Point–Black Head, Diamond Beach, Bawley Point, Gerroa, Lake Tabourie, Cunjurong Point–Manyana, Berrara–Cudmirrah, Red Head, Boomerang Beach–Blueys Beach, Currarong, Maloneys Beach, South Durras, Kioloa and Elizabeth Beach.

The proportion of residents employed in industries likely to be adversely affected in the event of inadvertent environmental damage is low across New South Wales coastal settlements for agriculture, forestry and fishing industry and generally moderate for accommodation and food services.

Table 5.4 New South Wales coastal settlement population and employment figures[1]

Settlement	Population	% of employment in industries relevant to potential impacts	
		Agriculture, forestry and fishing	Accommodation and food services
Pambula	1580	1.77	5.06
Merimbula	7520	0.68	6.46
Tathra	1552	1.61	5.28
Bermagui	1481	1.08	5.40
Narooma	3344	0.93	4.49
Dalmeny	1937	0.36	3.36
Tuross Head	2242	0.71	3.21
Broulee–Mossy Point	2248	0.53	3.20
Tomakin	1003	0.00	5.58
Malua Bay	2204	0.77	3.22
Maloneys Beach	369	0.00	3.52
South Durras	336	1.49	5.95
Kioloa	257	0.00	7.39
Bawley Point	684	0.73	4.53
Lake Tabourie	641	0.47	4.21
Ulladulla	13057	0.55	5.02
Cunjurong Point–Manyana	592	1.18	2.87
Berrara–Cudmirrah	575	0.00	4.52
Currarong	449	0.00	3.56
Culburra Beach–Orient Point	3484	0.43	2.35
Shoalhaven Heads	3075	0.55	3.64
Gerroa	645	0.47	4.81
Gerringong	4409	0.45	3.67
Kiama	13,455	0.22	3.98
Wollongong	261,897	0.13	3.22
Stanwell Park	1393	0.00	3.09
Sydney	4,321,534	0.14	3.16
Central Coast	307,740	0.22	3.26
Newcastle	322,279	0.16	3.52
Anna Bay–Boat Harbour	5056	0.51	4.25
Fingal Bay	1613	0.00	3.72
Hawks Nest	1216	0.00	4.85
Boomerang Beach–Blueys Beach	483	0.62	6.42
Elizabeth Beach	219	0.00	5.94
Forster–Tuncurry	19,918	0.58	3.88
Hallidays Point–Black Head	946	0.32	2.11
Red Head	515	0.97	3.50
Diamond Beach	880	0.00	4.20
Old Bar	3801	0.39	2.50

1Australian Bureau of Statistics (2018) – 2016 census data for “Urban Centres and Localities (UCL)” and “Employment, Income and Education”.

5.2 Commercial fisheries

Numerous Commonwealth- and state-managed fisheries are present within the Risk EMBA. These are identified and described below according to jurisdiction.

5.2.1 Commonwealth-managed fisheries

The Australian Fisheries Management Authority (AFMA) manages Commonwealth fisheries under the *Fisheries Management Act 1991*. The gross value of production of Commonwealth fisheries was $439M (million) in 2015–2016, accounting for 14.5% of Australia's total fisheries and aquaculture production (ABARES 2017).

There are eight Commonwealth-managed commercial fisheries that overlap the Risk EMBA:

- Bass Strait Central Zone Scallop Fishery
- Eastern Tuna and Billfish Fishery
- Skipjack Tuna Fishery
- Small Pelagic Fishery
- Southern and Eastern Scalefish and Shark Fisheries
- Southern Bluefin Tuna Fishery
- Southern Squid Jig Fishery
- Western Tuna and Billfish Fishery.

The jurisdictional area of each fishery is described in Table 5.5.

The well location is included within the boundary of each of these fisheries other than the Bass Strait Central Zone Scallop and Eastern Tuna and Billfish Fisheries. The Skipjack Tuna Fishery overlaps with the well location but has not been active since 2008–2009 and management arrangements for the fishery are under review. Area closures (shown in Figure 5.1) established in February 2013 and in place until at least May 2021, are enforced as part of the Southern and Eastern Scalefish and Shark Fishery (SESSF) and Small Pelagic Fishery (SPF) (Closures) Direction 2016 (F2016L00549) made under s41A (2) of the *Fisheries Management Act 1991*. Constraints on fishing methods in the Great Australian Bight Commonwealth Marine Reserve also restrict SESSF sectors and the SPF from operating near the well (refer to Table 5.5 for the restrictions applicable to each fishery). Maps of fishing effort in 2016 for each of the other Commonwealth-managed fisheries that may possibly fish in waters near the Stromlo-1 well (i.e. the Southern Bluefin Tuna Fishery, Western Tuna and Billfish Fishery and the Southern Squid Jig Fishery) are presented in Figure 5.2.

The areas fished and relative catch levels of all Commonwealth-managed fisheries from 2013–2016 is presented in Figure 5.3. Commonwealth-managed fishers are consistently shown to operate in certain Great Australian Bight shelf waters but not near the well. Consultation with commercial fishing industry representatives confirms that it is unlikely any Commonwealth-managed fisheries license holders are active in the vicinity of the well location (Table 5.5).

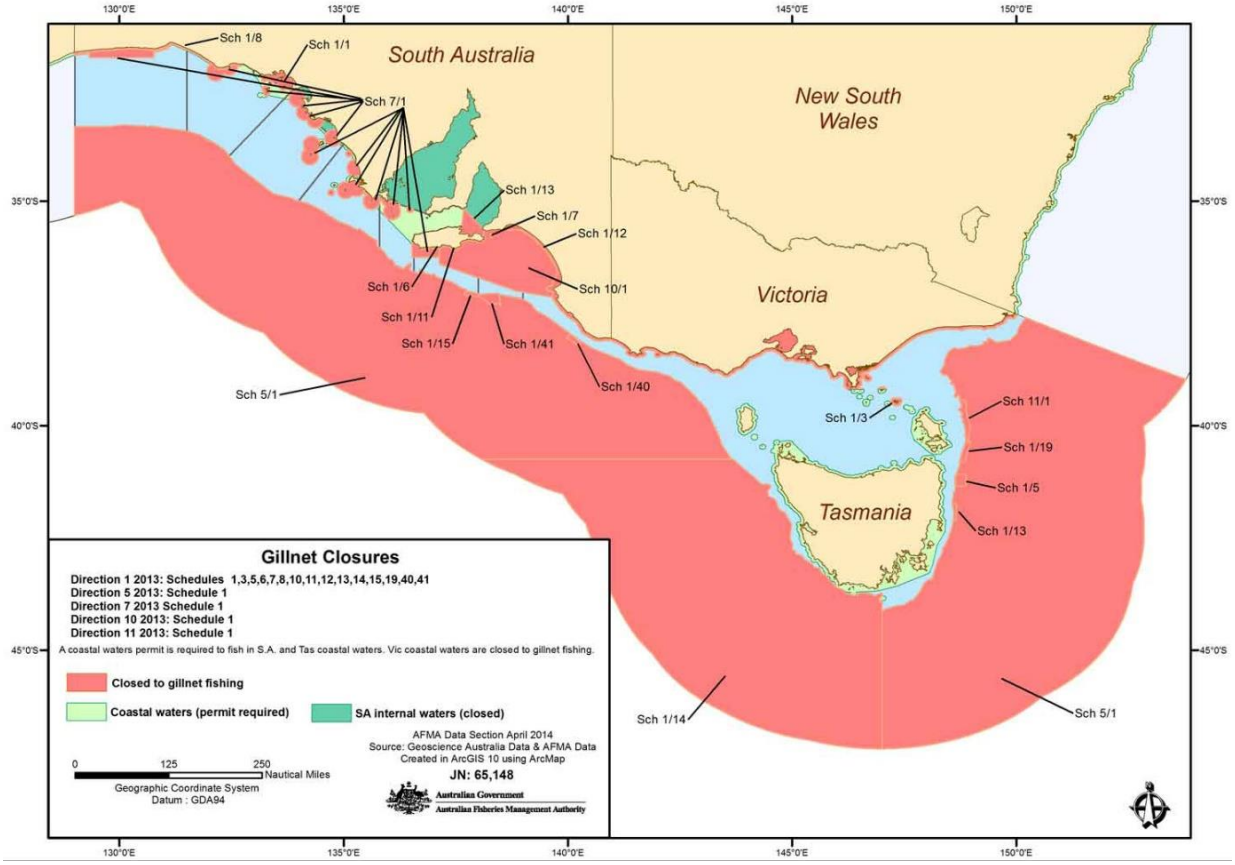
Table 5.5 Commonwealth-managed fisheries in the Risk EMBA

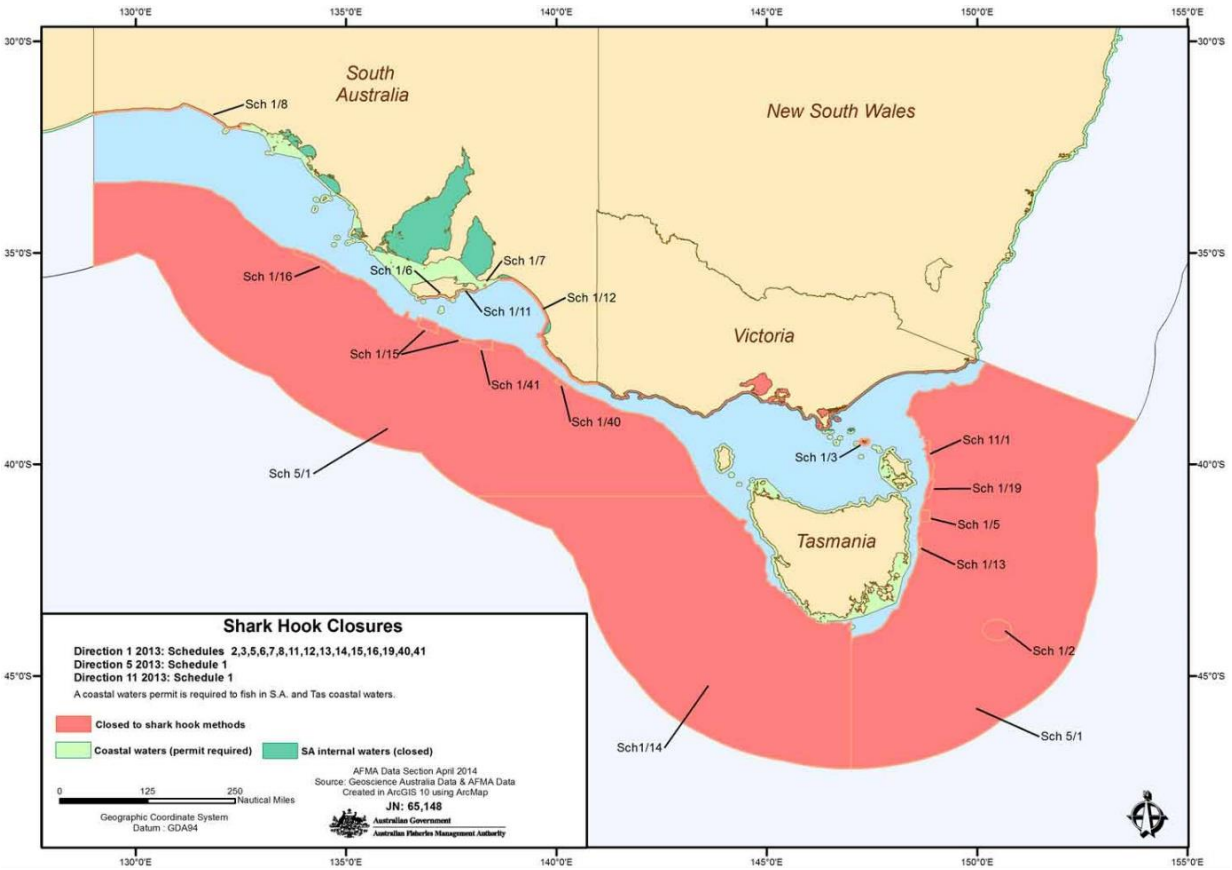
Fishery	Geographic extent	Target species	Season	Method	Catch and Value	Fishery jurisdiction intersects Stromlo-1 well location?	Fishing in Stromlo-1 well location?
Bass Strait Central Zone Scallop Fishery	This fishery operates in the Bass Strait above Tasmania and extends from the Victoria–New South Wales border, around southern Australia to the Victoria–South Australia border. The fishery is between the Victoria and Tasmania scallop fisheries that lie within 20 NM of their respective coasts	Commercial scallops	Default period for the season is 1 Apr to 31 Dec	Dredge	2885 t valued at $5.4M in 2015-16	No	NA
Eastern Tuna and Billfish Fishery	This fishery operates throughout the EEZ, from Cape York to the Victoria–South Australia border, including waters around Tasmania and the high seas of the Pacific Ocean	Yellowfin tuna, bigeye tuna, skipjack tuna, albacore, billfish	Year-round	Pelagic longline, purse seine, pole, trolling, rod and reel, handline	5139 t valued at $47.1M in 2015¬–16	No	NA
Skipjack Tuna Fishery	All external Commonwealth and state waters out to 200 NM	Skipjack tuna	Year-round	Purse seine and pole	Not active	Yes	No – license holders have not participated in the fishery since 2008–09 and management arrangements for the fishery are under review
Southern Bluefin Tuna Fishery	All AFZ waters (3–200 NM). Most of the Australian catch is taken in the Great Australian Bight, with small amounts taken off south-east Australia. Fishing in the Great Australian Bight occurs around the 200 m isobath near King Island and Port Lincoln. They are towed alive to grow-out cages off Port Lincoln for South Australia state-managed aquaculture production (Section 1.6.2.2).	Juvenile southern bluefin tuna (2–5 years)	Fishing occurs from the start of Dec to the end of Mar. After feeding in the grow-out cages, fish are generally harvested in Aug	Purse seine (in the Great Australian Bight), pole and line, longline and trolling (off south-east Australia)	5636 t valued at $35.8M in 2015-16 (based on the catch prior to transfer to grow-out cages)	Yes	Unlikely – purse seine fishing is permitted in the vicinity of the well location but historical catch and effort data show that it does not occur in the vicinity of the well location

Fishery	Geographic extent	Target species	Season	Method	Catch and Value	Fishery jurisdiction intersects Stromlo-1 well location?	Fishing in Stromlo-1 well location?
Western Tuna and Billfish Fishery	All AFZ waters (3–200 NM) from Cape York (Queensland) to the Victoria–South Australia border. In recent years, effort has concentrated off south-west Western Australia and South Australia	Yellowfin tuna, bigeye tuna, skipjack tuna, albacore, billfish	Year-round	Pole and line, purse seine, pelagic longline, troll, rod and reel, handline	320 t in 2015–16 Value not reported	Yes	Unlikely – fishing is permitted and occurs similar distances off of south-west Western Australia but historical fishing effort data shows that the area in the vicinity of the well has not been fished for at least a decade
Southern and Eastern Scalefish and Shark Fishery (SESSF)	Comprises three main sectors described in the rows below.	Multi-species (refer to SESSF rows below)	Year-round	Multi-gear (refer to SESSF rows below)	15,612 t valued at $68M in 2015–16 (overall)	Yes (refer to SESSF rows below)	No (refer to SESSF rows below)
	SESSF – Commonwealth trawl sector						
	Extends from Sydney southwards around Tasmania to Cape Jervis, South Australia	Mixed fish species, particularly pink ling, blue grenadier, flathead and silver warehou	Year-round	Otter trawl and Danish seine	10,222 t valued at $38.4M million in 2015–16	No	NA
	SESSF – gillnet, hook and trap sector						
	Comprises four subsectors: 1) Scalefish Hook Subsector – extends from Sydney southwards around Tasmania to the South Australia–Western Australia border, excluding 80 NM from the coast offshore of New South Wales 2) Shark Gillnet Subsector – extends from the New South Wales–Victoria border to the South Australia–Western Australia border 3) Shark Hook Subsector – extends from the New South Wales–Victoria border to	Mixed fish species particularly pink ling, blue-eye trevalla, gummy shark	Year-round	Demersal gillnet, demersal longline, dropline, trotline, trap, purse seine	3596 t valued at $20.9M million in 2015–16	Restrictions are in place for fishing near the well other than by the Trap subsector. Scalefish Hook Subsector: No – methods excluded from Great Australian Bight Marine Reserve area. Shark Gillnet Subsector and Shark Hook Subsector: No –	Trap Subsector: no to low historical effort and fishery landings, fishers set traps at depths between 300 and 700 m

Fishery	Geographic extent	Target species	Season	Method	Catch and Value	Fishery jurisdiction intersects Stromlo-1 well location?	Fishing in Stromlo-1 well location?
	the South Australia–Western Australia border 4) Trap Subsector – within the Shark Hook Subsector, in waters north of 42° 20” S					area closures prohibit fishing until at least May 2021 (see Section 1.6.2.1)	
	SESSF – Great Australian Bight trawl sector						
	Extends from Cape Jervis, South Australia westward to Cape Leeuwin, Western Australia. Excludes shelf waters to the extreme east and west fished by Western Australia and South Australia managed trawlers	Deepwater flathead, Bight redfish and orange roughy	Year-round	Demersal otter trawl, limited midwater trawl	1794 t valued at $8.5M million in 2015–16	No – methods excluded from Great Australian Bight Marine Reserve area	–
Small Pelagic Fishery	AFZ waters extending from the Queensland–New South Wales border around southern Australia to Lancelin, Western Australia	Blue mackerel, jack mackerel, redbait, Australian sardine	Year-round	Purse seine and mid-water trawl	8038 t in 2016–17. Value not reported	No – methods excluded from Great Australian Bight Marine Reserve area	–
Southern Squid Jig Fishery	AFZ waters adjacent to South Australia, Tasmania, New South Wales, Victoria and southern Queensland up to Sandy Cape. The major fishing ground is continental shelf waters around Portland, Victoria	Gould’s squid	Year-round, although fishing usually takes place from Jan to Jun	Jig	981 t valued at $2.57M in 2015–16	Yes	Unlikely – historical fishing effort data shows that activity is limited to waters off south-eastern Australia and depths <200 m

Source: Savage (2016) and ABARES (2017)

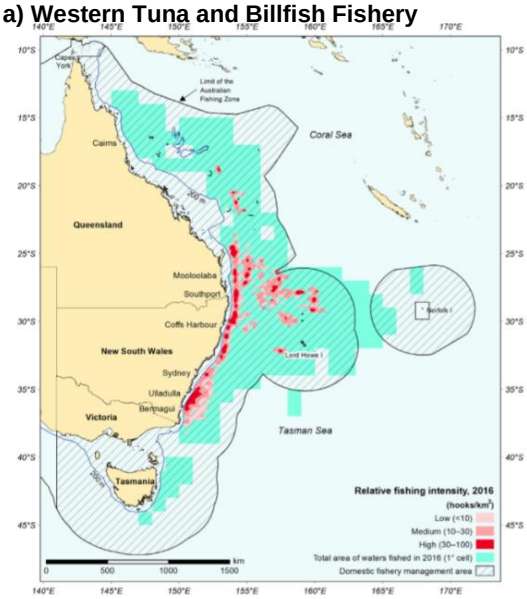




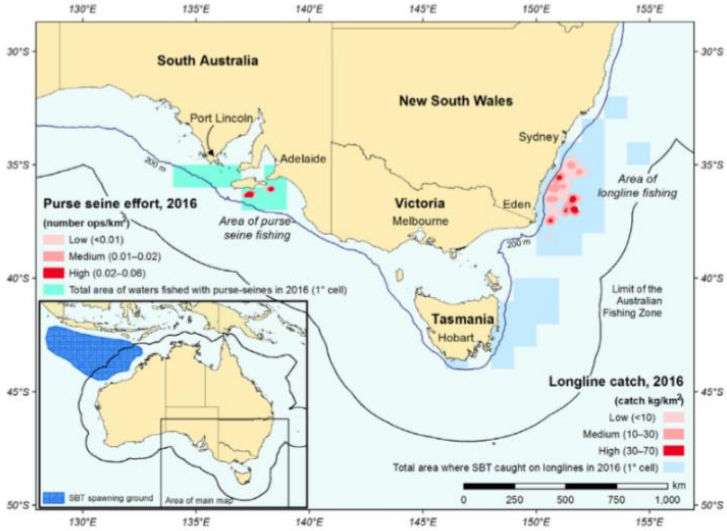
Source: www.afma.gov.au

Figure 5.1 Commonwealth-managed fisheries area closures for fisheries with jurisdictions within the Risk EMBA

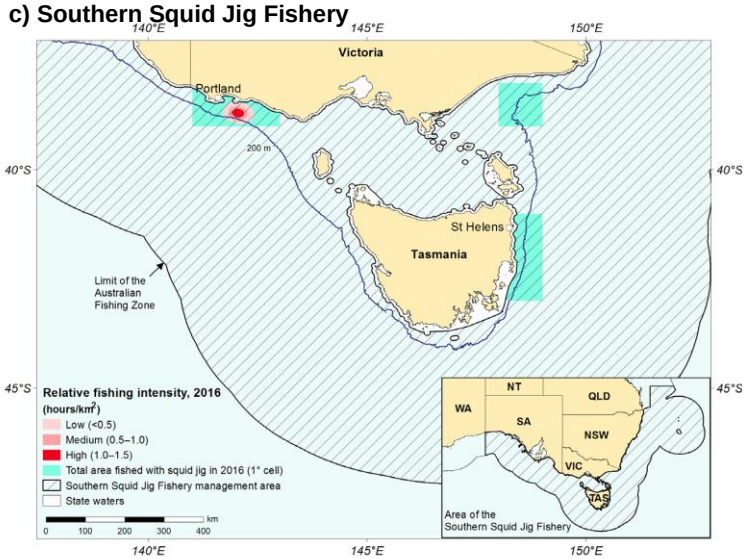
a) Western Tuna and Billfish Fishery



b) Southern Bluefin Tuna Fishery

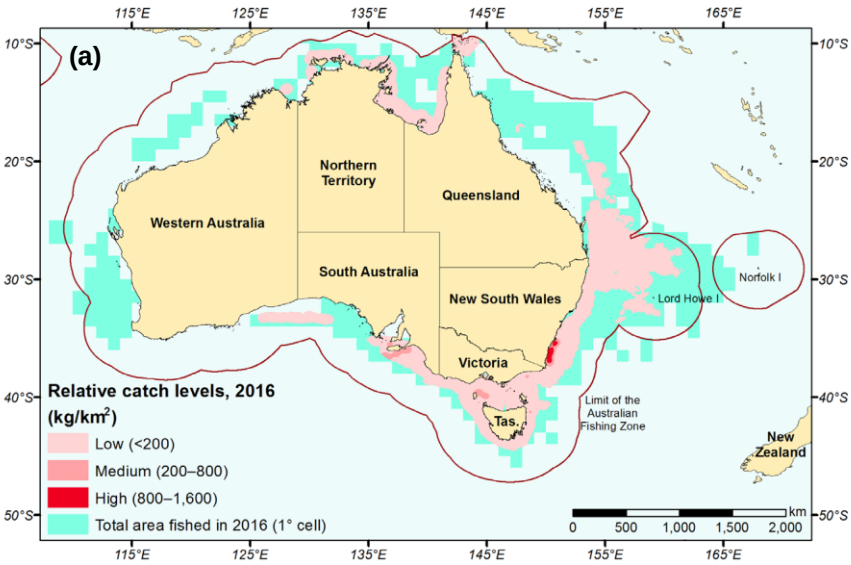


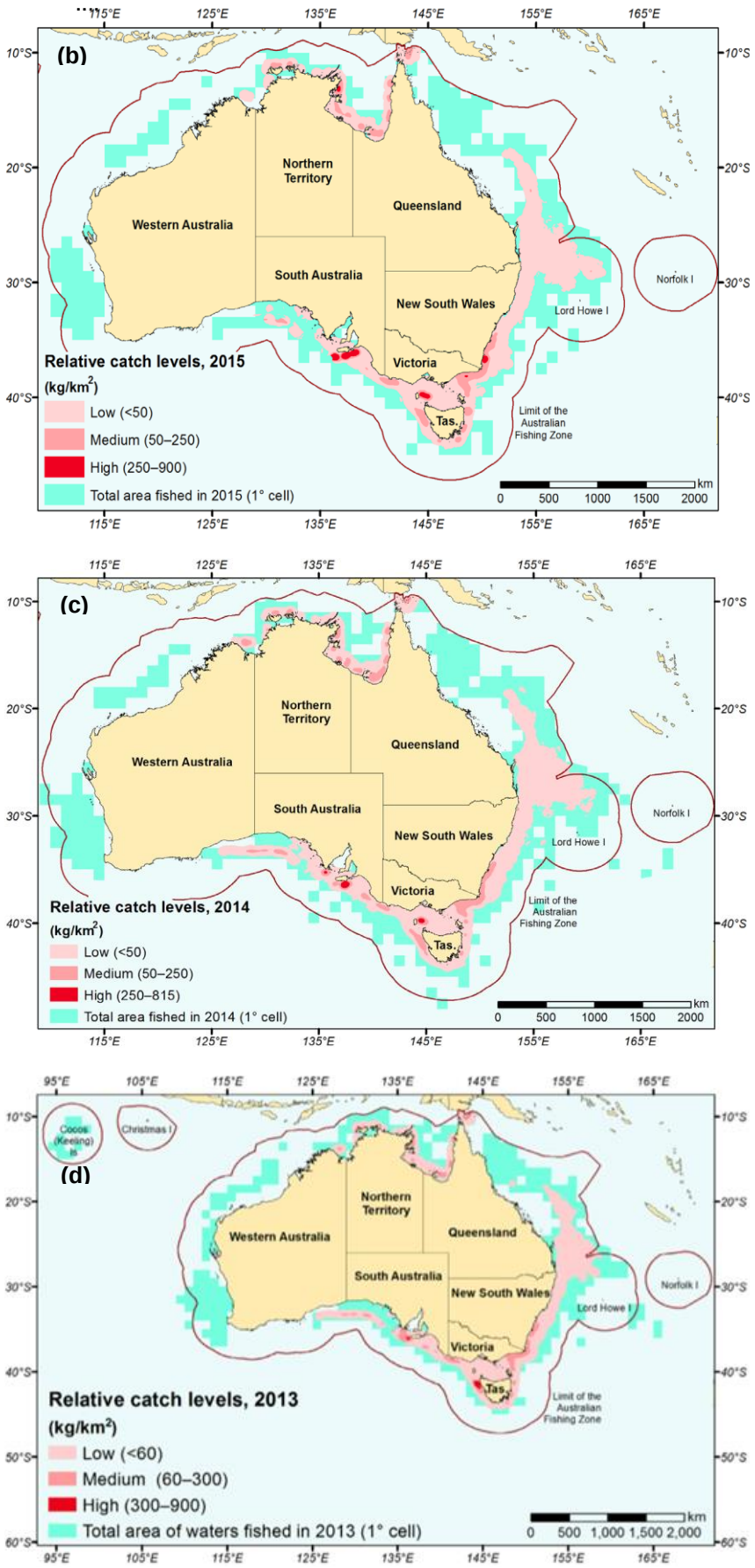
c) Southern Squid Jig Fishery



Source: ABARES(2017)

Figure 5.2 Commonwealth-managed fisheries fishing effort/catch (2016) for fisheries with jurisdictions within the Risk EMBA





Source: ABARES(2017)

Figure 5.3 Comparison of the area fished across all Commonwealth-managed fisheries in (a) 2016, (b) 2015, (c) 2014 and (d) 2013

5.2.2 South Australian managed fisheries

Primary Industries and Regions South Australia (PIRSA) manage commercial South Australia fisheries under the *Fisheries Management Act 2007* (South Australia) and aquaculture production under the *Aquaculture Act 2001* (South Australia). The gross value of production of South Australia commercial fisheries was $468M in 2014–15 (52% wild-catch, 48% aquaculture), accounting for 17% of Australia's total fisheries and aquaculture production. Key South Australia fisheries species include southern bluefin tuna (aquaculture), southern rock lobster (wild-catch), prawns (wild-catch), abalone (wild-catch) and oysters (aquaculture) (Savage 2016).

The jurisdiction of nine South Australia wild-catch commercial fisheries intersect with the Risk EMBA:

- Abalone Fishery
- Blue Crab Fishery
- Charter Boat Fishery
- Marine Scalefish Fishery
- Miscellaneous Fisheries
- Prawn Fishery – Gulf St Vincent
- Prawn Fishery – Spencer Gulf and west coast
- Rock Lobster Fishery
- Sardine Fishery.

The location of each of these fisheries is shown in Figure 5.4 and more details are given in Table 5.6. Information on the geographic extent, target species, season, method, catch, value and the likelihood of fisheries activities occurring in the vicinity of the well location is included in Table 5.6.

An equally significant amount of aquaculture production occurs in South Australia coastal waters within the Risk EMBA (19,763 t in 2014–15, valued at $227M) (Savage 2016). South Australia aquaculture production in 2014–15 was dominated by blue fin tuna production (8418 t, $131M) grown in sea cages (Savage 2016). In the same period, oysters (3891 t, $28.4M) and mussels (1577 t, $3.1M) grown in the intertidal zone on racks or line systems, and other species, including abalone and finfish (5530 t, $53.5M) grown at various onshore, coastal and offshore facilities, were also major sources of aquaculture production (Savage 2016).

The location of marine aquaculture facilities in South Australia waters is shown in Figure 5.4. Bluefin tuna grow-out cages occupy approximately 2300 ha of South Australia coastal waters off Port Lincoln, immediately seaward of Boston Island and near the Sir Joseph Banks Group of islands, to where catch from the Commonwealth-managed Southern Bluefin Tuna Fishery (see Table 5.5 for details) is towed alive. Oyster aquaculture is confined to discreet intertidal areas of the Yorke Peninsula, Kangaroo Island, Franklin Harbour, Streaky Bay, Coffin Bay, Smokey Bay and Denial Bay (PIRSA 2017). Mussel are grown in Boston Bay, Eyre Peninsula and Louth Bay in lower Spencer Gulf, and processed in Port Lincoln (PIRSA 2017).

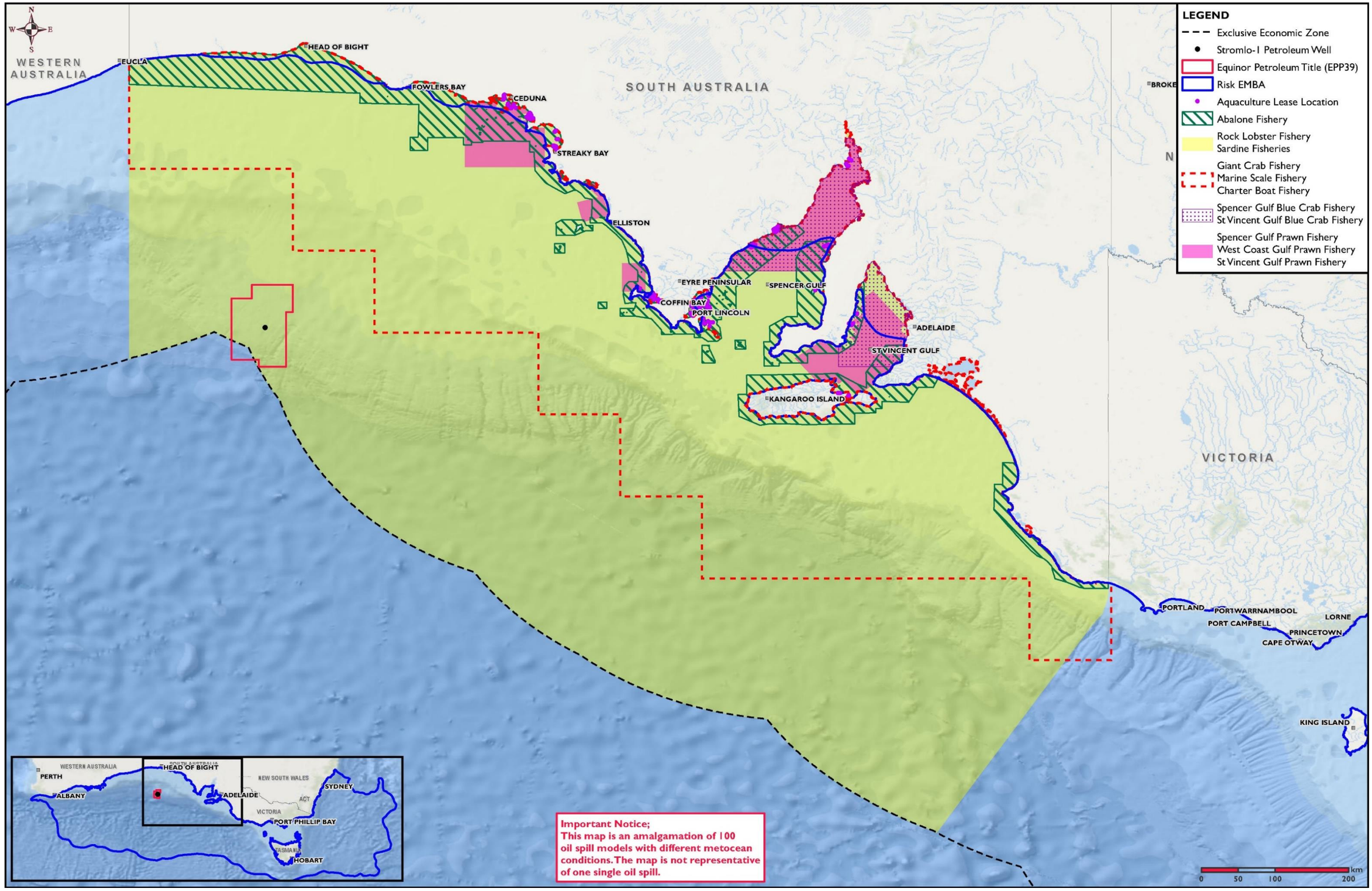


Figure 5.4 South Australian state-managed fisheries and aquaculture with jurisdictions overlapping the Risk EMBA

Table 5.6 South Australian state-managed wild-catch fisheries with jurisdictions overlapping the Risk EMBA

Fishery	Geographic extent	Target species	Season	Method	Catch and value	Fishery jurisdiction intersects drilling area?	Fishing in drilling area?
Abalone Fishery	All subtidal South Australia waters to 3 NM, although diving limits fishing to waters <30 m. Fishery divided into southern, central and western zone	Blacklip and greenlip abalone	Year-round	Diving	744 t in 2014–2015, valued at $25M	No	No – due to depth limitations
Blue Crab Fishery	All Gulf St Vincent and Spencer Gulf waters. Fishing occurs beyond the intertidal zone to 50 m water depth	Blue crab	Feb to Dec for Spencer Gulf. Jan to Oct for Gulf St Vincent	Pots	576 t in 2014–2015, valued at $4M	No	No – due to depth limitations
Prawn Fishery – Gulf St Vincent	All waters with a depth >10 m in Gulf St Vincent. Fishing occurs at depths of 10–45 m	Western king prawn	Nov to Jun, with exclusion period in Jan and Feb	Trawl	249 t in 2014–2015, valued at $4M	No	No – due to depth limitations
Prawn Fishery – Spencer Gulf and West Coast	All waters with a depth >10 m in Spencer Gulf and along west coast of Eyre Peninsula out to 3 NM. Fishing occurs at depths of 10–60 m	Western king prawn	Nov to Jun, with exclusion period in Jan and Feb	Trawl	1848 t in 2014–2015, valued at $31M	No	No – due to depth limitations
Sardine (pilchard) Fishery	All South Australia waters out to the edge of the 200 NM AFZ	Australian sardine. Majority of catch used as fodder for the SBT aquaculture sector	Year-round	Purse - seine nets	36,020 t in 2014–2015, valued at $22 million	Yes	No – fishing effort is concentrated elsewhere
Rock Lobster Fishery	All South Australia waters out to the edge of the 200 NM AFZ although fishing only occurs in depths <200 m. Fishery split into a Northern Zone and Southern Zone either side of the Murray River	Southern rock lobster	Nov to May for the Northern Zone. Oct to May for the Southern Zone	Pots	1622 t in 2014–2015, valued at $125m (321 t from the Northern Zone and 1238 t from the Southern Zone)	Yes	No – rock lobster not found in depths >100 m in South Australia waters
Marine Scalefish Fishery	All South Australia waters and out to the edge of the 200 NM AFZ. Deepest waters fished are generally 150 m	Various finfish, crustaceans, and molluscs; primarily King George whiting, southern garfish, snapper and southern calamari	Subject to a range of seasonal spatial closures	Netting, line fishing, handlines and traps	2500 t in 2014–2015, valued at $25m	Yes	No – due to depth limitations

Fishery	Geographic extent	Target species	Season	Method	Catch and value	Fishery jurisdiction intersects drilling area?	Fishing in drilling area?
Miscellaneous Fishery (specialised fisheries)	All South Australia waters out to the edge of the 200 NM AFZ	Sea urchins, scallop, native oyster, giant crab, western Australian salmon, beach cast seagrass and macroalgae, Eyre golden perch, Welch's grunter and Barcoo grunter	Subject to a range of seasonal spatial closures	Multiple types of fishing gear	Information not available	Yes	No – fishing effort is concentrated elsewhere
Charter Boat Fishery	All South Australia waters out to the edge of the 200 NM AFZ. Occurs in shelf waters; around reef, seagrass meadows, sheltered beaches and tidal flat		Subject to a range of seasonal spatial closures	Line fishing	15,129 clients in 2014–2015 valued at $3.6m. Catch information not available as it is considered recreational	Yes	No – fishing effort concentrated nearshore and trips are short-term in vicinity of harbours

Source: Savage (2016), EconSearch (2016), Fowler et al. (2015)

5.2.3 Western Australian managed fisheries

DPIRD manage commercial Western Australia fisheries and aquaculture (not including pearling) under the under the *Fish Resources Management Act 1994* (Western Australia), although the Aquatic Resources Management Bill 2015 is expected to come into force in 2019. The gross value of production of Western Australia commercial fisheries production was $569M in 2014–2015 (86% wild-catch; 14% aquaculture), accounting for 21% of Australia's total fisheries and aquaculture production (Savage 2016). Key Western Australia fisheries species include western rock lobster (wild-catch), pearl oysters (aquaculture) and prawns (wild-catch) (Savage 2016).

The jurisdiction of ten Western Australia wild-catch commercial fisheries intersect with the Risk EMBA (Figure 5.5):

- Abalone Managed Fishery
- Octopus Interim Managed Fishery
- Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery
- South Coast Crustacean Managed Fishery
- South Coast Demersal Scalefish Fishery
- South Coast Nearshore and Estuarine Finfish Fishery (South Coast Salmon Managed Fishery and South Coast Estuarine Managed Fishery)
- South Coast Purse Seine managed Fishery
- South Coast Trawl Fishery
- Marine Aquarium Fish Managed Fishery
- Specimen Shell Fishery.

These fisheries are described in Table 5.7. A limited amount of aquaculture production also occurs in Western Australia coastal waters within the Risk EMBA. The main aquaculture activities are mussel and oyster production in Oyster Harbour (Albany), and abalone production in coastal waters near Flinders Bay (Augusta) and Wylie Bay (near Esperance). Information on the amount and value of production of these operations is not publicly available. Other forms of aquaculture (e.g. sea cage farming) are restricted along Western Australia's south coast by the high-energy environment and limited availability of protected deep waters typically required by this sector.

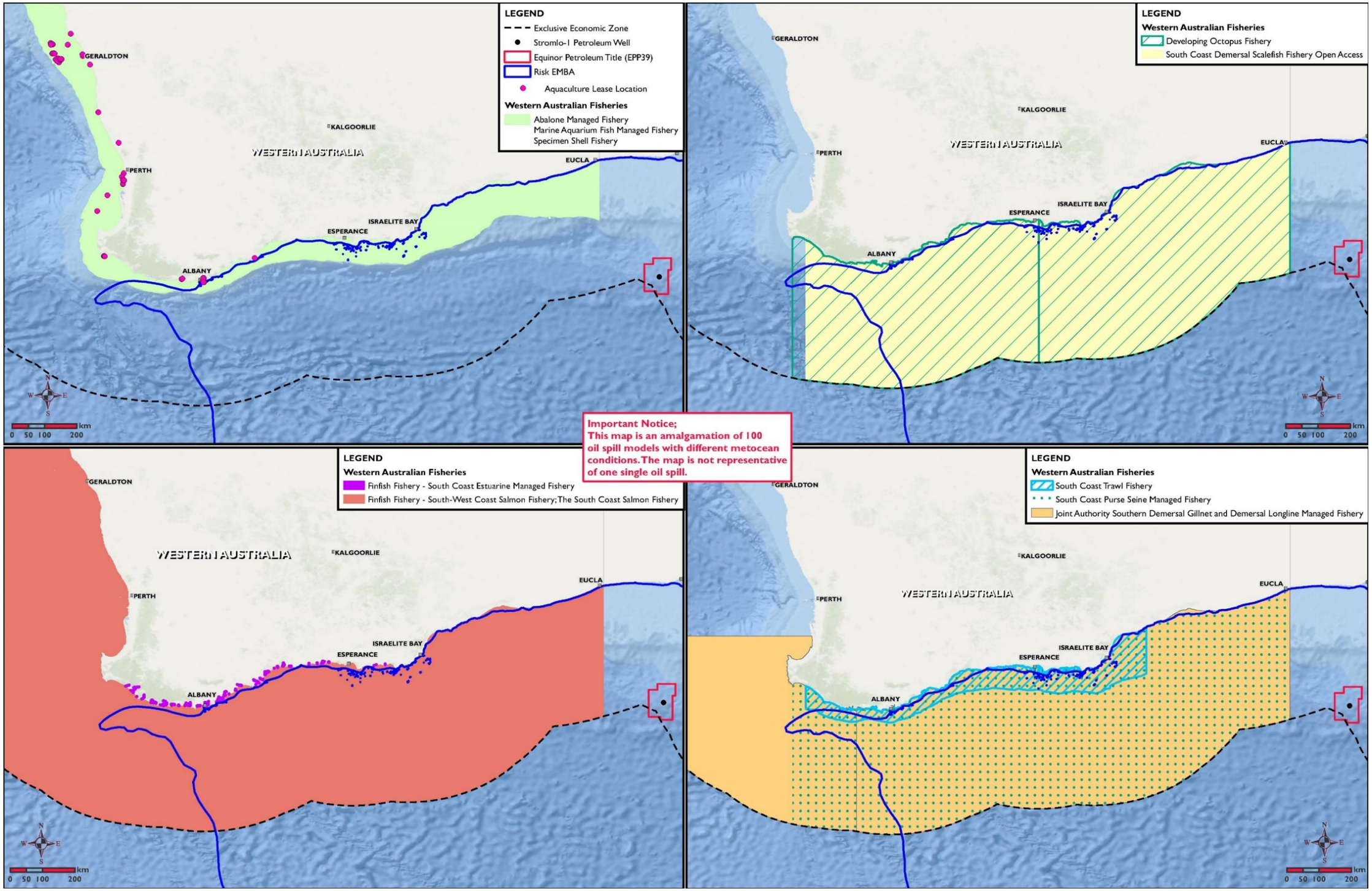


Figure 5.5 Western Australian state-managed fisheries and aquaculture with jurisdictions overlapping the Risk EMBA

Table 5.7 Western Australian state-managed fisheries within jurisdictions overlapping the Risk EMBA

Fishery	Geographic extent	Target species	Season	Method	Catch and value
Abalone Managed Fishery	Western Australia coastal waters. Fishery divided into 3 zones for the south coast. No commercial fishing is permitted in Zone 2 (between Point Culver and Shoal Cape)	Greenlip, brownlip and roe's abalone	1 Oct to 15 May for the south coast zones	Diving	186 t valued at $8.8M in 2015–2016
Octopus Interim Managed Fishery	Commonwealth and state waters out to 200 NM from Coral Bay to the South Australia border	Gloomy octopus	Year round	Active (trigger) and passive traps	252 t valued at $2.5M in 2015–2016
Joint Authority Southern Demersal Gillnet and Demersal Longline Managed Fishery	From 33°S latitude to the Western Australia–South Australia border, comprising three management zones, out to 200 NM (Zone 2 takes in most of the southern coastline)	Gummy, dusky, whisky and sandbar sharks	Year round	Demersal gillnets and longline	Approximately 700 t valued at $4.7M in 2014–2015
South Coast Crustacean Managed Fishery	Commonwealth and state waters out to 200 NM from Western Australia–South Australia border to Augusta	Southern rock lobster, western rock lobster, giant crab, crystal crab and champagne crab	15 Nov to 30 Jun for rock lobsters. Year-round for crabs	Pots	135 t valued at $7.6M in 2015–2016
South Coast Demersal Scalefish Fishery	Oceanic waters from near Black Point at 115°30"E to the Western Australia–South Australia border at 129°E	Pink snapper, Bight redfish, blue morwong and hapuku	Year-round	Droplines and handlines	121 t in 2014–2015. Value not reported
South Coast Nearshore and Estuarine Finfish Fishery (South Coast Salmon Managed Fishery and South Coast Estuarine Managed Fishery)	All Western Australia coastal waters and estuaries in the south coast bioregion between Cape Beaufort and 129°E	Western Australia salmon, Australian herring, southern sea garfish and sea mullet	Seasonal, area and size closures occur	Beach seine, haul nets and gillnets	317 t (143 t from ocean waters and 174 t from estuaries) valued between $1–5M in 2015–2016
South Coast Purse Seine managed Fishery	All waters between Cape Leeuwin and the Western Australia/South Australia border out to 200 NM	Australian sardine, yellowtail scad, Australian anchovy and scaly mackerel	Year-round	Purse seine nets	1734 t valued between $1–5M in 2015–2016
South Coast Trawl Fishery	Waters off the south coast of Western Australia, out to the 200 m isobath, between 115°30" E and 125° E. Effort is low and only 2–3% of the fishing area is actually fished each year	Saucer scallops	Temporary closures occur when stocks are low to allow scallop beds to recover	Trawl	437 t in 2014–205. Value not reported

Fishery	Geographic extent	Target species	Season	Method	Catch and value
Marine Aquarium Fish Managed Fishery	All Western Australia marine waters. Effort is generally restricted to areas around the Capes region, Perth, Geraldton, Exmouth and Dampier	Capacity to target thousands of species	Year-round	Hand caught while wading or diving	Quantities in 2014–2015: 20,052 fishes (excluding syngnathids), 359 syngnathids, 41,587 invertebrates (not including sponges or corals), 2580 sponges, 9500 kg of corals and 345 L of algae/ seagrasses. Value not reported
Specimen Shell Fishery	All Western Australia marine waters	Capacity to target thousands of species	Year-round	Hand caught while wading or diving	Quantity reported in 2014–2015 was 18,391

Sources: Savage (2016), WJ Fletcher et al. (2017)

5.2.4 Victorian managed fisheries

The Victorian Fisheries Authority (VFA) manage Victoria commercial fisheries and aquaculture under the under the *Fisheries Act 1995* (Victoria). The gross value of production of Victoria commercial fisheries was $59m in 2014–2015 (51% wild-catch, 49% aquaculture), accounting for 3.0% of Australia's total fisheries and aquaculture production (Savage 2016).

Twelve Victoria wild-catch commercial fisheries intersect with the Risk EMBA (Figure 5.6):

- Rock Lobster Fishery
- Giant Crab Fishery
- Abalone Fishery
- Scallop (Ocean) Fishery
- Pipi Fishery
- Sea Urchin Fishery
- Wrasse (Ocean) Fishery
- Scallop Dive (Port Phillip Bay) Fishery
- Port Phillip Bay and Western Port Fishery
- Bait (General) Fishery
- Trawl (Inshore) Fishery
- Ocean (General) Fishery.

Each of these is described in Table 5.8.

Aquaculture production also occurs at a variety of offshore, coastal and inland facilities. The majority of production is salmonids (trout and salmon; 1147 t valued at $7m in 2014–2015) grown inland, abalone (436 t valued at $15m in 2014–2015) and mussels (767 t in 2015–2016 valued around $3.5m) (Savage 2016). Abalone aquaculture occurs both onshore and offshore at a number of locations along Victoria's west coast, and mussels are grown in coastal waters around Port Phillip and Western Port. The total marine area licensed for grow-out operations is 469 ha (VFA 2017).

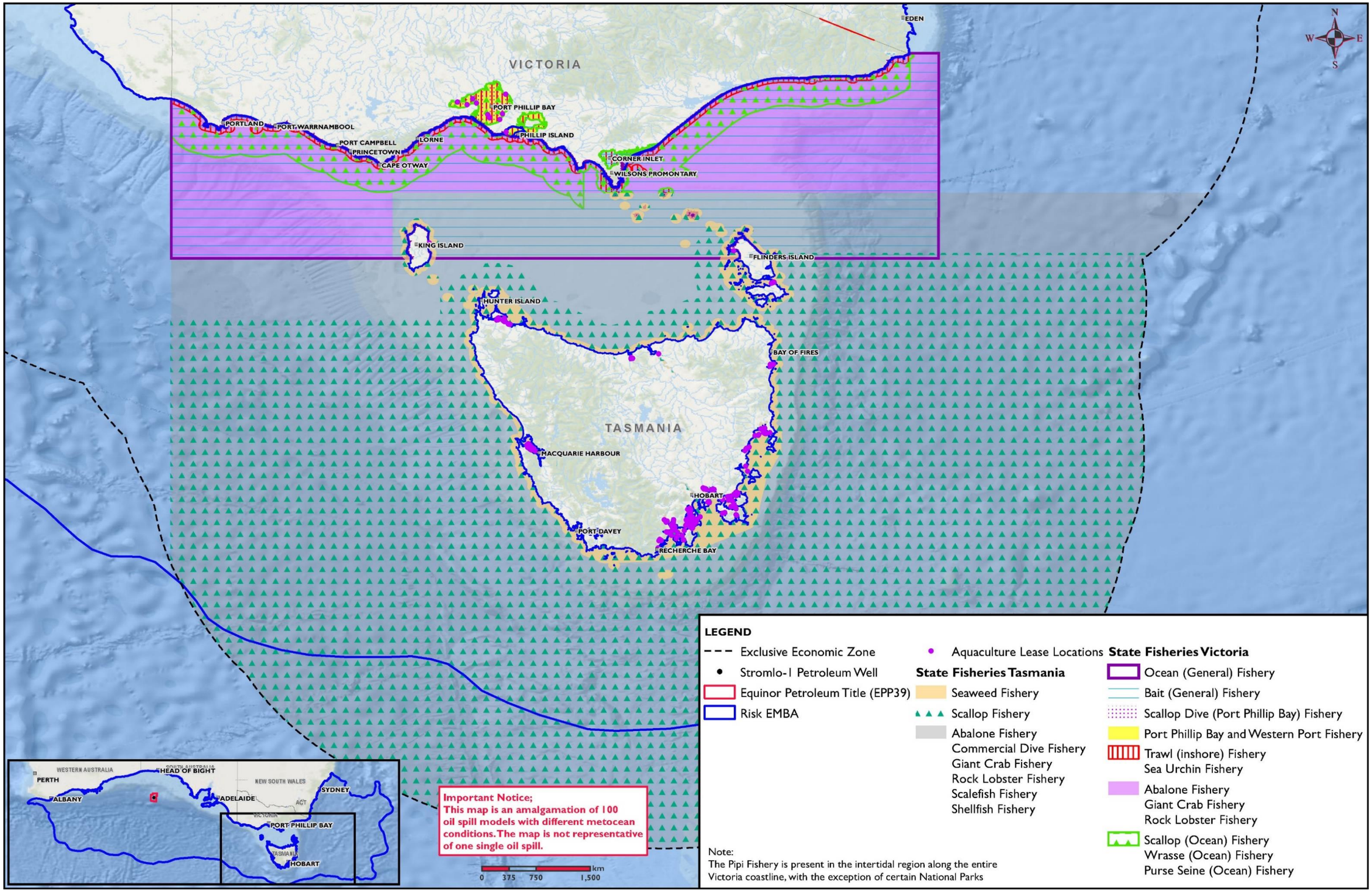


Figure 5.6 Victorian and Tasmanian state-managed fisheries and aquaculture with jurisdictions overlapping the Risk EMBA

Table 5.8 Victorian state-managed fisheries with jurisdictions overlapping the Risk EMBA

Fishery	Geographic extent	Target species	Fishing season	Fishing method	Fishery value and catch
Rock Lobster Fishery	The fishery extends along the entire Victoria coastline across to adjacent Commonwealth waters under an OCS. Commercial vessels fish nearshore waters to depths around 150 m, with the majority of catches taken in depths less than 60 m. This area is split into a Western Zone and Eastern Zone either side of Apollo Bay. In the Western Zone, most catch is landed through Portland, Port Fairy, Warrnambool, Port Campbell and Apollo Bay. The main ports in the Eastern Zone are Queenscliff, San Remo and Lakes Entrance	Southern rock lobster	Nov to Sep for males, Nov to Jun for females	Pots	287 t valued at $24.3m in 2015–2016
Giant Crab Fishery	Same boundary and management zones as the Victoria Rock Lobster Fishery but fishing for giant crabs only occurs in the Western Zone as the species is not abundant in the Eastern Zone. Fishing effort is concentrated on along the continental shelf edge with pots set at depths between 150 and 300 m	Giant crab	Nov to Sep	Pots	10 t valued at approximately $0.12m in 2015–2016
Abalone Fishery	Extends along the Victoria coastline out to 20 NM, although diving restricts fishers to depths under 30 m. Fishery is divided into three zones – the Eastern Zone (waters east of Lakes Entrance); the Western Zone (waters west of Hopkins River mouth); and the central zone (all water in between). Fishing effort is significantly lower in the Western Zone due to restriction on catch	Blacklip and greenlip abalone	Apr to Mar	Diving	747 t valued at $20.2m in 2014–2015
Scallop (Ocean) Fishery	Extends the length of the Victoria coastline from high tide mark to 20 NM offshore. Scallops are mostly fished from Lakes Entrance and Welshpool	Commercial scallops	Temporary closures occur when stocks are low to allow scallop beds to recover	Dredge	59 t valued at $0.72m in 2014–2015
Pipi Fishery	Intertidal region along the entire Victoria coastline, with the exception of Port Phillip Bay and Marine National Parks	Pipis	Year-round	Dip-nets	57 t in 2015–2016. Value not reported
Sea Urchin Fishery	Extends along the Victoria coastline out to 3 NM, although diving restricts fishers to depths under 30 m	White sea urchin and black, long-spined sea urchin	Year-round	Diving	37 t in 2014–2015. Value not reported
Wrasse (Ocean) Fishery	Extends the length of the Victoria coastline from high tide mark to 20 NM offshore	Bluethroat and purple wrasses	Year-round	Handlines	~30 t in 2014–2015. Value not reported

Source: Savage (2016), VFA (2017)

5.2.5 Tasmanian managed fisheries

The Department of Primary Industries, Parks, Water and Environment (DPIPWE) manage Tasmanian commercial fisheries and aquaculture under the under the *Living Marine Resources Management Act 1995* (Tasmania). The gross value of production of Tasmanian commercial fisheries was $825m in 2014–15 (21% wild-catch, 79% aquaculture), accounting for 30% of Australia's total fisheries and aquaculture production (Savage 2016). Key Tasmanian fisheries species include salmonids (aquaculture), abalone (wild-catch), southern rock lobster (wild-catch) (Savage 2016).

All eight Tasmanian wild-catch commercial fisheries intersect with the Risk EMBA (Figure 5.6):

- Abalone Fishery
- Commercial Dive Fishery
- Giant Crab Fishery
- Rock Lobster Fishery
- Scalefish Fishery
- Scallop Fishery
- Seaweed Fishery
- Shellfish Fishery.

Tasmanian state-managed fisheries within the Risk EMBA are described in Table 5.9.

Marine farming has expanded rapidly in Tasmania since the 1990s with aquaculture now by far the state's largest and most valuable fisheries resource (DPIPWE 2017). Tasmanian aquaculture production is dominated by salmonids (Atlantic salmon and rainbow trout; 47,184 t valued at $620m in 2014–15) grown in sea cages (Savage 2016). Oysters (3266 t valued at $23m in 2014–15) grown on racking or line systems and mussels (1020 t valued at $6m in 2014–15) grown along lines are the main other marine farms (Savage 2016).

Table 5.9 Tasmanian state-managed fisheries within the Risk EMBA

Fishery	Geographic extent	Target species	Fishing season	Fishing method	Fishery value and catch
Abalone Fishery	Collected on rocky substrate around the Tasmanian shoreline	Blacklip and greenlip abalone	Subject to a range of seasonal spatial closures	Diving	1693 t valued at $78m in 2015–2016
Commercial Dive Fishery	All Tasmania state waters, although effort is concentrated around ports on the south and east coasts of Tasmania	White and black sea urchins, and periwinkles	Year-round	Diving	115 t valued at $0.25m in 2010–2011 (most recent period that information is available)
Giant Crab Fishery	Waters surrounding Tasmania generally south of 39º12′ out to 200 NM. Most effort takes place on the edge of the continental slope in water depths of 140–270 m	Giant crab	Nov to May for females	Pots	25 t valued at $2m in 2015–2016
Rock Lobster Fishery	Waters surrounding Tasmania generally south of 39º12′ out to 200 NM. The catch is collected from waters around Tasmania, mostly <100 m deep, with southern rock lobsters only found to depths of 150 m	Southern rock lobster	Nov to Oct for males, Nov to May for females, plus various other seasonal spatial closures	Pots	1047 t valued at $89m in 2015–2016
Scalefish Fishery	Waters surrounding Tasmania generally south of 39º12′ out to 200 NM	Range of scalefish, shark and cephalopod species	Subject to a range of seasonal spatial closures	Netting and hooks	270 t in 2014–2015; production greatest for wrasse (81 t), southern calamari (76 t), flathead (36 t), southern garfish (34 t), banded morwong (30 t) and Australian salmon (23 t)
Scallop Fishery	Fishery area extends 20 NM from the high-water mark of Tasmania state waters into Bass Strait and out to 200 NM offshore from the remainder of the Tasmania coastline. Scallop beds are generally found along the east coast and Bass Strait in depths of 10–20 m but may occur in water deeper than 40 m in the Bass Strait. Scallop habitat is protected through a ban on dredging in waters <20 m and a network of dredge-prohibited areas around the state	Commercial scallop	Managed using an adaptable strategy where surveys are undertaken to estimate abundance and decision rules are used to open areas to fishing	Dredge	781 t in 2015–16. Note that there is high variability in the condition of scallop stock as recruitment is sporadic and intermittent. Average production since 2007 is around 750 t
Seaweed Fishery	Cast bull kelp can be collected from all Tasmania state waters (<3 NM) but is mostly collected from King Island. Minor bull kelp collection also occurs at two centres of operation on the Tasmania West Coast: around Bluff Hill Point and at Granville Harbour. Japanese kelp can only be harvested on the east coast where it is already established	Bull kelp and Japanese kelp	Year-round	Collecting beach-cast bull kelp and diving for harvesting of Japanese kelp	3000 t valued at $2m in 2015–2016
Shellfish Fishery	Defined locations on the east coast of Tasmania around Georges Bay and Ansons Bay	Katelysia cockles, Venerupis clam and native oysters	Year-round	Diving	Estimated annual production value of $0.35m based on landings from 2001–2005 (when information was last available)

*Information sourced from Savage (2016), DPIPWE (2017), (DEE 2017k) 2016)

5.2.6 New South Wales managed fisheries

The Department of Primary Industries (DPI) manage commercial New South Wales fisheries under the under the *Fisheries management Act 1994* (New South Wales). The gross value of production of New South Wales commercial fisheries was $147.7m in 2015–2016 (58.7% wild-catch; 41.3% aquaculture), accounting for 8.4% of Australia's total fisheries production (New South Wales DPI 2016). Key New South Wales fisheries species include prawns (wild-catch), sea mullet (wild-catch) and oysters (aquaculture) (Savage 2016).

All seven coastal wild-catch commercial fisheries in New South Wales intersect with the Risk EmBA (Figure 5.7):

- Abalone Fishery
- Estuary General Fishery
- Lobster Fishery
- Ocean Hauling Fishery
- Ocean Trap and Line Fishery
- Ocean Trawl Fishery
- Sea Urchin and Turban Shell Restricted Fishery.

Each fishery is described in Table 5.10.

There are also numerous aquaculture farms along the New South Wales coast. The major aquaculture activity is Sydney rock oyster (*Saccostrea glomerate*) production which occurs in most New South Wales estuaries and was worth $44.3m in 2015–2016 (New South Wales DPI 2016). Non-oyster aquaculture production includes both marine, estuarine and land based farms with their location dictated primarily by the environmental constraints of the species being grown. Some species such as silver perch and yabbies are grown widely across the state, while prawns are grown on the far north coast (outside the Risk EMBA), mussels near Eden, trout on the southern and northern slopes and yellowtail kingfish off the coast of Port Stephens (around the northern limit for the extent of the Risk EMBA). Hatcheries that produce fingerlings for aquaculture farms, stocking of farm dams and aquarium fish are also located throughout New South Wales. In 2015–2016, prawn production was worth $5.98m, followed by Murray cod at $2.99m, silver perch at $2.97m, trout at $2.29m, and barramundi at $0.98m (New South Wales DPI 2016).

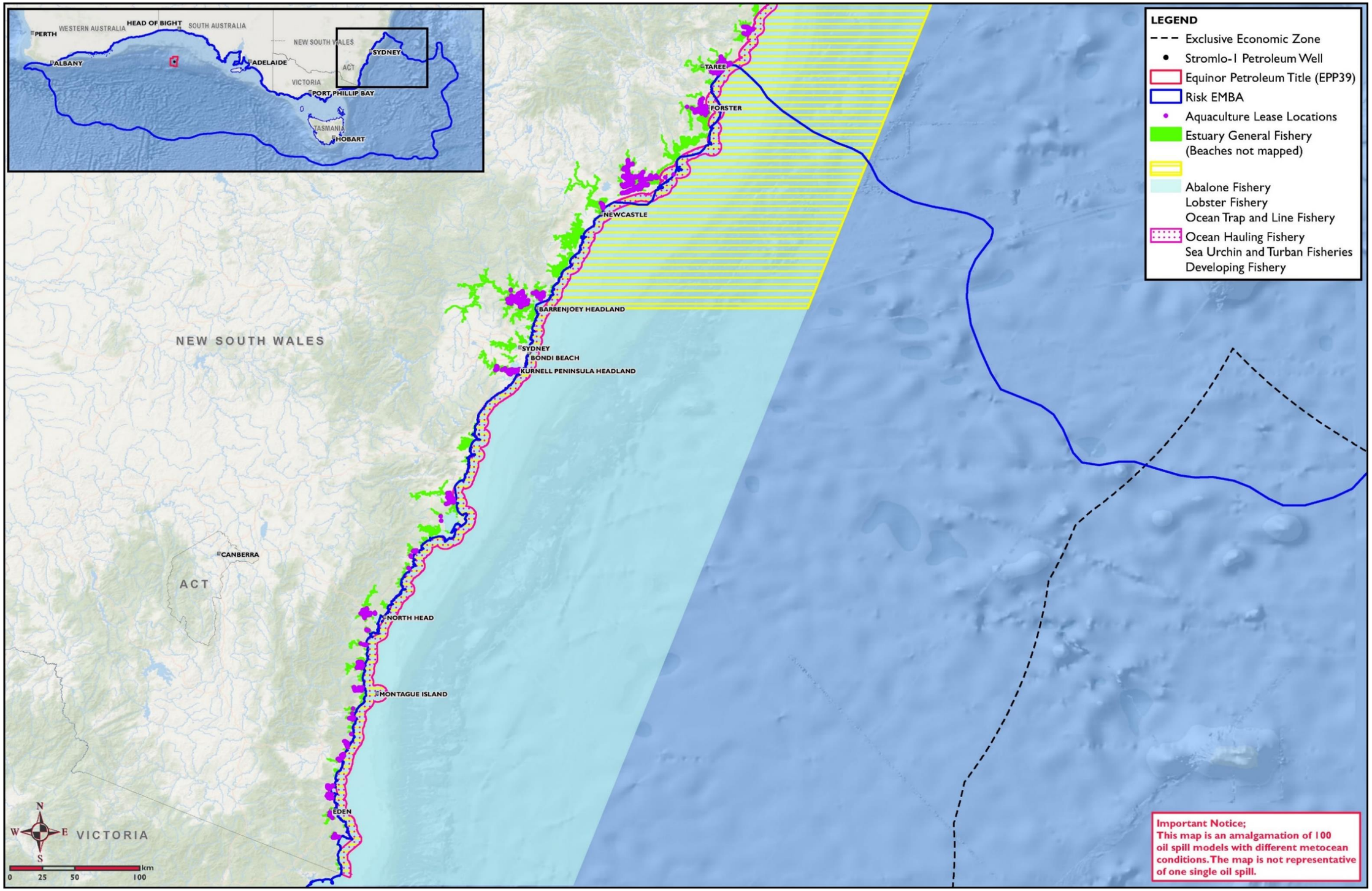


Figure 5.7 New South Wales state-managed fisheries and aquaculture with jurisdictions overlapping the Risk EMBA

Table 5.10 New South Wales state-managed fisheries within the Risk EMBA

Fishery	Geographic extent	Target species	Fishing season	Fishing method	Catch and value
Abalone Fishery	All New South Wales waters out to 3 NM, however diving restricts harvesting to depths <30 m and the industry has historically operated from the mid-north coast of New South Wales to the Victoria border	Blacklip abalone	Year-round	Diving	129.34 t valued at $3.73m
Estuary General Fishery	76 New South Wales estuaries and certain ocean beaches where pipis and beachworms may be collected	Sea mullet, luderick, prawns and pipis	Subject to a range of seasonal spatial closures	Mesh and haul, nets, hand gathering	3606 t valued at $29.1m
Lobster Fishery	All New South Wales waters out to 3 NM and Commonwealth waters within the jurisdiction of New South Wales under the OCS	Eastern rock lobster	Year-round	Traps	160 t valued at $12.1m
Ocean Hauling Fishery	Ocean waters within 3 NM of the New South Wales coastline, as well as the waters of Jervis Bay and of Coffs Harbour	Sea mullet, blue mackerel and yellowtail	Subject to a range of seasonal spatial closures	Purse seine, hauling (seine) nets	3347 t valued at $10.7M
Ocean Trap and Line Fishery	New South Wales coastal baseline to the 4000 m isobath (60–80 NM offshore)	Spanner crabs, snapper and bonito	Subject to a range of seasonal spatial closures	Fish traps, dropline, longline, spanner crab nets	2012 t valued at $12.5m
Ocean Trawl Fishery	All waters north of Barrenjoey Headland (Sydney) from the coastal baseline seaward to the 4000 m depth contour (including Coffs Harbour) and all waters south from the coastal baseline to 3 NM	Eastern king, school whiting and octopus	Subject to a range of seasonal spatial closures	Trawl	2514 t valued at $19.6m
Sea Urchin and Turban Shell Restricted Fishery	New South Wales coastal baseline to the limit of the OCS, although some areas are closed and diving restricts harvesting to depths <30 m	Sea urchin and turban shell	Year-round	Diving	75.3 t valued at $98,340m in 2014–2015

Source: (DEE 2017l), (New South Wales DPI 2016), Savage (2016)

5.3 Native title and heritage

5.3.1 Native title

Native title claims cover large areas of Australia including onshore waters. A search of the National Native Title Tribunal online database (NNTT 2019) found that native title has been determined for eight claims along shorelines within the Risk EMBA (Figure 5.8).

A Native Title claim describes who the title holders are and their rights and interests in the area described. It will also describe the non-Native Title rights, for example those of pastoralists, commercial fishers, and conservation interests. Native Title claims that allow only for the rights of the Native Title holders are deemed 'exclusive', and those that include the rights of non-Native Title holders are 'non-exclusive'.

Native Title claims can extend into on- and offshore waters, described as a 'sea claim'. The difference between 'state' and "Commonwealth' waters is not acknowledged in Native Title. A sea claim determination will include specific descriptions (e.g. co-ordinates) of the extent of that claim.

There are numerous claimant applications for Native Title in areas along the shoreline of the Risk EMBA that have been accepted for registration and are awaiting determination, some of which extend into onshore waters. These are identified in Table 5.11. No native title or native title claims exist in the Impact EMBA.

Table 5.11 Native title claims within the Risk EMBA

State	Native title claim	Tribunal ID	Sea claim	Area status
Determined native title claims				
South Australia	Far West Coast	SCD2013/002	No	Non-exclusive and exclusive areas
South Australia	Barngarla Native Title Claim	SCD2016/001	No	Non-exclusive
South Australia	Kaurna Peoples Native Title Claim	SCD2018/001	Yes	Non-exclusive
Victoria	Gunditjmara – Part A	VCD2007/001	No	Non-exclusive
Victoria	Gunai/Kurnai People	VCD2010/001	No	Non-exclusive
Western Australia	The Esperance Nyungars	WCD2014/002	No	Non-exclusive
Western Australia	Western Australia Mirning People	WCD2017/008	No	Non-exclusive
Native title claims accepted for registration				
South Australia	Wirangu No. 2 Native Title Claim	SC1997/006	Yes	–
South Australia	Nauo Native Title Claim	SC1997/008	Yes	–
South Australia	First Nations of the South East #1	SC2017/002	Yes	–
South Australia	Ngarrindjeri and Others Native Title Claim	SC1998/004	No	–
South Australia	Kaurna Peoples Native Title Claim	SC2000/001	Yes	–
South Australia	Narungga Nation	SC2013/002	Yes	–
South Australia	Far West Coast Sea Claim	SC2016/001	Yes	–
South Australia	Nauo No. 2	SC2016/003	Yes	–
Victoria	Eastern Maar People	VC2012/001	Yes	–
Victoria	Gunaikurnai People	VC2014/001	No	–
Western Australia	Southern Noongar	WC1996/109	Yes	–
Western Australia	Wagyl Kaip	WC1998/070	Yes	–
New South Wales	South Coast People	NC2017/003	Yes	–

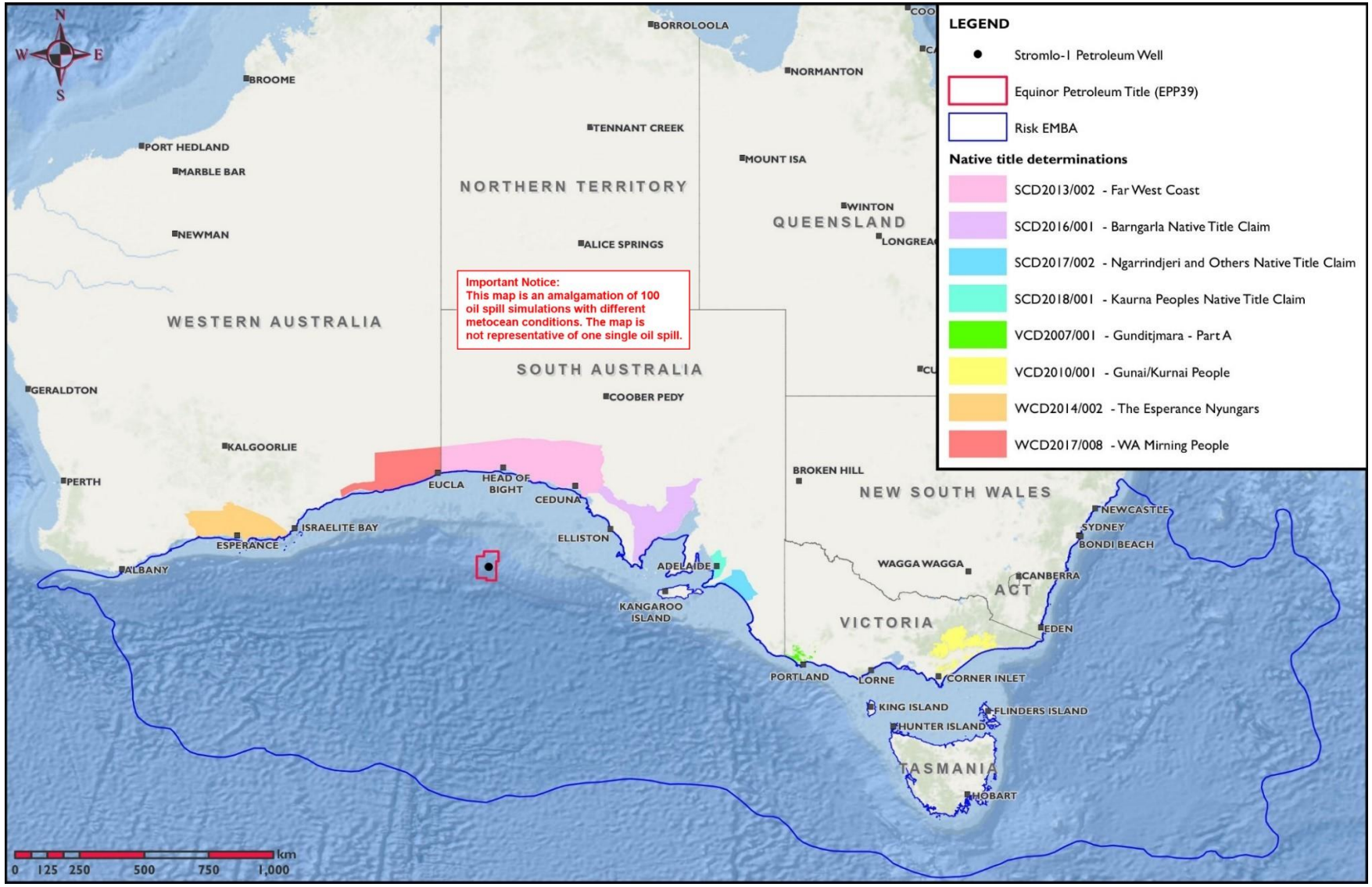


Figure 5.8 Native Title determinations within the Risk EMBA

5.3.2 Indigenous cultural values

Various Indigenous groups inhabit the south coast of Australia. Many have a long-standing relationship with coastal and marine environments and continue to rely on these environments and resources for their cultural identity, health and wellbeing, domestic and commercial economic needs.

The main Indigenous groups located within the Risk EMBA that are of Indigenous heritage significance are described below. The Indigenous values of the southern Australian coastline are not definitively mapped and extents referred to are approximations based on the best available evidence.

5.3.2.1 South Australia

The South Australian coastline within the Risk EMBA includes seven main Indigenous groups as follows:

- Mirning: from Belladonia to Nullabor (crosses the Western Australia–South Australia border)
- Wirangu: from Nullabor to Streaky Bay
- Yalata Anangu: at Yalata Station near the Head of the Bight
- Narangga: occupy most of the Yorke Peninsula
- Kaurna: occupy the Adelaide coast, ranging from Clinton near Port Arthur, to Deep Creek south of Cape Jervis
- Ngarrindjeri: from Victoria Harbour to Cape Jaffa
- Barngarla: at the western shore of Spencer Gulf
- Nauo: Southern Eyre Peninsula
- Buandig: from Cape Jaffa to south of Nelson.

The main South Australian Indigenous groups within the Risk EMBA have a strong spiritual and cultural connection with the Great Australian Bight sea country (areas of the sea that Indigenous people are particularly affiliated with through lore and customs). The history and coastal connection of these groups are described below.

Mirning

The people known today as the Mirning are ancestors of the Koonalda flint people who have been in the Nullarbor region for well over 20,000 years (DEH 2005). Their country extends from west of the Head of Bight to near Cape Pasley. The Miring people are traditionally coastal people who have a deep connection to “Jeerdara”, the whale dreaming, and are not known to have ventured inland of the coastal plain. The sea from Fowlers Bay in South Australia to Point Cuvier in Western Australia provides seafood, sacred stories and beliefs for the Mirning community and has been passed down from their ancestors (Mirning Elder, pers. comm). The Mirning people have cultural responsibilities for sea country in the Great Australian Bight Marine Park (Parks Australia 2019).

Wirangu

The Wirangu people’s country extends east from the Head of the Bight to the Gawler Ranges and Streaky Bay. These people are described as living in the coastal regions throughout spring and summer, moving inland when the sea was rough and the inland limestone rock holes were full of water, supporting movement across the Nullarbor plain (DEH 2005). The Wirangu people are acknowledged as the Traditional custodians of the Chain of Bays region and consider themselves to be coastal people who came from the sea. The Wirangu people have cultural responsibilities for sea country in the Great Australian Bight Marine Park (Parks Australia 2019).

Yalata Anangu

The Yalata Anangu people are originally the Anangu people that were people of the Great Victoria Desert. These people moved from the desert to Ooldea due to drought and subsequently were displaced during British atomic testing at Maralinga, when they moved to Yalata Station near the Head of the Bight. Today the Yalata Anangu hold cultural interests in the Bight, mainly focussing around the inshore reefs (DEH 2005).

Narangga

The Narangga (also known as Adjahdura or Narungga) people have occupied Yoke Peninsula for over 40,000 years. Remnants of stone, bone and shell tools can be found at coastal campgrounds that were of great importance as the inland area of the peninsula is harsh and dry. Fish traps attributed to the Narangga people are found on the Yorke Peninsula (Roberts et. Al. 2015). A large amount of language and heritage have been lost following pastoralisation of the peninsula (SA Memory 2019). The Yorke Peninsula Indigenous Land Use Agreement recognises the Naungga people as traditional owners in the Yorke Peninsula region including their attachment to the sea and sea lions (AIATSIS 2006). The Naungga people also hold the butterfish of special significance due to its plentiful supply of food, reflected in their annual "Gynburra" (big butterfish) festival.

Kaurna

The Kaurna people of the Adelaide Plains were known to move between the coastal and inland areas according to seasonal patterns. The Kaurna people follow dreaming trails along the coastline to collect ochre and access freshwater springs. Kaurna dreaming describes Kangaroo Island, which suggests the area has significance to the Kaurna people (AIATSIS 2006). The Kaurna people have a deep connection to the "Kondili" or "Kondoli", the whale dreaming.

Ngarrindjeri

The Ngarrindjeri people of lower Murray River and Coorong have had responsibilities over their sea country "Yarluwar-Ruwe" for at least 18,000 years. The coastal areas of Kangaroo Island and the Coorong coast hold many sacred sites and animals from their people and country creation dreaming "Ngurunderi the Creator". The Nganrrindjeri share the "Kondoli" (whale) dreaming with their Kaurna neighbours, as well as the "Paingal" (seal) dreaming. Ocean, lake and river waters are very important to the Ngarrindjeri people, particularly areas where fresh and salt water mix, as this is where the "Ngarjtis" (totems or spiritual animals) breed (Ngarrindjeri Nation, 2007).

Buandig

The Buandig or Boandik people of the Mount Gambier and Glenelg River region have thought to be in the area for at least 30,000 years, having settled there after moving around the wider region of Mount Muirhead fleeing the "bullin" evil spirits and cooking ovens that continually filled with underground water. Their boundaries with neighbouring groups were clearly marked and understood, with land passing from father to son. The banks and river mouth of the Glenelg River hold many sacred sites, including groundwater discharge (Smith, 1880).

Nauo

The Nauo peoples of Southern Eyre Peninsula occupied an area on the coast to the south-west of the settlement of Port Lincoln (Schurmann 1987:152-2 in Hercus and Simpson 2001:264). The western boundary has been suggested as near Elliston (cf. Hercus and Simpson 2001:270-272). According to Nauo beliefs, the spirits of the departed are thought to dwell on the islands in the Spencer Gulf.

Barngarla

The Barngarla people are the original inhabitants of the regions from northern Spencer Gulf to south of Port Lincoln. The area now known as Port Augusta was a cultural and trading hub and there are many sacred places around the area, including ceremony and ritual sites. The Barngala people have cultural connections with he Lake Eyre and Lake Torrens people, and share dreaming sites with the Kokatha people. The Barngala people are known to other Aboriginal people as the people who "sing to the sharks" in coastal ceremonies, and the coastal land at Weeroona Bay is still a significant site for this practice.

Coastal areas of Indigenous heritage significance in South Australia

Coastal areas in SA within the Risk EMBA that are of Indigenous heritage significance and are listed under the EBPC Act are:

- Piccaninnie Ponds Karts Wetlands (see Section 1.4.5.2), where the Buandig Traditional Owners of the land and local Indigenous people of the south-east have a strong connection with the site, recognising the importance of groundwater discharge and connections between culture and wetland health (DSEWPaC 2013b).
- Far West Coast Marine Park (see Section 1.5.1.1), where the Mirning, Wirangu and Yalata Anangu Aboriginal peoples have traditional associations with areas of the Marine Park, and with the Yalata Indigenous Protected Area lying at the edge of the Marine Park.

- Eastern and Southern Spencer Gulf Marine Park and the Lower Yorke Peninsula Marine Park (see Section 1.5.1.1), where the Narungga Aboriginal people have traditional associations with areas of the Marine Park and an Indigenous Land Use Agreement (ILUA) exists over areas of the marine park to allow customary fishing practices.
- Upper Gulf St Vincent Marine Park (see Section 1.5.1.1), where the Kaurna and Narungga Aboriginal peoples have traditional associations with areas of the Marine Park. The Kaurna people have lodged native title claims over parts of the Marine Park and parts of the Marine Park are also subject to an ILUA with the Narungga People of Yorke Peninsula that exercises their Native Title claim rights in the park.

5.3.2.2 Western Australia

The West Australian coastline within the Risk EMBA includes six main Indigenous groups as follows:

- Bibbulman: from Cape Leeuwin to Broke
- Minang: from Broke (south of Manjumup on the coast) to Beaufort Inlet
- Goreng: from the Beaufort Inlet to Bremer Bay
- Wudjari: from the Fitzgerald River National Park to Cape Pasley (Cape Arid)
- Ngatjumay: from Cape Arid to Belladonia
- Mirning: from Belladonia to Nullabor (crosses the Western Australia–South Australia border).

5.3.2.3 Victoria

The Victorian coast includes seven main Indigenous groups as follows:

- Gunditjmara: from south of Nelson to Warrnambool
- Giraiwurung: from Warrnambool to Glenaire
- Gadubanud: from Glenaire to Lorne
- Wathaurong: from Lorne to Altona
- Boonwurrung: from Altona to Toora
- Kurnai: from Toora to the south eastern extent of the Croajingolong National Park
- Bidwell: from within the Croajingolong National Park to Eden.

Coastal areas of Indigenous heritage significance in Victoria

Coastal areas in Victoria within the Risk EMBA of Indigenous heritage significance and are listed under the EBPC Act are:

- The Twelve Apostles Marine National Park, (see Section 1.5.1.3), where Gadubanud and Giraiwurung culture is based on spiritual connection to sea country and a history of marine resource use.
- Point Addis Marine National Park, (see Section 1.5.1.3), where there is evidence of a long history of Indigenous use, including many Wathaurong places and objects adjacent to the Park and sanctuaries near dunes, headlands, estuaries and creeks.
- Wilsons Promontory Marine National Park, (see Section 1.5.1.3), with seascape, cultural places and objects of high traditional and cultural significance to the Boonwurrung, Bunurong and Kurnai people. Indigenous cultural lore and interest is maintained by the Kurnai and Boonwurrung peoples.
- Bunurong Marine National Park, (see Section 1.5.1.3), with numerous places, objects, landscape and seascape of cultural significance to the Boonwurrung people.
- Point Hicks Marine National Park, (see Section 1.5.1.3), where there are signs of early Indigenous occupation and seascape and places of significance to the Bidwell and Kurnai people.
- Merri Marine Sanctuary, (see Section 1.5.1.3), culturally significant to the Gunditjmara community that have a long association with the area.

- Marengo Reefs Marine Sanctuary, (see Section 1.5.1.3), evidence of a long history of Indigenous use, including many Gadubanud places and objects nearby.
- Beware Reef Marine Sanctuary, (see Section1.5.1.3), a seascape of high cultural significance to the Bidwell and Gunaikurnai people.

5.3.2.4 Tasmania

The Tasmanian coastline within the Risk EMBA includes seven main Indigenous groups as follows:

- Peerapper: from Burnie to Cape Sorell
- Toogee: from Cape Sorell to Louisa Creek
- Nuenonne: from Louisa Creek to Hobart
- Paredareme: from Hobart to the Falmouth estuary
- Pyemmairrener: from the Falmouth estuary to Stony Head
- Tyerrernotepanner: from Stony Head to the Briggs Regional Reserve
- Tommeginne: from the Briggs Regional Reserve to Burnie.

Coastal areas of Indigenous heritage significance in Tasmania

Coastal areas in Tasmania that are within the Risk EMBA, are of Indigenous heritage significance and are listed under the EBPC Act are:

- Lavinia Ramsar Site, (see Section 1.4.5.4) which contains artefacts of unknown Indigenous Australian occupation around the lagoon and coastal beaches.
- Western Tasmanian Aboriginal Cultural Landscape, (see Section 5.3.3.1) which contains middens, hut depressions, indications of seal hunting, rock art, petroglyphs and other sites of Peerapper cultural significance.

5.3.2.5 New South Wales

The New South Wales coastline within the Risk EMBA includes six main Indigenous groups as follows:

- Yuin: from Eden to the northern extent of the Jervis Bay Territory
- Tharawal: from the northern extent of the Jervis Bay Territory to La Perouse, north of Botany Bay heads
- Eora: from La Perouse to Manly
- Kuring-gai: from Manly to Norah Head
- Awabakal: from Norah Head to Yacaaba Head
- Worimi: from Yacaaba Head to Forster-Tuncurry.

Coastal areas of Indigenous heritage significance in New South Wales

Coastal areas in New South Wales within the Risk EMBA of Indigenous heritage significance and are listed under the EBPC Act are:

- Myall Lakes Ramsar Wetland, (see Section 1.4.5.1), which contains middens of importance to the Worimi people.

5.3.3 Indigenous listed heritage places

5.3.3.1 Western Tasmanian Aboriginal Cultural Landscape

The Western Tasmanian Aboriginal Cultural Landscape (21,000 ha) is a 2 km wide area that runs along the north-west coast of Tasmania between Sandy Cape and the Pieman River. The landscape provides the best evidence of a specialised, semi-sedentary Indigenous Tasmanian way of life in which people moved seasonally up and down the coast and depended on fish, shellfish, seals and land mammals. This way of life began approximately 1900 years ago and lasted until the 1830s. The area is of great cultural importance to Indigenous Tasmanians and is dotted with middens, hut depressions, rock art, petroglyphs and other sites of cultural significance (DEE 2017m).

5.3.4 Heritage places

There are 12 National Heritage Places listed as MNES under the EPBC Act that are situated within and along the shoreline of the Risk EMBA identified in Table 5.12. Three have been listed based on their outstanding "natural" heritage value (located in New South Wales, Tasmania and Western Australia), seven for their outstanding "historic" heritage value (three located in New South Wales, two in Tasmania and one in Victoria) and the other for its outstanding "Indigenous" heritage value (Tasmania). Two have also been declared World heritage properties, with the Tasmanian Wilderness meeting the UNESCO criteria for a range of outstanding natural, indigenous and historic heritage values (predominantly natural) and Port Arthur, Tasmania for meeting criteria related to its historic significance as one of 11 properties declared as the "Australian Convict Sites". These National and World Heritage places are described in further detail below. Each place is state government managed under the individual management plans described in Table 5.12.

Table 5.12 Listed National and World heritage places within and along the Risk EMBA

Heritage place	State	World Heritage property	National heritage property	Relevant plan
Natural				
Royal National Park and Garawarra State Conservation Area	New South Wales		Listed place	Royal National Park, Heathcote National Park and Garawarra State Conservation Area Plan of Management (NPWS 2000)
Tasmanian Wilderness	Tasmania	Declared property	Listed place	Tasmanian Wilderness World Heritage Area Management Plan 2016 (DPIPWE 2016)
Fitzgerald River National Park	Western Australia		Listed place	Fitzgerald River National Park 1991-2001 (CALM 1991)
Historic				
Bondi Beach	New South Wales		Listed place	Bondi Park, Beach and Pavilion Plan of Management 2014–2024 (Waverly Council 2014)
Kurnell Peninsula Headland	New South Wales		Listed place	Botany Bay National Park Plan of Management (NPWS 2002)
North Head	New South Wales		Listed place	Management Plan – North Head Sanctuary (Sydney Harbour Federation Trust 2011)
Port Arthur	Tasmania	Declared property (Australian Convict Sites)	Listed place	Port Arthur Historic Sites Management Plan 2008
Recherche Bay (North East Peninsula) Area	Tasmania		Listed place	Recherche Bay Northeast Peninsula Management Plan 2016 (Tasmanian Land Conservancy 2007)
Great Ocean Road and Scenic Environs	Victoria		Listed place	Coastal Management Plan (Great Ocean Road Coast Committee 2013) Coastal Management Plan (Otway Coast Committee 2012) Great Otway NP and Otway Forest Park Management Action Plan (Parks Victoria 2009) Port Campbell National Park and Bay of Islands Coastal Park Management Plan (Parks Victoria 1998)
Point Nepean Defence Sites and Quarantine Station Area	Victoria		Listed place	Point Nepean National Park and Point Nepean Quarantine Station Management Plan (Parks Victoria and Point Nepean Community Trust 2013)
Indigenous				

Heritage place	State	World Heritage property	National heritage property	Relevant plan
Western Tasmania Aboriginal Cultural Landscape	Tasmania		Listed place	–

5.3.5 Natural listed heritage places

5.3.5.1 Royal National Park and Garawarra State Conservation Area (New South Wales)

Australia's first national park, Royal National Park (15,100 ha) and Garawarra State Conservation Area (949 ha to the south-west) are only 40 km south of the centre of Sydney and have a landscape that includes temperate wild heathlands, woodlands and beaches. These support abundant and diverse plant and animal life including a variety of insects, birds (231 species), mammals (43 species), reptiles (40 species) and amphibians (30 species) (DEE 2017m). Royal National Park is one of only four coastal national parks in New South Wales that protect land below the high-water mark. The associated estuarine habitats, including South West Arm and Cabbage Tree Basin, are sheltered bodies of water that are frequented by migratory birds support juvenile fish and invertebrates, seagrass beds and diverse benthic fauna.

The Royal National Park and Garawarra State Conservation Area is currently managed by the New South Wales NPWS under the Royal National Park, Heathcote National Park and Garawarra State Conservation Area Plan of Management, although a new plan is being developed and may come into effect over the life of the project.

5.3.5.2 Tasmanian Wilderness (Tasmania)

The Tasmanian Wilderness (1,600,000 ha) is a declared World Heritage place, one of the largest conservation reserves in Australia and one of the largest temperate wilderness areas remaining in the southern hemisphere. Due to the diversity of its vegetation and the age of some of its trees, the region is recognised as an "International Centre for Plant Diversity" by the International Union for Conservation of Nature (IUCN). The fauna is also of global significance because it includes an unusually high proportion of endemic species. The insularity of the Tasmanian Wilderness in particular has contributed to its uniqueness and resulted in the area becoming a stronghold for terrestrial animals that are either extinct or threatened on mainland Australia.

The south-west of the Tasmanian Wilderness is coastal and offers specialised niches for rare and restricted endemic plants with a shoreline that includes both sheltered and exposed cliffs, sandy beaches and saltmarshes. The coastal area includes Port Davey, the most southerly large estuary in Australia, which is relatively pristine and supports a variety of seaweeds, fish and invertebrates, with occasional visits from marine mammals. The Maatsuyker Islands 5–10 km offshore are also part of the Tasmanian Wilderness World Heritage area. The group of Islands has fewer flora due to the windy conditions but support fur seal colonies, visiting southern elephant seals (*M. leonina*) and an abundance of seabirds such as short-tailed shearwaters (*A. tenuirostris*), little penguins (*E. minor*), common diving-petrels (*P. urinatrix*) and Vulnerable species including soft-plumaged petrels (*P. mollis*) and fairy prions (*P. turtur subantarctica*) (DEE 2017m).

The Tasmanian Wilderness is also recognised as a World Heritage area for Indigenous and historic heritage criteria. The landscape contains hundreds of archaeological sites that are exceptional testimonies to indigenous culture and illustrate significant stages in human history (DEE 2017m). This includes cave sites dating from the late Pleistocene and early Holocene epochs, which are evidence of what are understood to be the southernmost people in the world during the last glacial period, who were part of the forefront of the first expansion of modern humans across the globe. The full number and significance of the archaeological sites within the Tasmanian Wilderness is the subject of ongoing study, which is expected to further illuminate the cultural heritage of the property.

The Tasmanian Wilderness is managed in partnership between the federal and Tasmanian governments, predominantly by the Tasmanian DPIPWE under the Tasmanian Wilderness World Heritage Area Management Plan 2016.

5.3.5.3 Fitzgerald River National Park (Western Australia)

The Fitzgerald River National Park (297,244 ha) in south-west Australia is an internationally recognised biodiversity hot spot and one of the most important reserves for plant conservation in Australia. The national park supports a rich variety of native plants (around 1748 species) including 75 species found nowhere else in the world and around 250 plants that are considered rare or geographically restricted with approximately 15% of Western Australia's described plant species (DEE 2017m).

Rugged hills with extensive vegetation rise above coastal landscapes that include long wind-swept sandy beaches, quartzite sea cliffs, inlets and islands with low density heath and beach grasses, as well as woodlands along rivers.

The Fitzgerald River National Park is reported to contain more species of terrestrial vertebrates than any other reserve in south-west Australia. This includes 22 mammal species, 41 reptile species, 12 frog species and more than 200 bird species (DEE 2017m).

5.3.6 Historic listed heritage places

5.3.6.1 Bondi Beach (New South Wales)

Bondi Beach (1 km in length) is one of the world's most famous beaches and is of significant cultural value as the birthplace of the surf lifesaving movement in 1907 and Australian beach culture in general. Situated close to Sydney's central business district, Bondi Beach is an urban beach landscape, where the natural features have been altered by development associated with beach use. The listing includes Bondi Beach, the Bondi Park and the headland reserves, the Bondi Surf Pavilion, the Bondi Surf Bathers Life Saving Club and North Bondi Surf Lifesaving clubhouse, and the Bondi Pool area and Icebergs building. Together these constitute an iconic place that is emblematic of the Australian beach experience.

5.3.6.2 Kurnell Peninsula Headland (New South Wales)

Kurnell Peninsula Headland (325 ha) on the southern headland at the entrance to Botany Bay is of outstanding historic value as the site of the landing in April 1770 by Lt James Cook where contact between British and Indigenous Australians in eastern Australia was first made. Botany Bay was also the landing place of the First Fleet on 26 January 1788. The Kurnell Peninsula Headland is a critical place in Australia's history and symbolically represents the birthplace of a nation and the dispossession of Indigenous people. The Meeting Place Precinct, including Captain Cook's Landing Place, features memorials and landscape plantings celebrating the events. Attributes specifically associated with its Indigenous values include the watering point and immediate surrounds, and the physical evidence of Indigenous occupation in the area broadly encompassed by the watering place and the landing stage.

5.3.6.3 North Head (New South Wales)

North Head is the northern expression of the seaward entrance to Sydney Harbour (Port Jackson). The towering sandstone cliffs have signified arrival and departure at Port Jackson since 1788 and is an iconic, national landmark. North Head also played a major role in the cultural and military life of the colony of New South Wales and includes Australia's first quarantine station, where ships carrying passengers with infectious diseases were isolated. From its beginning until 1977 when the facility was closed, a total of 580 ships were detained and about 13,000 passengers, including generations of free immigrants, convicts and war veterans, were quarantined for periods of up to 40 days (DEE 2017m). The major groups of buildings, although of a similar age as surviving complexes in other states, are rare in terms of their range and relative integrity.

5.3.6.4 Port Arthur (Tasmania)

Located on the Tasman Peninsula (60 km from Hobart), Port Arthur served as a penal colony for Australia's early convicts from 1833 to 1877. Port Arthur is a significant national example of a convict site that demonstrates, with a high degree of integrity and authenticity, an aspect of Britain's convict transportation strategy to Australia. The site forms part of the Australian Convict Sites, a World Heritage property consisting of 11 remnant penal sites originally built within the British Empire during the 18th and 19th centuries on fertile Australian coastal strips. The murder of 35 people at a gunman's hand in 1996 added another layer to the

history of Port Arthur and gave it a new national significance as the place that led to Australia's tightened gun laws. The picturesque coastal environment and buildings and offer visitors a challenging mix of both beauty and horror, which has helped the site to become the most popular tourist destination in Tasmania.

5.3.6.5 Recherche Bay (North East Peninsula) Area (Tasmania)

The north-east peninsula of Recherche Bay has an important association with the French scientific and exploratory expedition of Rear Admiral Bruni D'Entrecasteaux, which spent seven weeks there in 1792 and 1793. The relatively extensive, well-documented encounters between the expedition members and the Indigenous Tasmania ns provided important observations of the lives of the Indigenous Tasmania ns before they were significantly affected by European settlement and disease. In 1972, the French also camped ashore on the north-east peninsula, made scientific observations, collected numerous specimens of flora and fauna, and established a vegetable garden intended for the economic benefit of the Indigenous Tasmanian people. The significant activities of the French expeditioners associated with the place, constitute a significant, "associative" cultural landscape. The Tasmanian Aboriginal community have a strong association with the Recherche Bay as the place with the best documentary evidence of Indigenous Tasmanian culture. This relates to various parts of the north-east peninsula, principally including the area around Blackswan Lagoon, and the beach and hinterland east of Sullivan's Point (DEE 2017m).

5.3.6.6 Great Ocean Road and scenic environs

Stretching 242 km along the south-west coast of Victoria, the Great Ocean Road and scenic environs is an iconic road that hugs the coast and provides views of diverse scenery. Constructed by workers including more than 3000 returned servicemen as a utilitarian memorial to First World War servicemen, it is also a significant reminder of the participation of Australian servicemen in the First World War, the Australian community's appreciation of their service, and the support provided for the continuing welfare of servicemen upon returning to Australia. The route was designed to follow the lines of nature and facilitate public access to the coastline, creating a flowing, serpentine route that follows the coast and provides an exemplar scenic journey. This has made the Great Ocean Road Australia's most famous coastal drive and a popular tourist destination, with more than 7.5 million visits to the area in 2009–2010 (DEE 2017m).

5.3.6.7 Point Nepean defence sites and quarantine station area

Point Nepean, situated at the tip of the Mornington Peninsula at the entrance to Port Phillip Bay, is the site of two historic 19th century landmarks; the fortifications and the quarantine station that defended the Colony of Victoria against foreign attack and disease. Point Nepean has been part of a strategic outer line in the defence of Melbourne's ports and harbours since the 1870s. The fortifications on Point Nepean and Fort Nepean, in particular, are regarded as unique examples of the crucial role coastal defence played in protecting the Australian colonies of the British Empire. Point Nepean is the site of the oldest quarantine accommodation buildings in Australia, constructed in response to large increases in immigrants arriving by ship following the discovery of gold in 1851.

5.3.7 Historic shipwrecks

A search of the Australian National Shipwreck Database (DEE 2017n) identified 1037 historic shipwrecks within the Risk EMBA that are protected under the *Historic Shipwrecks Act 1976* (Commonwealth), *Maritime Archaeology Act 1973* (Western Australia), *Historic Shipwrecks Act 1981* (South Australia), *Heritage Act 1995* (Victoria), *Historic Cultural Heritage Act 1995* (Tasmania) and the *Heritage Act 1977* (New South Wales). In circumstances when a shipwreck is considered highly significant and/or vulnerable to disturbance a protected zone may be declared around the site, requiring a permit from the management authority to enter. Within the Risk EMBA, seven shipwrecks have been identified as being particularly sensitive and have a protection zone declared around them. This includes five historic shipwreck protection zones (exclusion zone of up to 800 m) established under the *Historic Shipwrecks Act 1976* (Commonwealth), as well as two protection zones (550 m exclusion zone) declared around shipwrecks in the Gulf St Vincent under the *Historic Shipwrecks Act 1981* (South Australia). There are few shipwrecks in offshore Great Australian Bight waters and none in the vicinity of the Stromlo-1 well location. The nearest shipwreck protection zone is the *HMAS Hobart* (scuttled in 2002), 680 km east of the well location, and the nearest historic shipwreck protection zone is for the *SS Alert* (1893), approximately 1350 km away near the entrance to Port Phillip Bay, Victoria.

5.4 Tourism and recreation

Most of the coast intersected by the Risk EMBA is remote, with few settlements, developments or tourist facilities (other than occasional roadhouses, motels, villages or small towns) and low levels of recreational or tourist activity. Only nature-based and niche market tourist activities tend to occur away from large towns, cities or metropolitan areas. Key recreational and tourist activities identified across the Risk EMBA through research and consultation with tourism industry representatives and relevant government authorities are described in Sections 1.6.4.2 to 1.6.4.5.

Swimming, surfing, snorkelling, diving, fishing, boating and sightseeing are major recreational activities practiced within the Risk EMBA and frequently occur along the coast in accessible, nearshore waters. No recreational or tourist activities occur within the vicinity of the permit area due to the remoteness and generally inaccessible nature of the well location.

5.4.1 Western Australian tourism

Boat-based commercial tourism activities within the Great Australian Bight include:

- whale watching ecotours from May to September (focussed on humpback and southern right whales), and diving and fishing charters operating out of Albany
- whale watching ecotours operating out of Bremer Bay from January to March, taking clients ~70 km offshore to the Bremer Canyons on the slope of the continental shelf to view killer whales
- Recherche Archipelago island cruises, wildlife ecotours and fishing charter vessels.

5.4.2 South Australian tourism

Marine mammal watching tours are popular tourist attractions in the region, particularly to view southern right whales and Australian sea lion colonies at the Head of Bight, where these animals can be observed from a viewing platform at the Bunda Cliffs. The Bunda Cliffs stretch uninterrupted for 200 km west of the Head of Bight and are themselves an attraction, being limestone cliffs 60–80 m in height. “Dolphin Watch”, a boat-based, dolphin tourism and research group, operates off Kangaroo Island year-round.

Shark cage diving is an increasingly important tourism industry for Port Lincoln, with operations centred on the Neptune Islands. Here, tourists have the only opportunity in Australia to view great white sharks year-round at close range from within submerged steel cages. Three tour companies operating from Port Lincoln provide this cage diving service, directly accounting for 70 jobs and generating more than $11m annually for the South Australian economy (National Parks South Australia 2014). Swimming with and feeding southern bluefin tuna is another tourism attraction centred around the grow-out cages off Port Lincoln, and several companies offer this opportunity (Gillanders et al. 2013).

The Adelaide to Port Lincoln Yacht Race 56-mile journey from Adelaide, around the foot of Yorke Peninsula and across Spencer Gulf to Port Lincoln takes place in mid-February.

Table 5.13 provides an outline of the tourist and recreational attractions in South Australia within the Risk EMBA.

Table 5.13 Key South Australian tourist and recreational attractions within the Risk EMBA

5	Attractions
Eyre	Key coastal tourism activities include great white shark viewing (topside and cage diving) and sea lion swims at Port Lincoln, whale watching at the Head of Bight, viewing the Bunda Cliffs (world’s longest line of cliffs), and fishing, camping and surfing.
Yorke Peninsula	Key coastal tourism activities include wildlife watching (emus, wallabies, kangaroos, dolphins and whales), fishing (blue swimmer crab, salmon and southern rock lobster), fishing charters, camping, surfing (south-west corner), diving and snorkelling (underwater maritime heritage trails), attending the Saltwater Classic (wooden and classic boat event held in April), bushwalking and bird watching.
Fleurieu Peninsula	Being close to South Australia’s capital Adelaide, key coastal attractions include cruising the Coorong lakes and the Murray River, hiking, fishing, camping and surfing, food and wine tasting, whale watching and little penguin watching.

5	Attractions
Kangaroo Island	A nature-based tourism destination (with one-third of the island declared as National Park), key activities include bush walking, sight-seeing (e.g. Remarkable Rocks, Admirals Arch), sea lion watching, food and wine tasting, fishing, camping and surfing.
Limestone Coast	The key attraction of the Limestone Coast is the Coorong lakes complex, with 61% of domestic visitor activity linked to visiting parks, bushwalking, fishing and general sight-seeing. Also, of tourism importance is Blue Lake in Mount Gambier, caving at Naracoorte (World Heritage Property) and wineries in the Coonawarra and Mount Gambier areas.

5.4.3 Victorian tourism

Key areas of tourism along the western Victoria coastal region include land-based sightseeing from the Great Ocean Road and lookouts along that road, as well as private and chartered vessels touring into the Twelve Apostles Marine Park, diving and fishing. Land-based tourism in the region peaks over holiday periods and in 2011, Tourism Victoria reported a total of approximately eight million visitors to the Great Ocean Road region.

Recreational and tourism activities are extremely valuable foundations for the local and regional economy. Key activities include sight-seeing, surfing and fishing, which are generally land based or nearshore activities.

Bass Strait hosts several recreational ocean yacht races each year. The main races are:

- Melbourne (Portsea) to Launceston December) – north coast of Tasmania race
- Melbourne (Portsea) to Hobart (December) – west coast of Tasmania race
- Port Fairy, Victoria to Grassy, King Island (March, Labour Day holiday)
- Melbourne (Queenscliff) to Stanley (November, Melbourne Cup holiday).

5.4.4 Tasmanian tourism

Major Tasmanian population centres are predominantly outside the Risk EMBA. Tourist attractions which are adjacent the Risk EMBA include the Tasmanian Wilderness and Port Arthur UNESCO World Heritage sites. Fishing and boating are also major attractions along the northern coast of Tasmania.

Tourism in Bass Strait is largely confined to land-based nature activities on King Island and Flinders Island. King Island is the most accessible of the islands with flights available from Melbourne, Devonport and Burnie.

5.4.5 New South Wales tourism

Numerous recreational and professional ocean yacht races are held along the east coast of Australia each year. This includes the Sydney to Hobart Yacht Race, which starts in Sydney on 26 December each year and lasts several days (typically 3–5 days) as the yachts travel over 1100 km south, finishing in Hobart.

5.5 Recreational fishing

Recreational fishing is an important activity for many Australians and contributes substantially to the Australian economy (Evans et al. 2017). At a national level, recreational fishing (including fresh water and marine) was estimated to have an annual economic value of $2.56 billion in 2013, based on an expenditure evaluation approach (Evans et al. 2017).

Recreational fishing within the Risk EMBA includes collection by hand, spear, net, angling (hook and line) and trap. It is concentrated inshore in predictable spatial areas throughout all regions, although these can vary substantially on seasonal and interannual time-scales (Evans et al. 2017). Recreational fishing participation and effort is described for different regions within the Risk EMBA in Sections 1.6.5.1 to 1.6.5.5.

Access to offshore areas in the Great Australian Bight is limited for small vessels (<8 m) due to the inaccessible coastline and exposed waters (Rogers et al. 2013). Some fishing occurs offshore for pelagic and deeper-water species, but recreational fishing is unlikely to occur in the vicinity of the well location.

5.5.1 Recreational fishing in Western Australia

Recreational fishing is a popular activity across Western Australia, providing significant economic benefits to the state's population. There are no contemporary estimates of the total boat- and shore-based fishing effort and catch in regions relevant to the Risk EMBA within Western Australia as no licence is required for shore-based recreational fishing. However, comprehensive estimates of fishing boat-based catch and effort are available.

Most of the boat-based fishing effort on the Western Australia south coast (Black Point to the Western Australia–South Australia border) occurs during summer and autumn (66%) in nearshore waters to a depth of 20 m (54%), followed by shelf waters in depths greater than 20 m (24%) and estuaries (17%). Low proportions of fishing effort occur in offshore demersal (2%), pelagic (1%) and freshwater (2%) habitats (Ryan et al. 2015). Boat-based fishing effort on the south coast of Western Australia south coast is mostly line fishing (92%), with lower proportions of fishing effort from pots (6%), diving (1%), nets (1%) and other (<1%) (Ryan et al. 2015).

The most common nearshore and estuarine finfish species taken along the south coast of Western Australia are King George whiting (38%), Australian herring (24%), school whiting (17%), black bream (6%), silver trevally (5%), snook (2%), Western Australian salmon (1%), southern bluespotted flathead (1%), garfish (1%) and oriental bonito (1%) (Ryan et al. 2015). Blue swimmer crab (43%) and squid (52%) are the most common invertebrate species taken (Ryan et al. 2015). The most common demersal finfish species taken off the Western Australia south coast are bight redfish (36%), breaksea cod (22%), blue morwong (11%), snapper (10%), swallowtail (6%), sea sweep (4%), harlequin fish (4%), West Australian dhufish (2%), sergeant baker (2%) and fox fish (1%). These 10 species/taxa accounted for 98% of the total demersal catch (by numbers).

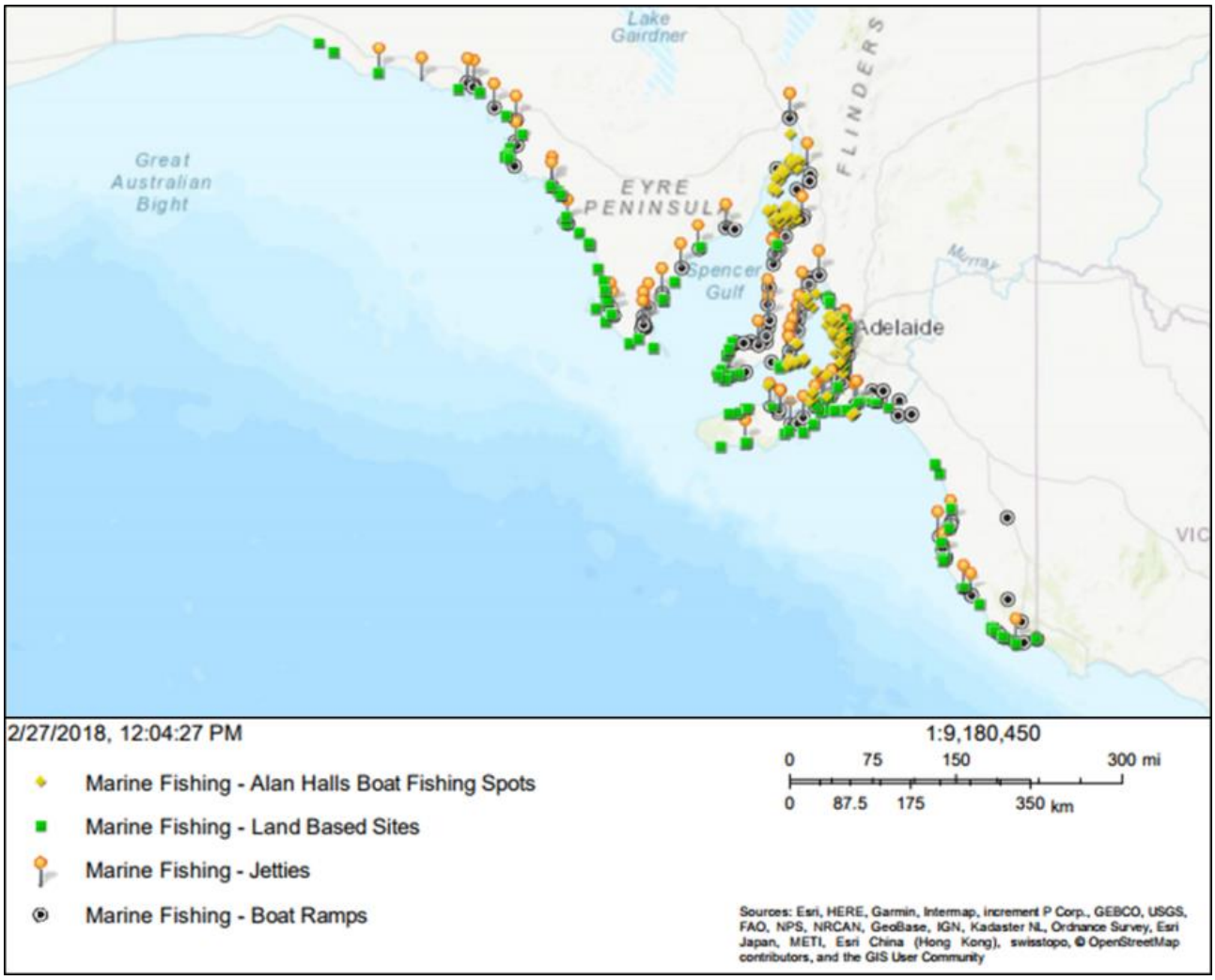
5.5.2 Recreational fishing in South Australia

Based on the last available recreational fishing survey (2013–2014), approximately 277,000 South Australians fish recreationally each year each year, representing a participation rate of 18.3% of the South Australia population (Giri & Hall 2015).

Line fishing is the predominant method used (84.3%), followed by rock lobster pots/crab nets (9.4%), dab netting (1.8%) and alternative activities such as hand collecting, diving and gill/drag netting (4.5%) (Giri & Hall 2015). The main species targeted by recreational fishers include King George whiting, Australian herring, southern garfish, striped trumpeter, Australasian snapper, pink snapper, queen snapper, European carp, Western Australian salmon, rock lobsters, blue swimmer crabs, southern calamari, arrow squid, abalone, scallops and pipi (Fletcher et al. 2017; PIRSA 2016).

The great majority of recreational fishing in South Australia occurs nearshore in shallow (<30 m depth) waters on the continental shelf within the gulfs, bays and estuaries (Figure 5.8) (Rogers et al. 2013). Recreational beach and boat fishing are concentrated around jetties and boat ramps at the main population and holiday centres and is low throughout most of the western and central Great Australian Bight, where the coast is more remote and generally difficult to access (Fletcher et al. 2017). In the eastern Great Australian Bight, the Spencer Gulf region has the highest level of fishing effort followed by Gulf St Vincent and Kangaroo Island, the West Coast and the Limestone Coast (PIRSA 2016).

There are limited data relating to the take of fish resources by recreational fishers in offshore Great Australian Bight waters. Charter boats offer a commercial platform for offshore recreational fishing activities, although the majority of charter boat fishing activities in the Great Australian Bight occur around reef, seagrass meadows, sheltered beaches and tidal flats, targeting snapper, King George whiting, Western Australia salmon, bight redfish and snook (PIRSA 2016). The closest charter boat fishing operators are based on Kangaroo Island, the Eyre Peninsula and at Streaky Bay and operate primarily around Flinders Reef and the offshore islands of the Nuyts Archipelago. The South Australia Charter Boat Fishery consists had around 15,129 clients in 2014–2015 and was valued at $3.6m (EconSearch 2016).



Source: RecFish South Australia (2018)

Figure 5.9 Popular marine recreational fishing locations and facilities in South Australia

5.5.3 Victorian recreational fishing

Recreational fishing is popular in Victoria and is largely centred within Port Phillip Bay and Western Port, although beach and nearshore boat-based fishing occurs along much of the Victorian coastline.

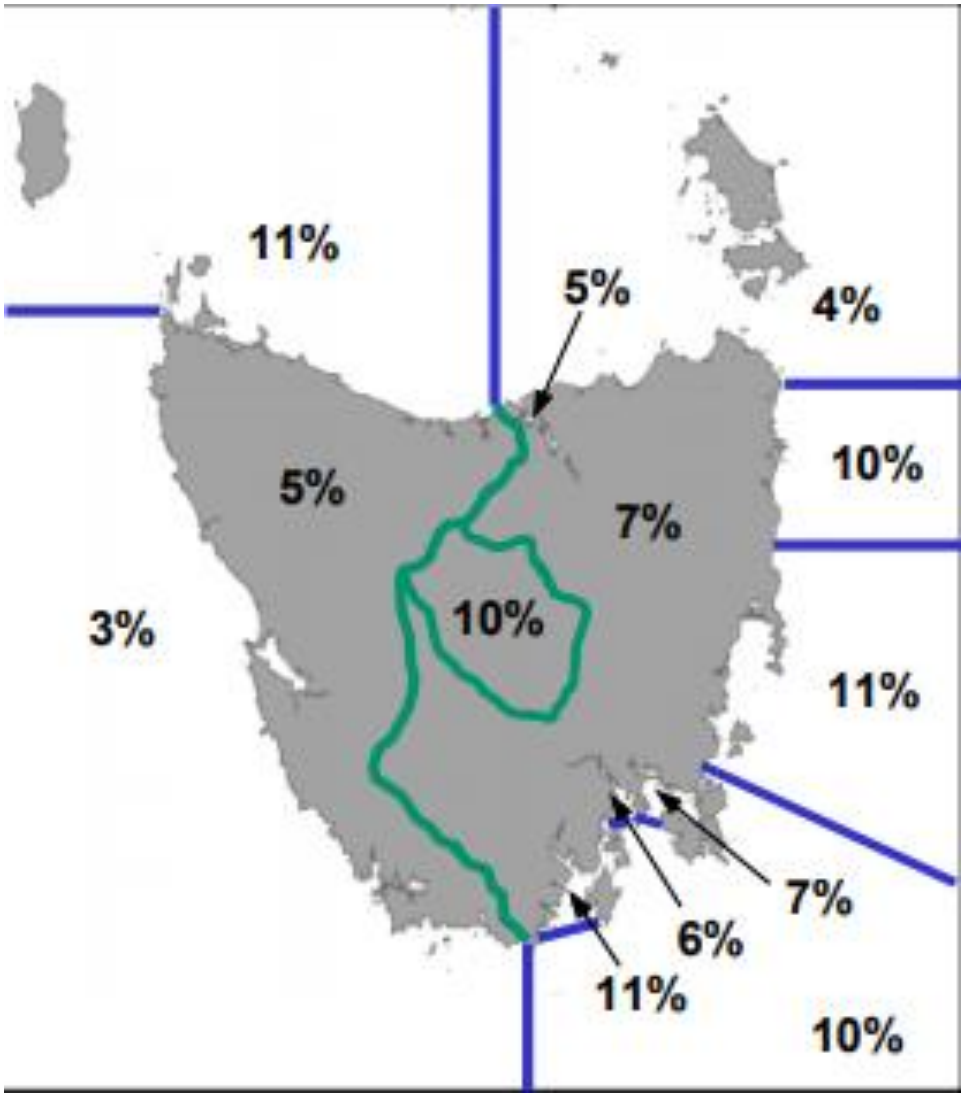
Victoria recreational fisheries that occur within the Risk EMBA include rock lobster, finfish (multiple species are targeted, including sharks), abalone, scallops, squid and pipi. Recreational scallop and squid fishing primarily occurs within Port Phillip Bay and Western Port. Active recreational fishing within the Risk EMBA is only likely to include pipis, abalone, rock lobster and finfish. These are collected from along the shore or by relatively small boats in operating in nearshore waters. Although fishing charter operators provide deeper water recreational fishing opportunities.

5.5.4 Tasmanian recreational fishing

Recreational fishing is a very popular pastime in Tasmania, with proportionally more Tasmania ns fishing each year (29.5% Tasmania participation rate) than in most other parts of the Risk EMBA (19.5% national participation rate) (Lyle et al. 2014). Recreational fishers make a significant contribution to the Tasmanian economy, spending a total of $93m on boats, fuel and fishing gear annually (Lyle et al. 2014).

Tasmanian recreational fisheries that occur within the Risk EMBA include rock lobster and crab; scalefish (multiple species are targeted, including sharks); abalone; scallops; and other fisheries (oysters, mussels, clams, seaweed and shells). Line fishing is the dominant activity undertaken, representing 450,000 fisher days (87% of total) or 1.5 million hours of effort. Other activities include pot fishing (9%), dive harvesting (3%), the use of gillnets (3%) and alternative methods e.g. spears, set-lines, seine or bait nets and hand collection (2.5%) (Lyle et al. 2014).

Distribution of fishing effort results from the most recent survey of Tasmanian recreational fishers (Figure 5.9) indicate that approximately 28% of fishing effort is distributed in waters within the Risk EMBA (Lyle et al. 2014). Statewide fishing effort is concentrated nearshore in coastal (58%) and estuarine waters (20% fisher days), as well as inland waters lakes and rivers (21%). Comparatively little fishing effort (1%) occurs in waters greater than 5 km offshore (Lyle et al. 2014).



Source: Lyle et al. (2014)

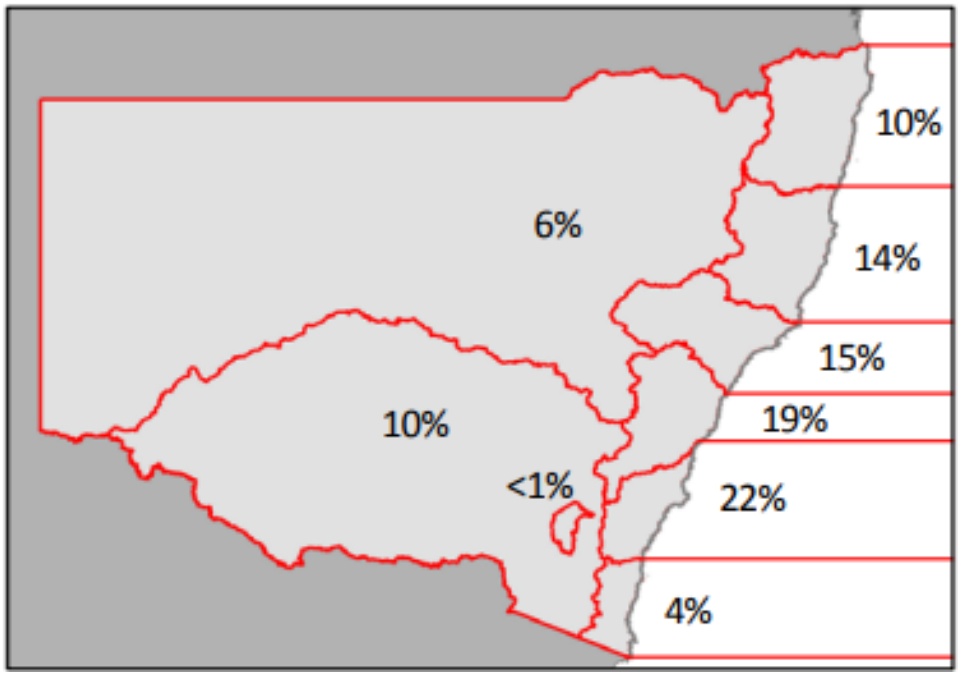
Figure 5.10 Regional distribution of Tasmanian recreational fishing effort

5.5.5 New South Wales recreational fishing

Recreational fishing has a participation rate of around 10.6% amongst New South Wales/ACT residents (West et al. 2015). The majority of recreational fishing activity in New South Wales and the ACT (Jervis Bay Territory) occurs in marine waters, with estuaries accounting for 56% of the total effort, inshore waters <5 km from the coastline accounting for 22% and offshore waters <2%. Recreational fishing effort along the New South Wales coast is most highly concentrated around the mid-south coast but occurs at relatively similar levels throughout the portion of the Risk EMBA under New South Wales jurisdiction, except for coast south of Narooma where it is considerably lower (Figure 5.10) (West et al. 2015).

Fish (scalefish, sharks and rays) account for 75% of the total catch in New South Wales/ACT marine waters by numbers, followed by crustaceans (21%), worms (2%), cephalopods and molluscs (at 1% each) (West et al. 2015). The fish most commonly caught within the Risk EMBA are bream, flathead (dusky, sand and tiger), snapper, whiting and tailor. The most commonly caught invertebrates are saltwater prawns, blue swimmer crabs and rock lobsters. Line fishing is by far the most common method, accounting for 93% fishing effort, followed by other/hand-collecting methods (3%), pot/trap fishing (2%), diving methods (1%) and various types of net (1%) (West et al. 2015).

To attract fish and improve fishing opportunities for recreational anglers the New South Wales DPI has introduced artificial reefs in estuarine and nearshore waters (~1 km from shore) and deploy fish aggregating devices on moorings positioned along the New South Wales coast between offshore throughout the summer months. Very little data are available for their level of use by recreational fishers, although the DPI actively promotes their use and thus, they are assumed to be popular with recreational fishers with access to a boat. The artificial reefs within the Risk EMBA are (from south to north) in Berry's Bay, off Bundeena, in the entrance to Botany Bay and off Watsons Bay. There are 17 moorings within the Risk EMBA on which fish aggregating devices are deployed. These are found in depths from 50 to 125 m (~8–30 km offshore), with the most concentrated between Wollongong and Sydney.



Source: Lyle et al. (2014)

Figure 5.11 Regional distribution of New South Wales recreational fishing effort

5.6 Shipping

Vessel traffic associated with commercial and recreational fishing, tourism, international shipping, and oil and gas operations is generally low throughout the Great Australian Bight. Vessel traffic densities derived from automatic identification system (AIS) data provided by AMSA for November 2017 to February 2018, show areas of medium to high shipping density from Cape Leeuwin to Perth in Western Australia, in the Spencer and St Vincent Gulfs and around Kangaroo Island in South Australia, and across Victoria, Tasmania and New South Wales waters in the east (Figure 5.11).

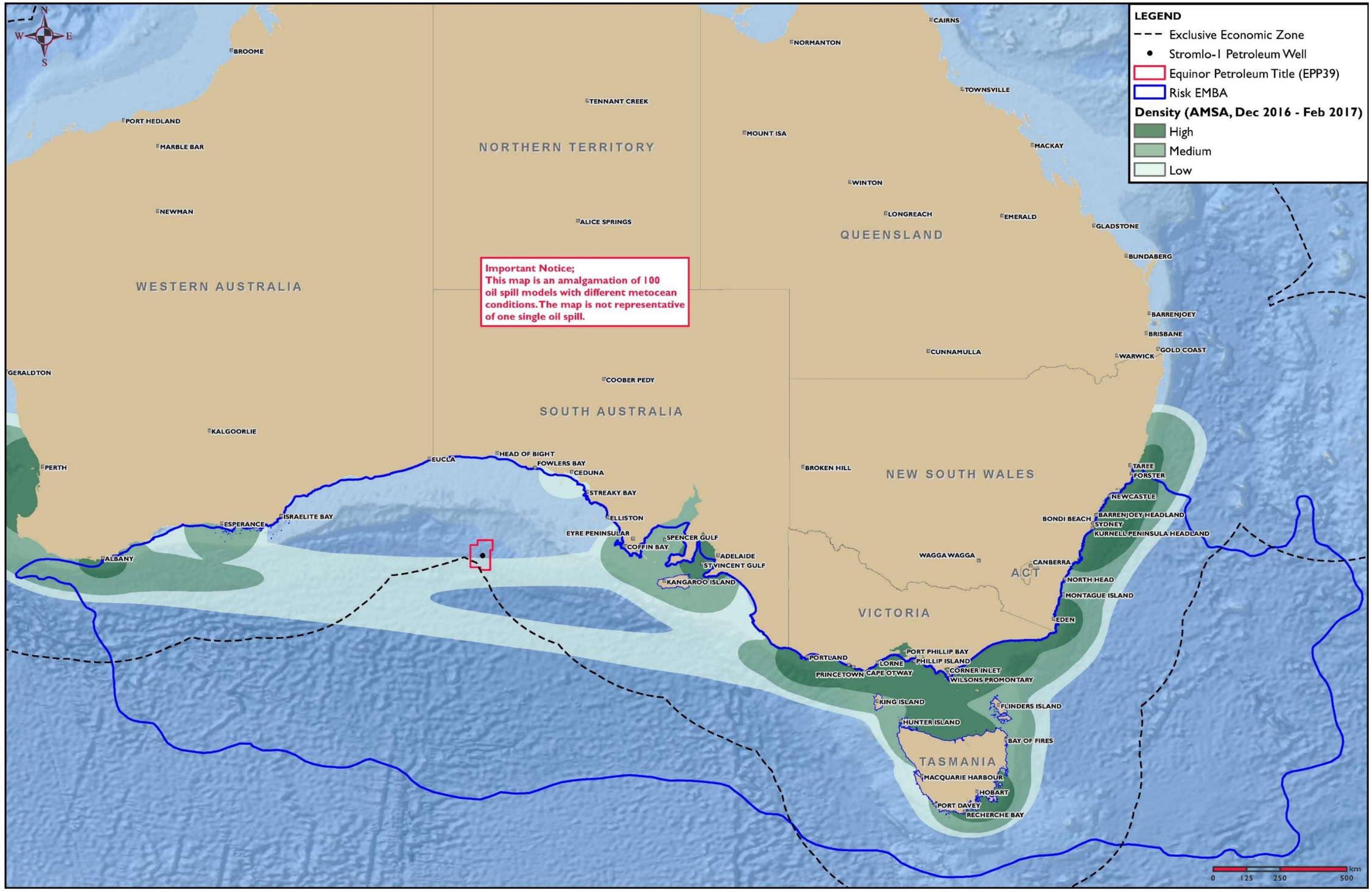


Figure 5.12 Shipping density within the Risk EMBA

5.7 Infrastructure and industry

5.7.1 Petroleum exploration and production

A search of the NOPTA (2017) National Offshore Petroleum Information Management System (NOPIMS) identified nine existing Petroleum Titles in the Great Australian Bight Basin, all of which are Exploration Permits (Table 5.14).

Table 5.14 Great Australian Bight petroleum titles

Petroleum titles	Titleholder
EPP39 and EPP40	Equinor Australia
EPP41 and EPP42	Bight Petroleum
EPP43	Murphy Australia EPP43 Oil and Santos Offshore
EPP44 and EPP45	Chevron Australia
EPP46	Karoon Gas
Western Australia-517-P	Santos Offshore Pty Ltd and JX Nippon Oil and Gas Exploration (Australia)
S18-1	Pending 2019 award

5.8 Defence

Five major Department of Defence (DoD) restricted areas occur within the Risk EMBA (Figure 5.12). The only DoD restricted area in the Great Australian Bight is the South Australian Exercise Area, which is used as a Training Area for military flying and firing. Port Wakefield Training and Prohibited Area in the upper Gulf St Vincent is located east of the well location and is used for weapons and munitions testing. The Bass Strait region hosts HMAS Cerberus, the Australian Navy's premier training establishment and features the West Head Gunnery Range Offshore Training Area, which is used for a variety of exercises. The other restricted areas are the Bruny Island Training Area and the East Australian Exercise Area, which are near the margin of the Risk EMBA off south-east Tasmania and southern New South Wales, respectively. Both are used a range of military training and defence exercises.

DoD activities are likely to take place within the Risk EMBA but not in the vicinity of the well location.

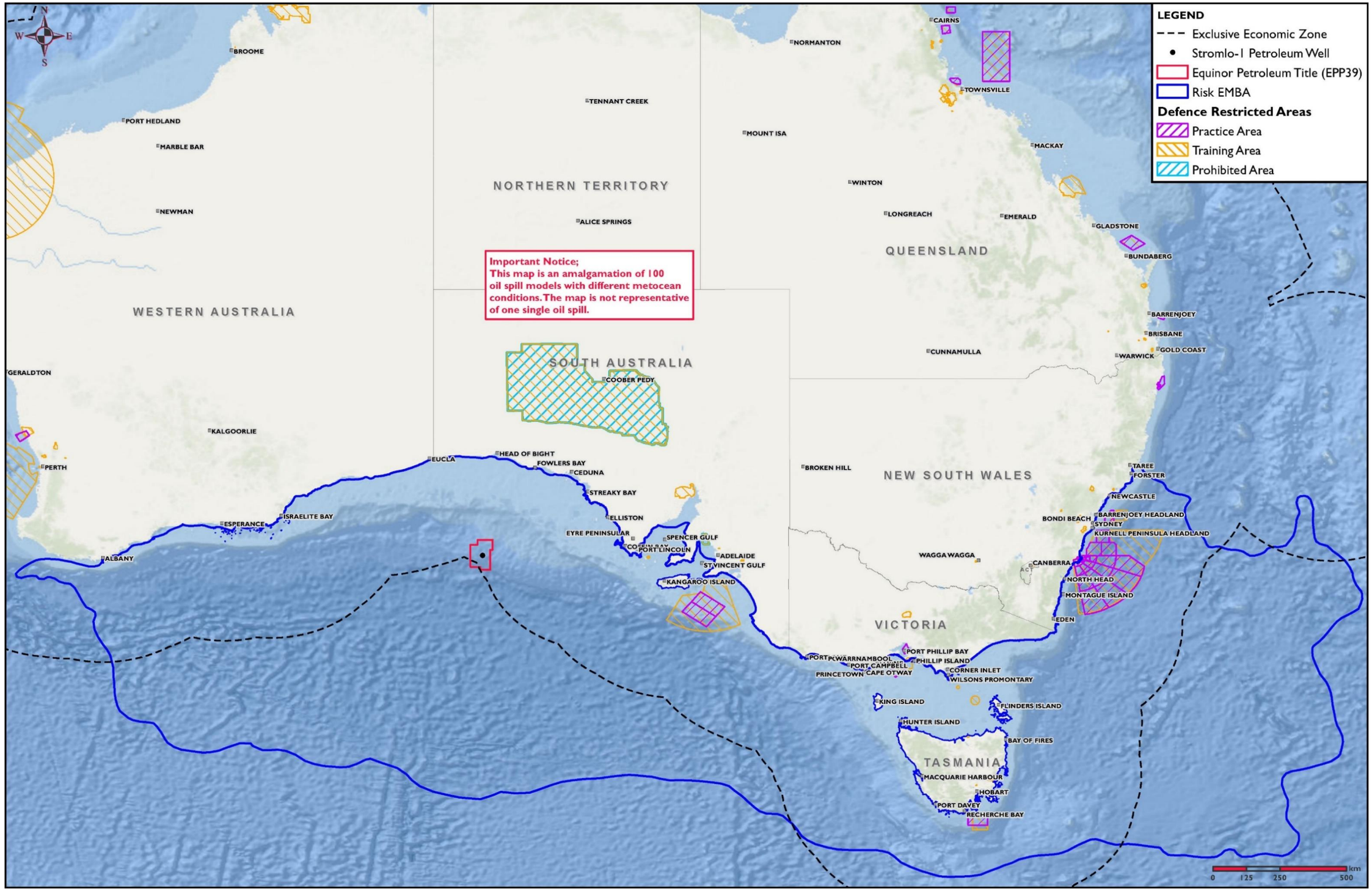


Figure 5.13 Department of Defence restricted areas within the Risk EMBA

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