EPBC Act Protected Matters Report Operational Areas

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 14-Apr-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance (Ramsar	None
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	None
Listed Threatened Species:	37
Listed Migratory Species:	38

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	61
Whales and Other Cetaceans:	14
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	None
Regional Forest Agreements:	None
Nationally Important Wetlands:	None
EPBC Act Referrals:	20
Key Ecological Features (Marine):	None
Biologically Important Areas:	15
Bioregional Assessments:	None
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
FISH		
Prototroctes maraena Australian Grayling [26179]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
MAMMAL		
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
REPTILE		
Caretta caretta		
Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas		
Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea		
Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
SHARK		
Carcharodon carcharias		
White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Galeorhinus galeus		
School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes		
Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea		
Sooty Shearwater [82651]		Species or species habitat may occur within area
Diomedea antipodensis		
Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora		
Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans		
Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi		
Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes giganteus		
Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Migratory Marine Species

Scientific Name	Threatened Category	Presence Text
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Species or species habitat known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Lagenorhynchus obscurus		
Dusky Dolphin [43]		Species or species habitat may occur within area
Lamna nasus		
Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae		
Humpback Whale [38]		Species or species habitat likely to occur within area
Orcinus orca		
Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Numenius madagascariensis		
Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Foraging, feeding or related behaviour likely to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]		Species or species habitat may occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Species or species habitat may occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat may occur within area overfly marine area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area overfly marine area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat may occur within area overfly marine area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Species or species habitat may occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Migration route likely to occur within area overfly marine area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat may occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Species or species habitat may occur within area
Stercorarius skua as Catharacta skua Great Skua [823]		Species or species habitat may occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei as Thalassarche sp. nov. Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Species or species habitat may occur within area
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Fish		
Heraldia nocturna Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Species or species habitat may occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Species or species habitat likely to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Species or species habitat likely to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		

Current Scientific Name	Status	Type of Presence
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour may occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Species or species habitat known to occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat likely to occur within area

Current Scientific Name	Status	Type of Presence
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Extra Information

EPBC Act Referrals			[Resource Information]
Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Not controlled action			
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed

Biologically Important Areas

Scientific Name	Behaviour	Presence
Seabirds		

Scientific Name	Behaviour	Presence
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging	Likely to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Distribution	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution (low density)	Likely to occur
Carcharodon carcharias White Shark [64470]	Known distribution	Known to occur
Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur

Scientific Name	Behaviour	Presence
Eubalaena australis		
Southern Right Whale [40]	Known core range	Known to occur

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Australian Government
Department of Agriculture, Water and the Environment

EPBC Act Protected Matters Report EMBA

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected. Please see the caveat for interpretation of information provided here.

Report created: 14-Apr-2022

Summary

Matters of National Environment Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	3
Wetlands of International Importance (Ramsar	6
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	1
Listed Threatened Ecological Communities:	11
Listed Threatened Species:	122
Listed Migratory Species:	77

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Lands:	45
Commonwealth Heritage Places:	6
Listed Marine Species:	129
Whales and Other Cetaceans:	30
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	4
Habitat Critical to the Survival of Marine Turtles:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have

State and Territory Reserves:	96
Regional Forest Agreements:	3
Nationally Important Wetlands:	14
EPBC Act Referrals:	165
Key Ecological Features (Marine):	2
Biologically Important Areas:	34
Bioregional Assessments:	1
Geological and Bioregional Assessments:	None

Details

Matters of National Environmental Significance

National Heritage Places [Resource Information]

Name	State	Legal Status
Historic		
Great Ocean Road and Scenic Environs	VIC	Listed place
Point Nepean Defence Sites and Quarantine Station Area	VIC	Listed place
Quarantine Station and Surrounds	VIC	Within listed place

Wetlands of International Importance (Ramsar Wetlands) [Resource Information]

Ramsar Site Name	Proximity
Corner inlet	Within Ramsar site
Glenelg estuary and discovery bay wetlands	Within Ramsar site
Lavinia	Within 10km of Ramsar site
Piccaninnie ponds karst wetlands	Within 10km of Ramsar site
Port phillip bay (western shoreline) and bellarine peninsula	Within Ramsar site
Western port	Within Ramsar site

Commonwealth Marine Area [Resource Information]

Approval is required for a proposed activity that is located within the Commonwealth Marine Area which has, will have, or is likely to have a significant impact on the environment. Approval may be required for a proposed action taken outside a Commonwealth Marine Area but which has, may have or is likely to have a significant impact on the environment in the Commonwealth Marine Area.

Feature Name
EEZ and Territorial Sea

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.
Status of Vulnerable, Disallowed and Ineligible are not MNES under the EPBC Act.

Community Name	Threatened Category	Presence Text
Assemblages of species associated with open-coast salt-wedge estuaries of western and central Victoria ecological community	Endangered	Community likely to occur within area

Community Name	Threatened Category	Presence Text
Giant Kelp Marine Forests of South East Australia	Endangered	Community may occur within area
Grassy Eucalypt Woodland of the Victorian Volcanic Plain	Critically Endangered	Community known to occur within area
Karst springs and associated alkaline fens of the Naracoorte Coastal Plain Bioregion	Endangered	Community likely to occur within area
Natural Damp Grassland of the Victorian Coastal Plains	Critically Endangered	Community likely to occur within area
Natural Temperate Grassland of the Victorian Volcanic Plain	Critically Endangered	Community likely to occur within area
Seasonal Herbaceous Wetlands (Freshwater) of the Temperate Lowland Plains	Critically Endangered	Community likely to occur within area
Subtropical and Temperate Coastal Saltmarsh	Vulnerable	Community likely to occur within area
Tasmanian Forests and Woodlands dominated by black gum or Brookers gum (Eucalyptus ovata / E. brookeriana)	Critically Endangered	Community may occur within area
Tasmanian white gum (Eucalyptus viminalis) wet forest	Critically Endangered	Community may occur within area
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland	Critically Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Status of Conservation Dependent and Extinct are not MNES under the EPBC Act.
Number is the current name ID.

Scientific Name	Threatened Category	Presence Text
BIRD		
Acanthiza pusilla magnirostris listed as Acanthiza pusilla archibaldi		
King Island Brown Thornbill, Brown Thornbill (King Island) [91709]	Endangered	Species or species habitat likely to occur within area
Acanthornis magna greeniana		
King Island Scrubtit, Scrubtit (King Island) [82329]	Critically Endangered	Species or species habitat likely to occur within area
Anthochaera phrygia		
Regent Honeyeater [82338]	Critically Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Aquila audax fleayi Tasmanian Wedge-tailed Eagle, Wedge-tailed Eagle (Tasmanian) [64435]	Endangered	Species or species habitat likely to occur within area
Botaurus poiciloptilus Australasian Bittern [1001]	Endangered	Species or species habitat known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Callocephalon fimbriatum Gang-gang Cockatoo [768]	Endangered	Species or species habitat known to occur within area
Calyptorhynchus banksii graptogyne South-eastern Red-tailed Black-Cockatoo [25982]	Endangered	Species or species habitat known to occur within area
Ceyx azureus diemenensis Tasmanian Azure Kingfisher [25977]	Endangered	Species or species habitat may occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Diomedea antipodensis gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Falco hypoleucos Grey Falcon [929]	Vulnerable	Species or species habitat likely to occur within area
Fregetta grallaria grallaria White-bellied Storm-Petrel (Tasman Sea), White-bellied Storm-Petrel (Australasian) [64438]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Limosa lapponica baueri Nunivak Bar-tailed Godwit, Western Alaskan Bar-tailed Godwit [86380]	Vulnerable	Species or species habitat known to occur within area
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Pachyptila turtur subantarctica Fairy Prion (southern) [64445]	Vulnerable	Species or species habitat known to occur within area
Pedionomus torquatus Plains-wanderer [906]	Critically Endangered	Species or species habitat likely to occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Platycercus caledonicus brownii Green Rosella (King Island) [67041]	Vulnerable	Species or species habitat known to occur within area
Pterodroma leucoptera leucoptera Gould's Petrel, Australian Gould's Petrel [26033]	Endangered	Species or species habitat may occur within area
Pterodroma mollis Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Pycnoptilus floccosus Pilotbird [525]	Vulnerable	Species or species habitat known to occur within area
Rostratula australis Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area
Sternula nereis nereis Australian Fairy Tern [82950]	Vulnerable	Species or species habitat known to occur within area
Strepera fuliginosa colei Black Currawong (King Island) [67113]	Vulnerable	Breeding likely to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche bulleri platei Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thinornis cucullatus cucullatus		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area
CRUSTACEAN		
Euastacus bispinosus		
Glenelg Spiny Freshwater Crayfish, Pricklyback [81552]	Endangered	Species or species habitat likely to occur within area
FISH		
Galaxiella pusilla		
Eastern Dwarf Galaxias, Dwarf Galaxias [56790]	Vulnerable	Species or species habitat known to occur within area
Hoplostethus atlanticus		
Orange Roughy, Deep-sea Perch, Red Roughy [68455]	Conservation Dependent	Species or species habitat likely to occur within area
Nannoperca obscura		
Yarra Pygmy Perch [26177]	Vulnerable	Species or species habitat known to occur within area
Nannoperca variegata		
Variegated Pygmy Perch, Ewens Pygmy Perch, Golden Pygmy Perch [26178]	Vulnerable	Species or species habitat likely to occur within area
Prototroctes maraena		
Australian Grayling [26179]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Seriolella brama		
Blue Warehou [69374]	Conservation Dependent	Species or species habitat known to occur within area
Thunnus maccoyii		
Southern Bluefin Tuna [69402]	Conservation Dependent	Species or species habitat likely to occur within area
FROG		
Litoria raniformis		
Growling Grass Frog, Southern Bell Frog, Green and Golden Frog, Warty Swamp Frog, Golden Bell Frog [1828]	Vulnerable	Species or species habitat known to occur within area
INSECT		
Synemon plana		
Golden Sun Moth [25234]	Vulnerable	Species or species habitat may occur within area
MAMMAL		
Antechinus minimus maritimus		
Swamp Antechinus (mainland) [83086]	Vulnerable	Species or species habitat known to occur within area
Balaenoptera borealis		
Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera musculus		
Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus		
Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Dasyurus maculatus maculatus (SE mainland population)		
Spot-tailed Quoll, Spotted-tail Quoll, Tiger Quoll (southeastern mainland population) [75184]	Endangered	Species or species habitat known to occur within area
Eubalaena australis		
Southern Right Whale [40]	Endangered	Breeding known to occur within area

Scientific Name	Threatened Category	Presence Text
Isoodon obesulus obesulus Southern Brown Bandicoot (eastern), Southern Brown Bandicoot (south-eastern) [68050]	Endangered	Species or species habitat known to occur within area
Mastacomys fuscus mordicus Broad-toothed Rat (mainland), Tooarrana [87617]	Vulnerable	Species or species habitat known to occur within area
Miniopterus orianae bassanii Southern Bent-wing Bat [87645]	Critically Endangered	Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Perameles gunnii Victorian subspecies Eastern Barred Bandicoot (Mainland) [88020]	Endangered	Translocated population known to occur within area
Petauroides volans Greater Glider [254]	Vulnerable	Species or species habitat may occur within area
Petaurus australis australis Yellow-bellied Glider (south-eastern) [87600]	Vulnerable	Species or species habitat known to occur within area
Potorous tridactylus trisulcatus Long-nosed Potoroo (southern mainland) [86367]	Vulnerable	Species or species habitat known to occur within area
Pseudomys fumeus Smoky Mouse, Konoom [88]	Endangered	Species or species habitat may occur within area
Pseudomys novaehollandiae New Holland Mouse, Pookila [96]	Vulnerable	Species or species habitat known to occur within area
Pseudomys shortridgei Heath Mouse, Dayang, Heath Rat [77]	Endangered	Species or species habitat known to occur within area
Pteropus poliocephalus Grey-headed Flying-fox [186]	Vulnerable	Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
PLANT		
Amphibromus fluitans River Swamp Wallaby-grass, Floating Swamp Wallaby-grass [19215]	Vulnerable	Species or species habitat known to occur within area
Astelia australiana Tall Astelia [10851]	Vulnerable	Species or species habitat may occur within area
Caladenia calcicola Limestone Spider-orchid [10065]	Vulnerable	Species or species habitat likely to occur within area
Caladenia colorata Coloured Spider-orchid, Small Western Spider-orchid, Painted Spider-orchid [54999]	Endangered	Species or species habitat known to occur within area
Caladenia hastata Melblom's Spider-orchid [16118]	Endangered	Species or species habitat likely to occur within area
Caladenia orientalis Eastern Spider Orchid [83410]	Endangered	Species or species habitat known to occur within area
Caladenia ornata Ornate Pink Fingers [76213]	Vulnerable	Species or species habitat likely to occur within area
Caladenia tensa Greencomb Spider-orchid, Rigid Spider-orchid [24390]	Endangered	Species or species habitat may occur within area
Caladenia tessellata Thick-lipped Spider-orchid, Daddy Long-legs [2119]	Vulnerable	Species or species habitat known to occur within area
Dianella amoena Matted Flax-lily [64886]	Endangered	Species or species habitat may occur within area
Dodonaea procumbens Trailing Hop-bush [12149]	Vulnerable	Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Eucalyptus strzeleckii Strzelecki Gum [55400]	Vulnerable	Species or species habitat known to occur within area
Euphrasia collina subsp. muelleri Purple Eyebright, Mueller's Eyebright [16151]	Endangered	Species or species habitat known to occur within area
Glycine latrobeana Clover Glycine, Purple Clover [13910]	Vulnerable	Species or species habitat known to occur within area
Grevillea infecunda Anglesea Grevillea [22026]	Vulnerable	Species or species habitat known to occur within area
Haloragis exalata subsp. exalata Wingless Raspwort, Square Raspwort [24636]	Vulnerable	Species or species habitat known to occur within area
Hypolepis distans Scrambling Ground-fern [2148]	Endangered	Species or species habitat likely to occur within area
Ixodia achillaeoides subsp. arenicola Sand Ixodia, Ixodia [21474]	Vulnerable	Species or species habitat known to occur within area
Lachnagrostis adamsonii Adamson's Blown-grass, Adamson's Blowngrass [76211]	Endangered	Species or species habitat may occur within area
Leiocarpa gatesii Wrinkled Buttons [76212]	Vulnerable	Species or species habitat likely to occur within area
Lepidium aschersonii Spiny Pepper-cress [10976]	Vulnerable	Species or species habitat known to occur within area
Lepidium hyssopifolium Basalt Pepper-cress, Peppercress, Rubble Pepper-cress, Pepperweed [16542]	Endangered	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Leucochrysum albicans subsp. tricolor Hoary Sunray, Grassland Paper-daisy [89104]	Endangered	Species or species habitat may occur within area
Pimelea spinescens subsp. spinescens Plains Rice-flower, Spiny Rice-flower, Prickly Pimelea [21980]	Critically Endangered	Species or species habitat likely to occur within area
Prasophyllum diversiflorum Gorae Leek-orchid [13210]	Endangered	Species or species habitat likely to occur within area
Prasophyllum frenchii Maroon Leek-orchid, Slaty Leek-orchid, Stout Leek-orchid, French's Leek-orchid, Swamp Leek-orchid [9704]	Endangered	Species or species habitat known to occur within area
Prasophyllum spicatum Dense Leek-orchid [55146]	Vulnerable	Species or species habitat known to occur within area
Pterostylis chlorogramma Green-striped Greenhood [56510]	Vulnerable	Species or species habitat known to occur within area
Pterostylis cucullata Leafy Greenhood [15459]	Vulnerable	Species or species habitat known to occur within area
Pterostylis tenuissima Swamp Greenhood, Dainty Swamp Orchid [13139]	Vulnerable	Species or species habitat known to occur within area
Pterostylis ziegeleri Grassland Greenhood, Cape Portland Greenhood [64971]	Vulnerable	Species or species habitat may occur within area
Senecio macrocarpus Large-fruit Fireweed, Large-fruit Groundsel [16333]	Vulnerable	Species or species habitat likely to occur within area
Senecio psilocarpus Swamp Fireweed, Smooth-fruited Groundsel [64976]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Taraxacum cygnorum Coast Dandelion, Native Dandelion [2508]	Vulnerable	Species or species habitat likely to occur within area
Thelymitra epipactoides Metallic Sun-orchid [11896]	Endangered	Species or species habitat known to occur within area
Thelymitra matthewsii Spiral Sun-orchid [4168]	Vulnerable	Species or species habitat known to occur within area
Xerochrysum palustre Swamp Everlasting, Swamp Paper Daisy [76215]	Vulnerable	Species or species habitat likely to occur within area
REPTILE		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Delma impar Striped Legless Lizard, Striped Snake-lizard [1649]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
SHARK		
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Centrophorus zeehaani Southern Dogfish, Endeavour Dogfish, Little Gulper Shark [82679]	Conservation Dependent	Species or species habitat likely to occur within area
Galeorhinus galeus School Shark, Eastern School Shark, Snapper Shark, Tope, Soupfin Shark [68453]	Conservation Dependent	Species or species habitat likely to occur within area

Scientific Name	Threatened Category	Presence Text
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Migratory Marine Birds		
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardenna carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat known to occur within area
Ardenna grisea Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Sternula albifrons Little Tern [82849]		Breeding known to occur within area
Thalassarche bulleri Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche salvini Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Migratory Marine Species		
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Carcharodon carcharias White Shark, Great White Shark [64470]	Vulnerable	Breeding known to occur within area
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area
Eubalaena australis as Balaena glacialis australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Isurus oxyrinchus Shortfin Mako, Mako Shark [79073]		Species or species habitat likely to occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lamna nasus Porbeagle, Mackerel Shark [83288]		Species or species habitat likely to occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Rhincodon typus Whale Shark [66680]	Vulnerable	Species or species habitat may occur within area
Migratory Terrestrial Species		
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area
Rhipidura rufifrons Rufous Fantail [592]		Species or species habitat known to occur within area
Migratory Wetlands Species		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area
Calidris acuminata Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba Sanderling [875]		Roosting known to occur within area
Calidris canutus Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area
Calidris melanotos Pectoral Sandpiper [858]		Species or species habitat known to occur within area
Calidris ruficollis Red-necked Stint [860]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Calidris tenuirostris Great Knot [862]	Critically Endangered	Roosting known to occur within area
Charadrius bicinctus Double-banded Plover [895]		Roosting known to occur within area
Charadrius leschenaultii Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area
Pluvialis squatarola Grey Plover [865]		Roosting known to occur within area
Thalasseus bergii Greater Crested Tern [83000]		Breeding known to occur within area
Tringa brevipes Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola Wood Sandpiper [829]		Roosting known to occur within area
Tringa incana Wandering Tattler [831]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area
Tringa stagnatilis Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area
Xenus cinereus Terek Sandpiper [59300]		Roosting known to occur within area

Other Matters Protected by the EPBC Act

Commonwealth Lands [Resource Information]

The Commonwealth area listed below may indicate the presence of Commonwealth land in this vicinity. Due to the unreliability of the data source, all proposals should be checked as to whether it impacts on a Commonwealth area, before making a definitive decision. Contact the State or Territory government land department for further information.

Commonwealth Land Name	State
Defence	
Defence - CROWS NEST CAMP - QUEENSCLIFF [21028]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21029]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21026]	VIC
Defence - CROWS NEST CAMP - QUEENSCLIFF [21027]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21031]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21034]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21032]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21030]	VIC
Defence - STAFF COLLEGE-FORT QUEENSCLIFF [21033]	VIC
Defence - SWAN ISLAND TRAINING AREA [21448]	VIC
Defence - SWAN ISLAND TRAINING AREA [21446]	VIC
Defence - SWAN ISLAND TRAINING AREA [21447]	VIC
Defence - TRAINING CENTRE (Norris Barracks) - Portsea [21025]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21021]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21020]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21013]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21010]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21011]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21016]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21014]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21018]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21019]	VIC

Commonwealth Land Name	State
Defence - Training Depot, Darts RD 3305 Portland [21024]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21017]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21015]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21012]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21007]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21009]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21022]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21023]	VIC
Defence - Training Depot, Darts RD 3305 Portland [21008]	VIC
Defence - WARRNAMBOOL TRAINING DEPOT [21111]	VIC
Defence - WEST HEAD GUNNERY RANGE [21112]	VIC
Unknown	
Commonwealth Land - [21488]	VIC
Commonwealth Land - [21509]	VIC
Commonwealth Land - [21489]	VIC
Commonwealth Land - [21487]	VIC
Commonwealth Land - [60114]	TAS
Commonwealth Land - [21570]	VIC
Commonwealth Land - [21491]	VIC
Commonwealth Land - [21492]	VIC
Commonwealth Land - [21490]	VIC
Commonwealth Land - [22391]	VIC
Commonwealth Land - [21582]	VIC
Commonwealth Land - [21583]	VIC

Commonwealth Heritage Places [Resource Information]

Name	State	Status
Historic		
Cape Wickham Lighthouse	TAS	Listed place

Name	State	Status
Fort Queenscliff	VIC	Listed place
Sorrento Post Office	VIC	Listed place
Swan Island Defence Precinct	VIC	Listed place
Wilsons Promontory Lighthouse	VIC	Listed place
Natural		
Swan Island and Naval Waters	VIC	Listed place

Listed Marine Species

[Resource Information]

Scientific Name	Threatened Category	Presence Text
Bird		
Actitis hypoleucos Common Sandpiper [59309]		Species or species habitat known to occur within area
Anous stolidus Common Noddy [825]		Species or species habitat likely to occur within area
Anseranas semipalmata Magpie Goose [978]		Species or species habitat may occur within area overfly marine area
Apus pacificus Fork-tailed Swift [678]		Species or species habitat likely to occur within area overfly marine area
Ardenna carneipes as Puffinus carneipes Flesh-footed Shearwater, Fleshy-footed Shearwater [82404]		Species or species habitat known to occur within area
Ardenna grisea as Puffinus griseus Sooty Shearwater [82651]		Species or species habitat may occur within area
Ardenna tenuirostris as Puffinus tenuirostris Short-tailed Shearwater [82652]		Breeding known to occur within area
Arenaria interpres Ruddy Turnstone [872]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Bubulcus ibis as Ardea ibis		
Cattle Egret [66521]		Species or species habitat may occur within area overfly marine area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Roosting known to occur within area
Calidris alba		
Sanderling [875]		Roosting known to occur within area
Calidris canutus		
Red Knot, Knot [855]	Endangered	Species or species habitat known to occur within area overfly marine area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat known to occur within area overfly marine area
Calidris ruficollis		
Red-necked Stint [860]		Roosting known to occur within area overfly marine area
Calidris tenuirostris		
Great Knot [862]	Critically Endangered	Roosting known to occur within area overfly marine area
Chalcites osculans as Chrysococcyx osculans		
Black-eared Cuckoo [83425]		Species or species habitat known to occur within area overfly marine area
Charadrius bicinctus		
Double-banded Plover [895]		Roosting known to occur within area overfly marine area
Charadrius leschenaultii		
Greater Sand Plover, Large Sand Plover [877]	Vulnerable	Species or species habitat known to occur within area

Scientific Name	Threatened Category	Presence Text
Charadrius mongolus Lesser Sand Plover, Mongolian Plover [879]	Endangered	Roosting known to occur within area
Charadrius ruficapillus Red-capped Plover [881]		Roosting known to occur within area overfly marine area
Chroicocephalus novaehollandiae as Larus novaehollandiae Silver Gull [82326]		Breeding known to occur within area
Diomedea antipodensis Antipodean Albatross [64458]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea antipodensis gibsoni as Diomedea gibsoni Gibson's Albatross [82270]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea epomophora Southern Royal Albatross [89221]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea exulans Wandering Albatross [89223]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Diomedea sanfordi Northern Royal Albatross [64456]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Eudyptula minor Little Penguin [1085]		Breeding known to occur within area
Gallinago hardwickii Latham's Snipe, Japanese Snipe [863]		Species or species habitat known to occur within area overfly marine area
Gallinago megala Swinhoe's Snipe [864]		Roosting likely to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Gallinago stenura Pin-tailed Snipe [841]		Roosting known to occur within area overfly marine area
Haliaeetus leucogaster White-bellied Sea-Eagle [943]		Breeding known to occur within area
Halobaena caerulea Blue Petrel [1059]	Vulnerable	Species or species habitat may occur within area
Himantopus himantopus Pied Stilt, Black-winged Stilt [870]		Roosting known to occur within area overfly marine area
Hirundapus caudacutus White-throated Needletail [682]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Larus dominicanus Kelp Gull [809]		Breeding known to occur within area
Larus pacificus Pacific Gull [811]		Breeding known to occur within area
Lathamus discolor Swift Parrot [744]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Limicola falcinellus Broad-billed Sandpiper [842]		Roosting known to occur within area overfly marine area
Limosa lapponica Bar-tailed Godwit [844]		Species or species habitat known to occur within area
Limosa limosa Black-tailed Godwit [845]		Roosting known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Macronectes giganteus Southern Giant-Petrel, Southern Giant Petrel [1060]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Macronectes halli Northern Giant Petrel [1061]	Vulnerable	Species or species habitat may occur within area
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area overfly marine area
Monarcha melanopsis Black-faced Monarch [609]		Species or species habitat known to occur within area overfly marine area
Morus capensis Cape Gannet [59569]		Breeding known to occur within area
Morus serrator Australasian Gannet [1020]		Breeding known to occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat likely to occur within area overfly marine area
Myiagra cyanoleuca Satin Flycatcher [612]		Breeding known to occur within area overfly marine area
Neophema chrysogaster Orange-bellied Parrot [747]	Critically Endangered	Species or species habitat known to occur within area overfly marine area
Neophema chrysostoma Blue-winged Parrot [726]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Numenius madagascariensis Eastern Curlew, Far Eastern Curlew [847]	Critically Endangered	Species or species habitat known to occur within area
Numenius minutus Little Curlew, Little Whimbrel [848]		Roosting likely to occur within area overfly marine area
Numenius phaeopus Whimbrel [849]		Roosting known to occur within area
Onychoprion fuscatus as Sterna fuscata Sooty Tern [90682]		Breeding known to occur within area
Pachyptila turtur Fairy Prion [1066]		Species or species habitat known to occur within area
Pandion haliaetus Osprey [952]		Species or species habitat known to occur within area
Pelecanoides urinatrix Common Diving-Petrel [1018]		Breeding known to occur within area
Phalacrocorax fuscescens Black-faced Cormorant [59660]		Breeding known to occur within area
Phalaropus lobatus Red-necked Phalarope [838]		Roosting known to occur within area
Philomachus pugnax Ruff (Reeve) [850]		Roosting known to occur within area overfly marine area
Phoebetria fusca Sooty Albatross [1075]	Vulnerable	Species or species habitat likely to occur within area
Pluvialis fulva Pacific Golden Plover [25545]		Roosting known to occur within area

Scientific Name	Threatened Category	Presence Text
Pluvialis squatarola		
Grey Plover [865]		Roosting known to occur within area overfly marine area
Pterodroma macroptera		
Great-winged Petrel [1035]		Foraging, feeding or related behaviour known to occur within area
Pterodroma mollis		
Soft-plumaged Petrel [1036]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Recurvirostra novaehollandiae		
Red-necked Avocet [871]		Roosting known to occur within area overfly marine area
Rhipidura rufifrons		
Rufous Fantail [592]		Species or species habitat known to occur within area overfly marine area
Rostratula australis as Rostratula benghalensis (sensu lato)		
Australian Painted Snipe [77037]	Endangered	Species or species habitat known to occur within area overfly marine area
Stercorarius skua as Catharacta skua		
Great Skua [823]		Species or species habitat may occur within area
Sternula albifrons as Sterna albifrons		
Little Tern [82849]		Breeding known to occur within area
Sternula nereis as Sterna nereis		
Fairy Tern [82949]		Breeding known to occur within area
Thalassarche bulleri		
Buller's Albatross, Pacific Albatross [64460]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area

Scientific Name	Threatened Category	Presence Text
Thalassarche bulleri platei as Thalassarche sp. nov.		
Northern Buller's Albatross, Pacific Albatross [82273]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche carteri		
Indian Yellow-nosed Albatross [64464]	Vulnerable	Species or species habitat likely to occur within area
Thalassarche cauta		
Shy Albatross [89224]	Endangered	Foraging, feeding or related behaviour likely to occur within area
Thalassarche chrysostoma		
Grey-headed Albatross [66491]	Endangered	Species or species habitat may occur within area
Thalassarche impavida		
Campbell Albatross, Campbell Black-browed Albatross [64459]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche melanophris		
Black-browed Albatross [66472]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche salvini		
Salvin's Albatross [64463]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalassarche steadi		
White-capped Albatross [64462]	Vulnerable	Foraging, feeding or related behaviour likely to occur within area
Thalasseus bergii as Sterna bergii		
Greater Crested Tern [83000]		Breeding known to occur within area
Thinornis cucullatus as Thinornis rubricollis		
Hooded Dotterel, Hooded Plover [87735]		Species or species habitat known to occur within area overfly marine area

Scientific Name	Threatened Category	Presence Text
Thinornis cucullatus cucullatus as Thinornis rubricollis rubricollis		
Eastern Hooded Plover, Eastern Hooded Plover [90381]	Vulnerable	Species or species habitat known to occur within area overfly marine area
Tringa brevipes as Heteroscelus brevipes		
Grey-tailed Tattler [851]		Roosting known to occur within area
Tringa glareola		
Wood Sandpiper [829]		Roosting known to occur within area overfly marine area
Tringa incana as Heteroscelus incanus		
Wandering Tattler [831]		Foraging, feeding or related behaviour known to occur within area
Tringa nebularia		
Common Greenshank, Greenshank [832]		Species or species habitat known to occur within area overfly marine area
Tringa stagnatilis		
Marsh Sandpiper, Little Greenshank [833]		Roosting known to occur within area overfly marine area
Xenus cinereus		
Terek Sandpiper [59300]		Roosting known to occur within area overfly marine area
Fish		
Acentronura australe		
Southern Pygmy Pipehorse [66185]		Species or species habitat may occur within area
Campichthys tryoni		
Tryon's Pipefish [66193]		Species or species habitat may occur within area
Heraldia nocturna		
Upside-down Pipefish, Eastern Upside-down Pipefish, Eastern Upside-down Pipefish [66227]		Species or species habitat may occur within area
Hippocampus abdominalis		
Big-belly Seahorse, Eastern Potbelly Seahorse, New Zealand Potbelly Seahorse [66233]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Hippocampus breviceps Short-head Seahorse, Short-snouted Seahorse [66235]		Species or species habitat may occur within area
Hippocampus minotaur Bullneck Seahorse [66705]		Species or species habitat may occur within area
Histiogamphelus briggsii Crested Pipefish, Briggs' Crested Pipefish, Briggs' Pipefish [66242]		Species or species habitat may occur within area
Histiogamphelus cristatus Rhino Pipefish, Macleay's Crested Pipefish, Ring-back Pipefish [66243]		Species or species habitat may occur within area
Hypselognathus rostratus Knifesnout Pipefish, Knife-snouted Pipefish [66245]		Species or species habitat may occur within area
Kaupus costatus Deepbody Pipefish, Deep-bodied Pipefish [66246]		Species or species habitat may occur within area
Kimblaeus bassensis Trawl Pipefish, Bass Strait Pipefish [66247]		Species or species habitat may occur within area
Leptoichthys fistularius Brushtail Pipefish [66248]		Species or species habitat may occur within area
Lissocampus caudalis Australian Smooth Pipefish, Smooth Pipefish [66249]		Species or species habitat may occur within area
Lissocampus runa Javelin Pipefish [66251]		Species or species habitat may occur within area
Maroubra perserrata Sawtooth Pipefish [66252]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Mitotichthys mollisoni Mollison's Pipefish [66260]		Species or species habitat may occur within area
Mitotichthys semistriatus Halfbanded Pipefish [66261]		Species or species habitat may occur within area
Mitotichthys tuckeri Tucker's Pipefish [66262]		Species or species habitat may occur within area
Notiocampus ruber Red Pipefish [66265]		Species or species habitat may occur within area
Phycodurus eques Leafy Seadragon [66267]		Species or species habitat may occur within area
Phyllopteryx taeniolatus Common Seadragon, Weedy Seadragon [66268]		Species or species habitat may occur within area
Pugnaso curtirostris Pugnose Pipefish, Pug-nosed Pipefish [66269]		Species or species habitat may occur within area
Solegnathus robustus Robust Pipehorse, Robust Spiny Pipehorse [66274]		Species or species habitat may occur within area
Solegnathus spinosissimus Spiny Pipehorse, Australian Spiny Pipehorse [66275]		Species or species habitat may occur within area
Stigmatopora argus Spotted Pipefish, Gulf Pipefish, Peacock Pipefish [66276]		Species or species habitat may occur within area
Stigmatopora nigra Widebody Pipefish, Wide-bodied Pipefish, Black Pipefish [66277]		Species or species habitat may occur within area

Scientific Name	Threatened Category	Presence Text
Stipecampus cristatus Ringback Pipefish, Ring-backed Pipefish [66278]		Species or species habitat may occur within area
Syngnathoides biaculeatus Double-end Pipehorse, Double-ended Pipehorse, Alligator Pipefish [66279]		Species or species habitat may occur within area
Urocampus carinirostris Hairy Pipefish [66282]		Species or species habitat may occur within area
Vanacampus margaritifer Mother-of-pearl Pipefish [66283]		Species or species habitat may occur within area
Vanacampus phillipi Port Phillip Pipefish [66284]		Species or species habitat may occur within area
Vanacampus poecilolaemus Longsnout Pipefish, Australian Long-snout Pipefish, Long-snouted Pipefish [66285]		Species or species habitat may occur within area
Vanacampus vercoi Verco's Pipefish [66286]		Species or species habitat may occur within area
Mammal		
Arctocephalus forsteri Long-nosed Fur-seal, New Zealand Fur-seal [20]		Species or species habitat may occur within area
Arctocephalus pusillus Australian Fur-seal, Australo-African Fur-seal [21]		Breeding known to occur within area
Neophoca cinerea Australian Sea-lion, Australian Sea Lion [22]	Endangered	Species or species habitat known to occur within area
Reptile		
Caretta caretta Loggerhead Turtle [1763]	Endangered	Foraging, feeding or related behaviour known to occur within area

Scientific Name	Threatened Category	Presence Text
Chelonia mydas Green Turtle [1765]	Vulnerable	Species or species habitat may occur within area
Dermochelys coriacea Leatherback Turtle, Leathery Turtle, Luth [1768]	Endangered	Foraging, feeding or related behaviour known to occur within area

Whales and Other Cetaceans [Resource Information]

Current Scientific Name	Status	Type of Presence
Mammal		
Balaenoptera acutorostrata Minke Whale [33]		Species or species habitat may occur within area
Balaenoptera bonaerensis Antarctic Minke Whale, Dark-shoulder Minke Whale [67812]		Species or species habitat likely to occur within area
Balaenoptera borealis Sei Whale [34]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Balaenoptera edeni Bryde's Whale [35]		Species or species habitat may occur within area
Balaenoptera musculus Blue Whale [36]	Endangered	Foraging, feeding or related behaviour known to occur within area
Balaenoptera physalus Fin Whale [37]	Vulnerable	Foraging, feeding or related behaviour known to occur within area
Berardius arnuxii Arnoux's Beaked Whale [70]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Caperea marginata Pygmy Right Whale [39]		Foraging, feeding or related behaviour likely to occur within area
Delphinus delphis Common Dolphin, Short-beaked Common Dolphin [60]		Species or species habitat may occur within area
Eubalaena australis Southern Right Whale [40]	Endangered	Breeding known to occur within area
Globicephala macrorhynchus Short-finned Pilot Whale [62]		Species or species habitat may occur within area
Globicephala melas Long-finned Pilot Whale [59282]		Species or species habitat may occur within area
Grampus griseus Risso's Dolphin, Grampus [64]		Species or species habitat may occur within area
Kogia breviceps Pygmy Sperm Whale [57]		Species or species habitat may occur within area
Kogia sima as Kogia simus Dwarf Sperm Whale [85043]		Species or species habitat may occur within area
Lagenorhynchus obscurus Dusky Dolphin [43]		Species or species habitat likely to occur within area
Lissodelphis peronii Southern Right Whale Dolphin [44]		Species or species habitat may occur within area
Megaptera novaeangliae Humpback Whale [38]		Species or species habitat known to occur within area

Current Scientific Name	Status	Type of Presence
Mesoplodon bowdoini Andrew's Beaked Whale [73]		Species or species habitat may occur within area
Mesoplodon densirostris Blainville's Beaked Whale, Dense-beaked Whale [74]		Species or species habitat may occur within area
Mesoplodon grayi Gray's Beaked Whale, Scamperdown Whale [75]		Species or species habitat may occur within area
Mesoplodon hectori Hector's Beaked Whale [76]		Species or species habitat may occur within area
Mesoplodon layardii Strap-toothed Beaked Whale, Strap-toothed Whale, Layard's Beaked Whale [25556]		Species or species habitat may occur within area
Mesoplodon mirus True's Beaked Whale [54]		Species or species habitat may occur within area
Orcinus orca Killer Whale, Orca [46]		Species or species habitat likely to occur within area
Physeter macrocephalus Sperm Whale [59]		Species or species habitat may occur within area
Pseudorca crassidens False Killer Whale [48]		Species or species habitat likely to occur within area
Tursiops aduncus Indian Ocean Bottlenose Dolphin, Spotted Bottlenose Dolphin [68418]		Species or species habitat likely to occur within area
Tursiops truncatus s. str. Bottlenose Dolphin [68417]		Species or species habitat may occur within area

Current Scientific Name	Status	Type of Presence
Ziphius cavirostris Cuvier's Beaked Whale, Goose-beaked Whale [56]		Species or species habitat may occur within area

Australian Marine Parks	[Resource Information]
Park Name	Zone & IUCN Categories
Apollo	Multiple Use Zone (IUCN VI)
Beagle	Multiple Use Zone (IUCN VI)
Zeehan	Multiple Use Zone (IUCN VI)
Zeehan	Special Purpose Zone (IUCN VI)

Extra Information

State and Territory Reserves [Resource Information]

Protected Area Name	Reserve Type	State
Aire River	Heritage River	VIC
Aire River W.R.	Natural Features Reserve	VIC
Aireys Inlet B.R.	Natural Features Reserve	VIC
Anglesea B.R.	Natural Features Reserve	VIC
Anser Island	Reference Area	VIC
Aquila Creek	Reference Area	VIC
Barham Paradise S.R.	Natural Features Reserve	VIC
Barwon Bluff	Marine Sanctuary	VIC
Bats Ridge W.R	Nature Conservation Reserve	VIC
Bay of Islands Coastal Park	Conservation Park	VIC
Bolwarra H43 B.R.	Natural Features Reserve	VIC
Bolwarra H44 B.R.	Natural Features Reserve	VIC
Bolwarra H45 B.R.	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State
Breamlea F.F.R.	Nature Conservation Reserve	VIC
Bunurong	Marine National Park	VIC
Bunurong Marine Park	National Parks Act Schedule 4 park or reserve	VIC
Calder River	Reference Area	VIC
Cape Liptrap Coastal Park	Conservation Park	VIC
Cape Nelson	State Park	VIC
Cape Patterson N.C.R	Natural Features Reserve	VIC
Cape Wickham	Conservation Area	TAS
Cape Wickham	State Reserve	TAS
Churchill Island	Marine National Park	VIC
Corner Inlet	Marine National Park	VIC
Corner Inlet Marine and Coastal Park	National Parks Act Schedule 4 park or reserve	VIC
Deen Maar	Indigenous Protected Area	VIC
Discovery Bay	Marine National Park	VIC
Discovery Bay Coastal Park	Conservation Park	VIC
Eagle Rock	Marine Sanctuary	VIC
East Moncoeur Island	Conservation Area	TAS
Edna Bowman N.C.R.	Natural Features Reserve	VIC
Entrance Point	Reference Area	VIC
Fingal B.R	Natural Features Reserve	VIC
Flinders G234 B.R.	Natural Features Reserve	VIC
Goose Lagoon W.R	Natural Features Reserve	VIC

Protected Area Name	Reserve Type	State
Great Otway	National Park	VIC
Hedditch Hill S.R.	Natural Features Reserve	VIC
Hogan Group	Conservation Area	TAS
Johanna Falls S.R.	Natural Features Reserve	VIC
Kilcunda N.C.R.	Natural Features Reserve	VIC
Lady Julia Percy Island W.R.	Nature Conservation Reserve	VIC
Lake Connewarre W.R	Natural Features Reserve	VIC
Lake Gillear W.R	Natural Features Reserve	VIC
Latrobe B.R.	Natural Features Reserve	VIC
Lawrence Rocks W.R.	Nature Conservation Reserve	VIC
Lily Pond B.R.	Natural Features Reserve	VIC
Lower Glenelg	National Park	VIC
Lower South East	Marine Park	SA
Marengo N.C.R.	Nature Conservation Reserve	VIC
Marengo Reefs	Marine Sanctuary	VIC
Merri	Marine Sanctuary	VIC
Mornington Peninsula	National Park	VIC
Mount Richmond	National Park	VIC
Mount Vereker Creek	Natural Catchment Area	VIC
Mushroom Reef	Marine Sanctuary	VIC
Narrawong F.R.	Nature Conservation Reserve	VIC
Nooramunga Marine & Coastal Park	National Parks Act Schedule 4 park or reserve	VIC

Protected Area Name	Reserve Type	State
North East Islet	Nature Reserve	TAS
Painkalac Creek	Reference Area	VIC
Parker River	Reference Area	VIC
Phillip Island Nature Park	Other	VIC
Point Addis	Marine National Park	VIC
Point Danger	Marine Sanctuary	VIC
Point Nepean	National Park	VIC
Port Campbell	National Park	VIC
Portland H46 B.R.	Natural Features Reserve	VIC
Portland H47 B.R.	Natural Features Reserve	VIC
Port Phillip Heads	Marine National Park	VIC
Princetown W.R	Natural Features Reserve	VIC
Rodondo Island	Nature Reserve	TAS
Seal Islands W.R.	Nature Conservation Reserve	VIC
Shallow Inlet Marine and Coastal Park	National Parks Act Schedule 4 park or reserve	VIC
Southern Wilsons Promontory	Remote and Natural Area - Schedule 6, National Parks Act	VIC
Stony Creek (Otways)	Reference Area	VIC
The Arches	Marine Sanctuary	VIC
Tower Hill W.R	Natural Features Reserve	VIC
Trewalla H48 B.R.	Natural Features Reserve	VIC
Trewalla H49 B.R.	Natural Features Reserve	VIC
Twelve Apostles	Marine National Park	VIC

Protected Area Name	Reserve Type	State
Tyrendarra F.R	Nature Conservation Reserve	VIC
Unnamed P0176	Private Nature Reserve	VIC
Ventnor B.R.	Natural Features Reserve	VIC
Vereker Creek	Reference Area	VIC
West Moncoeur Island	Nature Reserve	TAS
Wild Dog B.R.	Natural Features Reserve	VIC
Wild Dog Creek SS.R.	Natural Features Reserve	VIC
Wilsons Promontory	Wilderness Zone	VIC
Wilsons Promontory	National Park	VIC
Wilsons Promontory	Marine National Park	VIC
Wilsons Promontory Islands	Remote and Natural Area - Schedule 6, National Parks Act	VIC
Wilsons Promontory Marine Park	National Parks Act Schedule 4 park or reserve	VIC
Wilsons Promontory Marine Reserve	National Parks Act Schedule 4 park or reserve	VIC
Wongarra B.R.	Natural Features Reserve	VIC
Wonthaggi Heathlands N.C.R	Natural Features Reserve	VIC
Yambuk F.F.R.	Nature Conservation Reserve	VIC
Yambuk Wetlands N.C.R.	Natural Features Reserve	VIC

Regional Forest Agreements [Resource Information]

Note that all areas with completed RFAs have been included.

RFA Name	State
Gippsland RFA	Victoria
Tasmania RFA	Tasmania

RFA Name	State
West Victoria RFA	Victoria

Nationally Important Wetlands [Resource Information]

Wetland Name	State
Aire River	VIC
Anderson Inlet	VIC
Corner Inlet	VIC
Lake Connewarre State Wildlife Reserve	VIC
Long Swamp	VIC
Lower Aire River Wetlands	VIC
Lower Merri River Wetlands	VIC
Powlett River Mouth	VIC
Princetown Wetlands	VIC
Shallow Inlet Marine & Coastal Park	VIC
Swan Bay & Swan Island	VIC
Tower Hill	VIC
Western Port	VIC
Yambuk Wetlands	VIC

EPBC Act Referrals [Resource Information]

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Alston-1 petroleum exploration well, permit VIC/P44	2003/1315	Controlled Action	Post-Approval
Bald Hills Wind Farm 80 Turbines	2002/730	Controlled Action	Post-Approval
Casino Gas Field Development	2003/1295	Controlled Action	Post-Approval
City Of Greater Geelong Mosquito Control Program 2021-2030, Vic	2020/8782	Controlled Action	Further Information Request
Establishment of plantation for use of effluent water	2003/1063	Controlled Action	Completed
Gippsland Regional Port Project	2020/8667	Controlled Action	Assessment Approach

Title of referral	Reference	Referral Outcome	Assessment Status
Controlled action			
Kentbruck Green Power Hub, Vic	2019/8510	Controlled Action	Assessment Approach
Lonsdale Golf Club Redevelopment	2003/969	Controlled Action	Post-Approval
Lorne Golf Course redevelopment	2004/1513	Controlled Action	Post-Approval
Marinus Link underground and subsea electricity interconnector cable	2021/9053	Controlled Action	Assessment Approach
Mosquito Control	2005/2132	Controlled Action	Post-Approval
Otway Development	2002/621	Controlled Action	Post-Approval
Pacific Hydro (Portland) Wind Farm SW Victoria	2000/18	Controlled Action	Post-Approval
Port Phillip Bay Channel Deepening	2002/576	Controlled Action	Post-Approval
Redevelopment of post office and construction of dwellings	2007/3639	Controlled Action	Completed
Residential Subdivision & Infrastructure Parish of Belfast	2005/1954	Controlled Action	Completed
Schomberg 3D Marine Seismic Survey	2007/3754	Controlled Action	Completed
Star of the South Offshore Wind Farm Project	2020/8650	Controlled Action	Guidelines Issued
Strike Oil Gas Exploration Well, Otway Basin (VIC/P44)	2000/97	Controlled Action	Completed
Twelve Apostles Saddle Lookout	2019/8571	Controlled Action	Post-Approval
VIC Offshore Windfarm	2021/8966	Controlled Action	Assessment Approach
VICP61 2D Marine Seismic Survey	2008/4075	Controlled Action	Completed
Victorian Desalination Project, Bass Coast	2008/3948	Controlled Action	Post-Approval
Not controlled action			
accomodation units and associatedadministration and recreational facilities	2001/430	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Airey Inlet water reclamation plant to Anglesea sewerage system	2006/2539	Not Controlled Action	Completed
Alteration of Grass Maintenance Regime within Powling St Wetlands	2012/6527	Not Controlled Action	Completed
Amrit-1 exploration well	2004/1572	Not Controlled Action	Completed
Anglesea Mine South Wall Vegetation removal, Anglesea, Vic	2017/8060	Not Controlled Action	Completed
Apollo Bay Water Storage Basin, VIC	2012/6484	Not Controlled Action	Completed
Bluff Heights Estate Stages 2 to 4	2003/1047	Not Controlled Action	Completed
CO2 geosequestration - Otway Basin Pilot Project	2006/2699	Not Controlled Action	Completed
Communications tower extension	2003/1099	Not Controlled Action	Completed
Construct a Recycled Water Pipeline from Somers Treatment Plant to Blue Scope S	2009/4982	Not Controlled Action	Completed
Construction and operation of Barwon Water biosolids treatment facility	2008/4345	Not Controlled Action	Completed
Construction of Barwon Heads Bridge	2005/2375	Not Controlled Action	Completed
Construction of Infrastructure to Extract, Treat & Transfer Groundwater to Wurde	2008/4104	Not Controlled Action	Completed
Construction of Overtaking Lanes on Great Ocean Rd	2008/4044	Not Controlled Action	Completed
construction of pump station for pump diversion from the Barham River	2003/1242	Not Controlled Action	Completed
Construction of the Edgars Road Extension, from Childs Road, Lalor to Cooper Street, Epping	2003/1135	Not Controlled Action	Completed
Development of Pt Nepean Quarantine Station (former) National Centre for Coasts and Climate	2008/4653	Not Controlled Action	Completed
Divestment of Norris Barracks	2003/963	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Drilling of Callister-1 exploration well in VIC/P51	2004/1633	Not Controlled Action	Completed
Enterprise 1 Exploration Drilling Program, near Port Campbell, Vic	2019/8438	Not Controlled Action	Completed
Establishment of a 6 turbine windfarm near Wonthaggi	2002/820	Not Controlled Action	Completed
Exploration drilling for liquid/gaseous hydrocarbons	2004/1681	Not Controlled Action	Completed
Ferry Service Infrastructure Development	2001/269	Not Controlled Action	Completed
Flinders Backlog Sewer Project	2005/2275	Not Controlled Action	Completed
Gas Field Development	2006/2635	Not Controlled Action	Completed
Gas Fields Development	2011/5879	Not Controlled Action	Completed
Gas Pipeline Installation	2005/2495	Not Controlled Action	Completed
Golflinks Road Residential Development & Water Storage Facility at Barwon Heads	2004/1793	Not Controlled Action	Completed
Grevillea infecunda tip cuttings and soil samples	2005/1979	Not Controlled Action	Completed
Halladale and Speculant Gas Pipeline Project, North of Port Campbell, Vic	2015/7551	Not Controlled Action	Completed
Henry-1 Exploration Well, Petroleum Permit Area VIC/P44	2005/2147	Not Controlled Action	Completed
Improving rabbit biocontrol: releasing another strain of RHDV, sthrn two thirds of Australia	2015/7522	Not Controlled Action	Completed
INDIGO Central Submarine Telecommunications Cable	2017/8127	Not Controlled Action	Completed
Installation of a 35 metre telecommunications facility at Jirrahlinga Animal San	2003/1151	Not Controlled Action	Completed
Installation of optic fibre cable from Inverloch, Victoria to Stanley, Tasmania	2002/906	Not Controlled Action	Completed
Kelly Swamp Boardwalk Construction	2010/5371	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Kipper Tuna Turrum Project Maintenance Dredging	2010/5430	Not Controlled Action	Completed
Maintenance and priority works to heritage buildings at Point Nepean Quarantine	2006/3151	Not Controlled Action	Completed
Maintenance Dredging South Channel 2012	2011/6198	Not Controlled Action	Completed
Maintenance of Access Track and Weed Removal	2009/4973	Not Controlled Action	Completed
Maintenance works at Barwon Heads Bridge	2003/1199	Not Controlled Action	Completed
Minerva Cut Back Project, Vic	2017/8036	Not Controlled Action	Completed
Newhaven Yacht Squadron marina extension	2004/1450	Not Controlled Action	Completed
Nirranda South Wind Farm Pty Ltd	2002/763	Not Controlled Action	Completed
Oceanlinx South Australia 1mW Greenwave Project	2012/6528	Not Controlled Action	Completed
Offshore exploration drilling within permit area VIC/P 37(v)	2004/1466	Not Controlled Action	Completed
Optic fibre cable installation - San Remo to Cowes	2005/2386	Not Controlled Action	Completed
Point Nepean Quarantine Station (former)/Restoration of Medical Superintendent's	2006/3149	Not Controlled Action	Completed
Port Campbell Headland Walking Trail Realignment	2012/6676	Not Controlled Action	Completed
Portland Landfill Borehole Installation, Vic	2017/7886	Not Controlled Action	Completed
Port Phillip Channel Deepening Project - Trial Dredge Program	2005/2164	Not Controlled Action	Completed
Proposed replacement of existing road culvert	2013/7077	Not Controlled Action	Completed
Queenscliff Harbour Redevelopment	2004/1352	Not Controlled Action	Completed
Redevelopment Project to Upgrade and Extend the Portland Trawler Wharf	2008/4317	Not Controlled Action	Completed

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action			
Remedial Works to the Swan Island Bridge	2003/1129	Not Controlled Action	Completed
Residential/Resort/Golf Course development	2002/907	Not Controlled Action	Completed
Stage 1 residential subdivision, Anna Catherine Drive	2005/1992	Not Controlled Action	Completed
St Quentin Consulting Pty Ltd /Residential development/305 Great Ocean Road, Jan Juc/VIC/Development of approximately 10.3ha of land into 14 residential lots	2014/7184	Not Controlled Action	Completed
Telstra optic fibre cable across Bass Strait - Sub bottom profiler Surve	2002/779	Not Controlled Action	Completed
To construct a shared trail within the Arthurs Seat Road, road reserve south side from Mornington Flinders Road	2004/1565	Not Controlled Action	Completed
Torquay Sewerage Strategy - pipe replacement between Torquay and the Black Rock	2004/1704	Not Controlled Action	Completed
Track construction - Great Ocean Walk	2002/793	Not Controlled Action	Completed
Transfer of 90ha Point Nepean Quarantine Station from Commonwealth to Victorian	2008/4521	Not Controlled Action	Completed
Upgrade and Repairs to Flinders Pier	2008/4331	Not Controlled Action	Completed
Venus Bay Outfall Extension	2004/1555	Not Controlled Action	Completed
VIC-P44 Stage 2 Gas Field Development	2007/3767	Not Controlled Action	Completed
Victorian Generator Project	2005/1984	Not Controlled Action	Completed
West Triton Drilling Program - Otway Basin	2007/3909	Not Controlled Action	Completed
Wind Farm Construction and Operation	2001/471	Not Controlled Action	Completed
Not controlled action (particular manner)			
'Moonlight Head' 3D seismic survey, VIC/P38(V), VIC/P43 and VIC/RL8	2005/2236	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
2D Marine Seismic Survey	2005/2295	Not Controlled Action (Particular Manner)	Post-Approval
2D Marine Seismic Survey, EPP33	2004/1794	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey	2003/1214	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey, Petroleum Exploration Permit Area EPP27	2006/2776	Not Controlled Action (Particular Manner)	Post-Approval
2D Seismic Survey in VIC/P50 and VIC/P46	2004/1810	Not Controlled Action (Particular Manner)	Post-Approval
2D seismic survey VIC/P50	2005/2313	Not Controlled Action (Particular Manner)	Post-Approval
2D Siesmic Marine Survey	2008/4074	Not Controlled Action (Particular Manner)	Post-Approval
3D marine seismic survey near King Island	2004/1461	Not Controlled Action (Particular Manner)	Post-Approval
3D Marine Seismic Survey within Torquay Sub-basin off sthn Victoria	2012/6256	Not Controlled Action (Particular Manner)	Post-Approval
3D seismic program VIC/P38(v), VIC/P43 and VIC/RL8	2003/1137	Not Controlled Action (Particular Manner)	Post-Approval
Astrolabe 3D Marine Seismic Survey	2011/6048	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Bass Basin 2D and 3D seismic surveys (T/38P & T/37P)	2007/3650	Not Controlled Action (Particular Manner)	Post-Approval
Benbows Paddock residential development, Cape Bridgewater	2007/3247	Not Controlled Action (Particular Manner)	Post-Approval
Bernoulli 3D Seismic Survey	2006/3053	Not Controlled Action (Particular Manner)	Post-Approval
BHPBilliton Otway 3D Seismic Survey	2007/3443	Not Controlled Action (Particular Manner)	Post-Approval
Bream 3D seismic survey	2006/2556	Not Controlled Action (Particular Manner)	Post-Approval
Construction of wharf	2003/1050	Not Controlled Action (Particular Manner)	Post-Approval
Construct private dwelling	2008/4234	Not Controlled Action (Particular Manner)	Post-Approval
Controlled Burn, Understorey Clearance and Removal of UXO	2003/1030	Not Controlled Action (Particular Manner)	Post-Approval
Deepwater Sorell Basin 2001 Non-Exclusive 2D Seismic Survey	2001/156	Not Controlled Action (Particular Manner)	Post-Approval
Drill and Profile Exploration Well Somerset 1, License Area T34P	2009/5037	Not Controlled Action (Particular Manner)	Post-Approval
Enterprise Three-dimensional Transition Zone Seismic Survey, Victoria	2016/7800	Not Controlled Action (Particular Manner)	Post-Approval
Fuelbreak construction	2009/4915	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Geelong Bypass Section 3	2005/2099	Not Controlled Action (Particular Manner)	Post-Approval
Geographe-A gas exploration well	2000/82	Not Controlled Action (Particular Manner)	Post-Approval
Gippsland 2D Marine Seismic Survey - VIC/P-63, VIC/P-64 and T/46P	2009/5241	Not Controlled Action (Particular Manner)	Post-Approval
Hydrocarbon exploration wells	2003/1062	Not Controlled Action (Particular Manner)	Post-Approval
INDIGO Marine Cable Route Survey (INDIGO)	2017/7996	Not Controlled Action (Particular Manner)	Post-Approval
Inspection of project vessels for presence of invasive marine pests in Commonwealth waters off Victoria coast	2012/6362	Not Controlled Action (Particular Manner)	Post-Approval
La Bella 3D Marine Seismic Survey, Otway Basin, VIC	2012/6683	Not Controlled Action (Particular Manner)	Post-Approval
Maintenance Dredging Program 2012-21 in Port of Melbourne	2012/6332	Not Controlled Action (Particular Manner)	Post-Approval
OTE10 2D Marine Seismic Survey	2009/5223	Not Controlled Action (Particular Manner)	Post-Approval
Otway Astrolabe 3D Marine Seismic Survey, Otway Basin	2012/6421	Not Controlled Action (Particular Manner)	Post-Approval
Otway Basin Exploration Drilling Campaign, Vic	2011/6125	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Residential Development and Associated Infrastructure at Port Fairy	2012/6687	Not Controlled Action (Particular Manner)	Post-Approval
Santos 2D Seismic Survey VIC/P44 & VIC/P51	2003/1213	Not Controlled Action (Particular Manner)	Post-Approval
Santos Otway 3d Seismic VIC/P44	2007/3367	Not Controlled Action (Particular Manner)	Post-Approval
Schomberg 3D Marine Seismic survey	2007/3868	Not Controlled Action (Particular Manner)	Post-Approval
Seismic Survey in Petroleum Permit Area EPP27	2002/648	Not Controlled Action (Particular Manner)	Post-Approval
Seismic Survey VIC-P46	2002/826	Not Controlled Action (Particular Manner)	Post-Approval
Shaw River Power Station Project - Water Supply Pipeline	2009/5091	Not Controlled Action (Particular Manner)	Post-Approval
Shearwater 2D and 3D marine seismic survey	2005/2180	Not Controlled Action (Particular Manner)	Post-Approval
Southern Flanks 2D Marine Seismic Survey	2010/5288	Not Controlled Action (Particular Manner)	Post-Approval
Southern Gas Pipeline Project	2002/619	Not Controlled Action (Particular Manner)	Post-Approval
Southern Margins T/35P and T/36P 3D Seismic Surveys	2007/3817	Not Controlled Action (Particular Manner)	Post-Approval
Speculant 3D Transition Zone Seismic Survey	2010/5558	Not Controlled Action (Particular	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
		Manner)	
Strike Oil NL Seismic Surveys	2000/107	Not Controlled Action (Particular Manner)	Post-Approval
Surface Geochemical Exploration Program, TAS	2010/5780	Not Controlled Action (Particular Manner)	Post-Approval
Tap Oil Ltd Molson 2D Seismic Survey T47P	2008/3967	Not Controlled Action (Particular Manner)	Post-Approval
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, Vic	2012/6565	Not Controlled Action (Particular Manner)	Post-Approval
Thylacine-A Exploration Well	2000/81	Not Controlled Action (Particular Manner)	Post-Approval
Torquay Sub-basin (VIC/P62) OTE12-3D Seismic Survey	2012/6655	Not Controlled Action (Particular Manner)	Post-Approval
Undertake a three dimensional marine seismic survey	2010/5700	Not Controlled Action (Particular Manner)	Post-Approval
Vegetation clearance and residential subdivision near Mt Gambier	2004/1370	Not Controlled Action (Particular Manner)	Post-Approval
Vic/P37(v) and Vic/P44 3D marine seismic survey	2003/1102	Not Controlled Action (Particular Manner)	Post-Approval
VIC P44 Gas Exploration Wells	2002/662	Not Controlled Action (Particular Manner)	Post-Approval
Vic-P51 and Vic-P52 2D seismic survey	2002/811	Not Controlled Action (Particular Manner)	Post-Approval

Title of referral	Reference	Referral Outcome	Assessment Status
Not controlled action (particular manner)			
Vic-P51 and Vic-P52 3D seismic survey	2002/799	Not Controlled Action (Particular Manner)	Post-Approval
Referral decision			
2D & 3D Seismic Surveys - Permit Area - VIC/P50	2008/4517	Referral Decision	Completed
2D Seismic Survey	2008/3978	Referral Decision	Completed
3D Marine Seismic Survey	2011/6156	Referral Decision	Completed
3D Seismic Survey	2008/4014	Referral Decision	Completed
8 Lot Industrial Subdivision	2008/4527	Referral Decision	Completed
All actions taken in response to the current severe bushfires in Victoria.	2009/4787	Referral Decision	Completed
Alteration Reconstruction Restoration and Repairs to Buildings	2008/4179	Referral Decision	Completed
Offshore Tidal Energy Facility and Submarine Cable	2008/4480	Referral Decision	Referral Publication
Portland Wave Energy Project	2008/3946	Referral Decision	Completed
The Enterprise 3D Seismic Acquisition Survey, Otway Basin, VIC	2012/6545	Referral Decision	Completed
Upgrade of Services Infrastructure Point Nepean Quarantine Station	2008/4591	Referral Decision	Completed
VICP61 2D Marine Seismic Survey	2008/3975	Referral Decision	Completed
Wind Farm	2001/139	Referral Decision	Completed
Works to the buildings and surrounds at the former Point Nepean Quarantine Stati	2008/4156	Referral Decision	Completed

Key Ecological Features [Resource Information]

Key Ecological Features are the parts of the marine ecosystem that are considered to be important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area.

Name	Region
Bonney Coast Upwelling	South-east
West Tasmania Canyons	South-east

Biologically Important Areas

Scientific Name	Behaviour	Presence
Seabirds		
Ardenna pacifica Wedge-tailed Shearwater [84292]	Breeding	Known to occur
Ardenna pacifica Wedge-tailed Shearwater [84292]	Foraging	Likely to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Breeding	Known to occur
Ardenna tenuirostris Short-tailed Shearwater [82652]	Foraging	Known to occur
Diomedea exulans (sensu lato) Wandering Albatross [1073]	Foraging	Known to occur
Diomedea exulans antipodensis Antipodean Albatross [82269]	Foraging	Known to occur
Eudyptula minor Little Penguin [1085]	Breeding	Known to occur
Eudyptula minor Little Penguin [1085]	Foraging	Known to occur
Morus serrator Australasian Gannet [1020]	Aggregation	Known to occur
Morus serrator Australasian Gannet [1020]	Foraging	Known to occur
Pelagodroma marina White-faced Storm-petrel [1016]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Pelecanoides urinatrix Common Diving-petrel [1018]	Breeding	Known to occur
Pelecanoides urinatrix Common Diving-petrel [1018]	Foraging	Known to occur
Phalacrocorax fuscescens Black-faced Cormorant [59660]	Foraging	Known to occur
Thalassarche bulleri Bullers Albatross [64460]	Foraging	Known to occur
Thalassarche cauta cauta Shy Albatross [82345]	Foraging likely	Likely to occur
Thalassarche chlororhynchos bassi Indian Yellow-nosed Albatross [85249]	Foraging	Known to occur
Thalassarche melanophris Black-browed Albatross [66472]	Foraging	Known to occur
Thalassarche melanophris impavida Campbell Albatross [82449]	Foraging	Known to occur
Seals		
Neophoca cinerea Australian Sea Lion [22]	Foraging (male)	Known to occur
Sharks		
Carcharodon carcharias White Shark [64470]	Breeding (nursery area)	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution	Likely to occur
Carcharodon carcharias White Shark [64470]	Distribution	Known to occur
Carcharodon carcharias White Shark [64470]	Distribution (low density)	Likely to occur
Carcharodon carcharias White Shark [64470]	Foraging	Known to occur

Scientific Name	Behaviour	Presence
Carcharodon carcharias White Shark [64470]	Known distribution	Known to occur

Whales		
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Distribution	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging	Likely to be present
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Foraging (annual high use area)	Known to occur
Balaenoptera musculus brevicauda Pygmy Blue Whale [81317]	Known Foraging Area	Known to occur
Eubalaena australis Southern Right Whale [40]	Aggregation	Known to occur
Eubalaena australis Southern Right Whale [40]	Connecting habitat	Known to occur
Eubalaena australis Southern Right Whale [40]	Known core range	Known to occur
Eubalaena australis Southern Right Whale [40]	Migration and resting on migration	Known to occur

Bioregional Assessments

SubRegion	BioRegion	Website
Gippsland	Gippsland Basin	BA website

Caveat

1 PURPOSE

This report is designed to assist in identifying the location of matters of national environmental significance (MNES) and other matters protected by the Environment Protection and Biodiversity Conservation Act 1999 (Cth) (EPBC Act) which may be relevant in determining obligations and requirements under the EPBC Act.

The report contains the mapped locations of:

- World and National Heritage properties;
- Wetlands of International and National Importance;
- Commonwealth and State/Territory reserves;
- distribution of listed threatened, migratory and marine species;
- listed threatened ecological communities; and
- other information that may be useful as an indicator of potential habitat value.

2 DISCLAIMER

This report is not intended to be exhaustive and should only be relied upon as a general guide as mapped data is not available for all species or ecological communities listed under the EPBC Act (see below). Persons seeking to use the information contained in this report to inform the referral of a proposed action under the EPBC Act should consider the limitations noted below and whether additional information is required to determine the existence and location of MNES and other protected matters.

Where data are available to inform the mapping of protected species, the presence type (e.g. known, likely or may occur) that can be determined from the data is indicated in general terms. It is the responsibility of any person using or relying on the information in this report to ensure that it is suitable for the circumstances of any proposed use. The Commonwealth cannot accept responsibility for the consequences of any use of the report or any part thereof. To the maximum extent allowed under governing law, the Commonwealth will not be liable for any loss or damage that may be occasioned directly or indirectly through the use of, or reliance

3 DATA SOURCES

Threatened ecological communities

For threatened ecological communities where the distribution is well known, maps are generated based on information contained in recovery plans, State vegetation maps and remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species

Threatened, migratory and marine species distributions have been discerned through a variety of methods. Where distributions are well known and if time permits, distributions are inferred from either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc.) together with point locations and described habitat; or modelled (MAXENT or BIOCLIM habitat modelling) using

Where little information is available for a species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc.).

In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More detailed distribution mapping methods are used to update these distributions

4 LIMITATIONS

The following species and ecological communities have not been mapped and do not appear in this report:

- threatened species listed as extinct or considered vagrants;
- some recently listed species and ecological communities;
- some listed migratory and listed marine species, which are not listed as threatened species; and
- migratory species that are very widespread, vagrant, or only occur in Australia in small numbers.

The following groups have been mapped, but may not cover the complete distribution of the species:

- listed migratory and/or listed marine seabirds, which are not listed as threatened, have only been mapped for recorded
- seals which have only been mapped for breeding sites near the Australian continent

The breeding sites may be important for the protection of the Commonwealth Marine environment.

Refer to the metadata for the feature group (using the Resource Information link) for the currency of the information.

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of Agriculture Water and the Environment
GPO Box 858
Canberra City ACT 2601 Australia
+61 2 6274 1111

Appendix 3

Description of the Environment

Projects & Operations I EP

Document Control

Approvals	Name	Role	Signature	Document Control
Document Originator:	R Hooke	Env Consultant		**Document Number:** COE-EN-EMP-0001
Document Reviewer:	J Morris	Env Advisor		**Revision Number:** 5
Document Approver:	M Jacobsen	GM Projects & Operations		**Revision Date:** 10 March 2022

Revision History

Revision	Date	Originator	Revision Summary
0	20/10/2017	Xodus	For Submission
1	04/01/2018	Xodus	For Submission
2	29/04/2018	Xodus	For Submission.
3	12/10/2018	Xodus	For Submission. Annual updates and preparation of Otway Exploration EP.
4	19/10/2021	Xodus	For Submission. Annual updates and preparation of BMG Decom Phase 1 EP.
5	10/03/2022	JJM	For Submission. Additonal detail and updates related to BMG Decom Phase 1 EP.

Table of Contents

List of Appendices

List of Figures

List of Tables

1 Introduction

1.1 Regulatory Context

The OPGGS(E) Regulations 2009 define ‘environment’ as the ecosystems and their constituent parts, natural and physical resources, qualities and characteristics of areas, the heritage value of places and includes the social, economic and cultural features of those matters. In accordance with Regulation 13(2) of the OPGGS(E), this document describes the physical (Section 2), ecological (Section 3), and social (Section 5) components of the environment.

A greater level of detail is provided for those particular values and sensitivities as defined by Regulation 13(3) of the OPGGS(E) Regulations which states that particular relevant values and sensitivities may include any of the following:

(a) the world heritage values of a declared World Heritage property within the meaning of the EPBC Act;

(b) the national heritage values of a National Heritage place within the meaning of that Act;

(c) the ecological character of a declared Ramsar wetland within the meaning of that Act;

(d) the presence of a listed threatened species or listed threatened ecological community within the meaning of that Act;

(e) the presence of a listed migratory species within the meaning of that Act;

(f) any values and sensitivities that exist in, or in relation to, part or all of:

i. a Commonwealth marine area within the meaning of that Act; or

ii. Commonwealth land within the meaning of that Act.

With regards to 13(3)(d) and (e) more detail has been provided where threatened or migratory species have a spatially defined biologically important area (BIA), habitat critical to survival or identified biologically important behaviour such as breeding, foraging, resting or migration.

With regards to 13(3)(f) more detail has been provided for:

- Key Ecological Features (KEFs) as they are considered as conservation values under a Commonwealth Marine Area, and
- Australian Marine Parks (AMPs) as they are enacted under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

1.2 Environment Sectors

Due to the large area being described, smaller environmental sectors have been defined based on geology (e.g. petroleum geology) and ecology (e.g. IMCRA regions); these sectors are used throughout this document (Table 1.1, Figure 1-1).

As well as the environmental sectors within the Australian exclusive economic zone (EEZ), an additional sector has been defined for areas outside of the EEZ such as New Caledonia, New Zealand and international waters.

Cooper Energy petroleum titles are located in the Otway and Gippsland environmental sectors, therefore additional information is provided about receptors in each of these sectors.

Table 1.1: Bioregions and Geology of the Environment Sectors

Sector	General Boundary	IMCRA Provincial Bioregions[1]	Petroleum Geology[2]
Otway	Cape Jaffa (South Australia) to Cape Otway (Victoria); west of King Island to Cape Grim (northwest Tasmania)	• Western Bass Strait IMCRA Transition • West Tasmania Transition	• Otway Basin
Bass Strait	Cape Otway to Woodside Beach (Victoria); northern Tasmanian coast; and includes King and Flinders Island (and associated island chains)	• Western Bass Strait IMCRA Transition • Bass Strait IMCRA Province • Southeast IMCRA Transition	
Gippsland	Woodside Beach (Victoria) to Batemans Bay (New South Wales); east of Flinders Island to Eddystone Point (north-east Tasmania)	• Southeast IMCRA Transition • Southeast Transition	• Gippsland Basin
Sorell	Western coast of Tasmania, from Cape Grim to South East Cape	• Tasmanian IMCRA Province • Tasmania Province • West Tasmania Transition	• Sorell Basin
SE Tasmania	Eastern coast of Tasmania, from Eddystone Point to South East Cape	• Tasmanian IMCRA Province • Tasmania Province	
Central NSW	Batemans Bay to Coffs Harbour (New South Wales)	• Central Eastern IMCRA Province • Central Eastern Province	• Sydney Basin
SE Queensland	Coffs Harbour (New South Wales) to Gladstone (Queensland)	• Central Eastern IMCRA Province • Central Eastern Transition • Kenn Transition • Kenn Province • Central Eastern Province	• Capricorn Basin • Clarence-Morton Basin • Maryborough Basin • Nambour Basin
Lord Howe	Lord Howe Island	• Tasman Basin Province • Lord Howe Province	• Lord Howe Rise
Norfolk Island	Norfolk Island	• Norfolk Island Province	
Area outside the Australia EEZ	New Caledonia EEZ, New Zealand EEZ, International Waters	N/A	

Notes:

1. IMCRA regions as described by Commonwealth of Australia (2006).
2. Petroleum geology as described by Geoscience Australia (2017).

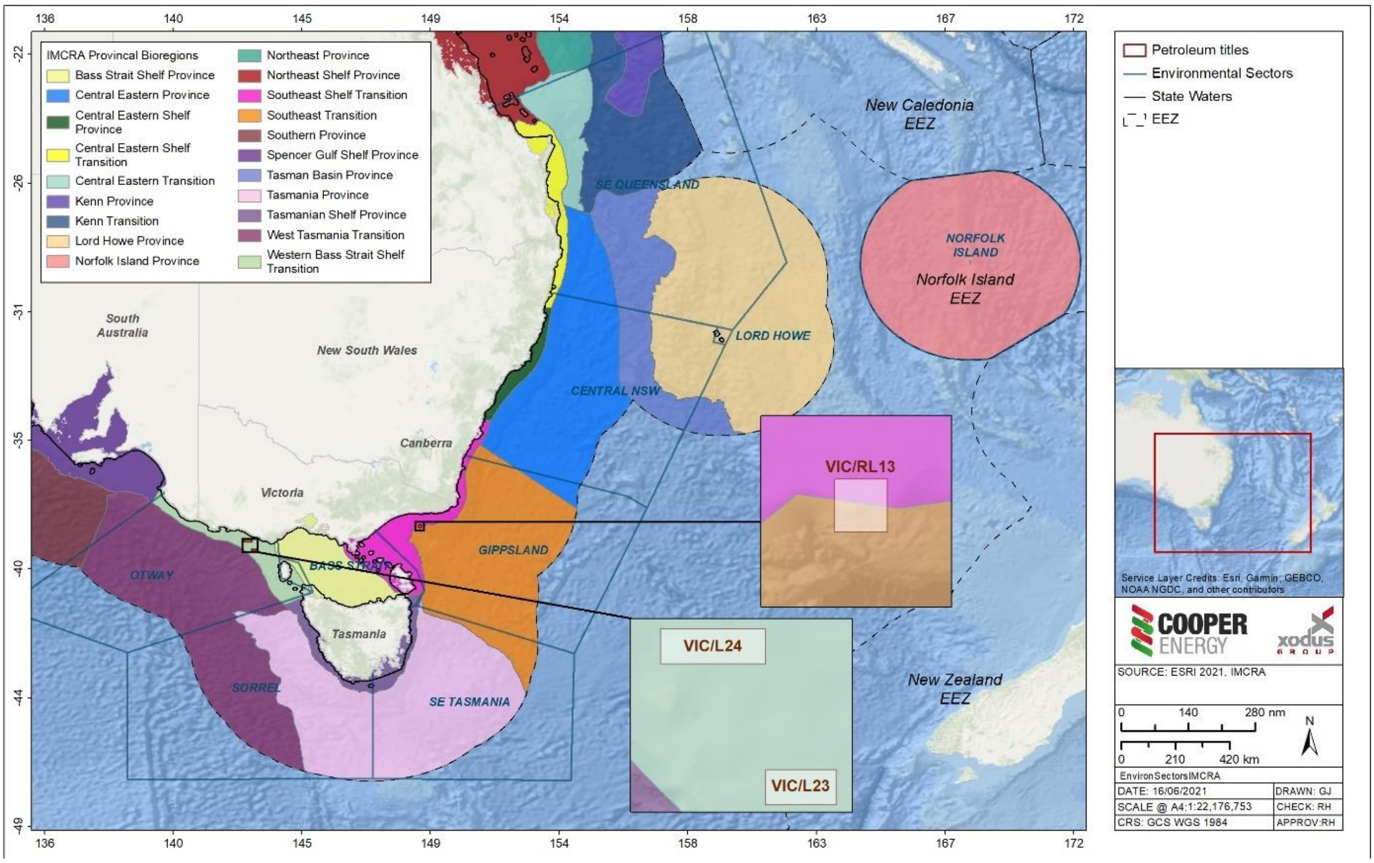


Figure 1-1: Environment Sectors (with IMCRA Provincial Bioregions)

2 Physical Environment

2.1 Bathymetry and Seabed Features

The geomorphology of Australia's continental margin is varied, with a number of different geomorphic features present, including basins, canyons, terraces, seamounts and plateaus (Figure 2-1, Figure 2-2). In the south-east, the continental shelf is broad, extending offshore to approximately 200 m water depth; in contrast, the shelf along eastern Australia is narrower and shallower, varying between approximately 10 km and 75 km offshore, and between 70–165 m water depth (Harris *et al.*, 2005). Some of the key features on the continental shelf include the Otway Depression and Otway Shelf, King Island Rise, Bass Basin and Gippsland Shelf (Figure 2-1, Figure 2-2). Geomorphic features on the continental slope and abyssal plain include: Bass Canyon, East Tasman Saddle and East Tasman Plateau, South Tasman Rise, Stradbroke Seamount and Moreton Seamount (Figure 2-1, Figure 2-2).

Bass Basin, a seaway separating the mainland and Tasmania, is a shallow depression approximately 120 km by 400 km, with water depths up to approximately 90 m (average water depth of approximately 60 m). The basin is bounded on the eastern and western margin by two granite plateaus: the Bassian Rise, and King Island Rise. The Bassian Rise (eastern margin) separates Bass Basin from the Gippsland Basin, and is associated with the Furneaux Islands. King Island Rise (western margin) includes the shallow (<40 m water depth) Tail Bank, and King Island itself; and separates Bass Basin from Otway Basin. To the southwest, there is a relatively narrow, 60 m-deep channel between King Island and Tasmania. Sandwaves and tidal current ridges occur on the seabed of both Bassian and King Island Rises. The largest of the tidal sand ridges, Moriarty Bank, lies east of Clarke Island and is approximately 20 km long and four kilometres wide, orientated east-west, sub-parallel to the flow of tidal currents (Harris *et al.*, 2005).

East of Bass Strait, on the continental slope and rise, are a number of submarine canyons; the largest of which is Bass Canyon. This submarine canyon is oriented east-southeast and is 10–15 km wide at its mouth, and approximately 60 km long (Harris *et al.*, 2005). This canyon area is associated with two Key Ecological Features: Bass Cascade, and Big Horseshoe Canyon (see Section 4.6). Similarly, east of Tasmania and east of King Island Rise, there are a series of canyons through the continental slope. At abyssal water depths, south of Tasmania, the seabed is characterised by gently undulating relief with irregular faulted basement blocks and seamounts.

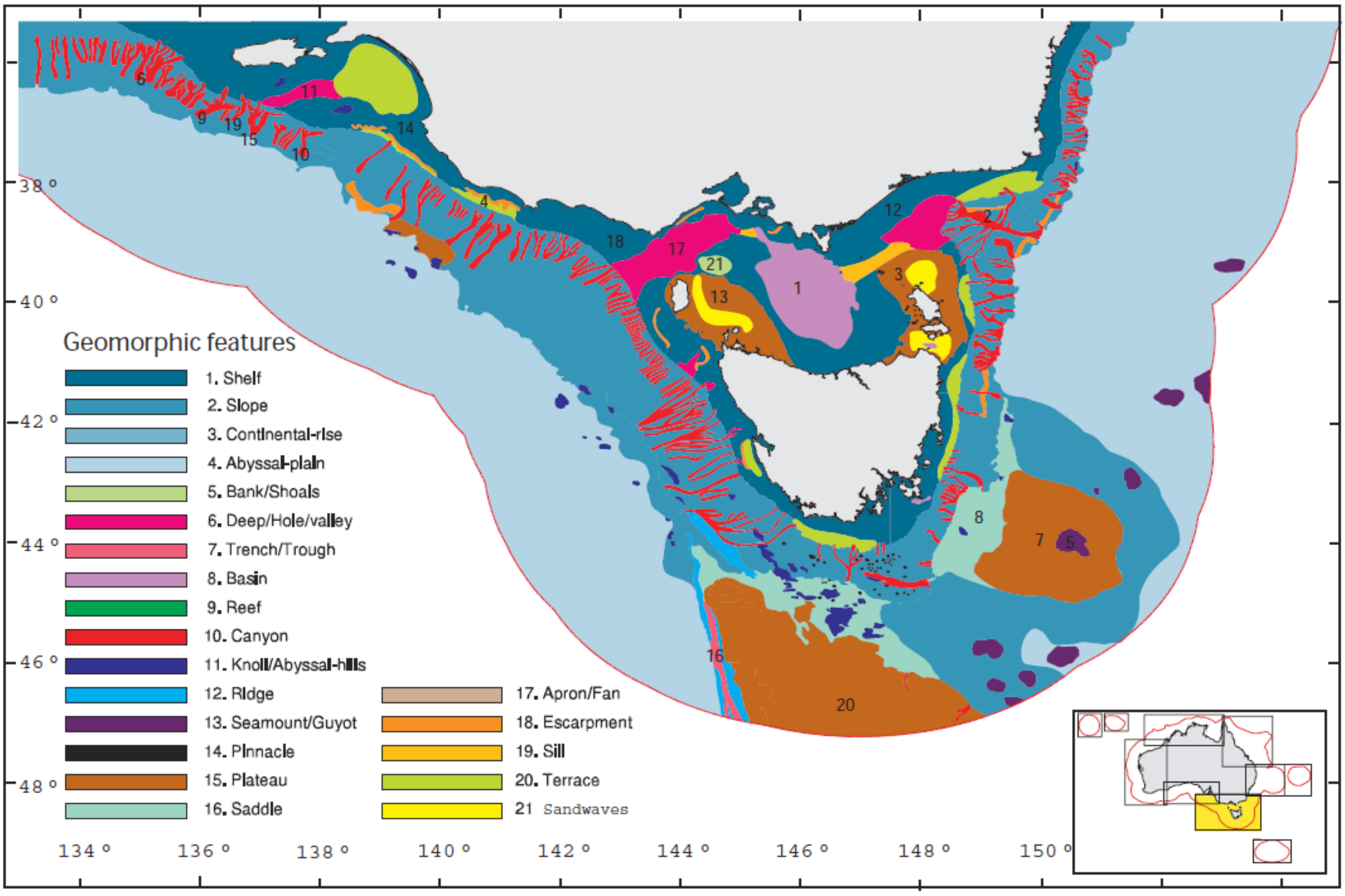
The volcanic seamounts of the Tasmantid Seamount Chain occur on the abyssal plain east of Australia, including Moreton Seamount, Brisbane Guyot, Queensland Guyot, Stradbroke Seamount, Derwent-Hunter Guyot, Barcoo Bank and Taupo Bank. These seamounts vary in size, Stradbroke Seamount rises to 900 m water depth, while Barcoo Bank rises to less than 1,400 m water depth (Harris *et al.*, 2005).

The seabed within the vicinity of the Gippsland sector tends to be slightly undulating (gradients <2°) and smooth. Noting however that the Basker-6 flowline (located between the BAM and Basker-6 wellhead) crosses the upper levels of the Bass Canyon scarp (decreasing from ~155–216 m water depth),) and as a result has unique characteristics.

There have been no seabed anomalies identified in the Gippsland environmental sector from geophysical surveys. The seabed at and around the BMG wells tend to be featureless with the seabed comprised of silty sand. The underlying geological structure tends to be dipping and slightly irregular, grading from silty fine sand at the seabed to over consolidated sandy silty clay at 10 m below seabed. The flowline route also crosses a narrow zone of what has been interpreted as variably cemented silty sand and gravel, which corresponds with the area of steepest gradient along the scarp edge.

Basker-6 flowline route can be divided into three zones; above the Bass Canyon Scarp (~ 150 m); on the Bass Canyon Scarp (~150 m to ~220 m with maximum slope ~ 20°) and below the Bass Canyon Scarp (~ 220 m to 270 m) towards the Basker-6 well (CTC Marine, 2011). Geotechnical survey conducted (CTC Marine, 2011), reported that the zone above the Bass Canyon Scarp tend to be flat and featureless, comprising silty fine sand with an increase in shell towards the scarp edge. While the seabed on Bass Canyon Scarp was "irregular in profile, consistent with erosion", with sediments comprising of clayey silty sand with a high proportion of shell and other carbonate fragments and areas of cemented soil at the base of the slope. Seabed below Bass Canyon Scarp was reported to have a gently undulating topography formed by slump material from the scarp area.

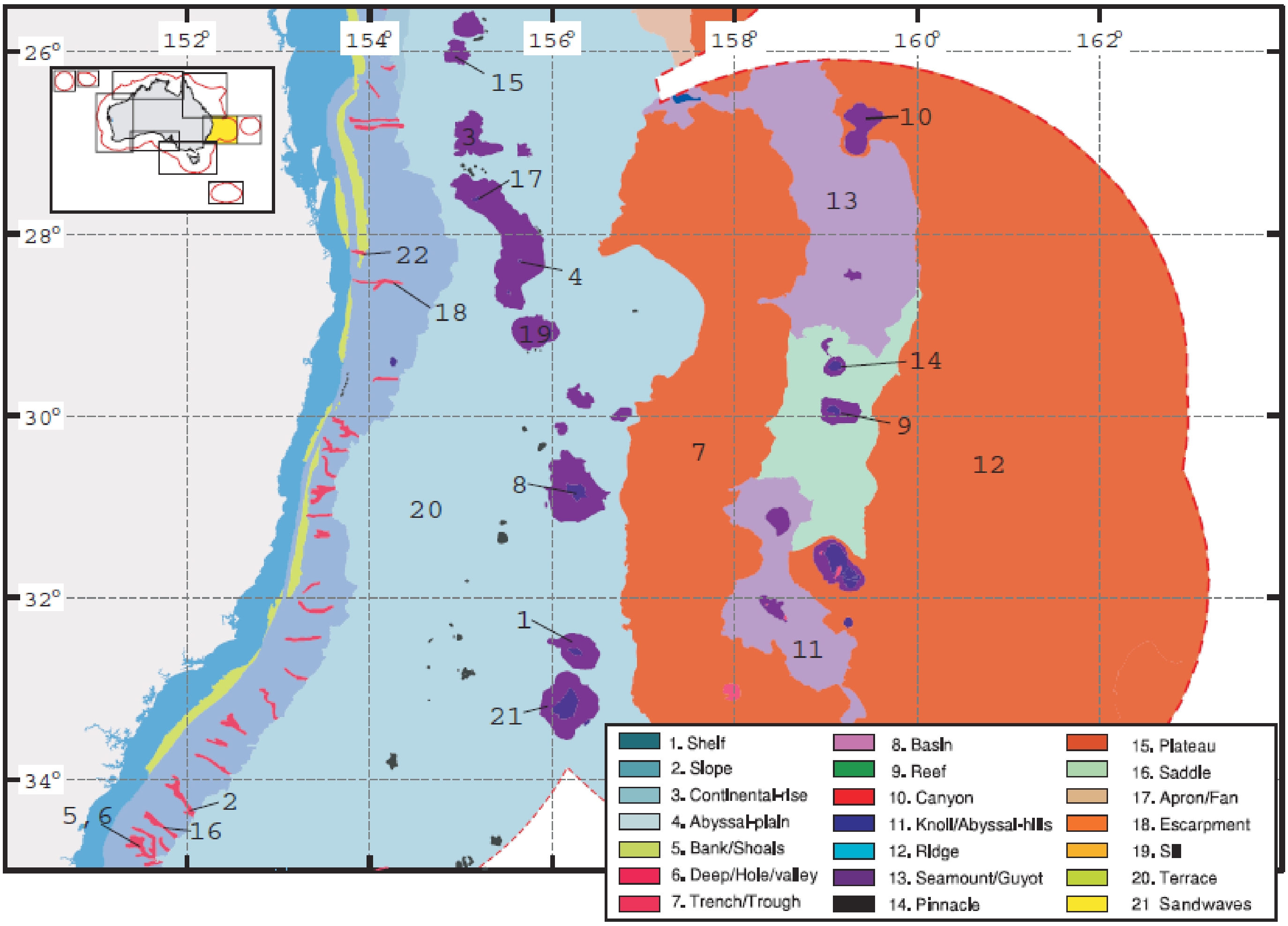
More recent surveys conducted by Ierodiaconou et al, (2020) confirmed that seabed surrounding subsea infrastructure tends to be dominated by a mix of sand and pebble/gravel.



(Source: Harris *et al.*, 2005)

Notes: Features within the Environmental Sectors, as labelled on above figure – (1) Bass Basin, (2) Bass Canyon, (3) Bassian Rise, (4) Beachport Plateau, (5) Cascade Seamount, (7) East Tasman Plateau, (8) East Tasman Saddle, (12) Gippsland Shelf, (13) King Island Rise, (16) Needwonne Ridge, (17) Otway Depression, (18) Otway Shelf, (20) South Tasman Rise, (21) South Tasman Saddle, (22) Tail Bank, (23) Toofee Ridge.

Figure 2-1: Geomorphic Features of the South-eastern Margin



(Source: Harris *et al.*, 2005)

Note: Features within the EMBA, as labelled on above figure – (1) Barcoo Bank, (2) Beecroft Canyon, (3) Brisbane Guyot, (4) Brittania Guyots, (5) Conjola Canyon A, (6) Conjola Canyon B, (7) Dampier Ridge, (8) Derwent-Hunter Guyot, (9) Elizabeth Reef, (10) Gifford Guyot, (11) Lord Howe Basin, (12) Lord Howe Rise, (13) Middleton Basin, (14) Middleton Reef, (15) Moreton Seamount, (16) Perpendicular Canyon, (17) Queensland Guyot, (18) Richmond Canyon, (19) Stradbroke Seamount, (20) Tasman Basin, (21) Taupo Bank, (22) Tweed Canyon.

Figure 2-2: Geomorphic Features of the Eastern Margin

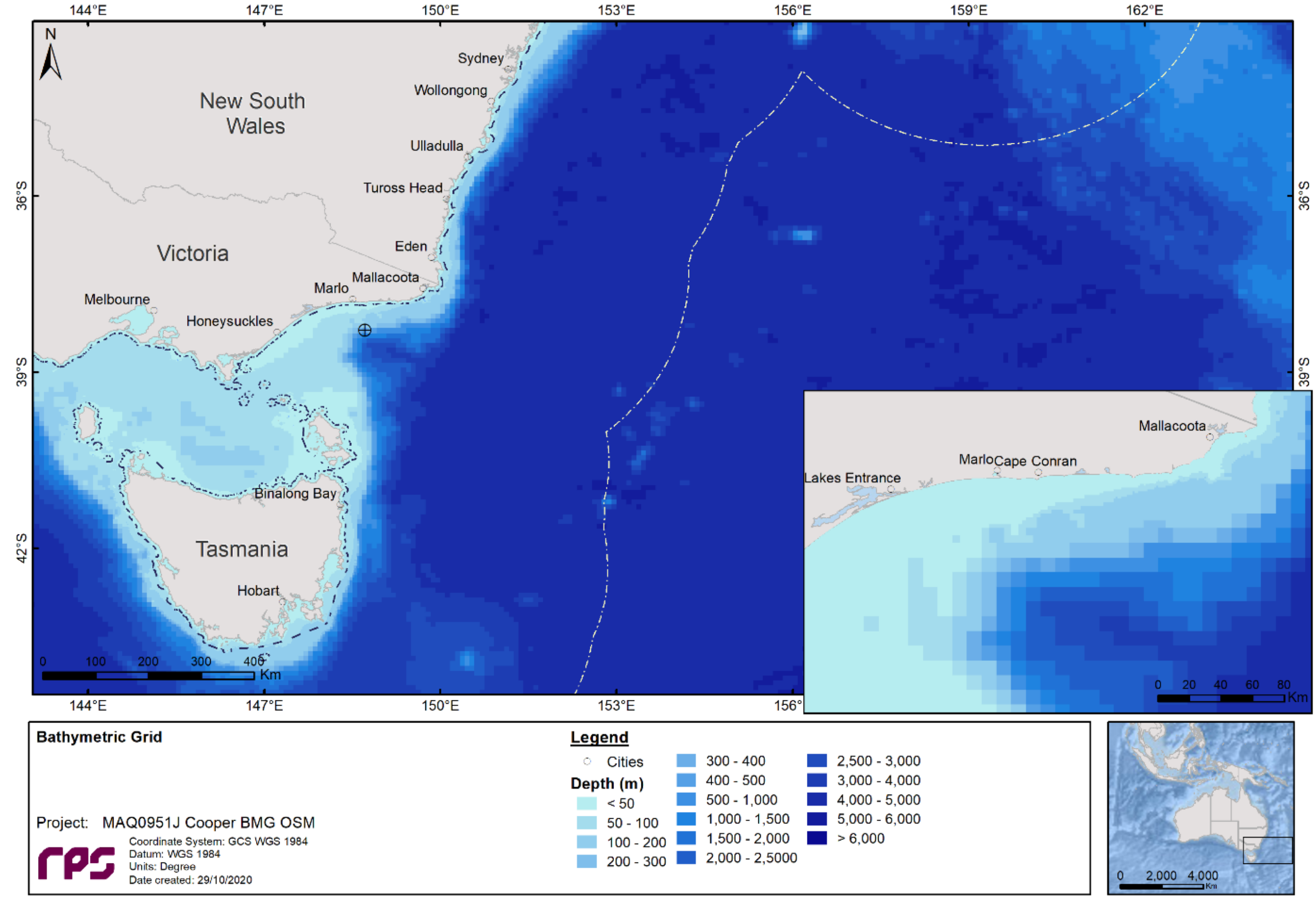


Figure 2-3 Bathymetry defined throughout Gippsland Basin region (RPS, 2021)

2.2 Oceanography

2.2.1 Currents

Australia is heavily influenced by four major currents: East Australian Current, Leeuwin Current, Indonesian Throughflow, and the Antarctic Circumpolar Current (Figure 2-4). These four currents have a driving influence on the conditions and biodiversity in Australian oceans and coastal environments. There are also a number of smaller and more complex current systems. All these ocean features can change from season to season, and may be more or less extensive and energetic, depending on climate factors.

The East Australian Current flows south along the east coast of Australia from near Queensland’s Fraser Island to Tasmania; and is an important feature of the Tasman Sea. This area has been warming faster than other parts of the ocean (CSIRO, no date). This has been driven by changes in atmospheric circulation causing an increase in strength of the South Pacific Gyre, resulting in the strengthening of the East Australian Current, so that the warm tropical waters from the Coral Sea region are forced further south, warming the Tasman Sea (CSIRO, no date).

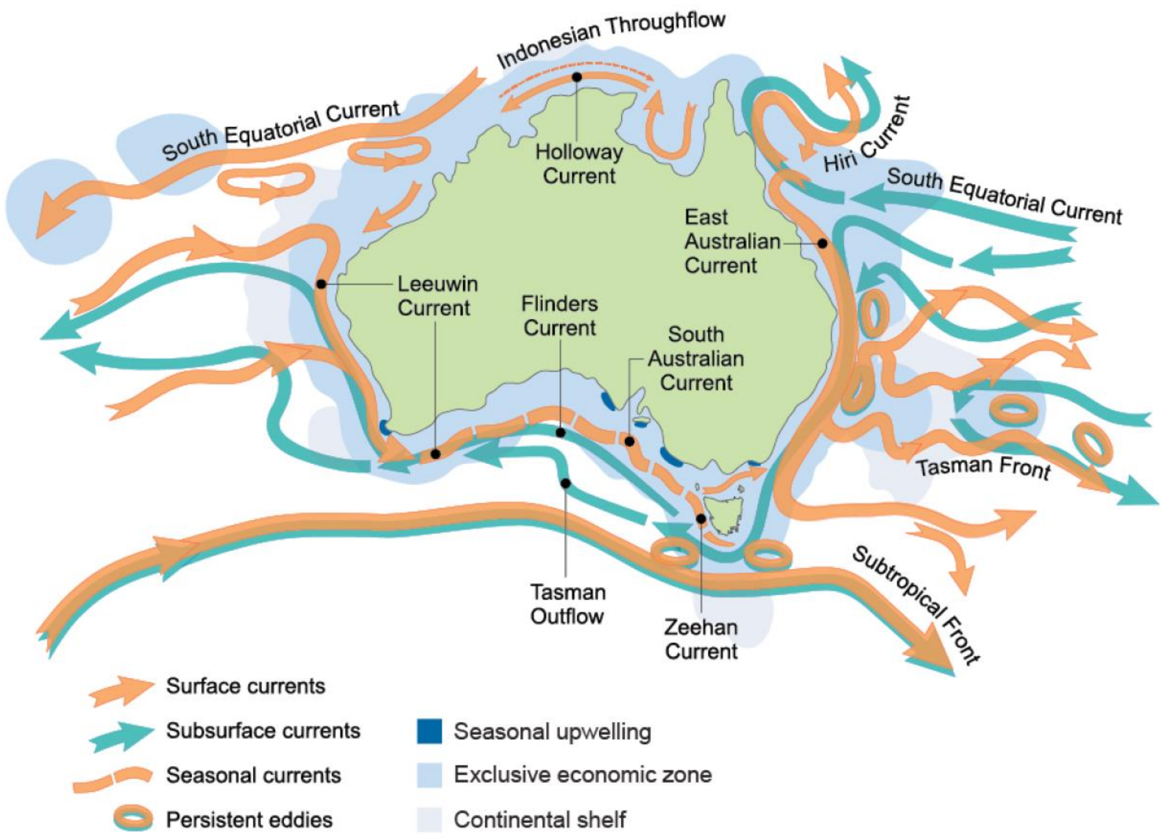


Figure 2-4: Major Ocean Currents and Features of Australia's Marine Environment

The Bass Strait region has a reputation for high winds and strong tidal currents (Jones, 1980). Currents within the Strait are primarily driven by tides, winds and density driven flows. Tides are semi-diurnal with some diurnal inequalities, generating tidal movements with a predominantly north-east to south-west orientation; with speeds ranging 0.1–2.5 m/s (Fandry, 1983). Tidal flows in Bass Strait come from the east and west during a rising (flood) tide, and flow out to the east and west during a falling (ebb) tide. During winter, the South Australian Current moves dense, salty water eastward from the Great Australian Bight into the western margin of the Bass Strait; and during summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds (RPS, 2017). In winter and spring, waters within the strait are well mixed with no obvious stratification, while during summer the central regions of the strait become stratified (RPS, 2017).

Bass Strait is a high-energy environment exposed to frequent storms and significant wave heights. The Otway coast has a predominantly south-westerly aspect and is highly exposed to swell from the Southern Ocean. Storms in Bass Strait can generate wave heights of 5 m or more (Cooper Energy 2019). In-situ wave measurements in the northern portion of the Casino pipeline, showed 2.0–3.5 m waves occur for 50% of the time, and waves over 7.6 m can occur during winter (Santos, 2004).

Within the Gippsland region, surface currents generally flow in a northeast to southwest axis with different intensities depending on the month. The average current speed ranged between 0.18 m/s and 0.24 m/s while maximum current speeds ranged between 0.59 m/s (December) and 0.96 m/s (March) (RPS, 2021).

The Key Ecological Feature (KEF) known as the Bass Cascade is present during winter, when down-welling is caused by the cooling of shallow waters of Bass Strait into Gippsland Basin. Down-welling currents that originate in the shallow eastern waters of Bass Strait flow down the continental slope to depths of several hundred metres or more into the Tasman Sea.

2.2.2 Sea Temperature and Salinity

Sea-surface temperatures vary throughout the year, from the monthly average temperatures range from 14.1°C (September) to 20.5°C (March). Salinity tends to remain consistent throughout the year, between 35.4-35.6 psu (RPS, 2021).

Waters of eastern Bass Strait are generally well mixed, but surface warming sometimes cause weak stratification in calm summer conditions. During these times mixing and interaction between varying water masses leads to variations in horizontal water temperature and a thermocline (temperature profile) develops. The thermocline acts as a low-friction layer separating the wind-driven motions of the upper well-mixed layer of Bass Strait from the bottom well-mixed layer (Esso, 2009).

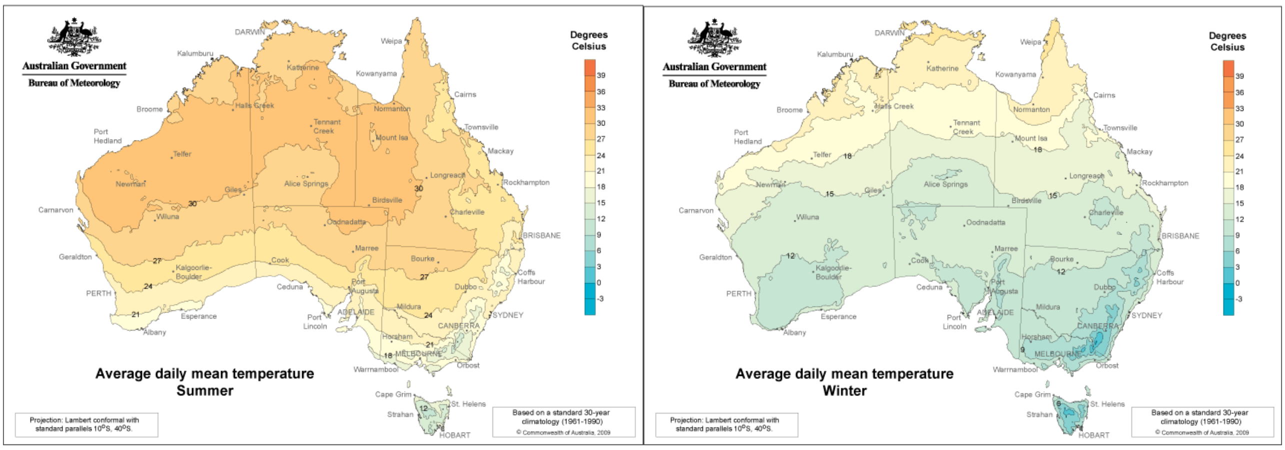
The southwest region of Victorian area has significant upwelling of colder, nutrient rich deep-water during summer (i.e. the Bonney Coast Upwelling KEF) that can cause sea surface temperatures to decrease by 3°C compared with offshore waters (Butler *et al.*, 2002).

2.3 Air Quality and Climate

Australia's size and geography gives rise to a diverse range of climate patterns across the continent and offshore islands. The south-eastern coast (Victoria, Tasmania, New South Wales) is primarily described as being 'temperate'; and the region extending into southern Queensland becomes 'subtropical'. There are seasonal variations in mean temperatures and rainfall, with northern Australia (including Queensland), having higher summer rainfall, compared to southern Australia when winter rainfall is more dominant (Figure 2-5, Figure 2-6).

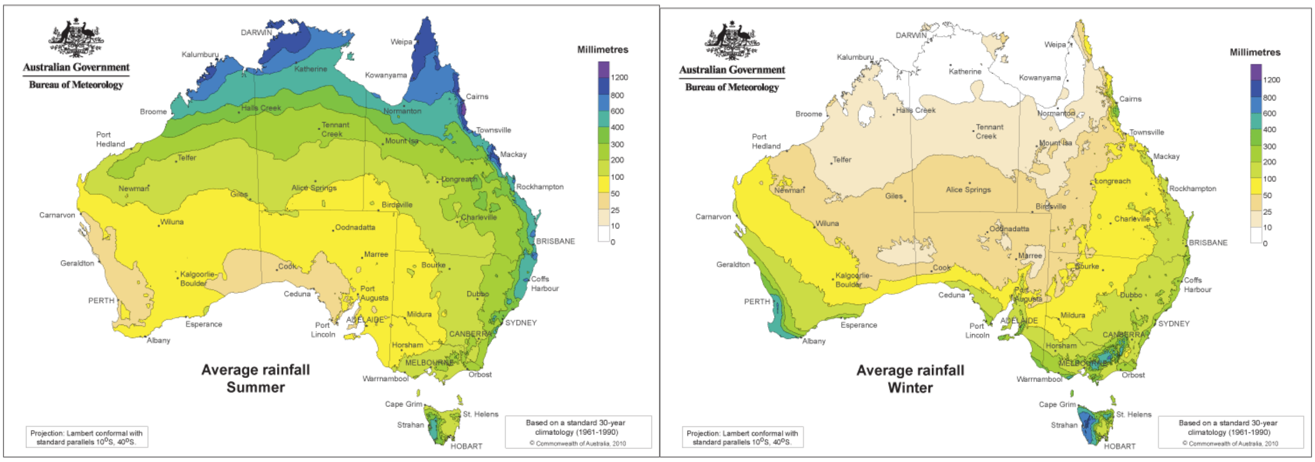
Victorian's climate can be characterised as cool temperate, with cool wet winters and cool summers. The conditions are primarily influenced by weather patterns originating in the Southern Ocean. It is dominated by sub-tropical high-pressure systems in summer and sub-polar low-pressure systems in winter. The low-pressure systems are accompanied by strong westerly winds and rain-bearing cold fronts that move from west to east across the region.

Bass Strait is located on the northern edge of the westerly wind belt known as the Roaring Forties. Hindcast modelled wind data from the National Centres for Environmental Predictions Climate Forecast System Reanalysis for the period 2008 to 2012 (inclusive), showed winds were typically from a westerly (west-southwest to west-northwest) direction, with average monthly wind speeds ranging from 14.1–16.5 knots. The dataset shown in Figure 2-7 demonstrates that the Gippsland Basin typically experiences moderate to strong winds all year round and although the monthly average wind speeds remain under 10 knots, winds can at times blow over 25 knots. Winds in the region typically blow from the southwest during the summer months and west-southwest during the winter months. (RPS, 2017)



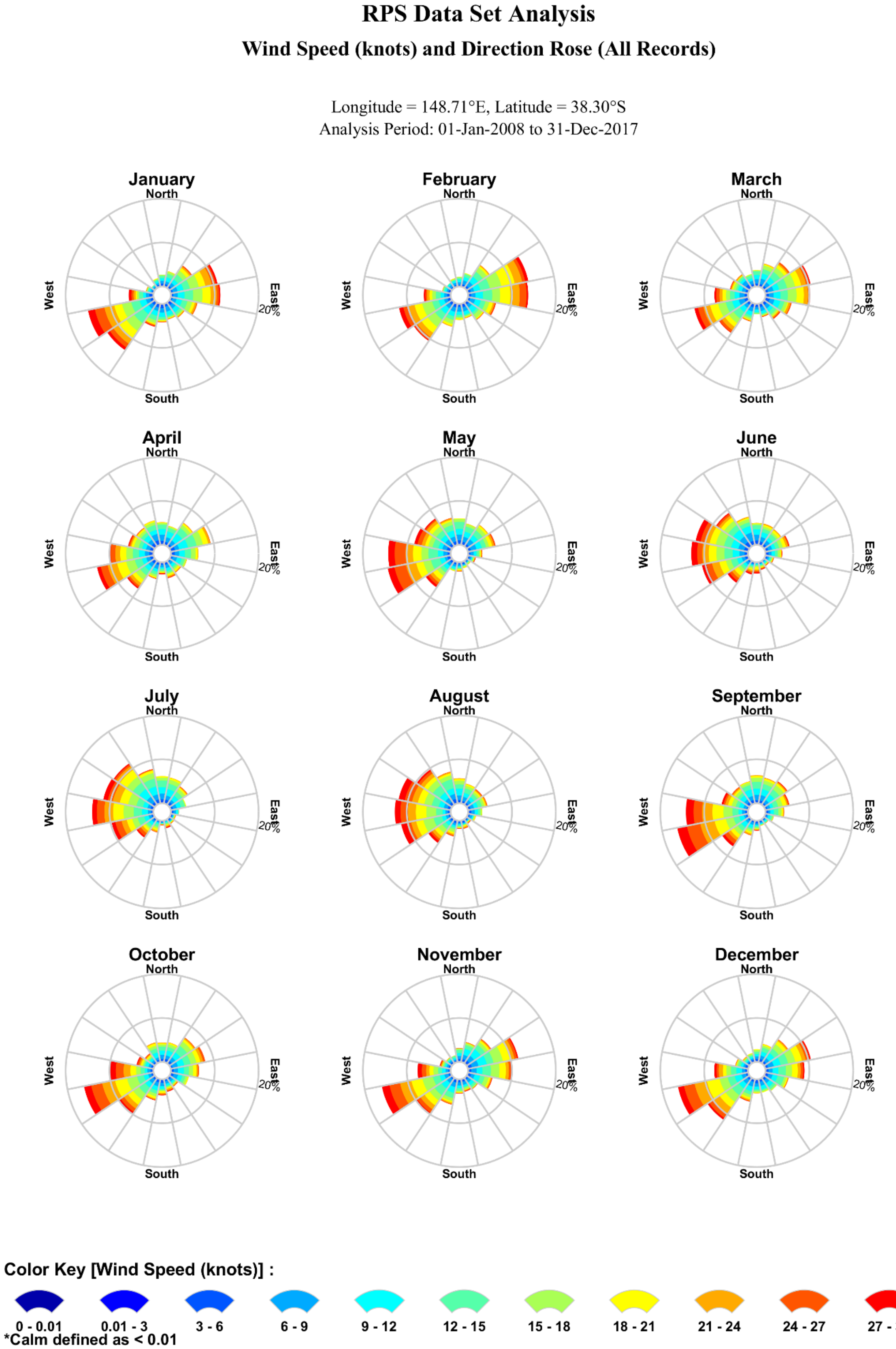
(Source: BoM, 2016)

Figure 2-5: Average daily mean temperatures in Summer (left) and Winter (right)



(Source: BoM, 2016)

Figure 2-6: Average rainfall in Summer (left) and Winter (right)



(Source: RPS, 2021)

Figure 2-7: Monthly wind rose distributions derived from CFSR model from 2008 to 2017 (inclusive), for the wind node closest to the B2 and M2A release locations.

Historical air quality data is available from the Environment Protection Authority (EPA) Victoria air quality monitoring stations, and Cape Grim Baseline Air Pollution Station on Tasmania's west coast, which is one of the three premier baseline air pollution stations in the World Meteorological Organisation-Global Atmosphere Watch (WMO-GAW) network, measuring greenhouse and ozone depleting gases and aerosols in clean air environments.

The Victorian air quality data is collected at 15 performance monitoring stations representing predominantly urban and industrial environments in the Port Phillip and Latrobe Valley regions of Victoria. Results are assessed against the requirements of the National Environment Protection (Ambient Air Quality) Measure for the pollutants carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), sulfur dioxide (SO_2), lead (Pb), particles less than 10 micrometres in diameter (PM_{10}) and particles less than 2.5 micrometres in diameter ($PM_{2.5}$). The most recent annual air monitoring report shows Victoria's air quality in 2015 was generally good with AAQ NEPM (Ambient Air Quality National Environmental Protection Measure) goals and standards being met for carbon monoxide (CO), nitrogen dioxide (NO2), Ozone (O3) and sulphur dioxide (SO_2). There were some exceedances for particles.

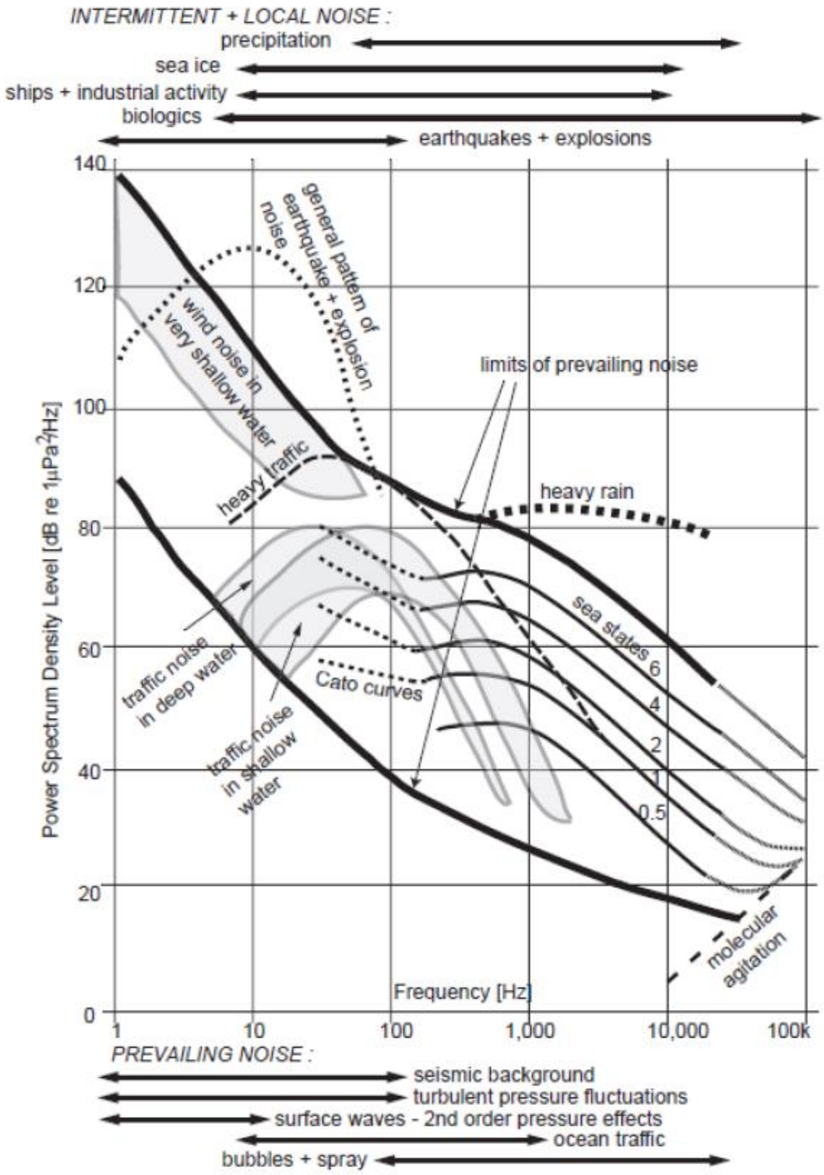
The Cape Grim station monitors greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and synthetic GHGs such as hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulfur hexafluoride (SF_6). Historical air quality data from Cape Grim show that most GHGs have shown continuous increases in concentration since the mid-to-late 1970s with carbon dioxide levels increasing by more than 15% since 1976, and concentrations of methane and nitrous oxide increasing by around 20% and 8% respectively since 1978. The increase in methane levels however has slowed recently and CFCs and halons are in decline. Increases have been attributed to anthropogenic causes, for example, fossil fuel consumption and agricultural practices (CSIRO, 2017). Increases have been attributed to anthropogenic causes, for example, fossil fuel consumption and agricultural practices (CSIRO, 2020).

2.4 Underwater Noise

Physical and biological processes contribute to natural background sound. Physical processes include that of wind and waves whilst biological noise sources include vocalisations of marine mammals and other marine species.

Iceberg calving, shoaling and disintegration has recently been identified as a dominant source of low frequency (<100 Hz) noise in the Southern Ocean. Wind is also a major contributor to noise between 30–100 Hz and can reach 85-95 dB re 1µPa^2/Hz under extreme conditions (WDCS, 2004). Rain may produce short periods of high underwater sound with a flat frequency spectrum to levels of 80 dB re 1µPa^2/Hz and magnitude four earthquakes have been reported to have spectral levels reaching 119 dB re 1µPa^2/Hz at frequency ranges 5-15 Hz. It is noted that earthquakes of this magnitude are relatively frequent along Australia's continental shelf in the southern margin (i.e. tens of small earthquakes per year) (McCauley & Duncan, 2001). Figure 2-8 provides generalised ambient noise spectra attributable to varies sources completed by Wenz (1962; cited in Richardson *et al.* 1995).

Since 2009 (paused 2017-2018 due to funding), the Integrated Marine Observing System (IMOS) has been recording underwater sound south of Portland, Victoria (38° 32.5' S, 115° 0.1' E). Prominant sound sources identified in recordings include blue and fin whales at frequencies below 100 Hz, ship noise at 20 to 200 Hz and fish at 1 to 2 kHz (Erbe *et al.* 2016). In the Gippsland Basin, primary contributors to background sound levels were wind, rain and current- and wave-associated sound at low frequencies under 2 kHz (Przeslawski *et al.* 2016). Biological sound sources including dolphin vocalisations were also recorded (Przeslawski *et al.* 2016). Ambient noise level in the Gippsland Basin at 100-500 Hz varied depending on recording location between 89.2 to 109.9 dB re 1 µPa^2/Hz, likely due to a varied increase in distance from shipping activity, and water depth.



(Source: Richardson *et al.*, 1995)

Figure 2-8: Generalised ambient noise spectra

3 Ecological Environment

3.1 Shorelines

The coastal environment throughout southern and eastern Australia is varied, and includes areas of rocky cliffs, sandy beaches, and tidal flats (Table 3.1). Each of these shoreline types has the potential to support different flora and fauna assemblage due to the different physical factors (e.g. waves, tides, light etc.) influencing the habitat.

Smartline[1] established a nationally-consistent map of the coastal landform types (geomorphology) of continental Australia and most adjacent islands (OzCoasts, 2015a; Sharples *et al.*, 2009). The single line consists of multiple attributes describing landform characteristics of the coastal area (defined as a nominal distance of 500 m inland and offshore from mean high water), including distinct attributes for the backshore, intertidal and subtidal regions (Figure 3-1) (Sharples *et al.*, 2009).

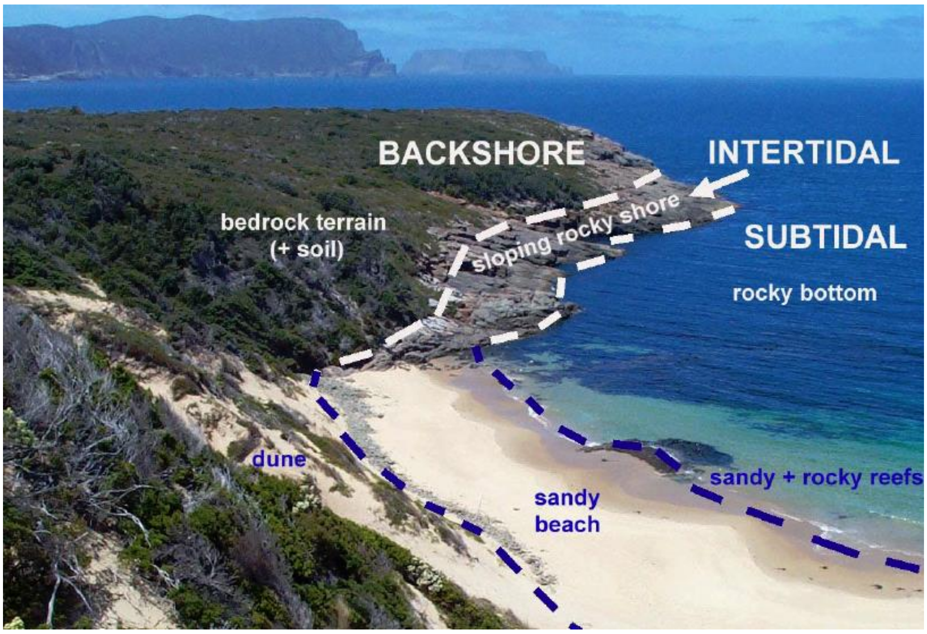
The Smartline system also includes an 'exposure' attribute, which is the degree of exposure of a shoreline segment to oceanic swell and storm wave energy (i.e. it is not a measure of actual wave energy received). The categories represent the degree of exposure or sheltering of a coastal segment; e.g. coastal lagoons and estuaries are ranked with 'very low' exposure, while open coast environments may be 'moderate' or 'high'. This attribute of Smartline was primarily sourced from previous OSRA shoreline mapping (Sharples *et al.*, 2009).

The coast of southern and eastern Australia has been mapped to show the variation in shoreline type (backshore, intertidal and subtidal attributes) and shoreline exposure (Figure 3-2).

Table 3.1: Shoreline types within the Environment Sectors

Shoreline Type	Description
Cliff	Hard and soft rock features, over five metres in height. This is a common shoreline type along stretches of the Tasmanian coast, including Cape Pillar, Cape Raoul, and Cape Hauy, on the Tasman Peninsula.
Rocky	Hard and soft rocky shores, including bedrock outcrops, platforms, low cliffs (less than five metres), and scarps. Depending on exposure, rocky shores can be host to a diverse range of flora and fauna, including barnacles, mussels, sea anemones, sponges, sea snails, starfish and algae. Australian fur-seals are also known to use rocky shores for haul-out and/breeding. This is common shoreline along southern and eastern Australian coasts, including the limestone coast and features along the Great Ocean Road, Victoria.
Gravel/Cobble	Beaches dominated by unconsolidated sediment with particle sizes > 2mm. Gravel beaches are typically steeper than sandy beaches, and fauna can include a variety of infauna, or small crustaceans. These are often co-located near cliff or rocky shoreline types; therefore similarly, are quite common along the southern Tasmania coast.
Sandy	Beaches dominated by sand-sized (0.063–2 mm) particles; also includes mixed sandy beaches (i.e. sediments may include muds or gravel, but sand is the dominant particle size). Sandy beaches are dynamic environments, naturally fluctuating in response to external forcing factors (e.g. waves, currents etc). Sandy beaches can support a variety of infauna and provide nesting and/or foraging habitat to shorebirds and seabirds and pinnipeds. Sand particles vary in size, structure and mineral content; this in turn affects the shape, colour and inhabitants, of the beach. This shoreline type is very common along the entire coast, including Ninety Mile Beach (East Gippsland, Victoria) and Apollo Bay (east of Cape Otway, Victoria).
Muddy	Shores with predominantly muddy (particle sizes <0.063 mm) shores. May also include mixed sediments (e.g. sands or gravel), where the mud fraction is dominant. This shoreline type typically occurs in more sheltered environments like estuaries or bays, including River Tamar estuary in northern Tasmania.
Tidal Flat	Shorelines exposed to high tidal variation; includes both sandy and muddy sediments. This shoreline type can often be associated with mangrove or saltmarsh environments. This shoreline type is typically patchy in southern Australia but does occur (e.g. Corner Inlet, Victoria); it is more common in northern Australia (e.g. Queensland).
Artificial	Man-made structures along the coast, including breakwaters, piers, jetties. This is a common feature in urban areas, although does not typically extend for long stretches of coast.

[1] The Smartline Project was commissioned by Department of Climate Change and Geoscience Australia in 2007.



(Source: Sharples *et al.*, 2009)

Figure 3-1: Example illustration showing Backshore, Intertidal and Subtidal zones within a coastal area

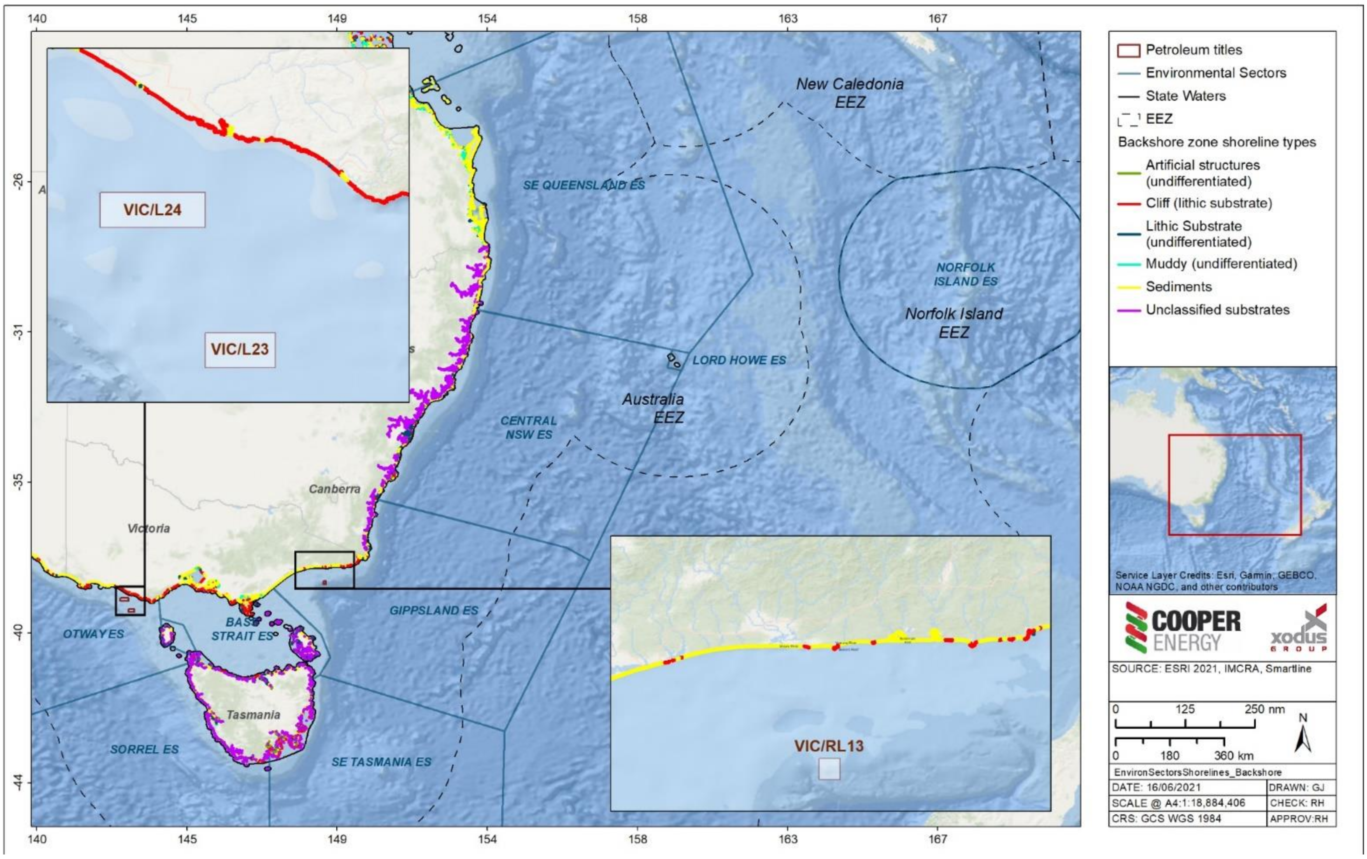


Figure 3-2: Shoreline types (Backshore) and Shoreline Exposure within the Environment Sectors

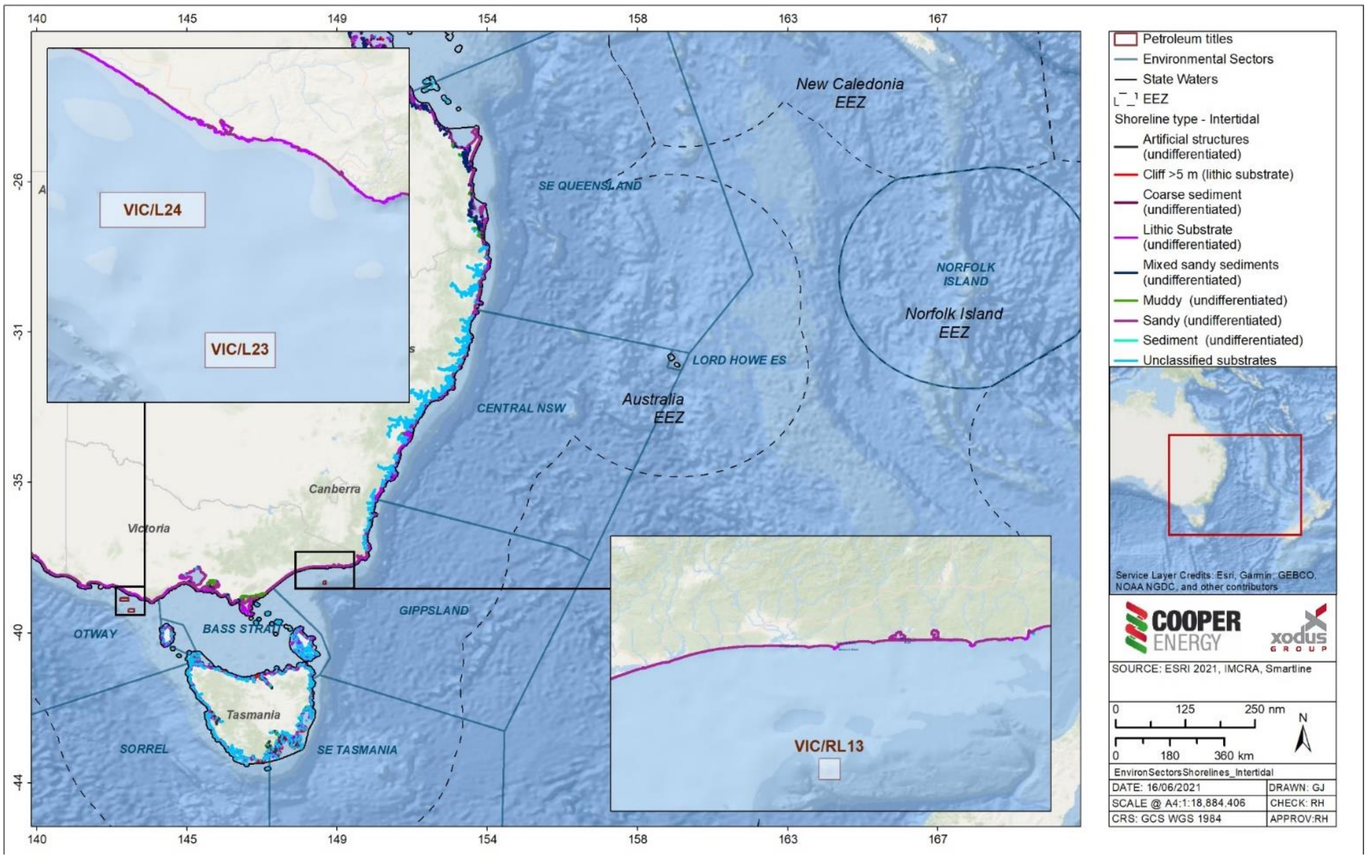


Figure 3-3: Shoreline types (Intertidal) and Shoreline Exposure within the Environment Sectors

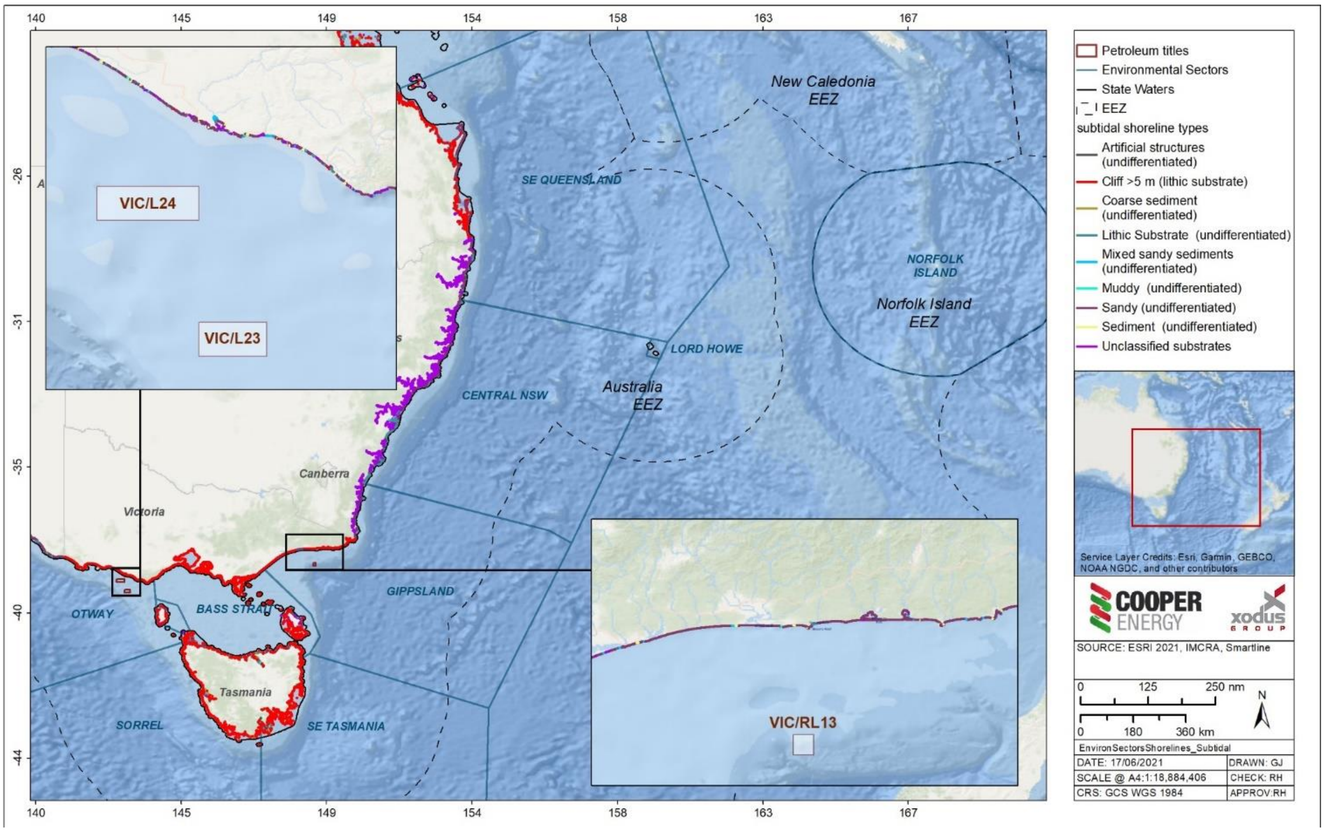


Figure 3-4: Shoreline types (Subtidal) and Shoreline Exposure within the Environment Sectors

3.2 Mangroves

Mangroves have been recorded in all Australian coastal states except Tasmania (Table 3.2, Figure 3-5). Mangroves grow in intertidal mud and sand, with specially adapted aerial roots (pneumatophores) that provide for gas exchange during low tide (McClatchie *et al.*, 2006). Mangrove forests can help stabilise coastal sediments, provide a nursery ground for many species of fish and crustacean, and provide shelter or nesting areas for seabirds (McClatchie *et al.*, 2006).

The mangroves in Victoria, found mostly along sheltered sections of the coast within inlets or bays, are the most southerly extent of mangroves found in the world (MESA, 2015). One species of mangrove, the white or grey mangrove (*Avicennia marina*) is the only species found in Victoria and is known to occur at Western Port and Corner Inlet, and also at larger estuaries like the Yarran and Barwon Rivers (Figure 3-5). The number of mangrove species increases as they occur further north, with six species found in New South Wales, and 39 in Queensland (MESA, 2015). In New South Wales, mangroves typically occur within tidal estuaries, coastal lakes and bays; but can occur across a diverse range of coastal and estuarine environments in Queensland (MESA, 2015).

The Estuarine, Coastal and Marine (ECM) National Habitat Map project[2] established a nationally consistent set of broad-scale habitat maps for Australia (Mount and Bricher, 2008). For the intertidal and subtidal environment, an area extending between approx. highest astronomical tide (HAT) and the outer limit of the photic benthic zone (approximately the 50-70 m depth contour), habitat classes were attributed using the National Intertidal/Subtidal Benthic (NISB) habitat classification scheme. The 'Mangrove Dominated' habitat class includes areas with greater than 10% coverage of mangroves (Figure 3-5) (Mount and Bricher, 2008; OzCoasts 2015b).

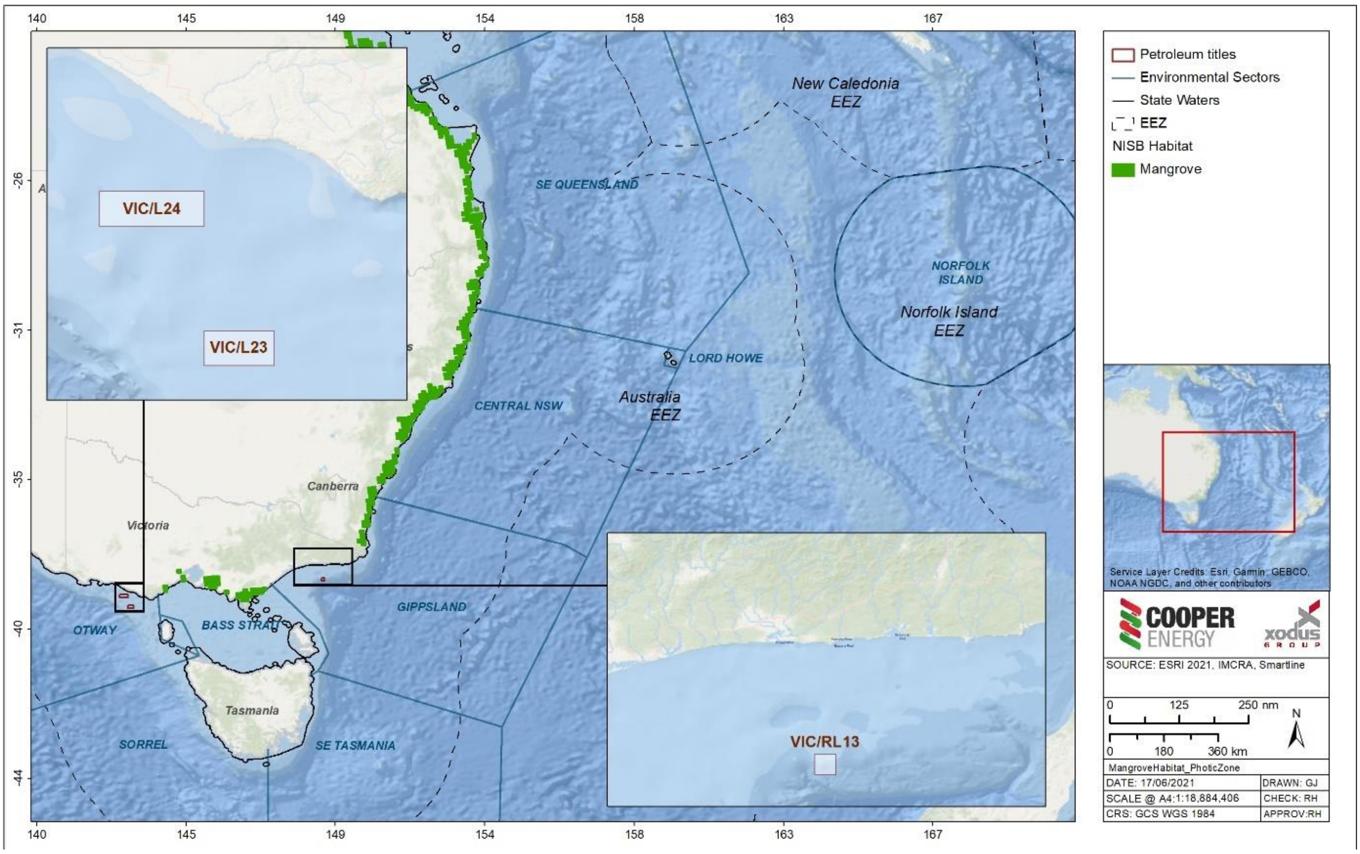
Table 3.2: Presence of mangroves within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Mangroves (Dominant Habitat)[1]		✓	✓			✓	✓	✓	

Notes:

1. Mangrove as a dominant intertidal/subtidal habitat determined from national mapping available from OzCoasts (2015b), and local flora reports for Lord Howe Island (Sheringham *et al.,* 2016).

[2] The Estuarine, Coastal and Marine National Habitat Map project was prepared for Department of Climate Change, and Land & Water Australia (specifically the National Land and Water Resources Audit).



Note: Map shows the 'mangrove dominated' habitat from the NISB Habitat Classification Scheme

Figure 3-5: Distribution of mangrove dominated habitat within the photic zone

3.3 Saltmarshes

Saltmarshes are terrestrial halophytic (salt-adapted) ecosystems that mostly occur in the upper-intertidal zone, and are widespread along the coast (Table 3.3, Figure 3-6). The 'Saltmarsh Dominated' habitat class includes areas with greater than 10% coverage of saltmarshes (Mount and Bricher, 2008; OzCoasts 2015b).

They are typically dominated by dense stands of halophytic plants such as herbs, grasses and low shrubs. The diversity of saltmarsh plant species increases with increasing latitude (in contrast to mangroves). The vegetation in these environments is essential to the stability of the saltmarsh, as they trap and bind sediments. The sediments are generally sandy silts and clays and can often have high organic material content. Saltmarshes provide a habitat for a wide range of both marine and terrestrial fauna, including infauna and epifaunal invertebrates, fish and birds.

Saltmarsh is found along many parts of the Victorian coast, although is most extensive in western Port Phillip Bay, northern Western Port, within the Corner Inlet-Nooramunga complex, and behind the sand dunes of Ninety Mile Beach in Gippsland (Boon *et al.*, 2011) (Figure 3-6). Saltmarsh environments are much more common in northern Australia (e.g. Queensland), compared to the temperate and southern coasts (i.e. New South Wales, Victoria, Tasmania) (Boon *et al.*, 2011).

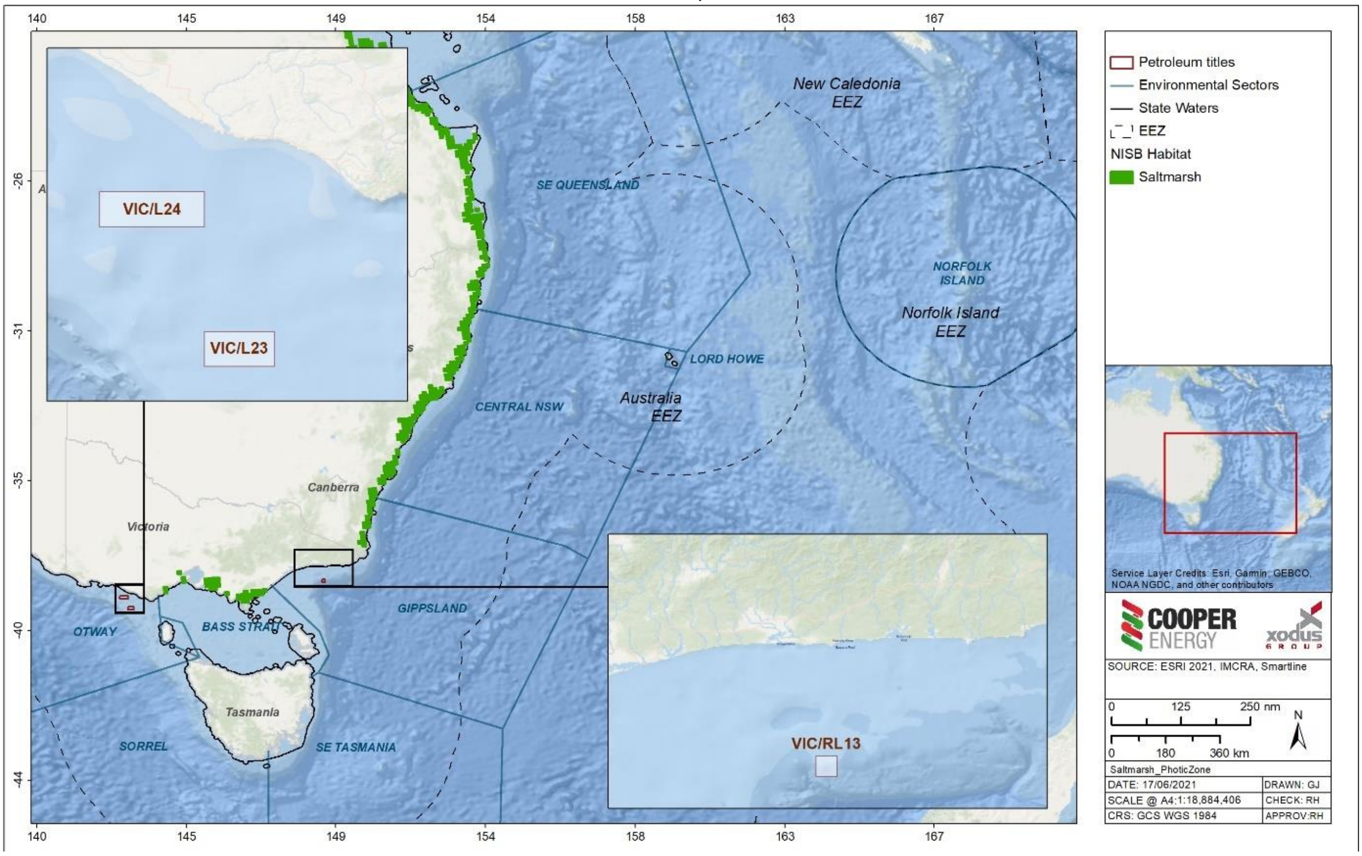
Table 3.3: Presence of saltmarsh within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Saltmarsh (Dominant Habitat)[1]	✓	✓	✓	✓	✓	✓	✓	✓	

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
TEC: Subtropical and Temperate Coastal Saltmarsh[2]	✓	✓	✓	✓	✓	✓	✓		

Notes:

1. Saltmarsh as a dominant intertidal/subtidal habitat determined from national mapping available from OzCoasts (2015b), and local flora reports for Lord Howe Island (Sheringham *et al.,* 2016).
2. Presence of TEC determined from EPBC Protected Matters search reports.



Note: Map shows the 'saltmarsh dominated' habitat from the NISB Habitat Classification Scheme

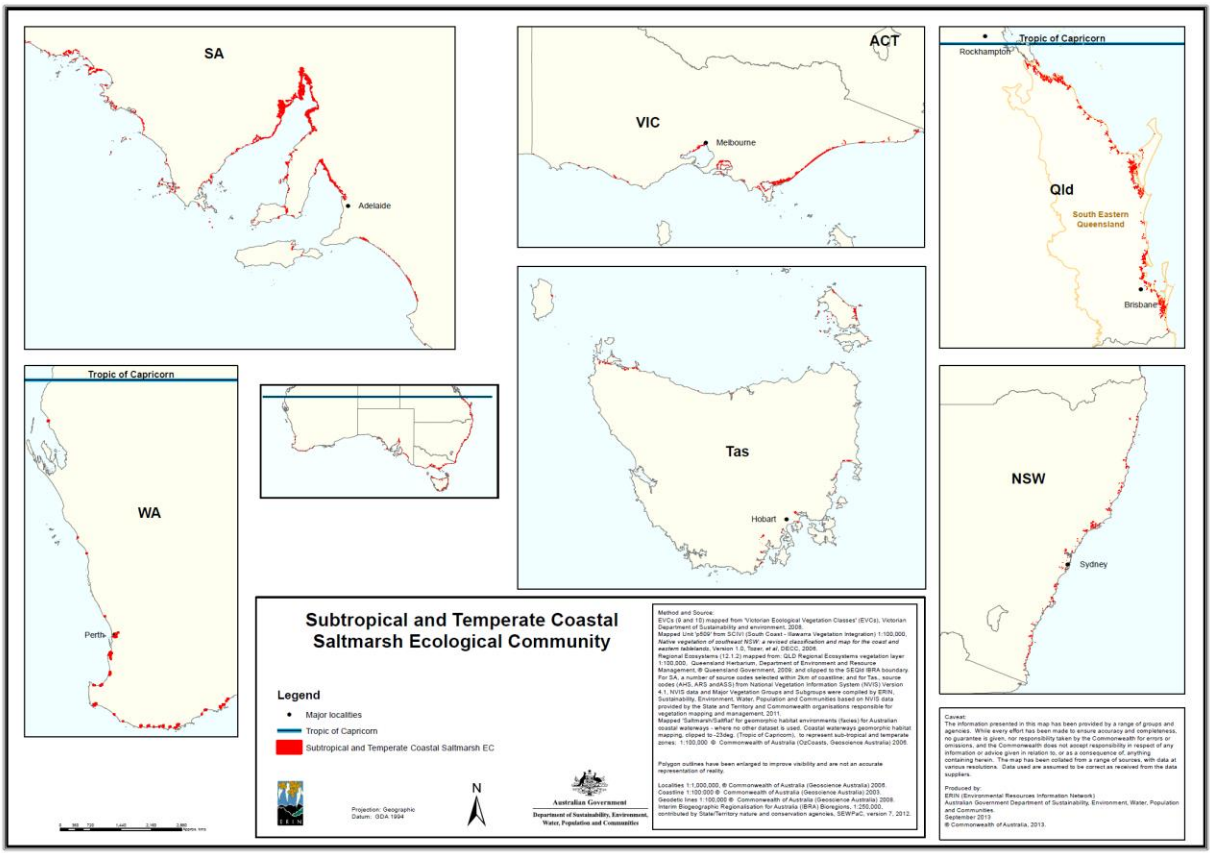
Figure 3-6: Distribution of saltmarsh dominated habitat within the photic zone

3.3.1 TEC: Subtropical and Temperate Coastal Saltmarsh

The 'Subtropical and Temperate Coastal Saltmarsh' is listed as a vulnerable Threatened Ecological Community (TEC) under the EPBC Act, and it's known distribution includes the southern and eastern coasts of Australia (Table 3.3, Figure 3-7). The Subtropical and Temperate Coastal Saltmarsh ecological community occurs within a relatively narrow margin along the Australian coast, within the subtropical and temperate climatic zones; and includes coastal saltmarsh occurring on islands within these climatic zones (TSSC, 2013a). The physical environment for the ecological community is coastal areas under regular or intermittent tidal influence (TSSC, 2013a).

The ecological community consists mainly of salt-tolerant vegetation (halophytes) including grasses, herbs, sedges, rushes and shrubs (TSSC, 2013a). Many species of non-vascular plants are also found in saltmarsh, including epiphytic algae, diatoms and cyanobacterial mats (TSSC, 2013a). The ecological community is inhabited by a wide range of infaunal and epifaunal invertebrates, and temporary inhabitants such as prawns, fish and birds (and can often constitute important nursery habitat for fish and prawn species) (TSSC, 2013a). Insects are also abundant and an important food source for other fauna, with some species being important pollinators (TSSC, 2013a). The dominant marine residents are benthic invertebrates, including molluscs and crabs that rely on the sediments, vascular plants, and algae, as providers of food and habitat across the intertidal landscape (TSSC, 2013a).

The key threats affecting the ecological community include: clearing and fragmentation, infilling, altered hydrology/tidal restriction, invasive species, climate change, mangrove encroachment, damage from recreational activities, pollution (including oil spills), eutrophication, acid sulphate soils, grazing, insect control, salt and other mining activities, and inappropriate fire regimes (TSSC, 2013a).



(Source: TSSC, 2013a)

Figure 3-7: Distribution of the TEC Subtropical and Temperate Coastal Saltmarsh

3.4 Coastal Vine Thickets

3.4.1 TEC: Littoral Rainforest and Coastal Vine Thickets of Eastern Australia

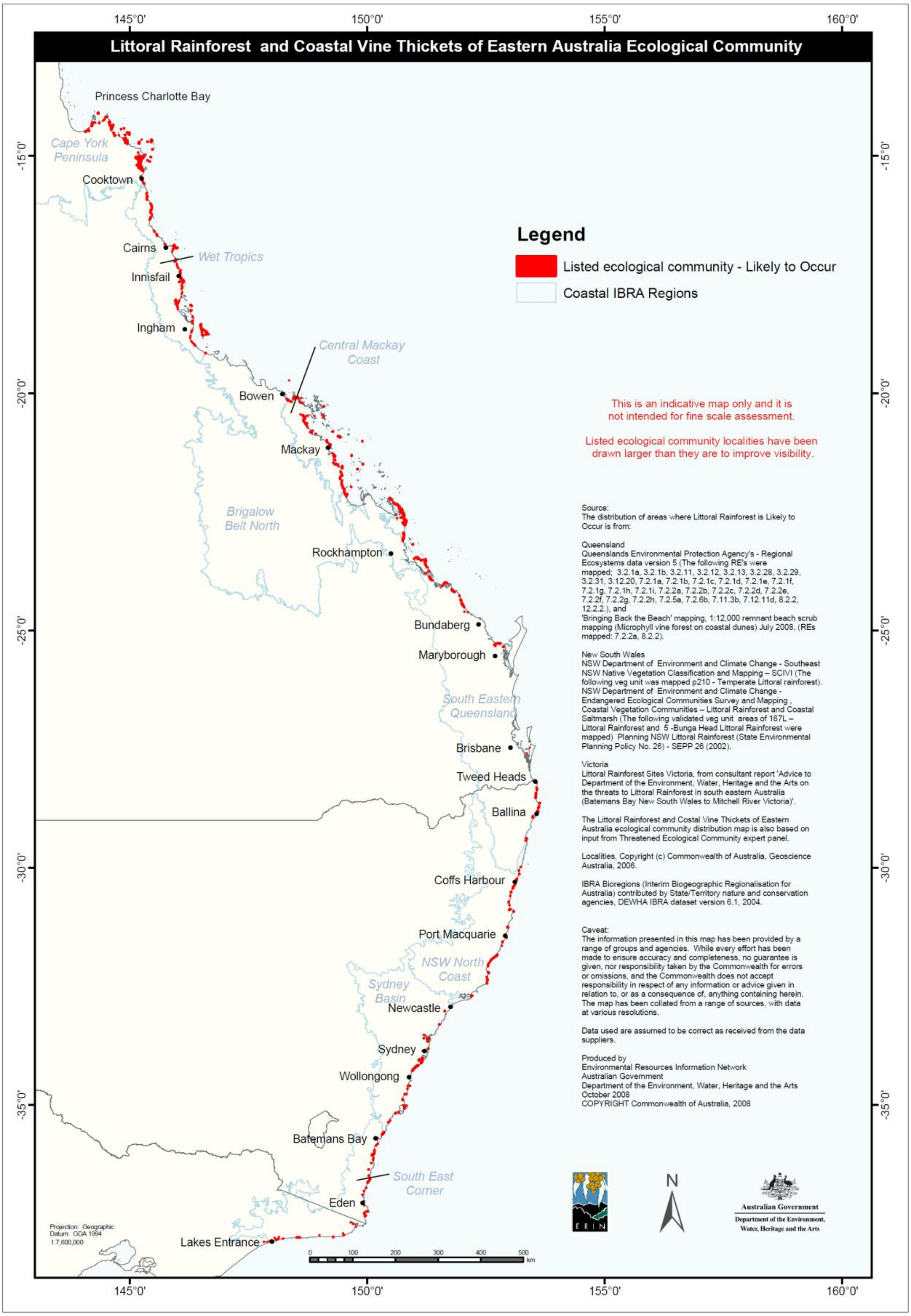
The 'Littoral Rainforest and Coastal Vine Thickets of Eastern Australia' is listed as a critically endangered TEC under the EPBC Act. The ecological community is a complex of rainforest and coastal vine thickets on the east coast of Australia influenced by its proximity to the sea; and provides habitat for over 70 threatened plants and animals, and also provides an important buffer to coastal erosion and wind damage (TSSC, 2015a; DEWHA 2009a).

The ecological community occurs within two kilometres of the eastern coastline of Australia, including offshore islands, from Princess Charlotte Bay, Cape York Peninsula to the Gippsland Lakes in Victoria (TSSC, 2015a) (Table 3.4, Figure 3-8). It occurs as a series of naturally disjunct and localised stands, on a range of landforms which have been influenced by coastal processes including dunes and flats, headlands and sea-cliffs (DEWHA, 2009a).

Table 3.4: Presence of coastal vine thickets within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
TEC: Littoral Rainforest and Coastal Vine Thickets of Eastern Australia[1]			✓			✓	✓		

Notes:
1. Presence of TEC determined from EPBC Protected Matters search reports.



(Source: DEWHA, 2009a)

Figure 3-8: Distribution of the TEC Littoral Rainforest and Coastal Vine Thickets of Eastern Australia

3.5 Soft Sediment

Unvegetated soft sediments are a widespread habitat in both intertidal and subtidal areas, particularly in areas beyond the photic zone. Within the photic zone, this habitat appears more common through southern Australia, than along the east coast (Figure 3-9). The ‘Sediment Dominated Habitat’ class includes all areas dominated by particles of gravel size or smaller (i.e. including sands and silts) (Figure 3-9) (Mount and Bricher, 2008; OzCoasts 2015b). The biodiversity and productivity of soft sediment habitat can vary depending upon depth, light, temperature and the type of sediment present.

The substrate across Bass Strait comprises a variety of sediment types, with sediment particle size associated with tidal currents and wave energy. Near-shore sediments consist of coarse sands with isolated areas of gravels, shells and pebbles; and become progressively finer offshore (Esso, 2009). The inshore seabed of Bass Strait consists of symmetrical, wave-generated sandy ripples, becoming shelly in troughs as the depth increases. Finer, muddy sands occur further offshore in the mid-shelf regions (Esso, 2009).

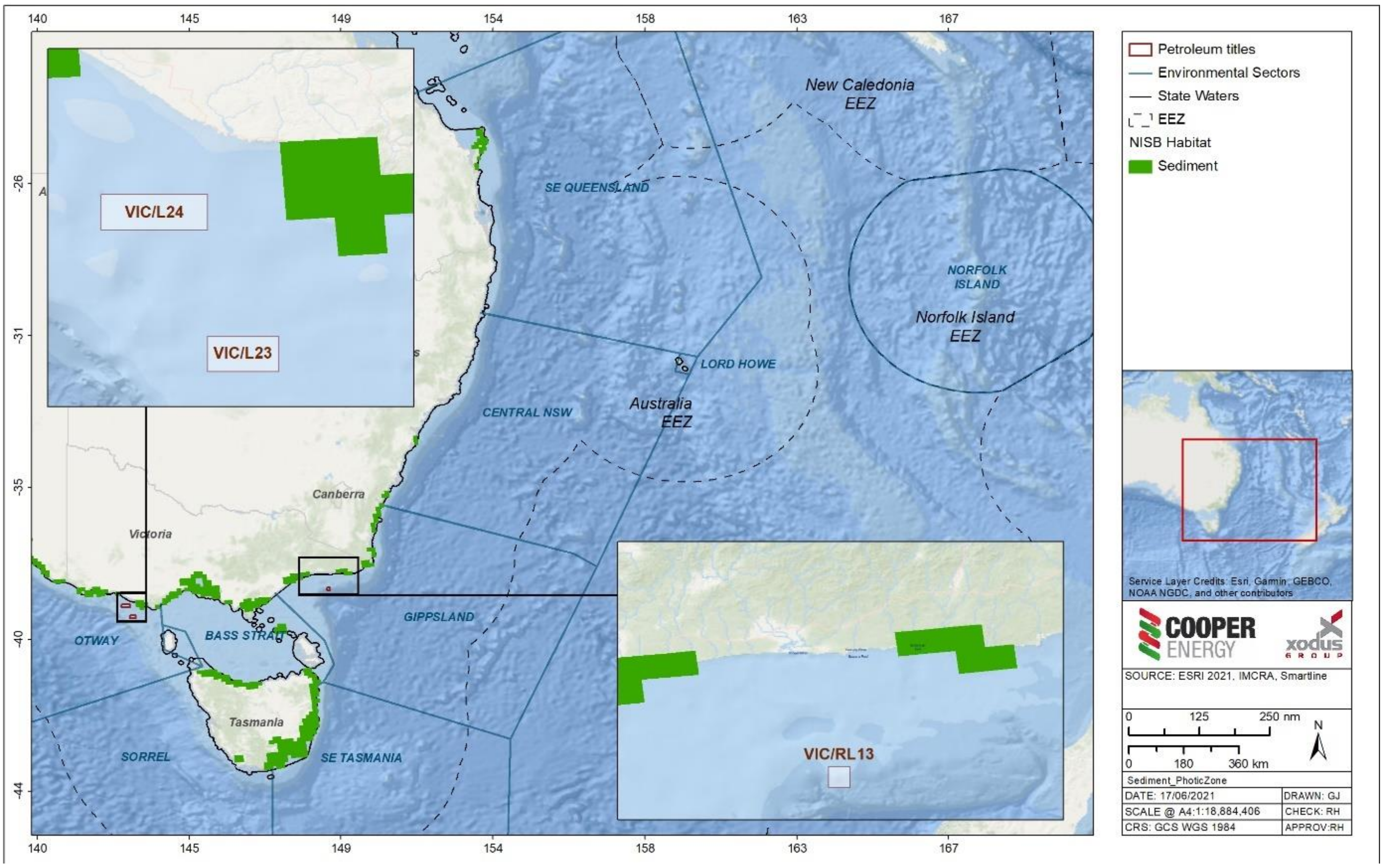
In the Gippsland Basin, seabed material is predominantly calcium carbonate comprised of calcarenite marls and marine shales (Esso, 2009). The Gippsland Basin is composed of a series of massive sediment flats, interspersed with small patches of reef, bedrock and consolidated sediment, submarine canyons, escarpments and a knoll that juts out from the base of the continental slope (Cooper Energy, 2017). The fine to course sandy plains and areas of shell are only occasionally broken by low ribbons of reef; however, these reefs do not support the large brown seaweeds characteristic of many Victorian reefs, but instead are inhabited by resilient red seaweeds and encrusting animals that can survive the sandy environment (Esso, 2009).

A survey undertaken along the Patricia-Baleen pipeline identified four general habitat associations on the seabed (Cooper Energy, 2017):

1. Medium sand and shell grit; extensive areas with pronounced sand waves. Epibiotic was generally sparse to commonly occurring sea pens, occasional sponges and stalked colonial ascidians.
2. Shell accumulations; areas of seabed comprised of old large shells, predominantly bivalves and scallops.
3. Sponge garden; small and distinct area of large sponges and bryzoans at approximately 50 m water depth. Sponges included fans, spheres, massives, cups and fingers. Bryzoans included lace-like corals, concertina fans, perforated rigid sheets and fern-like branches. This suggests that although the seabed is predominantly sand and grit it is stable enough to allow these associations to grow. Sponge gardens attracted schools of jackass morwong, butterfly perch and individual gurnard and leatherjackets.
4. Introduced New Zealand screw shell aggregations; NZ screw shell (*Maoricolpus roseus*) was commonly found at water depths greater than 40 m, sometimes forming dense beds covering 100% of the seabed.

A survey of the sole pipleline route showed a featureless seabed comprised of clays, silts, sands and gravel, and some consolidated bedded sediments (Cooper Energy, 2018). Extensive demersal fishing in the area may have resulted in modified seabed biota due to trawling and netting activities (CEE, 2003).

Scientific surveys have shown that some shallow Victorian sandy environments have the highest levels of animal diversity in the sea ever recorded (Parks Victoria, 2016). In the area around the Ninety Mile Beach Marine National Park in Gippsland more than 600 different marine animal species, many of them very small, have been found within an area of 10 m^2 (Parks Victoria, 2016). Larger animals found in these soft sediment environments in Victoria have included smooth stingray (*Dasyatis brevicaudata*), pipi (*Plebidonax deltoids*), dumpling squid (*Euprymna tasmanica*), common stargazer (*Kathetostoma leave*) and heart urchin (*Echinocardium cordatum*) (Parks Victoria, 2016).



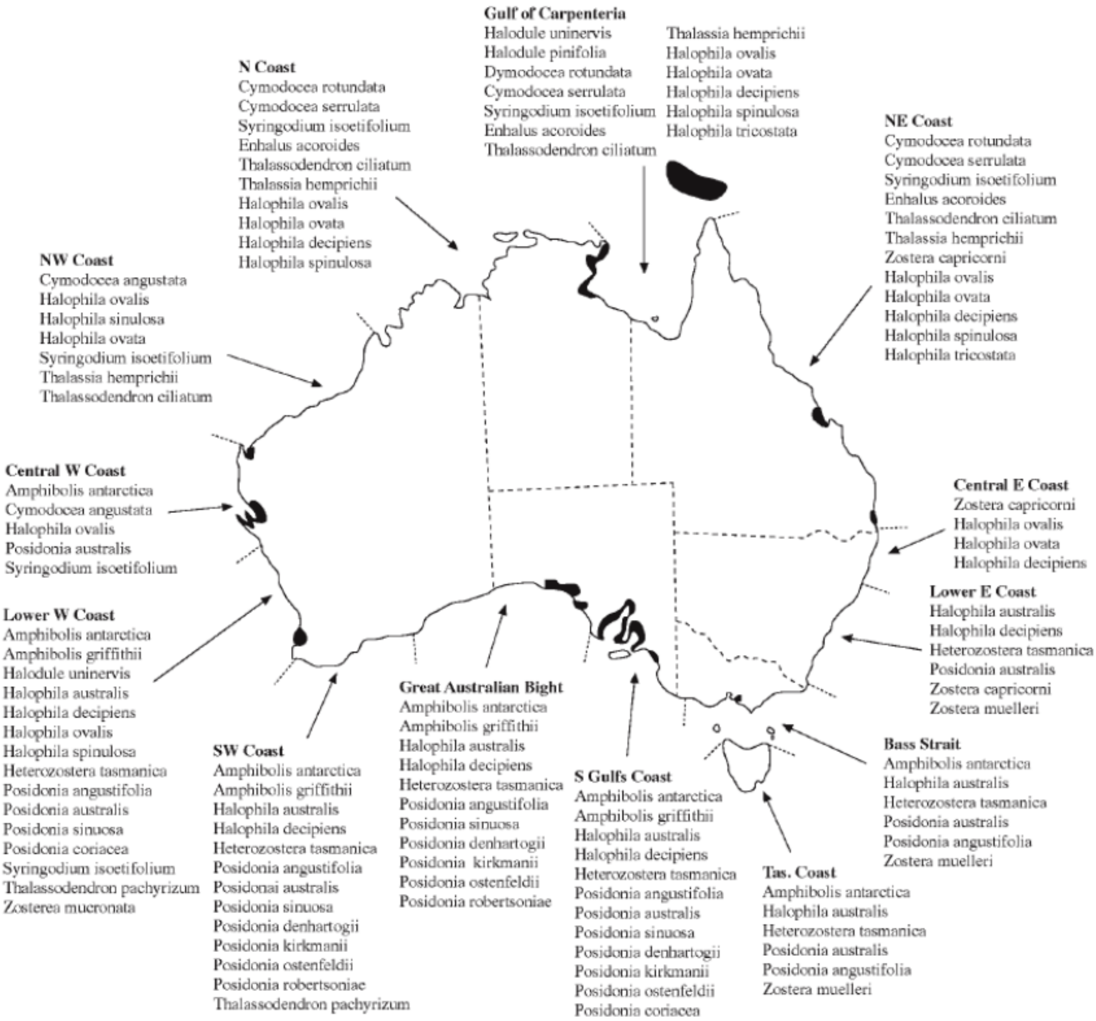
Note: Map shows the 'sediment and sand dominated' habitat from the NISB Habitat Classification Scheme

Figure 3-9: Distribution of sediment dominated habitat within the photic zone

3.6 Seagrass

Seagrasses are marine flowering plants, with about 30 species found in Australian waters (Huisman, 2000). There is a distinction between tropical and temperate seagrasses, and the approximate latitude for the change occurs at Moreton Bay (southern Queensland) (Kirkham, 1997); the variation in seagrass species around Australia is shown in Figure 3-10. While seagrass meadows are present throughout southern and eastern Australia (Table 3.5, Figure 3-11), the proportion of seagrass habitat within the south-eastern sector is not high compared to the rest of Australia (in particular with parts of South Australia and Western Australia) (Kirkham, 1997). The mapped 'Seagrass Dominated' habitat class includes areas with greater than 5% coverage of seagrass (Figure 3-11) (Mount and Bricher, 2008; OzCoasts 2015b).

Seagrass generally grows in soft sediments within intertidal and shallow subtidal waters where there is sufficient light, and are common in sheltered coastal areas such as bays, lees of islands and fringing coastal reefs (McClatchie *et al.*, 2006; McLeay *et al.*, 2003). Known seagrass meadows within this stretch of coast include Jervis Bay and Botany Bay (New South Wales), Norfolk Bay and Pittwater (south-eastern Tasmania), Corner Inlet, Port Phillip Bay and Western Port Bay (Victoria), and Moreton Bay (Queensland). Seagrass meadows are important in stabilising seabed sediments, and providing nursery grounds for fish and crustaceans, and a protective habitat for the juvenile fish and invertebrates species (Huisman, 2000; Kirkman, 1997).



(Source: Kirkham, 1997)

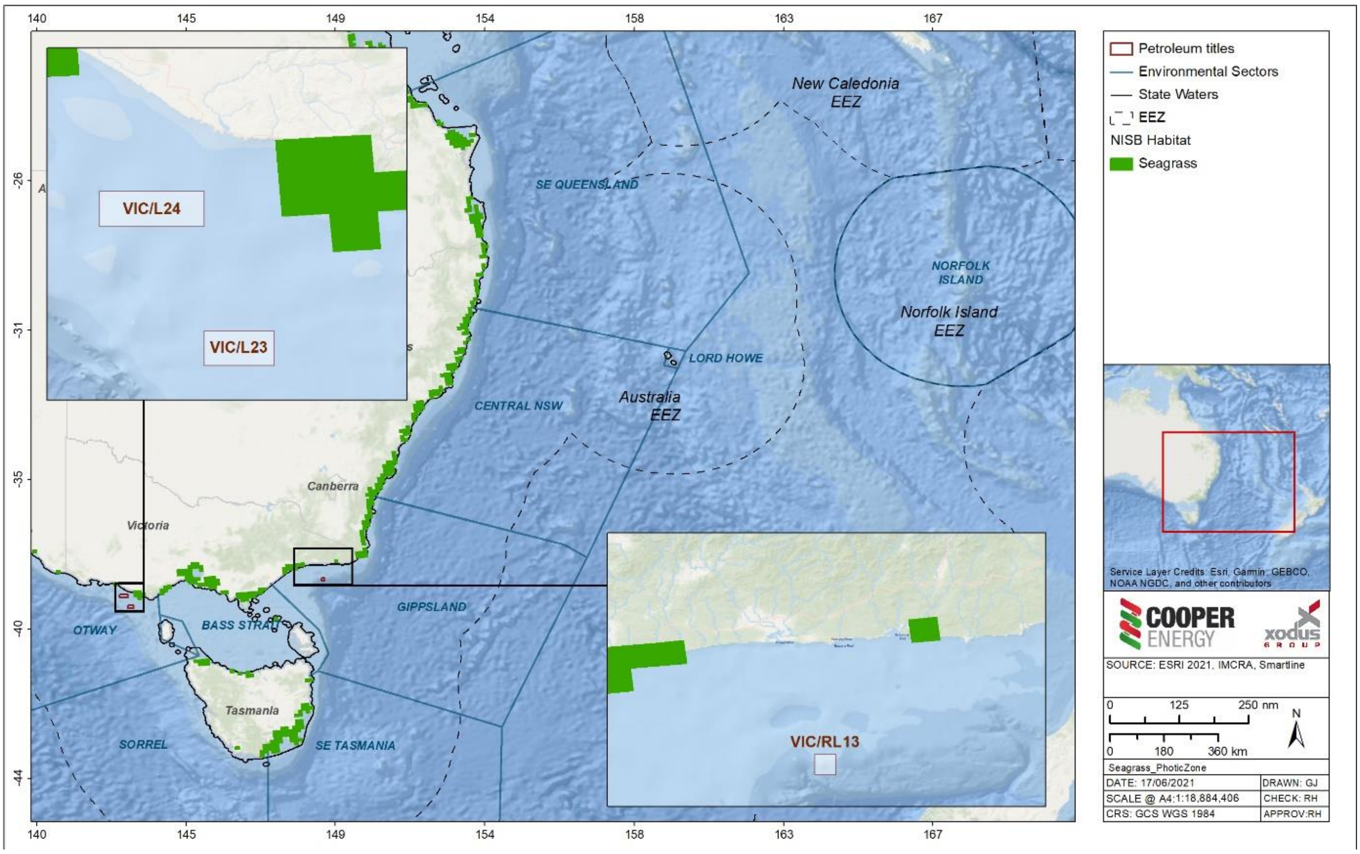
Figure 3-10: Distribution of seagrass species along the Australian coast

Table 3.5: Presence of seagrass within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Seagrass (Dominant Habitat)[1]	✓	✓	✓	✓	✓	✓	✓	✓	
TEC: *Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion[2]						✓			

Notes:

1. Seagrass as a dominant intertidal/subtidal habitat determined from national mapping available from OzCoasts (2015b), and local flora reports for Lord Howe Island (NSW DPI, no date).
2. Presence of TEC determined from EPBC Protected Matters search reports.



Note: Map shows the 'seagrass dominated' habitat from the NISB Habitat Classification Scheme

Figure 3-11: Distribution of seagrass dominated habitat within the photic zone

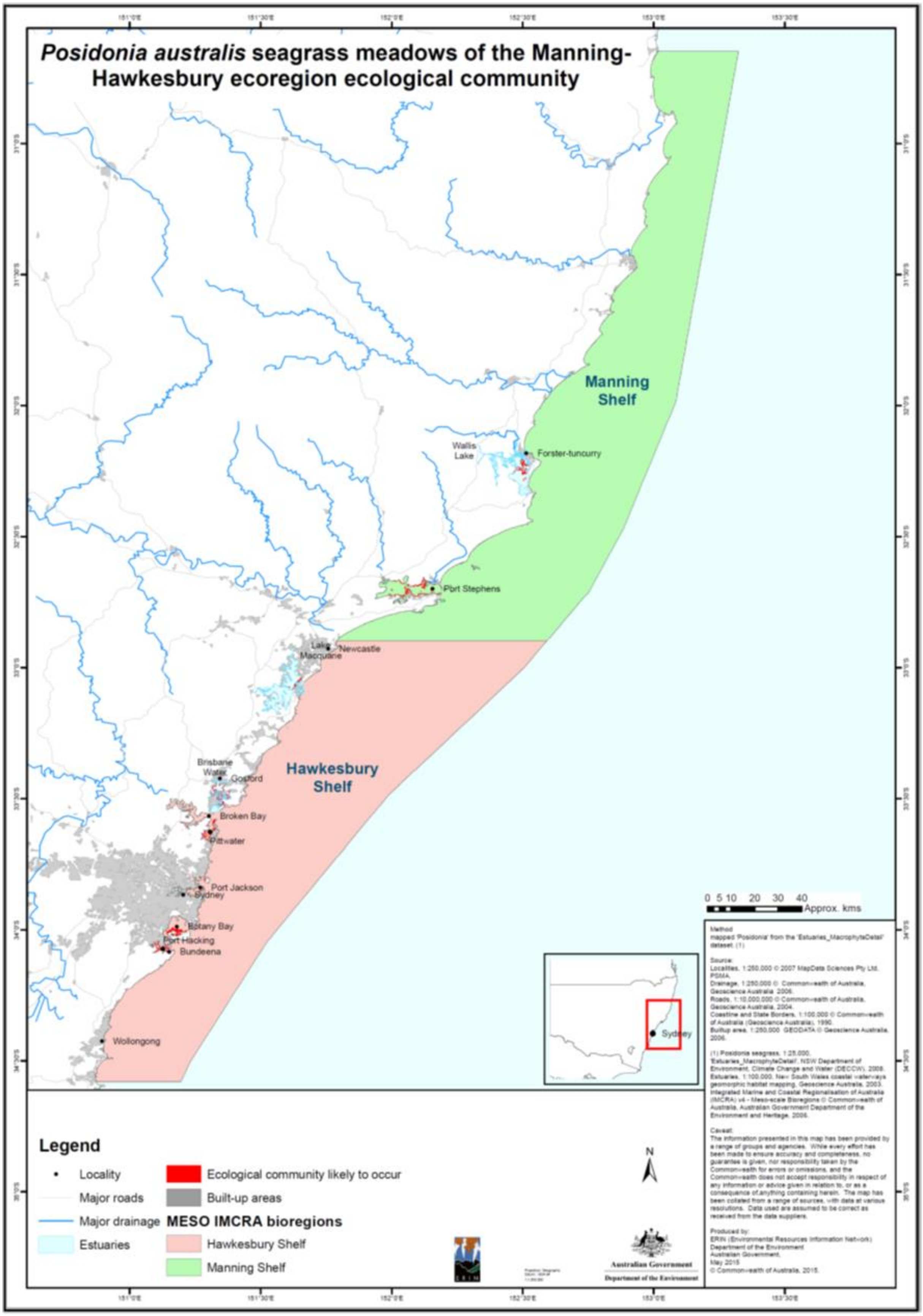
3.6.1 TEC: *Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion

The '*Posidonia australis* seagrass meadows of the Manning-Hawkesbury ecoregion' is listed as an endangered TEC under the EPBC Act. The ecological community is the assemblage of plants, animals and micro-organisms associated with seagrass meadows (dominated by *Posidonia australis*) that occurs within the warm temperate Manning Shelf and Hawkesbury Shelf bioregions (TSSC, 2015b). The ecological community occurs mostly within the sheltered environments of permanently open estuaries along the New South Wales coast; and is known to occur at Wallis Lake, Port Stephens, Lake Macquarie, Brisbane Water, Hawkesbury River, Pittwater, Port Jackson (Sydney Harbour), Botany Bay, Port Hacking, and Broughton Island (Table 3.5, Figure 3-12) (TSSC, 2015b).

The ecological community provides important ecosystem functions (TSSC, 2015b), including:

- 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 which 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; and
- Protect water quality and sequester carbon.

The key threats affecting the ecological community have been identified as: coastal development, dredging, boat mooring (and other boat related activities), catchment disturbance and pollution, and climate change (TSSC, 2015b).



(Source: TSSC, 2015b)

Figure 3-12: Distribution of the TEC Posidonia australis seagrass meadows of the Manning-Hawkesbury ecoregion

3.7 Algae

3.7.1 Microalgae

Benthic microalgae are ubiquitous in aquatic areas where sunlight reaches the sediment surface. Benthic microalgae are often much more highly concentrated in the surficial sediment layer in comparison to the concentration of planktonic microalgae (i.e. phytoplankton) in water (Ansell *et al.*, 1999). Benthic microalgae can assist with the exchange of nutrients across the sediment-water interface; and in sediment stabilisation due to the secretion of extracellular polymetric substances (Ansell *et al.*, 1999). Benthic microalgae can also provide a food source to grazers such as gastropod and amphipods (Ansell *et al.*, 1999).

3.7.2 Macroalgae

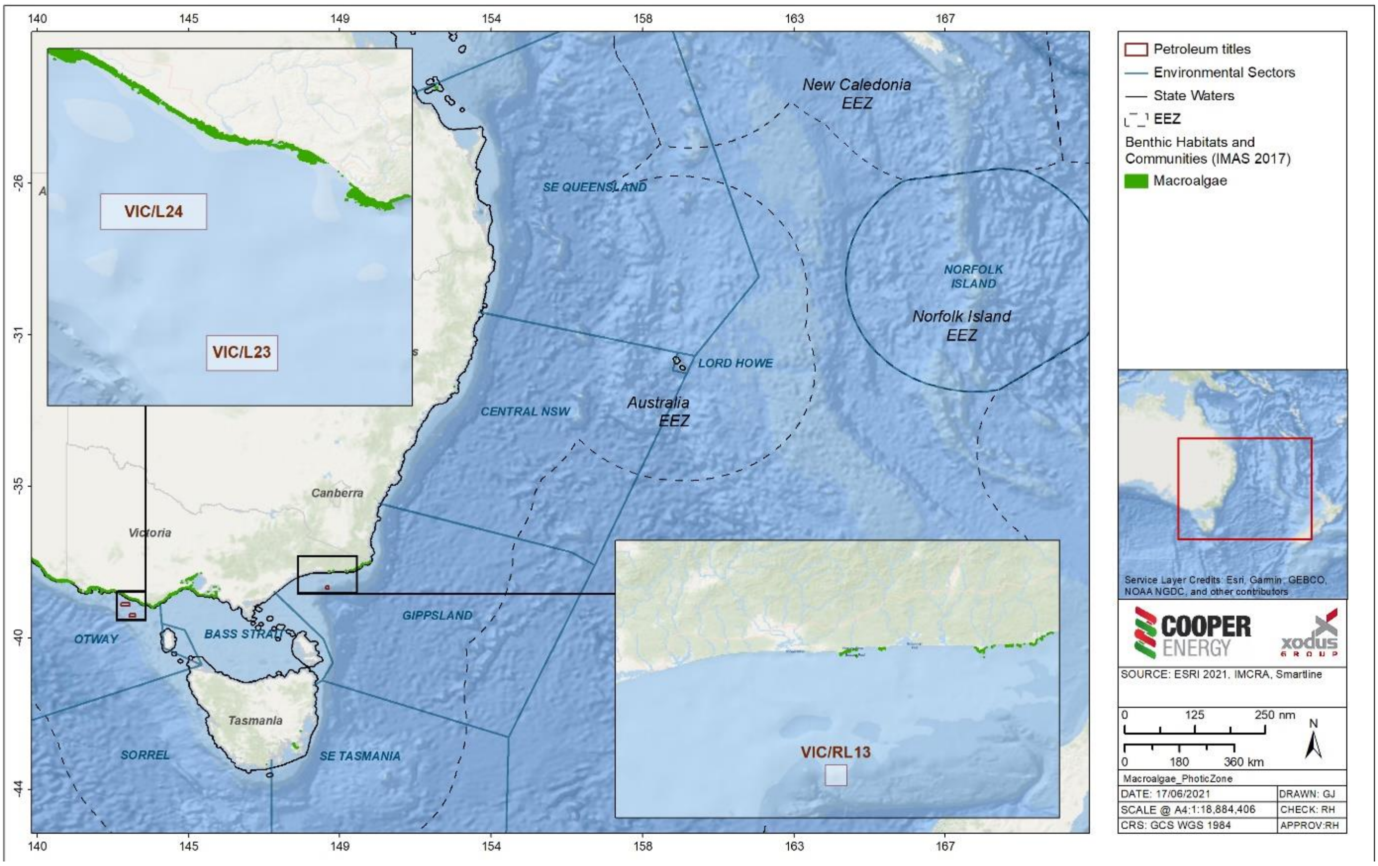
Macroalgae communities are generally found on intertidal and shallow subtidal rocky substrates and can occur throughout the Australian coast (Table 3.6). Macroalgal systems are an important source of food and shelter for many ocean species; including in their unattached drift or wrack forms (McClatchie *et al.*, 2006). Macroalgae are divided into three groups: Phaeophyceae (brown algae), Rhodophyta (red algae), and Chlorophyta (green algae). Brown algae are typically the most visually dominant and form canopy layers (McClatchie *et al.*, 2006). The principal physical factors affecting the presence and growth of macroalgae include temperature, nutrients, water motion, light, salinity, substratum, sedimentation and pollution (Sanderson, 1997). Macroalgae assemblages vary, but *Ecklonia radiata* and *Sargassum* sp. are typically common in deeper areas. Known areas of macroalgae communities within this stretch of coast include Port Philip Bay (Victoria; Figure 3-13), D'Entrecastuaux Channel and George III Reef (Tasmania), and Jervis and Botany Bays (New South Wales).

Table 3.6: Presence of macroalgae within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Macroalgae (Dominant Habitat)[1]	✓	✓	✓	✓	✓	✓	✓	✓	
TEC: Giant Kelp Marine Forests of South East Australia[2]	✓	✓	✓	✓	✓				

Notes:

1. Macroalgae as a dominant intertidal/subtidal habitat determined from national mapping available from OzCoasts (2015b), and management plans for Lord Howe Island (Commonwealth of Australia, 2002).
2. Presence of TEC determined from EPBC Protected Matters search reports.



Note: Map shows the 'macroalgae dominated' habitat from the NISB Habitat Classification Scheme

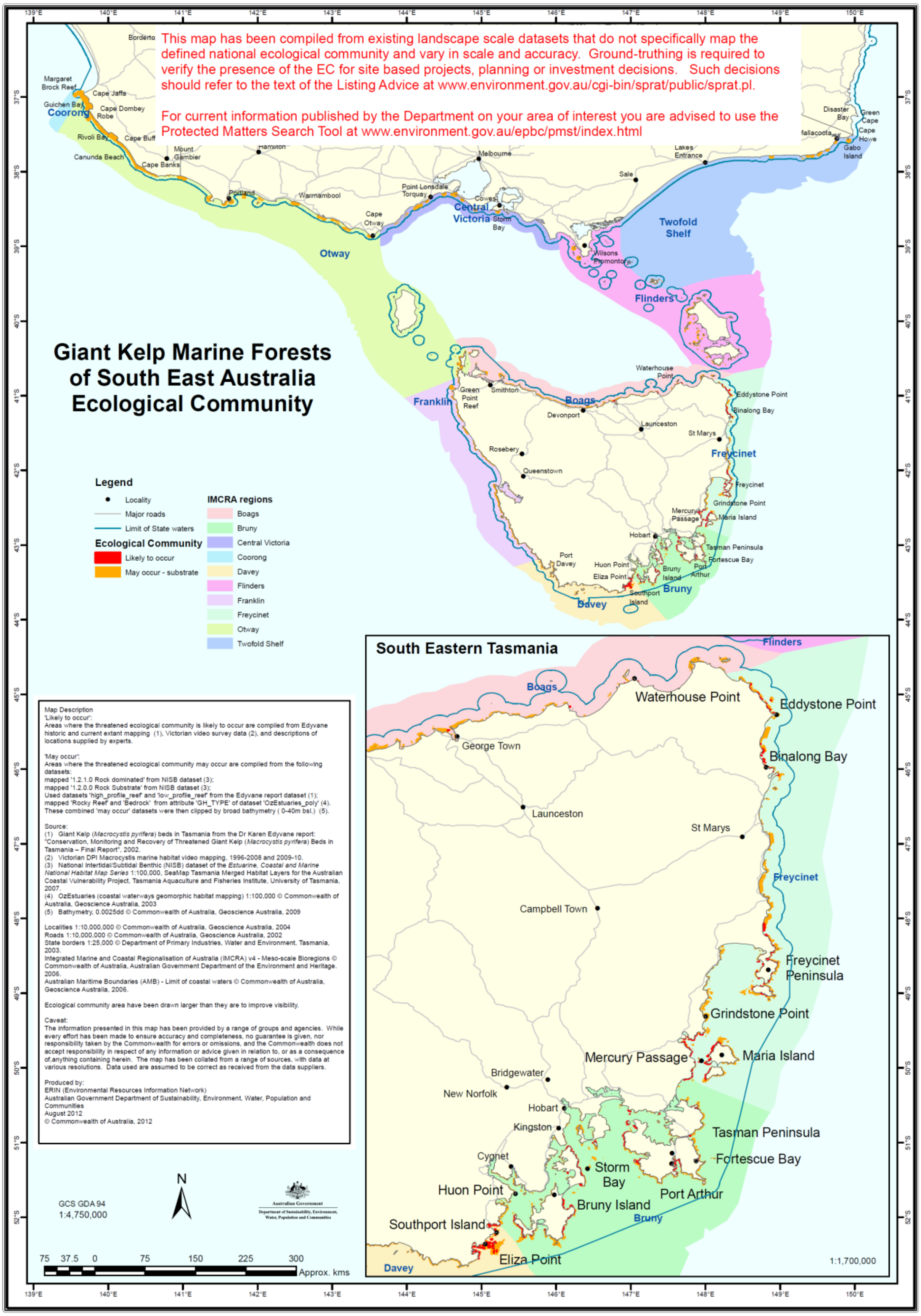
Figure 3-13: Distribution of macroalgae dominated nearshore habitat within the photic zone

3.7.3 TEC: Giant Kelp Marine Forests of South East Australia

The 'Giant Kelp Marine Forests of South East Australia' is listed as an endangered TEC under the EPBC Act and is known to occur within southern Australia (Table 3.6). The ecological community is characterised by a closed to semi-closed surface or subsurface canopy of *Macrocystis pyrifera*, and extends between the ocean floor and ocean surface, exhibiting a 'forest-like' structure with a diverse range of organisms occupying its benthic, pelagic and upper-canopy layers (TSSC, 2012a). *M. pyrifera* is the only species of kelp to provide this three-dimensional structure from the sea floor to the sea surface (TSSC, 2012a). This ecological community occurs on rocky substrate along the east and south coastlines of Tasmania; some patches may also occur in the coastal waters of western and northern Tasmania, south eastern South Australia, and Victoria (Figure 3-14) (TSSC, 2012a).

The high primary and secondary productivity of the giant kelp forests create and provide a number of ecosystem services to the local environment including settlement habitat for juvenile life stages of commercially important fisheries, improvements in local water quality conditions and coastal protection via buffering strong wave conditions from reaching the shore (TSSC, 2012a).

The key threats affecting the ecological community include increasing sea surface temperatures, changes in nutrient availability in warmer waters, changes in weather patterns and large-scale oceanographic conditions, and associated range expansion of invasive species (TSSC, 2012a). Other threats include impacts on water quality from land-based activities and aquaculture and potential loss from catastrophic storm events (TSSC, 2012a).



(Source: TSSC, 2012a)

Figure 3-14: Distribution of the TEC Giant Kelp Marine Forests of South East Australia

3.8 Coral

Corals are generally divided into two broad groups: the zooxanthellate (‘reef-building’, ‘hermatypic’ or ‘hard’) corals, which contain symbiotic microalgae (zooxanthellae) that enhance growth and allow the coral to secrete large amounts of calcium carbonate; and the azooxanthellate (‘ahermatypic’ or ‘soft’) corals, which are generally smaller and often solitary (Tzioumis and Keable, 2007). Hard corals are generally found in shallower (<50 m) waters while the soft corals are found at most depths, particularly those below 50 m (Tzioumis and Keable, 2007).

Corals may only occur as the dominant habitat type in Queensland (Table 3.7, Figure 3-15), however their presence has been recorded throughout the Temperate East Marine Region (Figure 3-16), and further south into the South-east Marine Region (e.g. Kent Group Marine Protected Area near Flinders Island; Freycinet Commonwealth Marine Park, eastern Tasmania; Wilsons Promontory National Park and Cape Otway, Victoria). The southern limit of reef development is seen at Lord Howe Island; however, many hard-coral species are present in non-reef environments in coastal areas such as Moreton Bay (Queensland) and the Solitary Islands (New South Wales) (Tzioumis and Keable, 2007). Soft corals are typically present in deeper waters throughout the continental shelf, slope and offslope regions, to well below the limit of light penetration.

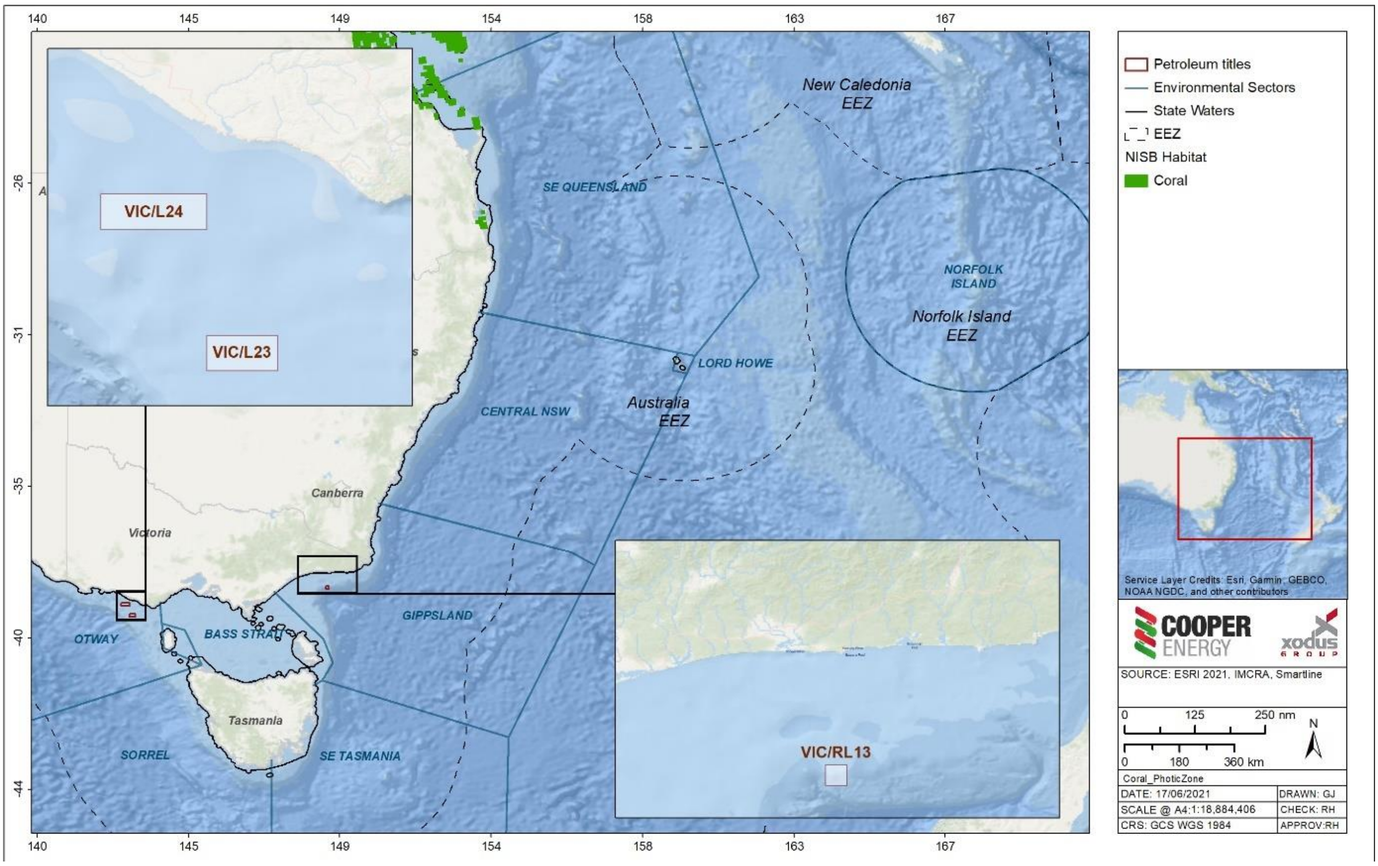
There are three factors that appear to drive the spawning of warm water corals – a gradual rise in sea temperature (this triggers the gametes to mature), the lunar cycle, and the diurnal light cycle. As such, the timing of coral spawning events varies around Australia. Large spawning events for Great Barrier Reef corals typically occur four to five days after the full moon in October or November (and occasionally into December). Reproduction methods for cold water corals are not as well understood, but it is likely that some are still broadcast spawners (like their tropical counterparts), while others brood and release formed larvae (Roberts *et al.*, 2009).

Table 3.7: Presence of coral within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Coral (Dominant Habitat)[1]							✓	✓	
Coral (Presence)[2]	✓	✓	✓	✓	✓	✓	✓	✓	✓

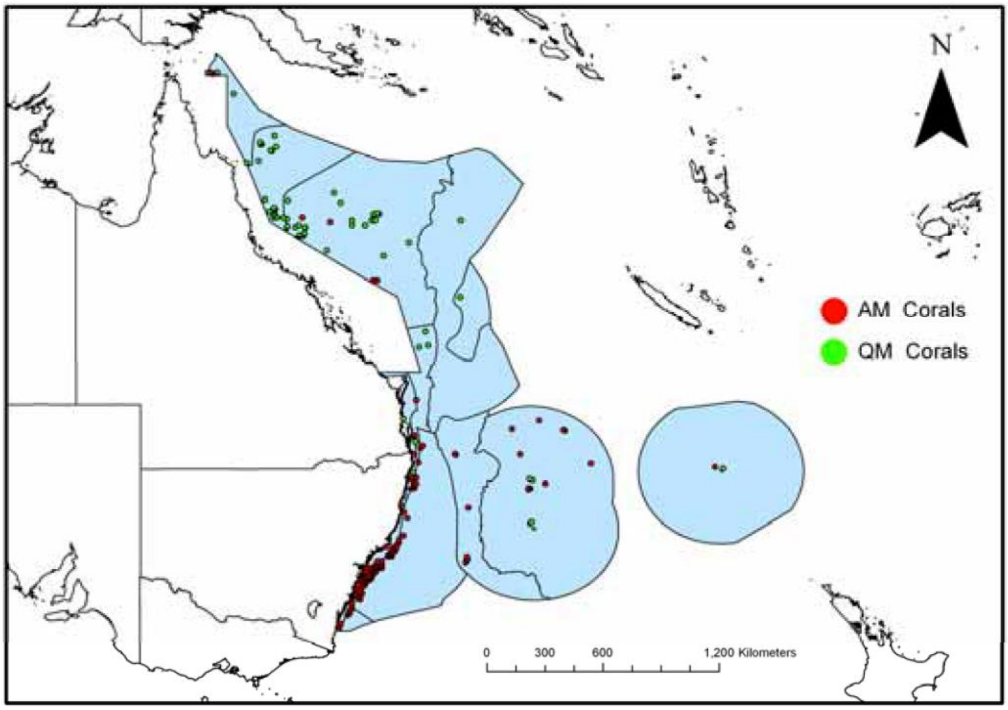
Notes:

1. Coral as a dominant intertidal/subtidal habitat determined from national mapping available from OzCoasts (2015b), and management plans for Lord Howe Island (Commonwealth of Australia, 2002).
2. Coral were a record exists for any coral presence.



Note: Map shows the 'coral dominated' habitat from the NISB Habitat Classification Scheme

Figure 3-15: Distribution of coral dominated habitat within the photic zone



(Source: Tzioumis and Keable, 2007)

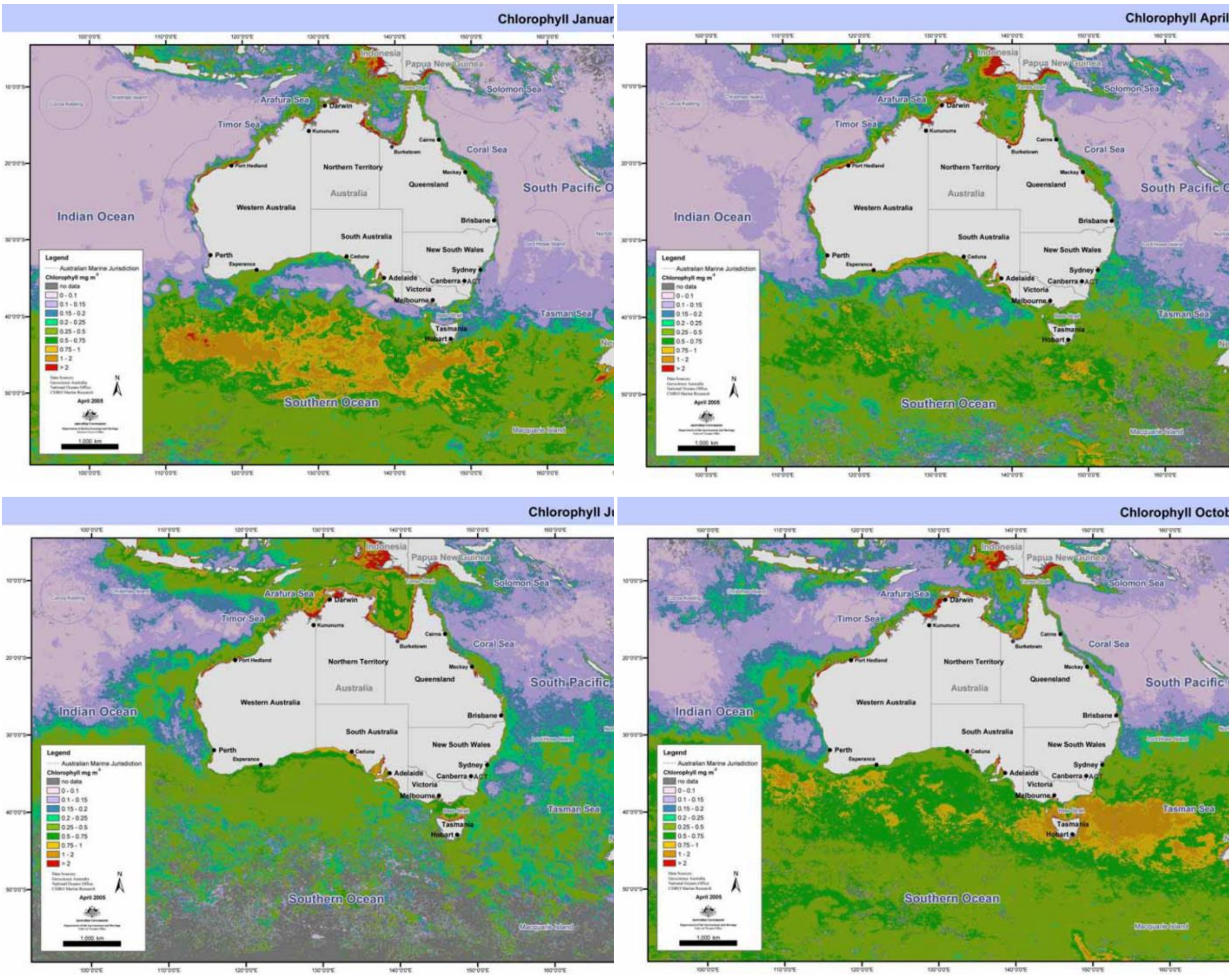
Figure 3-16: Hard coral records for the Temperate East Marine Region based on Queensland (QM) and Australian (AM) Museum datasets

3.9 Plankton

Plankton species, including both phytoplankton and zooplankton, are a key component in oceanic food chains.

Phytoplankton are autotrophic planktonic organisms living within the photic zone; and are the start of the food chain in the ocean (McClatchie *et al.*, 2006). Phytoplankton communities are largely comprised of protists, including green algae, diatoms, and dinoflagellates (McClatchie *et al.*, 2006). There are three size classes of phytoplankton: microplankton (20-200 µm), nanoplankton (2-20 µm) and picoplankton (0.2-2 µm). Diatoms and dinoflagellates are the most abundant of the micro and nanoplankton size classes and are generally responsible for the majority of oceanic primary production (McClatchie *et al.*, 2006). Phytoplankton are dependent on oceanographic processes (e.g. currents and vertical mixing), that supply nutrients needed for photosynthesis. Thus, phytoplankton biomass is typically variable (spatially and temporally), but greatest in areas of upwelling, or in shallow waters where nutrient levels are high. Seasonal variation in phytoplankton (via chlorophyll-a concentrations) has been demonstrated in Australian waters from the analysis for MODIS-Aqua sensor imagery (Figure 3-17).

Zooplankton is the faunal component of plankton, comprised of small protozoa, crustaceans (e.g. krill) and the eggs and larvae from larger animals. Zooplankton includes species that drift with the currents and also those that are motile. More than 170 species of zooplankton have been recorded in eastern and central Bass Strait, but it has been found that seven dominant species make up 80% of individuals (Esso, 2009). Copepods make up approximately half of the species encountered (Watson and Chaloupka, 1982).



(Source: McClatchie *et al.*, 2006)

Figure 3-17: Monthly composites of MODIS ocean colour data showing seasonal phytoplankton growth

3.10 Seabirds and Shorebirds

There are 130 seabird and shorebird species (or species habitat) that may occur within the Environment Sectors; this includes species classified as threatened and migratory (Table 3.8). A list of the relevant conservation advice and/or recovery plans is also provided in Table 3.8, with relevant management actions in Table 3.9. The type of presence varies between species and location, and includes important behaviours (e.g. foraging, roosting, breeding) for some species (Table 3.8).

There is also a listed critical habitat for the shy albatross (*Thalassarche cauta*) present on islands off the coast of Tasmania (Table 3.8).

3.10.1 Albatross

There are 15 species of albatross that may occur within the Environment Sectors, and all except one (Sooty Albatross) has been identified as using the area for foraging (Table 3.8). Albatross species exhibit a broad range of diets and foraging behaviours; this combined with their ability to cover vast oceanic distances, means all waters within Australian jurisdiction can be considered foraging habitat for this species (DSEWPaC, 2011a). However, the most critical foraging habitat is considered to be in waters south of 25°S where most species spend the majority of their foraging time (DSEWPaC, 2011a).

Albatross's typically feed offshore, mainly along the edge of the continental shelf and over open waters, where they catch fish and cephalopods (e.g. squid, cuttlefish) by diving into the water (DSEWPaC, 2012a). A BIA for foraging, has been identified for the following albatross species: antipodean, wandering, Buller's, shy, campbell, black-browed and white-capped (Figure 3-18, Figure 3-19).

There is only one species, the shy albatross, that is known to breed within the waters off mainland Australia (Table 3.8) (DSEWPaC, 2011a). Albatross Island (off north-west Tasmania), and Mewstone and Pedra Branca (in southern Tasmania) are known breeding locations, and also listed as Critical Habitat under the EPBC Act for this species (Table 3.8). This species is not known to breed outside of Australian jurisdiction (DSEWPaC, 2011a). Previous breeding population estimates suggest approximately 5,200 at Albatross Island, 9–11,000 at Mewstone, and <250 at Pedra Branca (DSEWPaC, 2011a). The breeding season is highly synchronised, with all eggs in a colony laid during a short period in late-September. The egg is protected during incubation by one of the parents until it hatches approx. 70 days later.

3.10.2 Petrels

There are 13 species of petrel that may occur within the Environment Sectors, with most either foraging and/or breeding within the area (Table 3.8). Similar to albatrosses, the petrels have a diverse foraging range, and all waters within Australian jurisdiction can be considered foraging habitat for this species (DSEWPaC, 2011a). Typical diet for petrels includes cephalopods (e.g. squid) and fish, and prey is predominately caught by surface-seizing (DSEWPaC, 2011b).

BIAs, for foraging and breeding, have been identified for the following species: white-bellied storm-petrel, white-faced storm petrel, common diving-petrel, and the Gould's, soft-plumaged, black-winged, providence and kermadec petrels (Figure 3-19, Figure 3-20, Figure 3-21, Figure 3-22). BIAs for foraging have also been established for the northern and southern giant petrel and the great-winged petrel (Figure 3-20, Figure 3-21).

The white-bellied storm petrel, black-winged, kermadec and providence petrel all breed within the Lord Howe and/or Norfolk Island groups. Breeding season is typically October through to May, with the exception of the Providence petrel that breeds during winter. Nesting is usually in burrows, or in sheltered rocky crevices (DECC, 2007; DEE 2017a; DEE 2017b; DEE 2017c; Hutton and Priddel, 2002).

Gould's petrel is Australia's rarest endemic seabird. Breeding for Gould's petrel is restricted to Cabbage Tree Island, located offshore from Port Stephens, New South Wales (NSW DEC, 2006). Gould's Petrels begin to arrive on Cabbage Tree Island to breed from mid to late September; egg laying takes place over a six-week period commencing in early November (NSW DEC, 2006).

In Australian waters, the soft-plumaged petrel breeds at two sites: Maatsuyker Island (off Tasmania) and Macquarie Island (TSSC, 2015c). The main factor causing the species to be listed as vulnerable is its small breeding population size – only seven breeding pairs are known to have occurred on Maatsuyker Island (TSSC, 2015c).

Both the common diving-petrel and the white-faced storm petrel are not listed as threatened species under the EPBC Act, and have large populations within Australia, accounting for 5% and 25% respectively of the global population (DoE, 2015a). The common diving-petrel breeds on islands off south-east Australia and Tasmania; there are 30 sites with significant breeding colonies (defined as more than 1,000 breeding pairs) known in Tasmania, and 12 sites in Victoria (including Seal Island, Wilson's Promontory and Lady Julia Percy Island) (DoE, 2015a). There are 15 sites with significant breeding colonies in Tasmania, and three sites with Victoria, for the White-faced Storm Petrel (DoE, 2015a).

3.10.3 Shearwaters

The shearwaters represent the most abundant seabird in Australia. There are six species of shearwater that may occur within the Environment Sectors, and all but one (Streaked Shearwater) have been identified as using the area for foraging and breeding (Table 3.8). BIAs, for foraging and breeding, have been identified for the following other five species: Little, Flesh-footed, Sooty, Wedge-tailed, and Short-tailed shearwaters (Figure 3-23, Figure 3-24).

Shearwaters are typically pelagic species, except during breeding seasons where they are found on remote islands or coastal headlands. Known breeding locations include:

- Lord Howe Island group (flesh-footed shearwater, wedge-tailed shearwater, little shearwater);
- Queensland oceanic islands (e.g. Capricorn Group, Mudjimba Island) (wedge-tailed shearwater)
- New South Wales oceanic islands (e.g. Solitary Island, Cabbage Tree Island, Muttonbird Island, Bird Island) (sooty shearwater, wedge-tailed shearwater)
- Tasmanian oceanic islands (e.g. Babel Island) (sooty shearwater, short-tailed shearwater).

Breeding season in eastern and south-eastern Australia for shearwaters is typically over summer; late-August/early-September to May (DEE 2017d, 2017e, 2017f, 2017g). However, the little shearwater breeds during winter and spring (DEE 2017h). Shearwater nests are usually in burrows or rock crevices.

Shearwaters are known to forage for a variety of pelagic prey, including krill, cephalopods, fish and crustaceans. Food is usually taken by pursuit-plunging, surface plunging or surface-seizing; however other methods (e.g. hydroplaning, deep plunging) may be used.

The short-tailed shearwater is one of few native birds that is commercially harvested (Tasmania Parks & Wildlife Service, 2014).

3.10.4 Terns

There are 11 species of tern that may occur within the Environment Sectors, and all have been identified as using the area for breeding (Table 3.8). A BIA, for foraging and breeding, has been identified for the following three tern species: crested, sooty and white-fronted (Figure 3-23, Figure 3-24, Figure 3-25).

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 (DEWHA, 2007).

Terns breed in colonies on small offshore islands, including those of the Furneaux Group in eastern Bass Strait, and the Lord Howe island group. Nests are typically in sand or coral scrapes (Birdlife Australia, 2017a, 2017b; NSW OEH, 2017).

3.10.5 Other

A variety of the seabird and shorebird species aggregate in areas of the Environment Sectors to roost (Table 3.8), including:

- Seven species of plover (double-banded, greater sand, lesser sand, red-capped, oriental, pacific golder, and grey plover)
- Five species of sandpiper (sharp-tailed, broad-billed, wood, marsh, and Terek sandpiper)
- Three species of snipe (Latham's, Swinhoe's, and pin-tailed snipe)
- Two species of tattler (grey-tailed and wandering tattler)
- Two species of stint (red-necked and long-toed stint); and
- Numerous individuals: ruddy turnstone, sanderling, great knot, Asian dowitcher, black-tailed godwit, little curlew, whimbrel, red-necked phalarope, ruff, red-necked advocet, and Australian proatincole.

Many other species also breed within areas of the Environment Sectors (Table 3.8), including:

- black and common noddy
- great and cattle egret
- Tasmanian wedge-tailed eagle
- little penguin
- white-bellied sea eagle
- kelp, silver and pacific gulls
- cape and Australian gannet
- satin flycatcher
- orange-bellied parrot
- osprey
- red-tailed tropicbird
- black-faced cormorant
- grey ternlet
- masked and brown booby

The black and common noddy can be found off the Queensland coast, and around Lord Howe Island. They are typically pelagic during non-breeding season, but during breeding season can be found on or near islands, rocky islets or rocky cliff areas. Breeding is not synchronised and can occur at varied times throughout the year. A BIA for breeding and foraging, has been identified around Lord Howe Island and offshore Queensland (Figure 3-25).

The Little Penguin is the smallest species of penguin in the world and are permanent residents on a number of inshore and offshore islands. The Australian population is large but not thought to exceed one million birds (DoE, 2015a). Bass Strait has the largest proportion (approximately 60%) of the known breeding colonies in Australia; however, breeding populations are also found on the New South Wales coast. Individuals exhibit strong site fidelity, returning to the same breeding colony each year to breed in the winter and spring months (Gillanders *et al.*, 2013). The diet of a Little Penguin includes small school fish, squid and krill. Prey is typically caught with rapid jabs of the beak and swallowed whole. A BIA for breeding and foraging, has been identified for the little penguin (Figure 3-25). Little penguins are also an important component of the Australian and New Zealand fur-seals' diet (Parliament of South Australia, 2011).

The Australasian gannet generally feeds over the continental shelf or inshore waters. Their diet is comprised mainly of pelagic fish, 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). Important breeding locations for the Australian Gannet within the Environment Sectors include Pedra Branca, Eddystone Rocks, Sidmouth Rocks, and Black Pyramid (Tasmania) and Lawrence Rocks (Victoria). A BIA, for foraging and aggregation, has been established (Figure 3-25).

The red-tailed tropicbird is an oceanic seabird widely distributed through the tropical Pacific and Indian Oceans. It is typically a pelagic species but comes onshore during breeding season. The red-tailed tropicbird nests individually or in small breeding colonies and is territorial. Within the EMBA, breeding is known to occur on Lord Howe Island; and a BIA around this region has been established (Figure 3-26). The birds forage on fish and squid by diving deeply into the water.

The black-faced cormorant is endemic to southern Australia (DoE, 2015a); and favours rocky coasts. The species feeds in coastal waters on a variety of fish, typically catching prey by pursuit-diving. There are 40 significant breeding sites (defined as more than 10 breeding pairs) known for the species in southern Australia, recognised as BIAs (Figure 3-25). Breeding usually occurs on rocky islands, but also on stacks, slopes and sea cliffs in colonies of up to 2500 individuals (DoE, 2015a).

Within Australia waters, the grey ternlet is found on both the Lord Howe and Norfolk Island groups; and may occasionally occur in waters off the eastern coast of Australia. A BIA has been established for this species around Lord Howe Island (Figure 3-19). They typically nest and roost in coastal regions, usually on steep cliff faces; and forage over waters close to shore. In Australia, breeding takes place during spring and summer; eggs have been recorded from early-September to early-January, and nestlings from early-October to mid-March.

The masked booby occurs across northern Australia, extending to Brisbane and islands offshore of the east coast of Australia (including Lord Howe Island). The masked booby is a pelagic marine bird using tropical and subtropical waters. The masked booby breeds on oceanic islands, atolls and cays, usually far from mainland area; and areas of level open ground are preferred for nest sites. The breeding population on Lord Howe Island is the most southerly breeding colony in the world; on Lord Howe Island, peak laying is in December. A BIA, for breeding, has been identified around Lord Howe Island and offshore from Queensland (Figure 3-25).

Table 3.8: Seabird and Shorebird species or species habitat that may occur within the Environment Sectors

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Albatross															
Diomedia antipodensis	Antipodean Albatross	V	✓(M)	✓	*	[1]	FLO*[f]	FLO	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO	FLO	FLO
Diomedia epomophora	Southern Royal Albatross	V	✓(M)	✓		[1]	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO
Diomedia exulans	Wandering Albatross	V	✓(M)	✓	*	[1]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO	FLO
Diomedia gibsoni	Gibson's Albatross	V		✓		[1]		FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO
Diomedia sanfordi	Northern Royal Albatross	E	✓(M)	✓		[1]	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO
Phoebetria fusca	Sooty Albatross	V	✓(M)	✓		[1]	LO	LO	LO	LO	LO	MO	MO		
Thalassarche bulleri	Buller's Albatross	V	✓(M)	✓	*	[1]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	MO	MO	MO	MO
Thalassarche bulleri platei	Pacific Albatross	V		✓		[1]	FLO	FLO	FLO	FLO	FLO	MO	MO	MO	MO
Thalassarche cauta	Shy Albatross	E	✓(M)	✓	*	[1]	FLO*[f]	BKO*[b,f]	FLO*[f]	BKO*[b,f]	FLO	FLO	MO	MO	
Thalassarche chrysostoma	Grey-headed Albatross	E	✓(M)	✓		[2],[1]	MO	MO	MO	FLO	FLO				
Thalassarche eremita	Chatham Albatross	E	✓(M)	✓		[1]		FLO	FLO		FLO	FLO	MO	MO	FLO
Thalassarche impavida	Campbell Albatross	V	✓(M)	✓	*	[1]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	MO*[f]	MO*[f]	MO	MO
Thalassarche melanophris	Black-browed Albatross	V	✓(M)	✓	*	[1]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	FLO*[f]	MO*[f]	MO*[f]	MO	MO
Thalassarche salvini	Salvin's Albatross	V	✓(M)	✓		[1]	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO	FLO
Thalassarche steadi	White-capped Albatross	V	✓(M)	✓	*	[1]	FLO	FLO	FLO*[f]	FLO	FLO	FLO*[f]	FLO	FLO	FLO
Petrel															
Fregetta grallaria grallaria	White-bellied Storm-Petrel	V			*	[3]	LO	LO	LO	LO	LO	BKO	LO	BKO*[b,f]	
Halobaena caerulea	Blue Petrel	V		✓		[4]	MO	MO	MO	MO	MO				

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Macronectes giganteus	Southern Giant Petrel	E	✓(M)	✓	*	[1]	FLO	FLO	FLO[*f]	FLO	FLO	MO[*f]	MO[*f]	MO	MO
Macronectes halli	Northern Giant Petrel	V	✓(M)	✓	*	[1]	MO	MO	MO[*f]	FLO	FLO	MO[*f]	MO[*f]	MO	MO
Pelagodroma marina	White-faced Storm Petrel			✓	*		BKO	BKO[*b,f]	BKO[*b,f]		BKO[*b,f]	BKO			
Pelecanoides urinatrix	Common Diving-Petrel			✓	*		BKO[*b,f]	BKO[*b,f]		BKO[*b,f]	BKO[*b,f]				
Pterodroma cervicalis	White-necked Petrel			✓											BKO
Pterodroma heraldica	Herald Petrel	CE				[5]						LO	LO	MO	
Pterodroma leucoptera leucoptera	Gould's Petrel	E			*	[6]	MO	MO	BKO	MO	MO	BKO[*b,f]	MO	MO	
Pterodroma macroptera	Great-winged Petrel			✓	*		FKO		[*f]			[*f]	[*f]	[*f]	
Pterodroma mollis	Soft-plumaged Petrel	V		✓	*	[7]	FLO	MO		BKO[*b,f]	MO[*f]				
Pterodroma nigripennis	Black-winged Petrel			✓	*							BKO	BKO	BKO[*b,f]	BKO
Pterodroma solandri	Providence Petrel			✓	*									BKO[*b,f]	BKO
Pterodromoa neglecta neglecta	Kermadec Petrel (western)	V			*	[8],[3]			FMO			BKO	FMO	BKO	
Plover															
Charadrius bicinctus	Double-banded Plover		✓(W)	✓			RKO	RKO	RKO	RKO	RKO	RKO	RKO		
Charadrius leschenaultii	Greater Sand Plover	V	✓(W)	✓		[9]	RKO	RKO		RKO		RKO	RKO		
Charadrius mongolus	Lesser Sand Plover	E	✓(W)	✓		[10]	RKO	RKO		RKO	KO	RKO	RKO		
Charadrius ruficapillus	Red-capped Plover			✓			RKO	RKO	RKO	RKO	RKO	RKO	RKO		
Charadrius veredus	Oriental Plover		✓(W)	✓				KO	KO		KO	RKO	RKO		
Pluvialis fulva	Pacific Golden Plover		✓(W)	✓			RKO	RKO		RKO	RKO	RKO	RKO		
Pluvialis squatarola	Grey Plover		✓(W)	✓			RKO	RKO		RKO	KO	RKO	RKO		
Thinornis rubricollis	Hooded Plover			✓			KO	KO	KO	KO	KO	KO			

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Thinornis rubricollis rubricollis	Hooded Plover (eastern)	V		✓		[11]	KO	KO	KO	KO	KO	KO			
Sandpiper															
Actitis hypoleucos	Common Sandpiper		✓(W)	✓			KO	KO	KO	MO	KO	KO	KO	KO	KO
Calidris acuminata	Sharp-tailed Sandpiper		✓(W)	✓			RKO	RKO	RKO	RKO	KO	RKO	RKO	KO	KO
Calidris ferruginea	Curlew Sandpiper	CE	✓(W)	✓		[12]	KO	KO	KO	KO	KO	KO	KO	KO	
Calidris melanotos	Pectoral Sandpiper		✓(W)	✓			KO	KO	KO	MO	KO	KO	KO	KO	KO
Limicola falcinellus	Broad-billed Sandpiper		✓(W)	✓				RKO				RKO	RKO		
Tringa glareola	Wood Sandpiper		✓(W)	✓			RKO	RKO				FKO	RKO		
Tringa stagnatilis	Marsh Sandpiper		✓(W)	✓			RKO	RKO				RKO	RKO		
Xenus cinereus	Terek Sandpiper		✓(W)	✓			RKO	RKO		RKO	KO	RKO	RKO		
Shearwater															
Calonectris leucometas	Streaked Shearwater		✓(M)	✓								KO	KO		
Puffinus assimilis	Little Shearwater			✓	*							BKO		BKO[*b,f]	BKO
Puffinus carneipes	Flesh-footed Shearwater		✓(M)	✓	*		KO	FLO	FLO[*f]	FLO	FLO	BKO[*f]	KO[*f]	BKO[*b,f]	KO
Puffinus griseus	Sooty Shearwater		✓(M)	✓	*		MO	MO	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	LO		KO
Puffinus pacificus	Wedge-tailed Shearwater		✓(M)	✓	*		[*b,f]	[*b,f]	BKO[*b,f]			BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO
Puffinus tenuirostris	Short-tailed Shearwater		✓(M)	✓	*		BKO[*f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]			
Tern															
Sterna albifrons	Little Tern		✓(M)	✓			BKO	BKO	BKO	MO	BKO	BKO	BKO		
Sterna anaethetus	Bridled Tern		✓(M)	✓									BKO		
Sterna bengalensis	Lesser Crested Tern			✓									BKO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Sterna bergii	Crested Tern			✓	*		BKO	BKO	BKO*[b,f]	BKO		BKO	BKO*[b,f]		
Sterna caspia	Caspian Tern		✓(M)	✓			BKO	BKO	BKO	BKO	BKO		BKO		
Sterna dougallii	Roseate Tern		✓(M)	✓									BKO		
Sterna fuscata	Sooty Tern			✓	*		BKO	BKO	BKO						
Sterna nereis	Fairy Tern			✓			BKO	BKO	BKO						
Sterna striata	White-fronted Tern			✓	*			BKO*[b,f]							
Sterna sumatrana	Black-naped Tern		✓(M)	✓									BKO		
Sternula nereis nereis	Australian Fairy Tern	V				[13]	KO	KO	KO	KO	KO	KO			
Thalasseus bergii	Greater Crested Tern		✓(W)				BKO		BKO	BKO					
Other															
Anous minutus	Black Noddy			✓	*								BKO*[b,f]	*[b,f]	
Anous stolidus	Common Noddy		✓ (M)	✓	*		LO	LO				BKO	BKO*[b,f]	BKO*[b,f]	BKO
Anseranas semipalmata	Magpie Goose			✓			MO						MO		
Apus pacificus	Fork-tailed Swift		✓ (M)	✓			LO	LO	LO	LO	LO	LO	LO		
Ardea ibis	Cattle Egret			✓			BLO	LO	MO	MO	MO	BLO	BLO		
Arenaria interpres	Ruddy Turnstone		✓ (W)	✓			RKO	RKO	RKO	RKO	RKO	RKO	RKO		
Aulia audax fleayi	Tasmanian Wedge-tailed Eagle	E				[14]	BLO	BKO		BLO	BLO				
Botaurus poiciloptilus	Australasian Bittern	E				[15]	KO	KO	KO	KO	KO	KO	KO		
Calidris alba	Sanderling		✓ (W)	✓			RKO	RKO	RKO	RKO	RKO	RKO	RKO		
Calidris canutus	Red Knot	E	✓ (W)	✓		[16]	KO	KO	KO	KO	KO	KO	KO	KO	MO
Calidris ruficollis	Red-necked Stint		✓ (W)	✓			RKO	RKO	RKO	RKO	RKO	RKO	RKO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Calidris subminute	Long-toed Stint		✓ (W)	✓				RKO				RKO	RKO		
Calidris tenuirostris	Great Knot	CE	✓ (W)	✓		[17]	RKO	RKO	RKO	RKO	KO	RKO	RKO		
Catharacta skua	Great Skua			✓			MO	MO	MO	MO	MO	MO	MO		
Cuculus optatus	Oriental Cuckoo		✓ (T)	✓					KO			KO	KO		
Dasyomis brachypterus	Eastern Bristlebird	E				[18]			KO			KO	KO		
Epthianura crocea macgregori	Capricorn Yellow Chat	CE				[19]							MO		
Erythrotriorchis radiatus	Red Goshawk	V				[20]						KO	KO		
Eudyptula minor	Little Penguin			✓	*		BKO	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]	BKO[*b,f]			
Fregata ariel	Lesser Frigatebird		✓ (M)	✓								KO	KO	LO	KO
Fregata minor	Great Frigatebird		✓ (M)	✓								KO	KO	KO	KO
Gallinago hardwickii	Latham's Snipe		✓ (W)	✓			KO	KO	KO	KO	KO	KO	KO		
Gallinago megala	Swinhoe's Snipe		✓ (W)	✓			RLO	KO	RLO	RLO	RLO	RLO	RKO		
Gallinago stenura	Pin-tailed Snipe		✓ (W)	✓			RLO	RKO	RLO	RLO	RLO	RLO	RLO		
Glareola maldivarum	Oriental Pratincole		✓ (W)	✓									RKO		
Haliaeetus leucogaster	White-bellied Sea Eagle			✓			BKO	BKO	BKO	BKO	BKO	BKO	BKO		
Heteroscelus brevipes	Grey-tailed Tattler			✓			RKO	RKO	FKO	RKO	KO	RKO	RKO		
Heteroscelus incanus	Wandering Tattler		✓ (W)	✓				RKO				RKO	RKO		
Himantopus himantopus	Black-winged Stilt			✓			RKO	RKO	RKO	RKO	KO	RKO	RKO		
Hirundapus caudacutus	White-throated Needletail	V	✓ (T)	✓			RKO	RKO	RKO	RKO	KO	KO	RKO		
Larus dominicanus	Kelp Gull			✓				BKO				BKO			
Larus novaehollandiae	Silver Gull			✓			BKO	BKO	BKO	BKO	BKO	BKO	BKO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Larus pacificus	Pacific Gull			✓			BKO	BKO		BKO	BKO				
Lathamus discolor	Swift Parrot	CE		✓		[21]	KO	BKO	KO	KO	BKO	KO	KO		
Limnodromus semipalmatus	Asian Dowitcher		✓ (W)	✓				RKO					RKO		
Limosa lapponica	Bar-tailed Godwit		✓ (W)	✓			KO	KO	KO	KO	KO	KO	KO	KO	KO
Limosa lapponica baueri	Western Alaskan Bar-tailed Godwit (baueri)	V				[22]	KO	KO	KO	KO	KO	KO	KO	KO	
Limosa lapponica menzbieri	Northern Siberian Bar-tailed Godwit	CE				[23]		MO	MO	MO	MO	MO	MO	MO	
Limosa limosa	Black-tailed Godwit		✓ (W)	✓			RKO	RKO		RKO	KO	RKO	RKO		
Merops ornatus	Rainbow Bee-eater			✓			MO	MO	MO			MO	MO		
Monarcha melanopsis	Black-faced Monach		✓ (T)	✓			MO	KO	KO			KO	KO		
Monarcha trivirgatus	Spectacled Monach		✓ (T)	✓					KO			KO	KO		
Morus capensis	Cape Gannet			✓			BKO	BKO							
Morus serrator	Australasian Gannet			✓	*		BKO*[a,f]	BKO*[a,f]		BKO*[a,f]					BKO
Motacilla cinerea	Grey Wagtail		✓T)	✓			KO								
Motacilla flava	Yellow Wagtail		✓ (T)	✓			KO	KO	MO	KO		KO	KO		
Myiagra cyanoleuca	Satin Flycatcher		✓ (T)	✓			BKO	BKO	KO	KO	BKO	BKO	BKO		
Neophema chrysogaster	Orange-bellied Parrot	CE		✓		[24]	Mr	Mr	LO	BKO		MO			
Numenius madagascariensis	Eastern Curlew	CE	✓ (W)	✓		[25]	KO	KO	KO	KO	KO	KO	KO	KO	KO
Numenius minutus	Little Curlew		✓ (W)	✓			RLO	RKO	RLO	RLO	RLO	RLO	RKO		
Numenius phaeopus	Whimbrel		✓ (W)	✓			RKO	RKO	RKO	RKO	KO	RKO	RKO		
Pachyptila turtur	Fairy Prion			✓			KO	KO	KO	KO	KO	KO	KO	KO	

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Pachyptila turtur subantartica	Fairy Prion (southern)	V				[26]	KO	KO	KO	KO	KO	KO	KO	KO	
Pandion haliaetus	Osprey		✓ (W)	✓			KO	KO	KO			BKO	BKO		
Phaethon rubricauda	Red-tailed Tropicbird		✓ (M)	✓	*							BKO	BKO	BKO*[b,f]	BKO
Phalacrocorax fuscescens	Black-faced Cormorant			✓	*		BKO	BKO*[b,f]		BKO*[b,f]	BKO*[b,f]				
Phalaropus lobatus	Red-necked Phalarope		✓ (W)	✓				RKO							
Philmachus pugnax	Ruff		✓ (W)	✓			RKO	RKO		RKO	KO	RKO	RKO		
Procelsterna cerulea	Grey Ternlet, Grey noddy, Blue noddy			✓	*							BKO		BKO*[b,f]	BKO
Recurvirostra novaehollandiae	Red-necked Avocet			✓			RKO	RKO			KO	RKO	RKO		
Rhipidura rufifrons	Rufous Fantail		✓ (T)	✓			KO	KO	KO			KO	KO		
Rostratula australis	Australian Painted Snipe	E		✓		[27]	KO	LO	KO			KO	KO		
Stiltia isabella	Australian Pratincole			✓				RKO							
Sula dactylatra	Masked Booby		✓ (M)	✓	*									BKO*[b,f]	BKO
Sula leucogaster	Brown Booby		✓ (M)	✓									BKO		
Tringa nebularia	Common Greenshank		✓ (W)	✓			KO	KO	KO	KO	KO	KO	KO	MO	
Listed Critical Habitat															
Thalassarche cauta (Shy Albatross) - Albatross Island, The Mewstone, Pedra Branca								✓		✓	✓				

Threatened Species:
V *Vulnerable*
E *Endangered*
CE *Critically Endangered*
Migratory Species:
M *Marine*

Type of Presence:
MO *Species of species habitat may occur within area*
LO *Species or species habitat likely to occur within area*

Plan Reference:
[1] *National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011-2016 (DSEWPaC, 2011a)*
[2] *Approved Conservation Advice for Thalassarche chrysostoma (grey-headed Albatross) (TSSC, 2009a)*
[3] *Lord Howe Island Biodiversity Management Plan (DECC, 2007)*

	Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island

W	*Wetland*
T	*Terrestrial*
Biologically Important Area	
✓	*BIA Present*
a	*Aggregation*
b	*Breeding*
f	*Foraging*

KO	*Species or species habitat known to occur within area*
Mr	*Migration route known to occur within area*
FMO	*Foraging, feeding or related behaviour may occur within area*
FLO	*Foraging, feeding or related behaviour likely to occur within area*
FKO	*Foraging, feeding or related behaviour known to occur within area*
BLO	*Breeding likely to occur within area*
BKO	*Breeding known to occur within area*
RMO	*Roosting may occur within area*
RLO	*Roosting likely to occur within area*
RKO	*Roosting known to occur within area*

[4] Approved Conservation Advice for Halobaena caerulea (Blue Petrel) (TSSC, 2015d)

[5] Approved Conservation Advice for Pterodroma heraldica (Herald Petrel) (TSSC, 2015e)

[6] Gould's Petrel (Pterodroma leucoptera leucoptera) Recovery Plan (NSW DEC, 2006)

[7] Approved Conservation Advice for Pterodroma mollis (Soft-plumaged Petrel) (TSSC, 2015c)

[8] Norfolk Island Region Threatened Species Recovery Plan (DNP, 2010)

[9] Approved Conservation Advice for Charadrius leschenaultia (Greater Sand Plover) (TSSC, 2016a)

[10] Approved Conservation Advice for Charadrius mongolus (Lesser Sand Plover) (TSSC, 2016b)

[11] Approved Conservation Advice for Thinornis rubricollis rubricollis (Hooded Plover, Easter) (TSSC, 2014a)

[12] Approved Conservation Advice for Calidris ferruginea (Curlew Sandpiper) (TSSC, 2015f)

[13] Approved Conservation Advice for Sternula nereis nereis (Fairy Tern) (TSSC, 2011a)

[14] Threatened Tasmanian Eagles Recover Plan, 2006-2010 (AGDEW, 2006)

[15] Approved Conservation Advice for Botaurus poiciloptilus (Australasian Bittern) (TSSC, 2019)

[16] Approved Conservation Advice for Calidris canutus (Red Knot) (TSSC, 2016c)

[17] Approved Conservation Advice for Calidris tenuirostriss (Great Knot) (TSSC, 2016d)

[18] National Recovery Plan for Eastern Bristlebird (Dasyornis brachypterus) (NSW OEH, 2012)

[19] Yellow chat (Capricorn subspecies) Epthianura crocea macgregori recovery plan (Houston and Melzer, 2008)

[20] Approved Conservation Advice for Erythrotriorchis radiates (red Goshawk) (TSSC, 2015g)

[21] Approved Conservation Advice for Lathamus discolour (Swift Parrot) (TSSC, 2016e)

[22] Approved Conservation Advice for Limosa lapponica baueri (western Alaskan Bar-tailed Godwit) (TSSC, 2016f)

[23] Approved Conservation Advice for Limosa lapponica menzbieri (Northern Siberian Bar-tailed Godwit) (TSSC, 2016g)

[24] National Recovery Plan for the Orange-bellied Parrot (Neophema chrysogaster) (DELWP, 2016)

[25] Approved Conservation Advice for Numenius madagascariensis (Eastern Curlew) (TSSC, 2015h)

[26] Approved Conservation Advice for Pachyptila turtur subantartica (Fairy Prion Southern) (TSSC, 2015i)

[27] Approved Conservation Advice for Rostratula australis (Australian Painted Snipe) (TSSC, 2013b)

Table 3.9: Seabird and Shorebird threatened species management advice relevant to petroleum activities under this EP

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities[1]	Applicable Management Advice relevant to activities under this EP
• **Antipodean Albatross** • **Southern Royal Albatross** • **Wandering Albatross** • **Gibson's Albatross** • **Northern Royal Albatross** • **Sooty Albatross** • **Buller's Albatross** • **Pacific Albatross** • **Shy Albatross** • **Grey-headed Albatross** • **Chatham Albatross** • **Campbell Albatross** • **Black-browed Albatross** • **Salvin's Albatross** • **White-capped Albatross**	National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011-2016 (DSEWPaC, 2011a)	• Marine pollution	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented • **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented • Note: Shy Albatross is the only species that breeds within the Environment Sectors
• **Grey-headed Albatross**	Approved Conservation Advice for *Thalassarche chrysostoma* (grey-headed Albatross) (TSSC, 2009a)	• Marine pollution, including marine debris	• See above (for National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011-2016) • Note: Grey-headed Albatross breeding locations are outside of the Environment Sectors
• **White-bellied Storm-Petrel**	Lord Howe Island Biodiversity Management Plan (DECC, 2007)	• None identified	• None identified
• **Blue Petrel**	Approved Conservation Advice for *Halobaena caerulea* (Blue Petrel) (TSSC, 2015d)	• None identified	• None identified
• **Southern Giant Petrel** • **Northern Giant Petrel**	National Recovery Plan for Threatened Albatrosses and Giant Petrels, 2011-2016 (DSEWPaC, 2011a)	• Marine pollution, including marine debris	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented • **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented • Note: breeding locations are outside of the Environment Sectors

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities[1]	Applicable Management Advice relevant to activities under this EP
• **Herald Petrel**	Approved Conservation Advice for *Pterodroma heraldica* (Herald Petrel) (TSSC, 2015e)	• None identified	• None identified
• **Gould's Petrel**	Gould's Petrel (*Pterodroma leucoptera leucoptera*) Recovery Plan (NSW DEC, 2006)	• Oil spills • Note: oil spills in the vicinity Cabbage Tree Island are not considered a threat because the Gould's Petrel does not feed in coastal waters however, oceanic oil spills may pose some risk (NSW DEC, 2006)	• None identified
• **Soft-plumaged Petrel**	Approved Conservation Advice for *Pterodroma mollis* (Soft-plumaged Petrel) (TSSC, 2015c)	• None identified	• None identified
• **Kermadec Petrel (western)**	Norfolk Island Region Threatened Species Recovery Plan (DNP, 2010) Lord Howe Island Biodiversity Management Plan (DECC, 2007)	• None identified	• None identified
• **Greater Sand Plover**	Approved Conservation Advice for *Charadrius leschenaultia* (Greater Sand Plover) (TSSC, 2016a)	• Habitat loss and degradation from pollution	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Lesser Sand Plover**	Approved Conservation Advice for *Charadrius mongolus* (Lesser Sand Plover) (TSSC, 2016b)		
• **Hooded Plover (eastern)**	Approved Conservation Advice for *Thinornis rubricollis* (Hooded Plover, Easter) (TSSC, 2014a)	• Oil spills • Entanglements and ingestion of marine debris	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities[1]	Applicable Management Advice relevant to activities under this EP
			• **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented
• **Curlew Sandpiper**	Approved Conservation Advice for *Calidris ferruginea* (Curlew Sandpiper) (TSSC, 2015f)	• Habitat loss and degradation from pollution • Environmental pollution	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Australian Fairy Tern**	Approved Conservation Advice for *Sternula nereis nereis* (Fairy Tern) (TSSC, 2011a)	• Oil spills, particularly in Victoria, where the close proximity of oil facilities poses a risk • of oil spills that may affect the species' breeding habitat	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Tasmanian Wedge-tailed Eagle**	Threatened Tasmanian Eagles Recover Plan, 2006-2010 (AGDEW, 2006)	• Oiling, entanglement, Pollution	• None identified
• **Australasian Bittern**	Approved Conservation Advice for *Botaurus poiciloptilus* (Australasian Bittern) (TSSC, 2019)	• Reduced water quality as a result of increasing salinity, siltation and pollution	• None identified
• **Red Knot**	Approved Conservation Advice for *Calidris canutus* (Red Knot) (TSSC, 2016c)	• Habitat loss and degradation from environmental Pollution • Pollution or contamination impacts	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Great Knot**	Approved Conservation Advice for *Calidris tenuirostriss* (Great Knot) (TSSC, 2016d)		
• **Eastern Bristlebird**	National Recovery Plan for Eastern Bristlebird (*Dasyornis brachypterus*) (NSW OEH, 2012)	• None identified	• None identified

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities[1]	Applicable Management Advice relevant to activities under this EP
• **Capricorn Yellow Chat**	Approved Conservation Advice for *Epthianura crocea macgregori* (Yellow Chat) (TSSC, 2002)	• None identified	• None identified
• **Red Goshawk**	Approved Conservation Advice for *Erythrotriorchis radiates* (Red Goshawk) (TSSC, 2015g)	• None identified	• None identified
• **Swift Parrot**	Approved Conservation Advice for *Lathamus discolour* (Swift Parrot) (TSSC, 2016e)	• None identified	• None identified
• **Western Alaskan Bar-tailed Godwit (baueri)**	Approved Conservation Advice for *Limosa lapponica baueri* (western Alaskan Bar-tailed Godwit (TSSC, 2016f)	• Habitat loss and degradation from pollution • Pollution/contamination	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Northern Siberian Bar-tailed Godwit**	Approved Conservation Advice for *Limosa lapponica menzbieri* (Northern Siberian Bar-tailed Godwit) (TSSC, 2016g)		
• **Orange-bellied Parrot**	National Recovery Plan for the Orange-bellied Parrot (*Neophema chrysogaster*) (DELWP, 2016)	• None identified	• None identified
• **Eastern Curlew**	Approved Conservation Advice for *Numenius madagascariensis* (Eastern Curlew) (TSSC, 2015h)	• Habitat loss and degradation from pollution • Environmental pollution	• **Marine pollution:** Evaluate risk of oil spill impact to nest locations and, if required, appropriate mitigation measures are implemented
• **Fairy Prion (southern)**	Approved Conservation Advice for *Pachyptila turtur subantartica* (Fairy Prion Southern) (TSSC, 2015i)	• None identified	• None identified
• **Australian Painted Snipe**	Approved Conservation Advice for *Rostratula australis* (Australian Painted Snipe) (TSSC, 2013b)	• None identified	• None identified

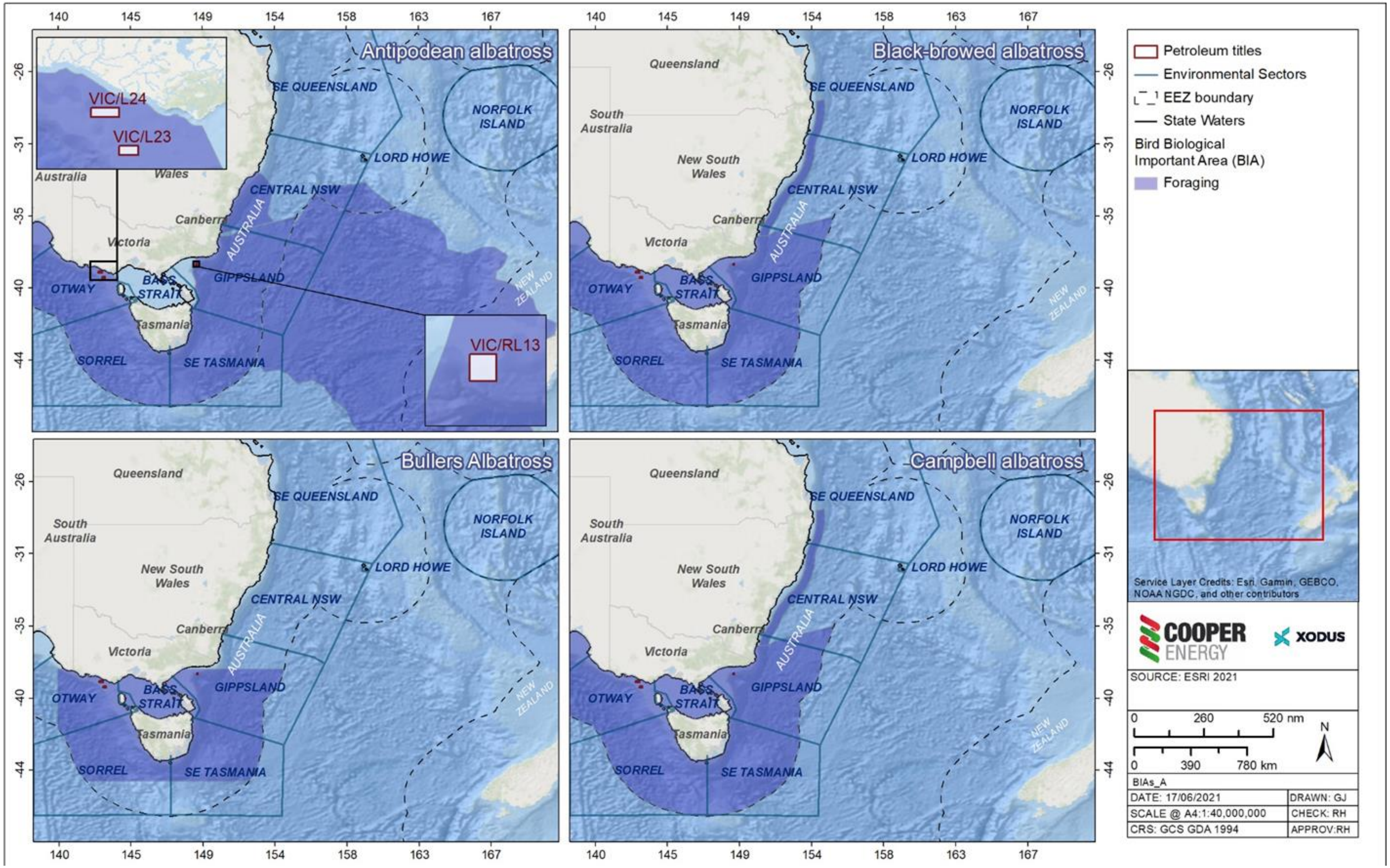


Figure 3-18: BIAs for the Antipodean, Black-browed, Buller's and Campbell Albatross

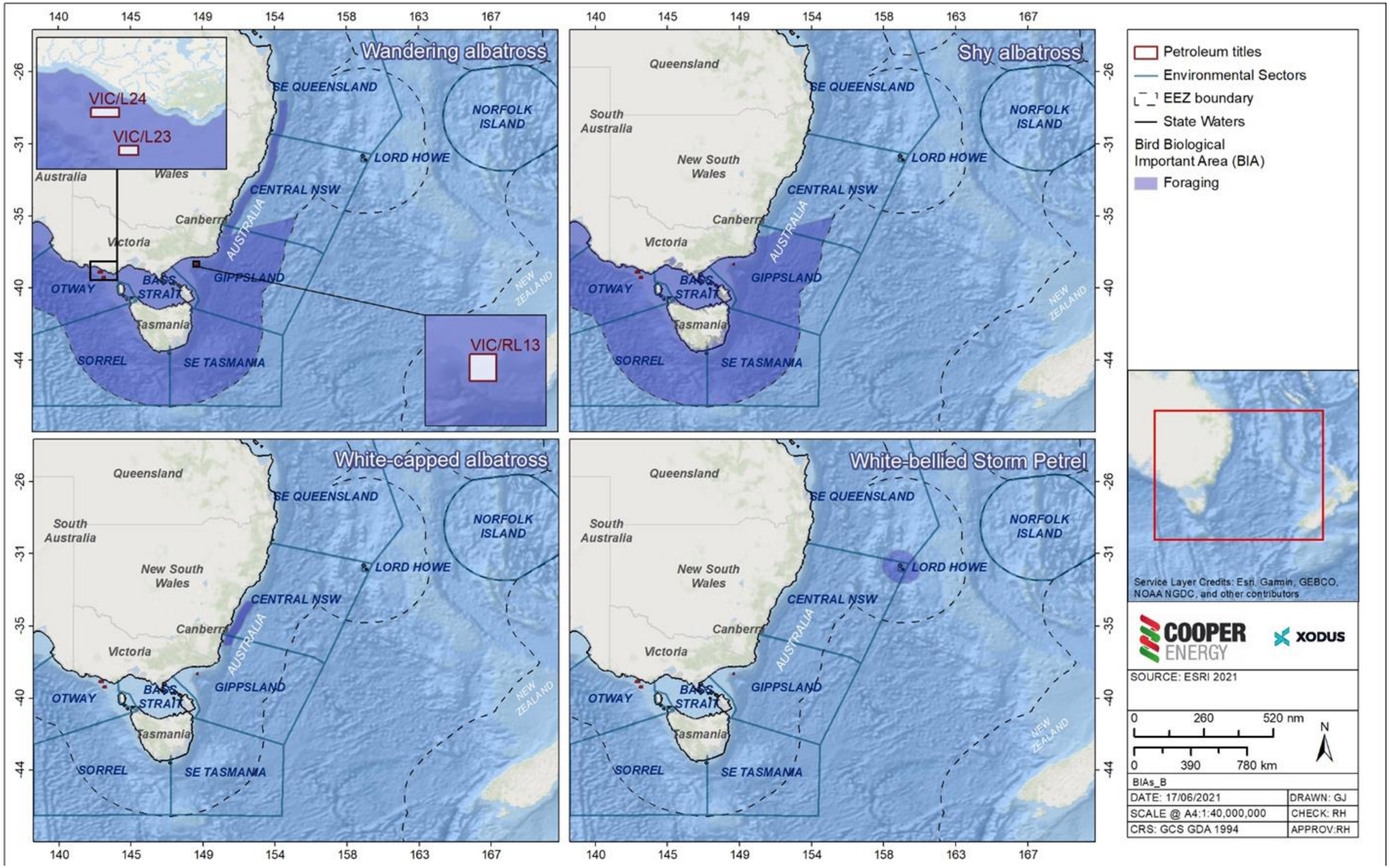


Figure 3-19: BIAs for the Wandering albatross, shy albatross, white-capped albatross and white-bellied storm petrel

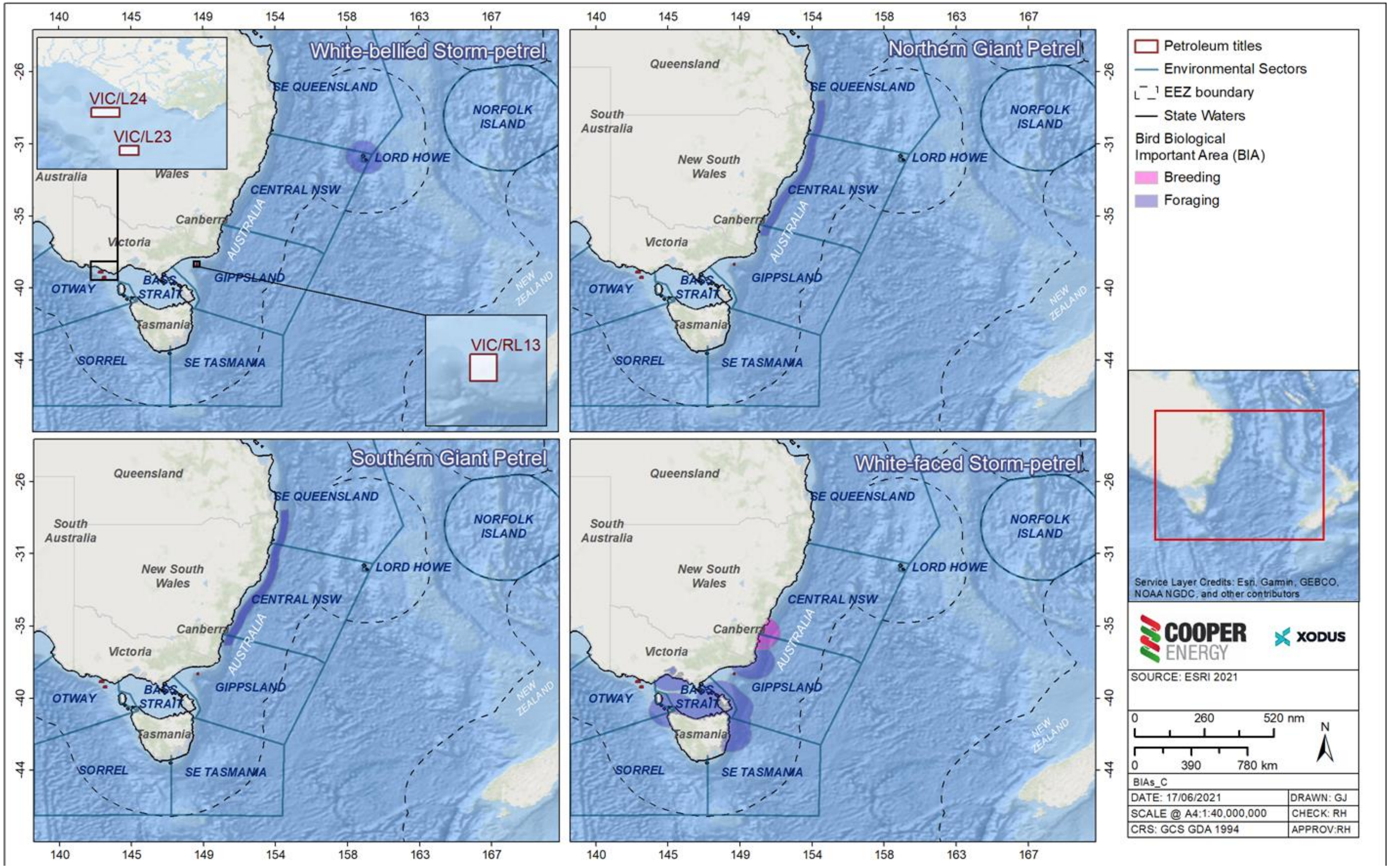


Figure 3-20: BIAs for the Northern Giant, Southern Giant and White-faced Petrel

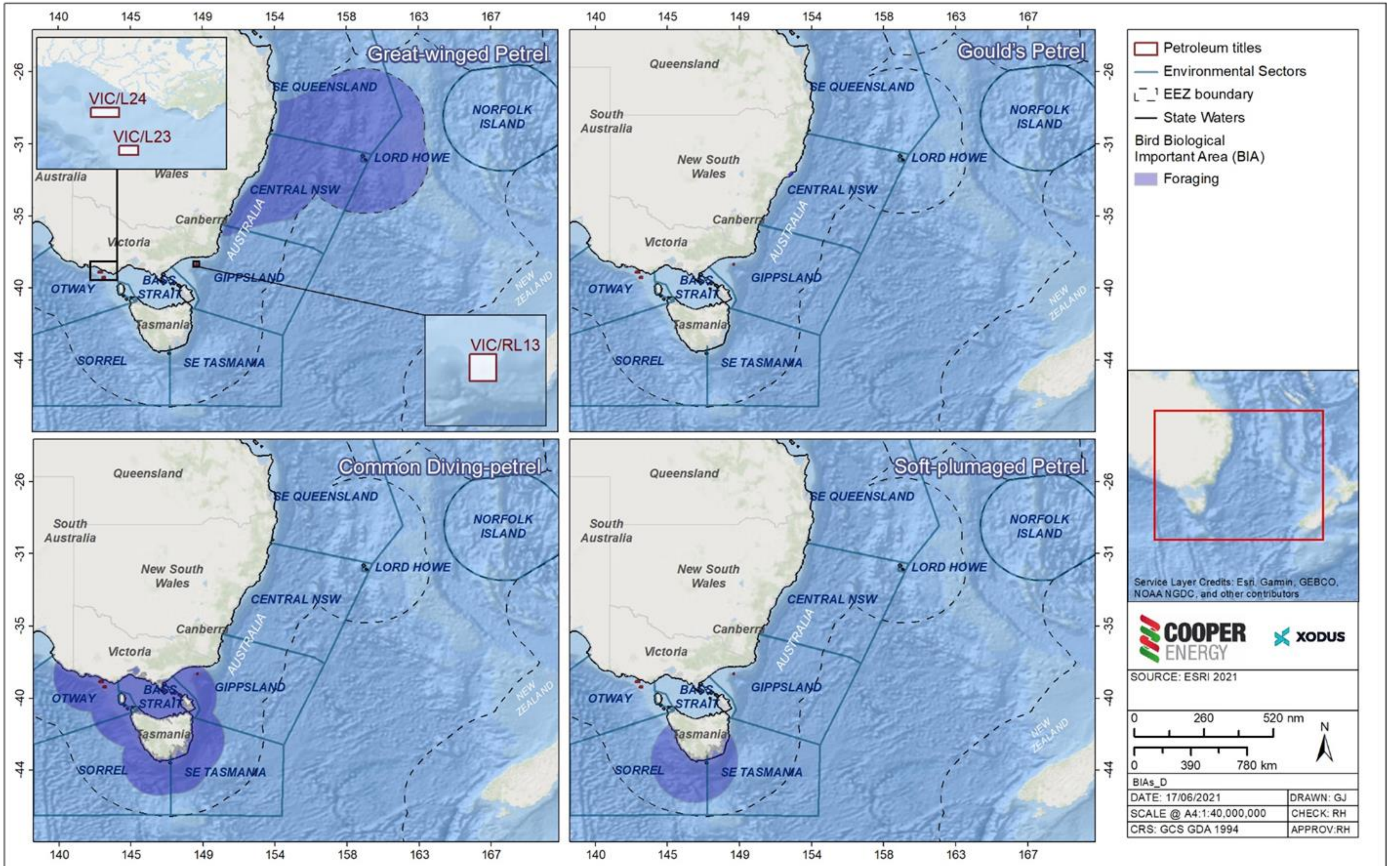


Figure 3-21: BIAs for the great-winged petrel, Gould's petrel, common diving petrel and soft-plumage petrel

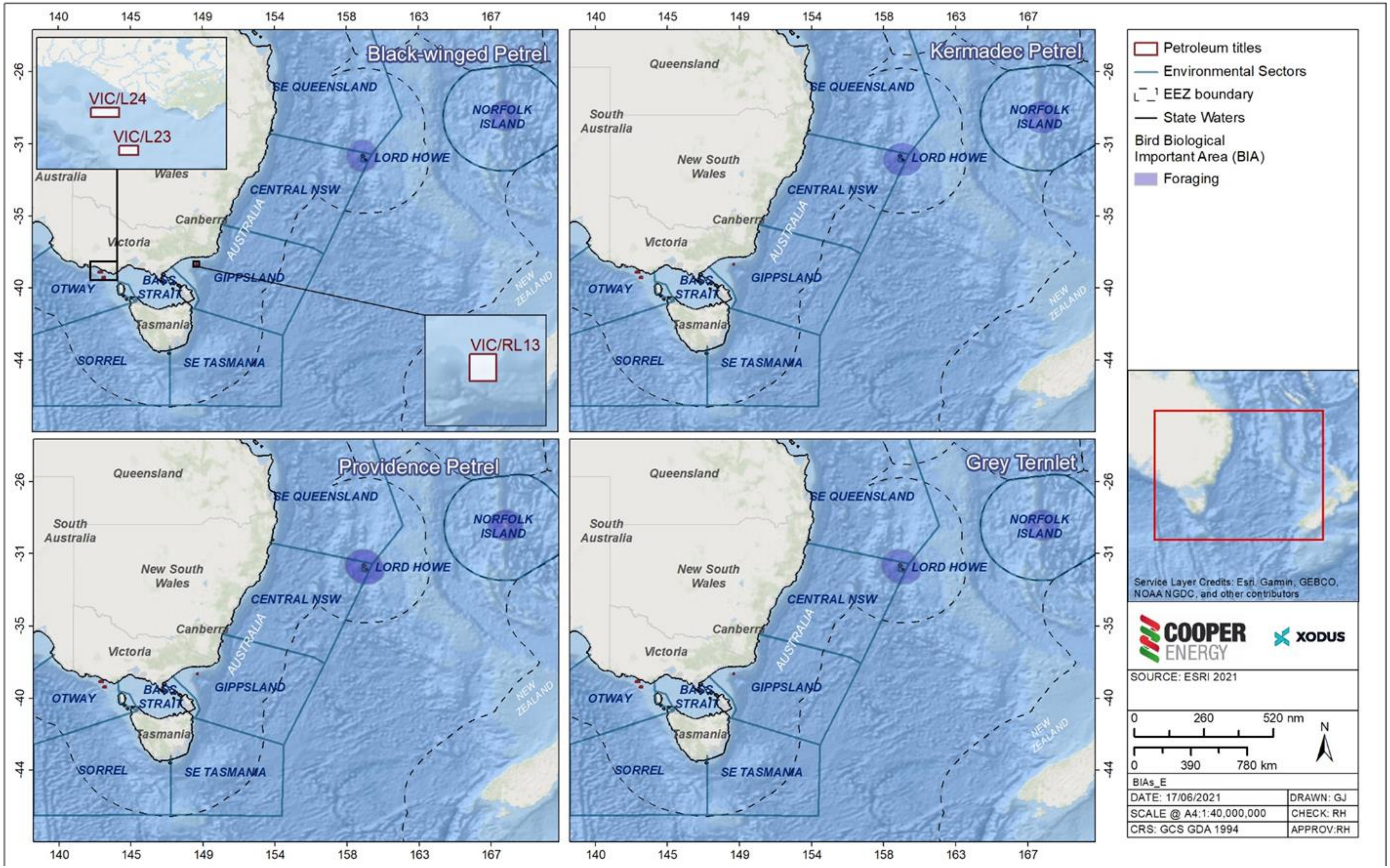


Figure 3-22: BIAs for the black-winged petrel, Kermadec petrel, Providence petrel and grey ternlet

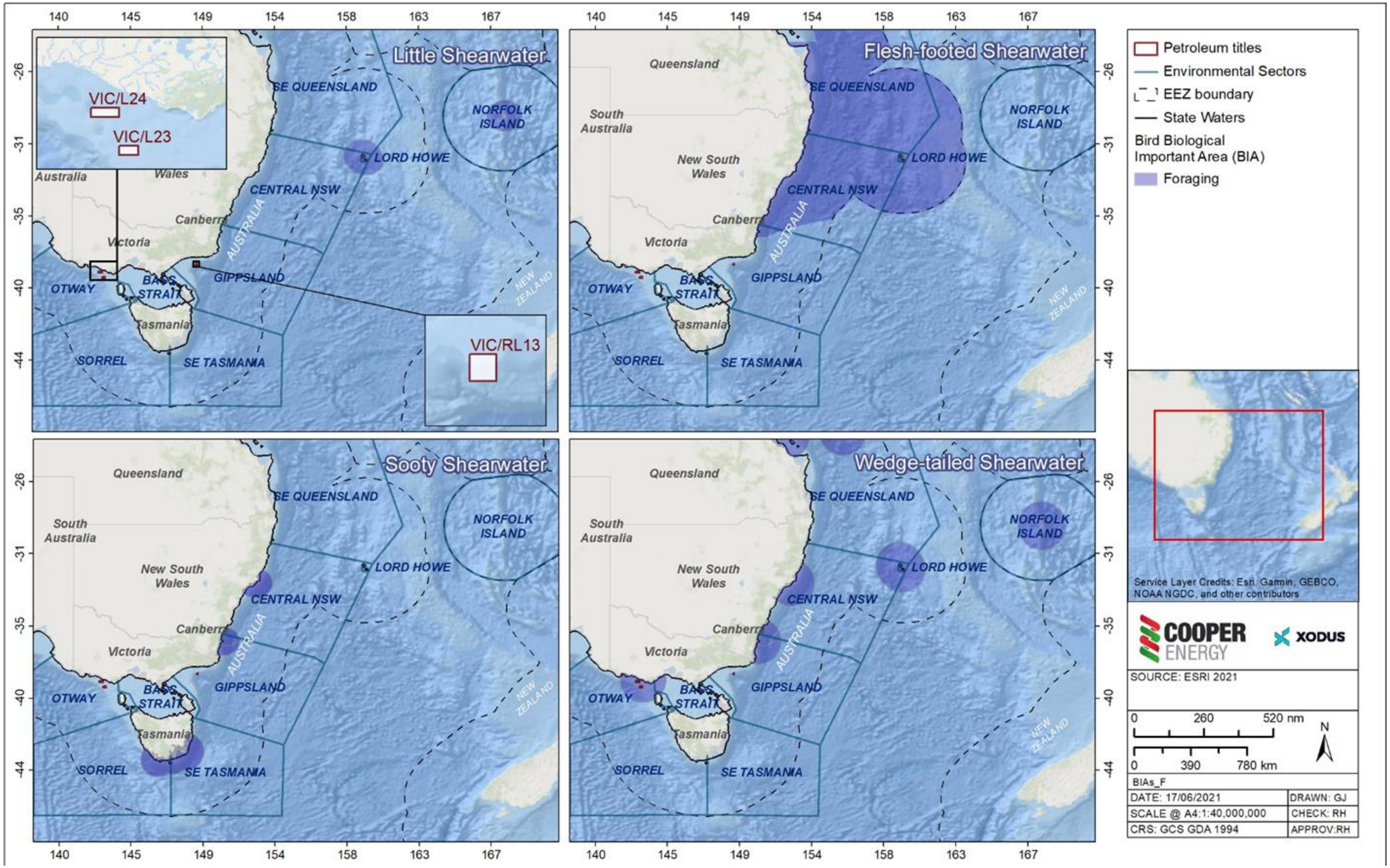


Figure 3-23: BIAs for the little shearwater, flesh-footed shearwater, sooty shearwater and wedge-tailed shearwater

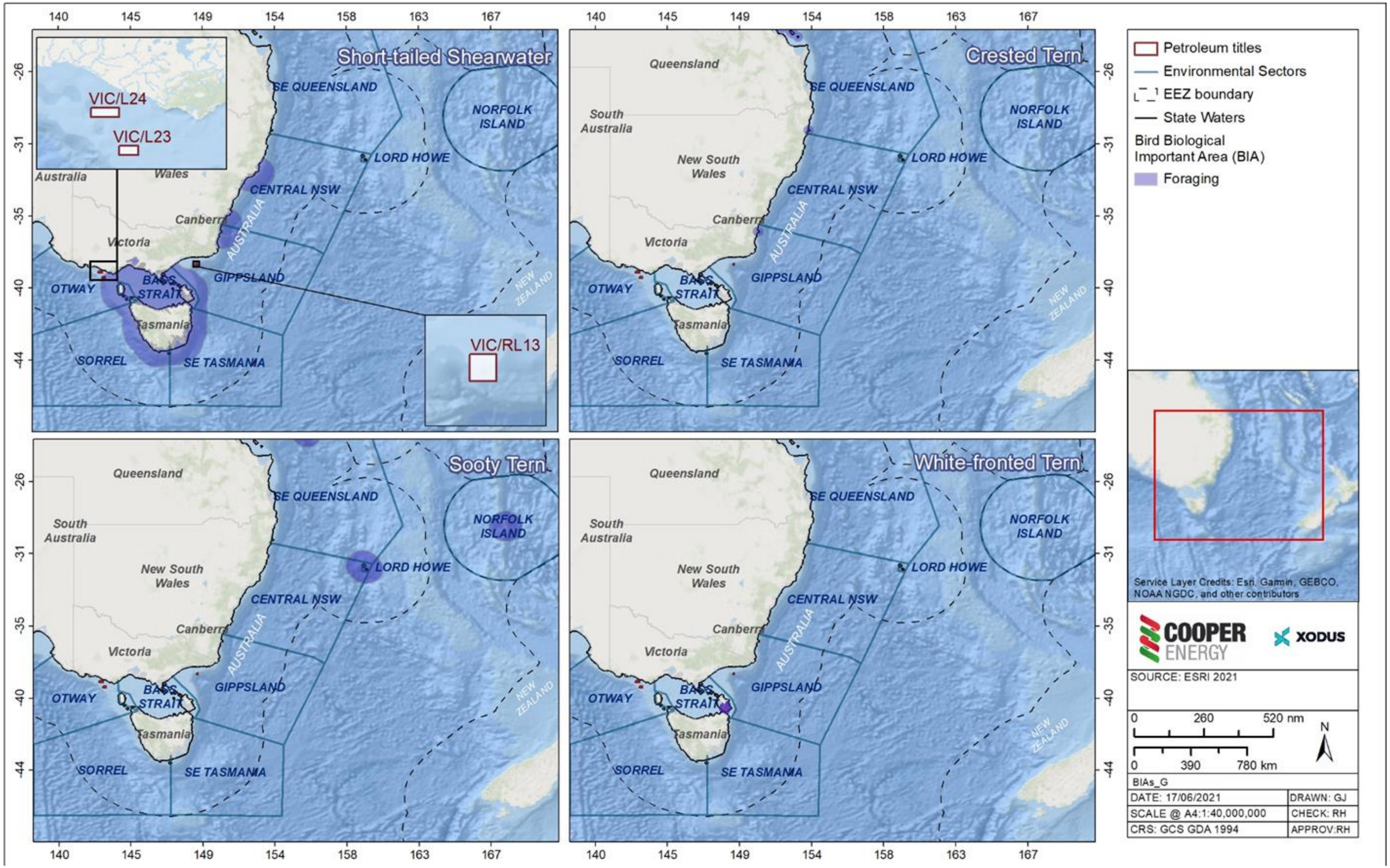


Figure 3-24: BIAs for the short-tailed shearwater, crested tern, sooty tern, white-fronted tern

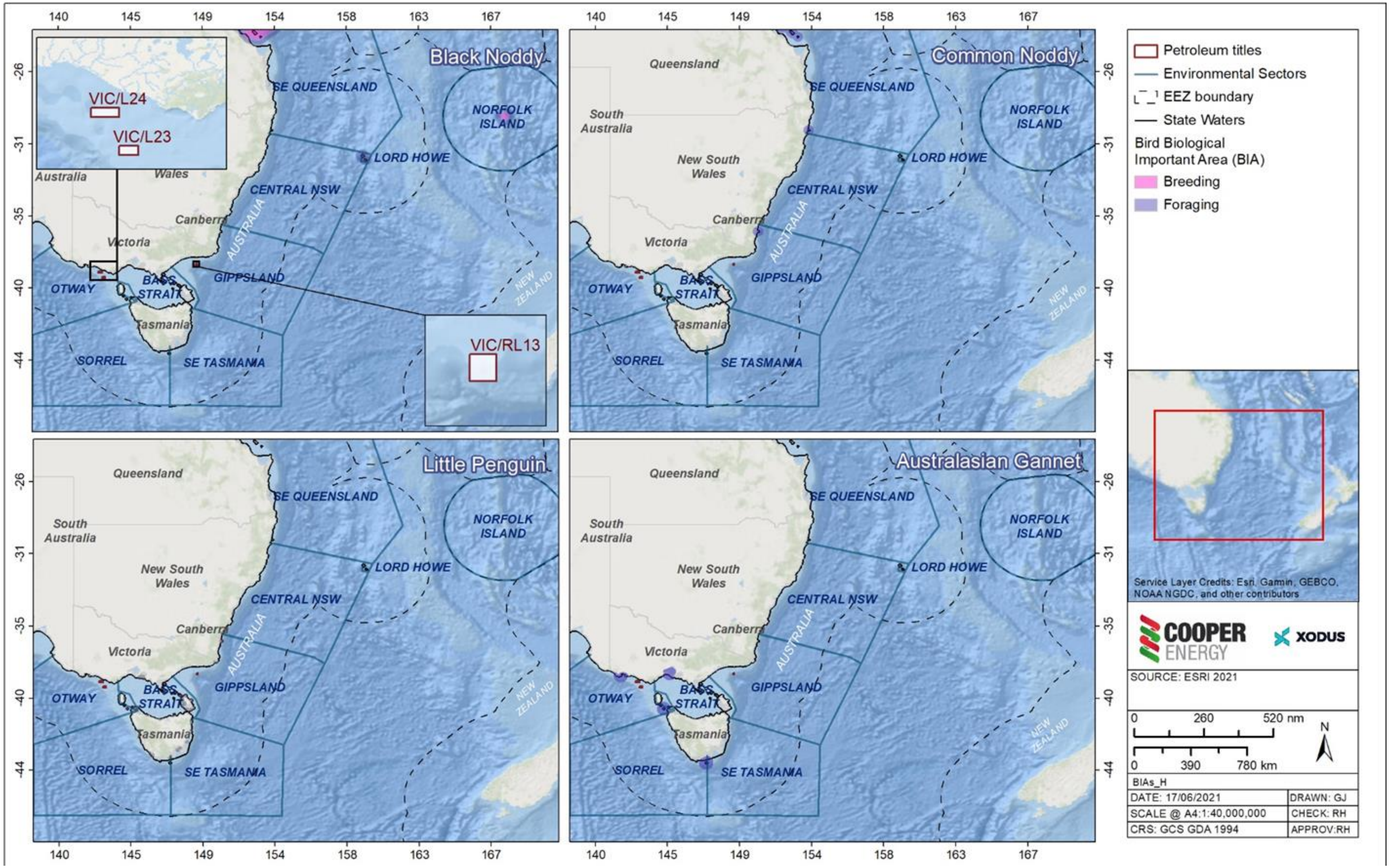


Figure 3-25: BIAs for the black noddy, common noddy, little penguin and Australasian gannet

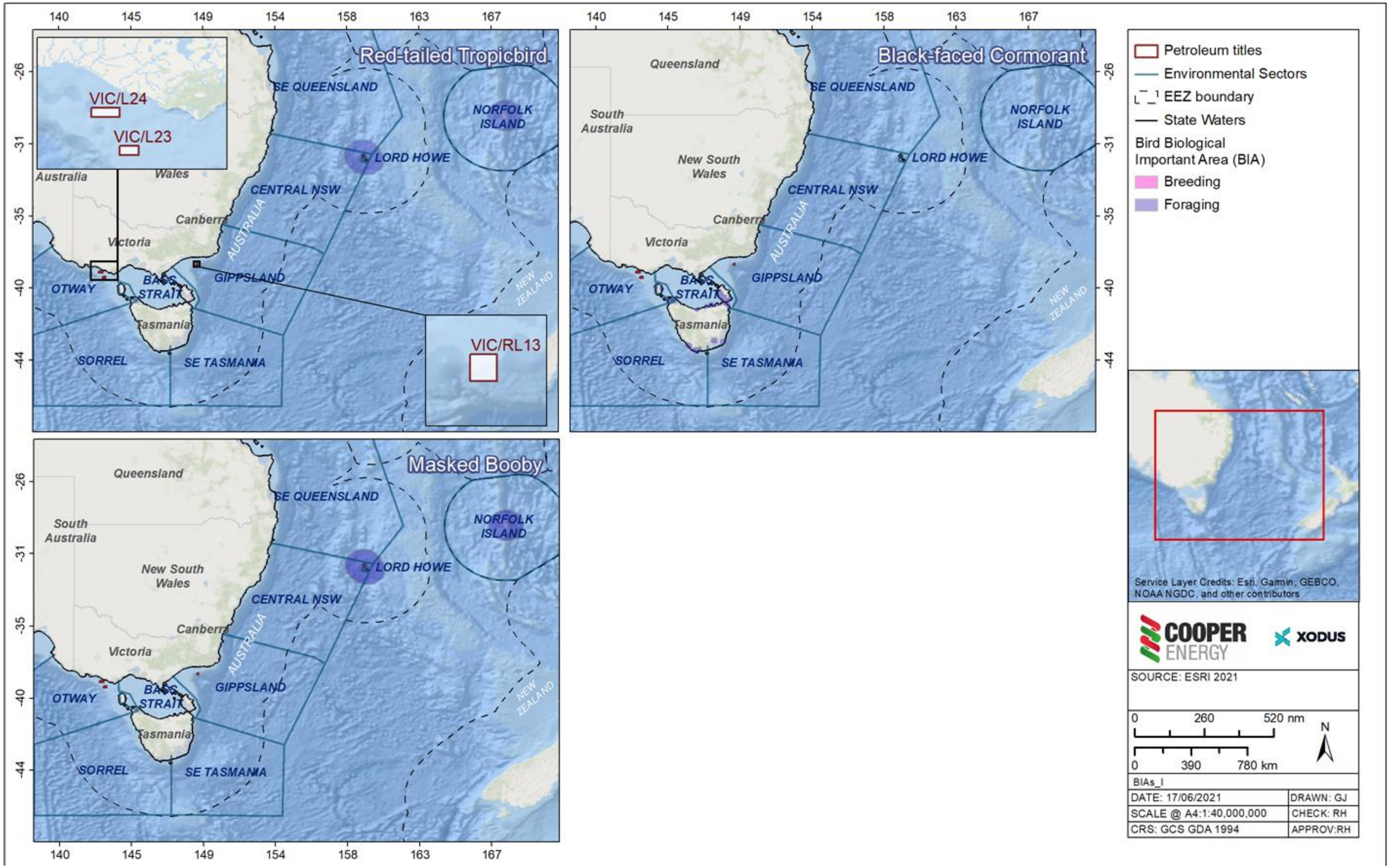


Figure 3-26: BIAs for the red-tailed tropicbird, black-faced cormorant and masked booby

3.11 Marine Invertebrates

Marine invertebrates comprise a variety of different organisms that can live in either the benthic or pelagic zone. The most common marine invertebrates include:

- Sponges
- Cnidarians (e.g. hydroids, anemones, jellyfish)
- Marine worms
- Arthropods (e.g. krill, prawn, crabs, lobster)
- Molluscs (e.g. nudibranch, sea slugs, mussels, oysters, squid, octopus)
- Echinoderms (e.g. sea stars, sea urchins, sea cucumbers)
- Hemichordates (e.g. acorn worms); and
- Lophophorates (e.g. bryozoans).

Studies by the Museum of Victoria found that invertebrate diversity was high in southern Australian waters, although the distribution of species was patchy, with little evidence of any distinct biogeographic regions (Wilson and Poore, 1987; Poore *et al.*, 1985). Results of sampling in shallower inshore sediments also reported high diversity and patchy distribution (Parry *et al.*, 1990).

In 1998 the Department of Natural Resources and Environment commissioned a survey of infauna along the entire length of the open Victorian coast (the 'Victorian coastal benthos study') (Heislers and Parry, 2007). The survey collected samples at three depths (10 m, 20 m and 40 m) on 50 transects running perpendicular to the coast. Data from the survey provided evidence that species diversity in Bass Strait was higher than that recorded in other regions, with a particular region of elevation species diversity in East Gippsland (Heislers and Parry, 2007). Crustaceans (particularly amphipods) were the dominant taxa in each depth class, representing more than half of the twenty most abundant families; followed by polychaetes. There was no clear difference in the representation of families between bioregions (e.g. between Otway and Two-fold Shelf regions) (Heislers and Parry, 2007). The total number of species per site increased with depth (Heislers and Parry, 2007).

Habitat characterisation surveys along the Patricia-Baleen pipeline route (OMV Australia, 2002) showed a sand and shell/rubble seabed, with sparse epibiotic (e.g. sponges) coverage, with no reef systems (OMV Australia, 2002).

A video survey undertaken along the Patricia-Baleen pipeline in 2003 (CEE, 2003) indicates that there are four general habitat associations on the seabed along the pipeline route. Large epibiota are very sparse, with extensive areas of sandy and shell/rubble seabed being devoid of large epibiota except for introduced screw shells and sponges. The biota identified are described below:

- large patches of seabed comprised of old large shells, predominantly bivalves and scallops, with New Zealand screw shells present in large numbers.
- Sponge garden – a small and distinct area of large sponges and bryozoans occurs at about 50 m water depth. The sponges varied in form and colour and included fans, spheres, massives, cups and fingers. Bryozoans included lace-like corals, concertina fans, perforated rigid sheets and fern-like branches. These associations indicate that although the seabed is comprised predominantly of sand and shell grit, it is stable enough to allow these associations to grow. Schools of jackass morwong, butterfly perch and individual gurnard and leatherjackets were attracted to the sponge garden.

There is limited information on the location, distribution and dispersion, or species composition of the epibenthic fauna in Gippsland Basin region. However, records demonstrate that within the Bass Strait (eastern Gippsland Basin) region, beyond the 'mud line' greater than ~110 m, a muddy sand biotope dominates that is recognised as quite different to the upper inner shelf areas in the region (Beaman et al. 2005).

Epifauna within the vicinity of the BMG field is expected to be sparse compared to nearshore regions given the water depths, coverage of silty sand and limited availability of hard substrate. During habitat surveys conducted within the BMG field (Ierodiaconou et al, 2020), observed epibenthic communities on the surface of subsea structures to consist primarily of sand, biofilm (thin layer of epibenthos) and shells along flowlines, with the presence of some black corals/octocorals and encrusting sponges observed on well infrastructure.

Black/octocorals, bryozoans and ascidians were not observed on flowlines. Along flowlines, burrows from infauna biota in mid shelf muddy sands were identified indicating extensive bioturbation.

Site specific studies conducted around the BMG subsea infrastructure by Ierodiaconou et al (2020) identified commercially fished species including arrow squid (*Nototodarus gouldi*), Balmain bug (*Ibacus peronii*), Cuttlefish (*Sepiidae* spp.), red prawn (*Haliporoides sibogae*), Tasmanian giant crab (*Pseudocarcinus gigas*) and octopus (*Octopodiadea* spp.).

Commercially important invertebrates include lobsters, prawns, scallop species (see Section 5.1).

There is one threatened echinoderm species (or species habitat) that may occur within the Environment Sectors (Table 3.10, Table 3.11). The Tasmanian live-bearing seastar inhabits sheltered waters in the upper intertidal zone of rocky areas of southeast Tasmania, with an estimated population size of at least 350,000 individuals within 13 isolated populations (TSSC, 2009b). The species is listed as vulnerable due to its restricted geographic distribution.

Table 3.10: Marine Invertebrate species or species habitat that may occur within the Environment Sectors

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Echinoderms															
Parvulastra vivipara	Tasmanian Live-bearing Seastar	V				[1]				LO	LO				

Threatened Species: ***V Vulnerable***	*Type of Presence:* *MO Species of species habitat may occur within area* *LO Species or species habitat likely to occur within area*	*Plan Reference:* *[1] Approved Conservation Advice for Patiriella vivipara (Tasmanian Live-bearing Seastar) (TSSC, 2009b)*

Table 3.11: Marine Invertebrate threatened species management advice relevant to petroleum activities under this EP

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under this EP
Tasmanian Live-bearing Seastar	Approved Conservation Advice for *Patiriella vivipara* (Tasmanian Live-bearing Seastar) (TSSC, 2009b)	• Habitat modification and destruction	• **Marine pollution:** Evaluate risk of oil spill impact and, if required, appropriate mitigation measures are implemented

3.12 Fish and Sharks

There are five fish, 11 shark and ray, and 77 syngnathid species (or species habitat) that may occur within the Environment Sectors; this includes species classified as threatened and migratory (Table 3.12). A list of the relevant conservation advice and/or recovery plans is also provided in Table 3.12, with relevant management actions in Table 3.13. The type of presence varies between species and location, and includes important behaviours (e.g. foraging, breeding) for some species (Table 3.12).

Commercially important fish include salmon and tuna species (see Section 5.1).

Note that the seabed in the vicinity of Cooper Energy assets is predominantly sediment; and the absence of any reef structures is expected to reduce the likelihood of fish species (threatened or commercial) to aggregate in the immediate areas. That is, any presence of fish species within the immediate area is expected to be transitory.

3.12.1 Sharks and Rays

In Australia, the grey nurse shark primarily has an inshore coastal distribution in sub-tropical to cool temperate waters on the continental shelf (DoE, 2014). The east coast population covers a range extending from the Capricornia coast (central Queensland) to Narooma in southern New South Wales (DoE, 2014), and is listed as critically endangered (TSSC, 2001). The Grey Nurse Shark generally occurs as solitary individuals or in small schools; larger aggregations of individuals may occur for courtship and mating (DoE, 2014). A number of key aggregation sites and habitat critical for the survival of the grey nurse shark have been identified within the Environment Sectors (Table 3.14). The grey nurse shark migrates within its range, making seasonal north–south movements to form aggregations at critical habitat sites, thought to be related to breeding (DEE, 2017i). The precise timing of mating and pupping in Australian waters is unknown; however, in South Africa mating occurs between late-October and late-November (DEE, 2017i). A BIA for breeding and distribution has been identified for the grey nurse shark along the east coast of Australia (Figure 3-29).

The great white shark has a range extending from central Queensland, around the south coast, to north-west Western Australia (DSEWPaC, 2013a). The shark is primarily found on the continental shelf and coastal waters, including inshore waters around oceanic islands. The Great White Shark is not evenly distributed throughout its range, with observations more frequent in some areas, including those around fur-seal or sea-lion colonies (DSEWPaC, 2013a). Juveniles appear to aggregate seasonally in key areas, including Wilsons Promontory (Victoria), and the coast between Newcastle and Forster (New South Wales) (DSEWPaC, 2013a). Recent studies have found that juvenile white sharks (<3m) occupy estuaries at Port Stephens, New South Wales and Corner Inlet, Victoria during October to January (Harasti *et al*., 2017). A BIA for breeding (nursery ground) has been established in the coastal region extending east from Wilsons Promontory; and a BIA for aggregation off the Newcastle coast (Figure 3-28). The great white shark moves seasonally along the south and east Australian coasts, moving northerly along the coast during autumn and winter, and returning to southern Australian waters by early summer. The Great White Shark is not known to form and defend territories, however, its ability to return on a seasonal basis implies a degree of site fidelity (DSEWPaC, 2013a).

The shortfin mako shark (*Isurus oxyrinchus*) has been recorded in offshore waters all around the Australian coastline except for the Arafura Sea, Gulf of Carpentaria and Torres Strait in the north (TSSC, 2014b). It is a pelagic species, primarily occurring in offshore, oceanic waters (Last and Stevens, 2009). The shortfin mako is highly migratory and can cover large distances, migrating from Australian waters to areas well beyond the Australian Exclusive Economic Zone (Rogers *et al.*, 2009). The shortfin mako inhabits depths down to 600 m, with a slight trend indicating the species spend the majority of the night in shallow water, and the majority of daylight hours in deeper waters (Rogers *et al*., 2009). It is not normally found in waters below 16 °C (RPS, 2015). Satellite tracking data for shortfin makos showed a potential for year-round occupation of the Otway, Bass Strait and Gippsland Basins (Rogers and Bailleul, 2015).

The green sawfish is a species of ray that has a historic range extending from northern Australia down the east coast to Jervis Bay in New South Wales (DEE, 2017j). However, no records of this species exist south of Cairns since the 1960's (DEE, 2017j). The green sawfish prefers muddy bottom habitats, and has previously been recorded in inshore marine waters, estuaries, river mouths, embankments and along sandy and muddy beaches. Sawfish return seasonally to inshore coastal waters to breed and pup; pupping may occur during the summer wet season (DEE, 2017j). Given the contraction of the green sawfish's range, this species is not expected to be encountered within the Environment Sectors.

3.12.2 Handfish

Site specific habitat surveys of BMG subsea infrastructure conducted by Ierodiaconou et al (2020) noted that fish assemblages present along wells and flowlines generally reflect those known to occur in the region. During analysis of survey footage, a tentative identification of handfish (Family Brachionichthyidae) was made. The species could not be confirmed due to image resolution.

Stuart-Smith et. Al 2020 reports 14 different species of handfish. Seven species of handfish are listed on the IUCN red list as either Critically Endangered or Endangered. Three of these IUCN listed species are also EPBC listed either Vulnerable or Endangered.

Handfish are relatively small (60–151 mm) marine fishes with distributions restricted to the temperate waters of south-eastern Australia, predominantly concentrated in Tasmania (Last and Gledhill, 2009). They are demersal, generally cryptic in nature. Lacking a swim bladder, they prefer to use their 'hands' to 'walk' across the sea floor, rather than swim (although can do so over short distances when disturbed).

The images captured of the Handfish were done so by ROV mounted high definition camera flying over the known flowline routes. These sections of flowlines were trenched and buried in 2012 (or have been naturally buried since installation). The specimens observed at BMG were all seen on areas of seabed covering the B6 EHU and B6 Oil Flowline (Figure 3-27). The seabed appears sandy/shell/silty/muddy. There is evidence of infauna (burrows/mounds) and epifauna. It is not obvious that the seabed was trenched, or that a flowline is buried beneath. Whilst detailed footage was taken (and analysed by Deakin) of exposed sections of flowlines at similar depths; no specimens were observed on or around the exposed flowlines. This may indicate that the handfish specimens are not interacting with the flowline directly. The specimens observed were at least 200 m from the well centres.

Based on recorded distributions (Stuart-Smith etal 2020), the more likely explanation as to what species of handfish were observed around BMG is the Australian handfish. This species is not EPBC listed threatened, and is listed by the IUCN as 'least concern'. Other handfish species with recorded localities and depth ranges resembling the BMG area include the warty handish, moultons handfish, narrowbody handfish and humpback handfish. These species are listed by the IUCN as 'data deficient'. No EPBC listed handfish species are expected to be found within the Operational Area, due to the depth (listed species are found in water depths up to 60 m) and the location (listed species have been observed in Tasmania only).

The combination of poor dispersal potential with highly localised distributions and generally low population numbers means that they are highly susceptible to local disturbance events and broader environmental change (Bruce et al., 1998; Last and Gledhill, 2009; Last et al., 1983). Threats to handfish are noted as 'Prolonged Trawl and Dredge effort within its range possibly causing both habitat destruction and direct mortality' (Stuart-Smith et al 2020).

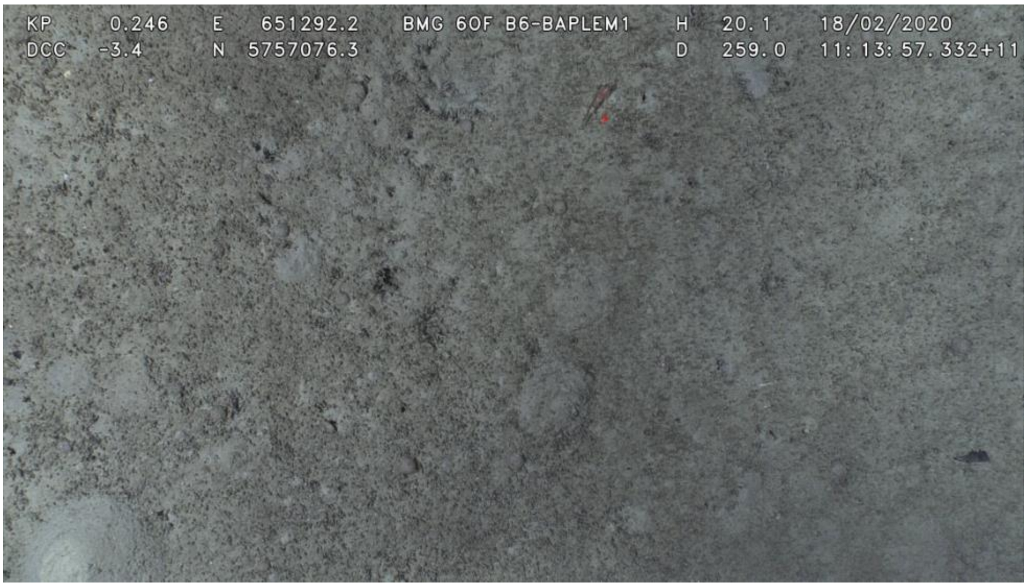


Figure 3-27 Suspected handfish sighting (Ierodiaconou et al (2021))

3.12.3 Pipefish, Seahorse and Seadragons

Syngnathidae is a group of bony fishes that includes seahorses, pipefishes, pipehorses and sea dragons; the closely related Solenostomidae family includes ghost pipefish. These species occupy a range of habitats, however, generally display a preference for seagrass and macroalgal beds, coral reefs, mangroves or sponge gardens (i.e. a habitat offering a protective environment) (DSEWPaC, 2012b). Habitat that supports syngnathid populations is generally patchy, so populations of syngnathid species may be dispersed and fragmented (DSEWPaC, 2012b). Syngnathids are typically carnivorous, feeding in the water column on or near the sea floor; their diet including small crustaceans, invertebrates, and zooplankton.

Table 3.12: Fish species or species habitat that may occur within the Environment Sectors

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Fish															
Brachionichthys hirsutus	Spotted Handfish	CE				[1],[2]				MO	KO				
Brachiopsilus ziebelli	Ziebell's Handfish	V				[2]				LO	LO				
Epinephelus daemelii	Black Rockcod	V				[3]			LO			LO	LO	LO	KO
Prototroctes maraena	Australian Grayling	V				[4]	KO	KO	KO	KO	KO	KO			
Thymichthys politus	Red Handfish	CE				[5],[2]		MO	MO	LO	KO				
Sharks and Rays															
Anoxupristis cuspidata	Narrow Sawfish		✓										MO		
Carcharhinus longimanus	Oceanic Whitetip Shark		✓						MO						
Carcharias taurus	Grey Nurse Shark (east coast population)	CE			*	[6]			KO*[f.m]			KO*[f.m]	KO*[f.m]		
Carcharodon carcharias	Great White Shark	V	✓		*	[7]	FKO*[d]	BKO*[b,d]	BKO*[b,d]	FKO*[d]	KO*[d]	BKO*[a,d]	C/A*[a,d]	LO	LO
Isurus oxyrinchus	Shortfin Mako		✓				LO	LO	LO	LO	LO	LO	LO		
Isurus paucus	Longfin Mako		✓									LO	LO		
Lamna nasus	Porbeagle, Mackerel Shark		✓				LO	LO	LO	LO	LO	LO	MO	MO	
Manta alredi	Reef Manta Ray		✓									KO	KO	LO	
Manta birostris	Giant Manta Ray		✓						KO			LO	LO	LO	
Pristis zijsron	Green Sawfish	V	✓			[8],[9]							BLO		
Rhincodon typus	Whale Shark	V	✓			[10]		MO	MO			MO	MO		
Zearaja maugeana	Maugean Skate	E				[11]				KO					

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Pipefish, Seahorse and Seadragons															
Acentronura australe	Southern Pygmy Pipehorse			✓			MO								
Acentronura tentaculate	Shortpouch Pygmy Pipehorse			✓					MO			MO	MO		
Campichthys tryoni	Tryon's Pipefish			✓			MO					MO	MO		
Choeroichthys brachysoma	Pacific Short-bodied Pipefish			✓									MO		
Corythoichthys amplexus	Fijian Banded Pipefish			✓								MO	MO		
Corythoichthys flavofasiatus	Reticulate Pipefish			✓									MO		
Corythoichthys haematopterus	Reef-top Pipefish			✓									MO		
Corythoichthys intestinalis	Australian Messmate Pipefish			✓									MO		
Corythoichthys ocellatus	Orange-spotted Pipefish			✓								MO	MO		
Corythoichthys paxtoni	Paxton's Pipefish			✓									MO		
Corythoichthys schultzi	Schultz's Pipefish			✓									MO		
Cosmocampus howensis	Lord Howe Pipefish			✓					MO			MO		MO	
Doryrhamphus excisus	Bluestripe Pipefish			✓									MO		
Festuclex cinctus	Girdled Pipefish			✓								MO	MO		
Filicampus tigris	Tiger Pipefish			✓								MO	MO		
Halicampus boothae	Booth's Pipefish			✓								MO		MO	MO
Halicampus dunckeri	Red-hair Pipefish			✓									MO		
Halicampus grayi	Mud Pipefish			✓									MO		
Halicampus nitidus	Glittering Pipefish			✓									MO		
Halicampus spinirostris	Spiny-snout Pipefish			✓									MO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Heraldia nocturna	Upside-down Pipefish			✓			MO	MO	MO	MO	MO	MO			
Hippichthys cyanospilos	Blue-speckled Pipefish			✓								MO	MO		
Hippichthys heptagonus	Madura Pipefish			✓								MO	MO		
Hippichthys peniculls	Beady Pipefish			✓								MO	MO		
Hippocampus abdominalis	Big-belly Seahorse			✓			MO	MO	MO	MO	MO	MO			
Hippocampus bargibanti	Pygmy Seahorse			✓									MO		
Hippocampus berviceps	Short-head Seahorse			✓			MO	MO	MO	MO	MO	MO			
Hippocampus kelloggi	Kellogg's Seahorse			✓								MO	MO	MO	
Hippocampus kuda	Spotted Seahorse			✓								MO	MO		
Hippocampus minotaur	Bullneck Seahorse			✓			MO	MO	MO						
Hippocampus planifrons	Flat-face Seahorse			✓								MO	MO		
Hippocampus trimaculatus	Three-spot Seahorse			✓								MO	MO		
Hippocampus whitei	White's Seahorse			✓				MO				KO	MO		
Hippocampus zebra	Zebra Seahorse			✓									MO		
Histiogamphelus briggsii	Crested Pipefish			✓			MO	MO	MO	MO	MO	MO			
Histiogamphelus cristatus	Rhino Pipefish			✓			MO	MO	MO	MO					
Hypselognathus rostratus	Knifesnout Pipefish			✓			MO	MO	MO	MO	MO				
Kaupus costatus	Deepbody Pipefish			✓			MO	MO	MO	MO	MO				
Kimblaeus bassensis	Trawl Pipefish			✓			MO	MO	MO	MO	MO	MO			
Leptoichthys fistularius	Brushtail Pipefish			✓			MO	MO	MO	MO					
Lissocampus caudalis	Australian Smooth Pipefish			✓			MO	MO	MO	MO					

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Lissocampus runa	Javeline Pipefish			✓			MO	MO	MO	MO	MO	MO	MO		
Maroubra perserrata	Sawtooth Pipefish			✓			MO	MO	MO	MO	MO	MO	MO		
Micrognathus andersons	Anderson's Pipefish			✓								MO	MO		
Micrognathus brevirostris	Thorntail Pipefish			✓								MO	MO		
Microphis manadensis	Manado Pipefish			✓								MO	MO		
Mitotichthys mollisoni	Mollison's Pipefish			✓			MO	MO	MO	MO	MO				
Mitotichthys semistriatus	Halfbanded Pipefish			✓			MO	MO	MO	MO	MO				
Mitotichthys tuckeri	Tucker's Pipefish			✓			MO	MO	MO	MO	MO				
Nannocampus pictus	Painted Pipefish			✓									MO		
Notiocampus ruber	Red Pipefish			✓			MO	MO	MO	MO	MO	MO			
Phycodurus eqques	Leafy Seadragon			✓			MO	MO	MO	MO					
Phyllopteryx taeniolatus	Common Seadragon			✓			MO	MO	MO	MO	MO	MO			
Pugnaso curtirostris	Pugnose Pipefish			✓			MO	MO	MO	MO	MO				
Solegnathus dunckeri	Duncker's Pipehorse			✓								MO	MO	MO	
Solegnathus harwickii	Pallid Pipehorse			✓								MO	MO		
Solegnathus robustus	Robust Pipehorse			✓			MO	MO	MO	MO	MO				
Solegnathus spinosissimus	Spiny Pipehorse			✓			MO	MO	MO	MO	MO	MO	MO		
Solenostomus cyanopterus	Robust Ghostpipefish			✓					MO			MO	MO		
Solenostromus paradoxus	Ornate Ghostpipefish			✓								MO	MO		
Stigmatopora argus	Spotted Pipefish			✓			MO	MO	MO	MO	MO	MO			
Stigmatopora nigra	Widebody Pipefish			✓			MO	MO	MO	MO	MO	MO	MO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Stipecampus cristatus	Ringback Pipefish			✓			MO	MO	MO	MO					
Syngnathoides biaculeatus	Double-end Pipehorse			✓				MO	MO			MO	MO		
Trachyrhamphus bicoarctatus	Bentstick Pipefish			✓								MO	MO		
Urocampus carinirostris	Hairy Pipefish			✓			MO	MO	MO	MO	MO	MO	MO		
Vanacampus margaritifer	Mother-of-pearl Pipefish			✓			MO	MO	MO	MO		MO	MO		
Vanacampus phillipi	Port Phillip Pipefish			✓			MO	MO	MO	MO	MO	MO			
Vanacampus poecilolaemus	Longsnout Pipefish			✓			MO	MO	MO	MO	MO				
Vanacampus vercoi	Verco's Pipefish			✓			MO								

Threatened Species:
V *Vulnerable*
E *Endangered*
CE *Critically Endangered*
Biologically Important Area
* *BIA Present*
a *Aggregation*
b *Breeding*
d *Distribution*

Type of Presence:
MO *Species or species habitat may occur within area*
LO *Species or species habitat likely to occur within area*
KO *Species or species habitat known to occur within area*
Tr *Translocated population known to occur within area*
C/A *Congregation or aggregation known to occur within area*
FKO *Foraging, feeding or related behaviour known to occur within area*
BMO *Breeding may occur within area*
BKO *Breeding known to occur within area*

Plan Reference:
[1] Approved Conservation Advice on Brachionichthus hirsutus (Spotted Handfish) (TSSC 2012b)
[2] Recovery Plan for Three Handfish Species: Spotted Handfish (Brachionichthys hirsutus), Red Handfish (Thymichthys politus), and Ziebell's Handfish (Branchiopsilus ziebelli) (DoE, 2015b)
[3] Approved Conservation Advice for Epinephelus daemelii (Black Rock-cod) (TSSC, 2012c)
[4] National Recovery Plan for Australian Grayling (DEWHA, 2008)
[5] Approved Conservation Advice for Thymichthys politus (Red Handfish) (TSSC, 2012d)
[6] Recovery Plan for the Grey Nurse Shark (Carcharias Taurus) (DoE, 2014)
[7] Recovery Plan for the White Shark (Carcharodon carcharias) (DSEWPaC, 2013a)
[8] Approved Conservation Advice for Pristis zijsron (Green Sawfish) (TSSC, 2008a)
[9] Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015c)
[10] Approved Conservation Advice for Rhincodon typus (Whale Shark) (TSSC, 2015j)
[11] Approved Conservation Advice for Raja sp. L (Maugean Skate) (TSSC, 2008b)

Table 3.13: Fish threatened species management advice relevant to petroleum activities under this EP

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under this EP
Fish			
• **Spotted Handfish** • **Ziebell's Handfish** • **Red Handfish**	Recovery Plan for Three Handfish Species: Spotted Handfish (*Brachionichthys hirsutus*), Red Handfish (*Thymichthys politus*), and Ziebell's Handfish (*Branchiopsilus ziebelli*) (DoE, 2015b)	• None identified	• None identified
• **Spotted Handfish**	Approved Conservation Advice on *Brachionichthus hirsutus* (Spotted Handfish) (TSSC 2012b)		
• **Red Handfish**	Approved Conservation Advice for *Thymichthys politus* (Red Handfish) (TSSC, 2012d)		
• **Black Rockcod**	Approved Conservation Advice for *Epinephelus daemelii* (Black Rock-cod) (TSSC, 2012c)	• None identified	• None identified
• **Australian Grayling**	National Recovery Plan for Australian Grayling (DEWHA, 2008)	• None identified	• None identified
Sharks and Rays			
• **Grey Nurse Shark (east coast population)**	Recovery Plan for the Grey Nurse Shark (*Carcharias Taurus*) (DoE, 2014)	• None identified	• None identified
• **Great White Shark**	Recovery Plan for the White Shark (*Carcharodon carcharias*) (DSEWPaC, 2013a)	• None identified	• None identified
• **Green Sawfish**	Approved Conservation Advice for *Pristis zijsron* (Green Sawfish) (TSSC, 2008a) Sawfish and River Sharks Multispecies Recovery Plan (DoE, 2015c)	• None identified	• None identified
• **Whale Shark**	Approved Conservation Advice for *Rhincodon typus* (Whale Shark) (TSSC, 2015j)	• Vessel strike • Habitat disruption from mineral exploration, production and transportation • Marine debris	• **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Maugean Skate**	Approved Conservation Advice for *Raja sp. L* (Maugean Skate) (TSSC, 2008b)	• None identified	• None identified

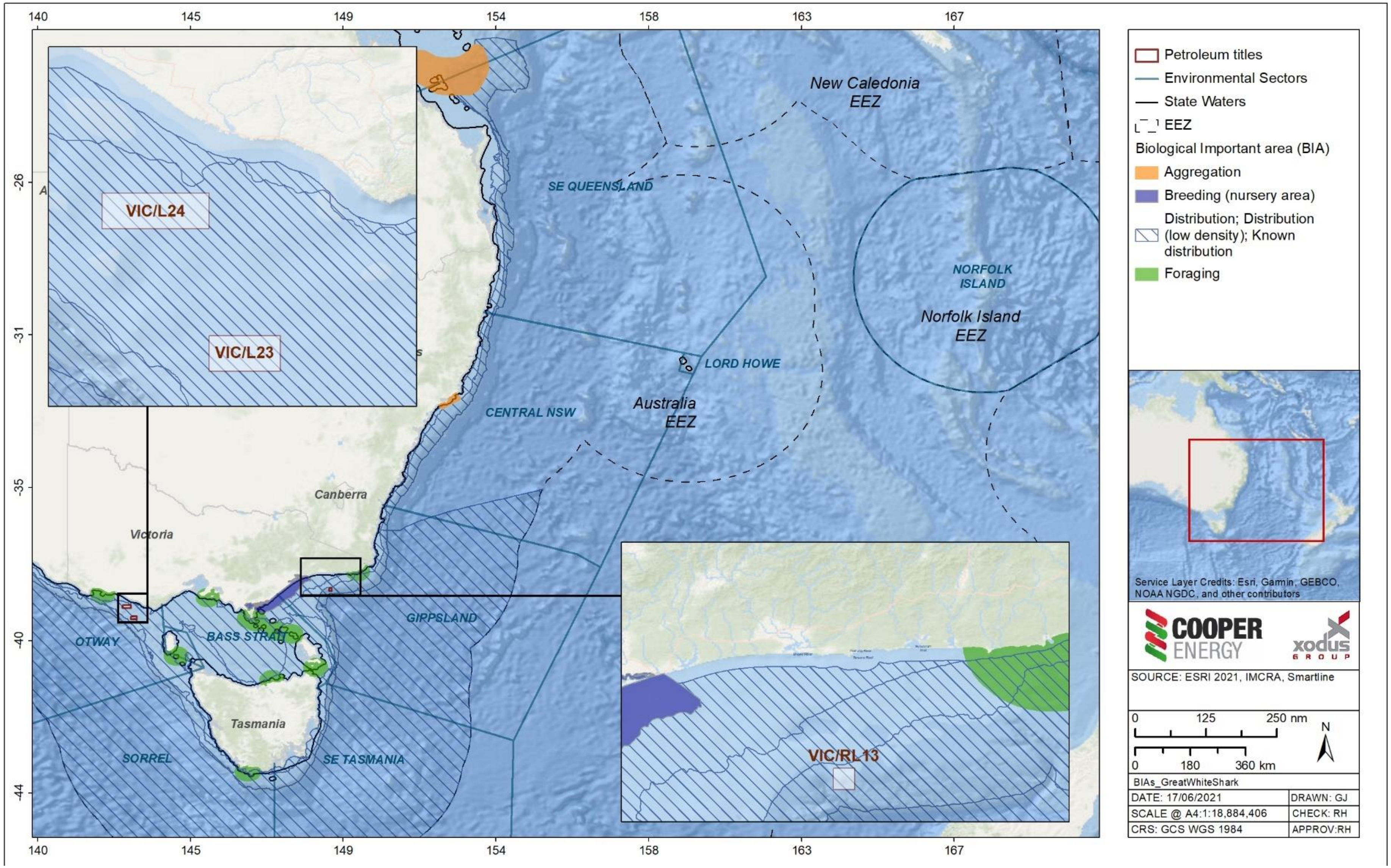


Figure 3-28: BIAs for the Great White Shark

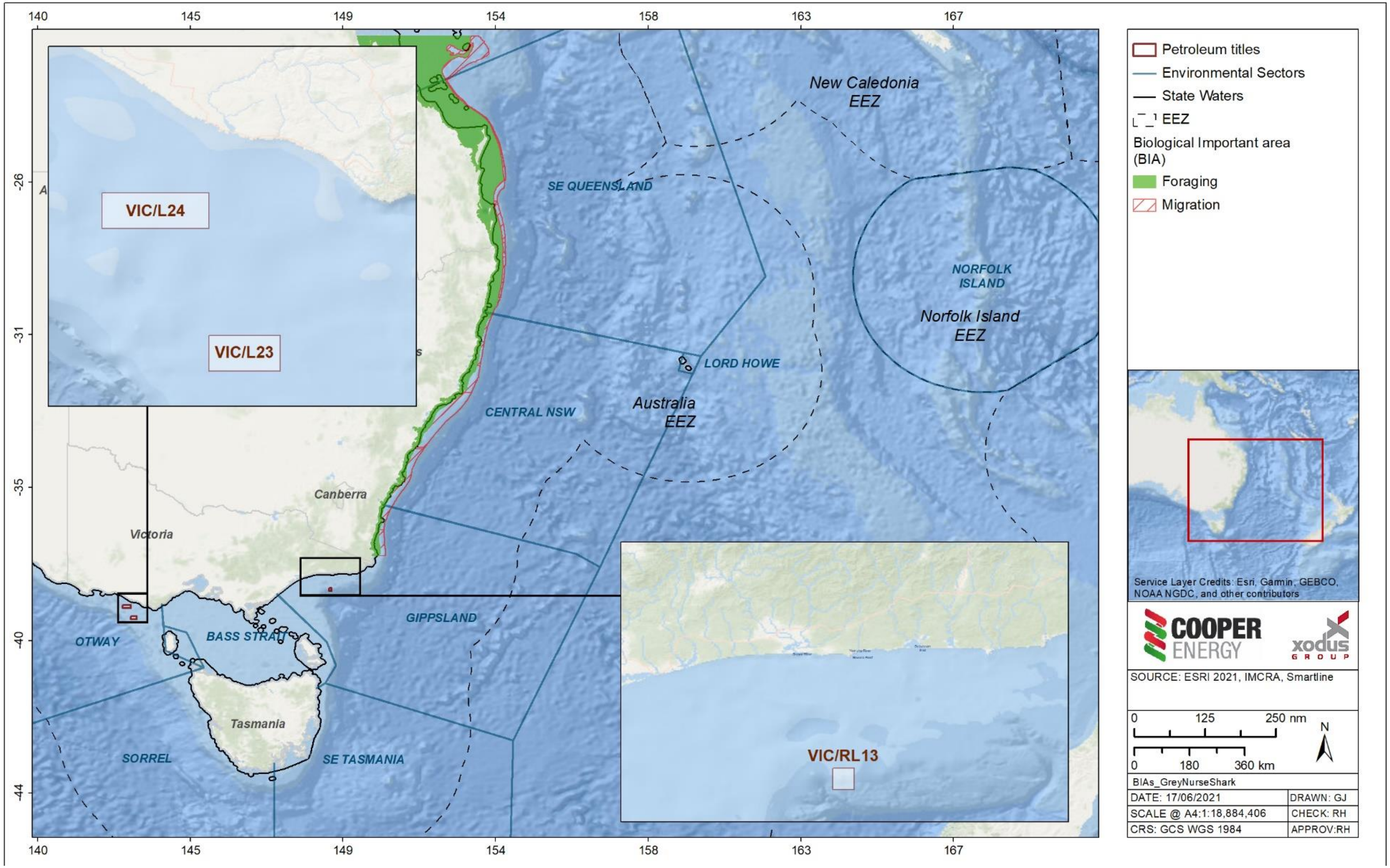


Figure 3-29: BIAs for the Grey Nurse Shark

Table 3.14: Known key aggregation sites[1] critical for the survival of the Grey Nurse Shark in Australian waters

Queensland Waters	New South Wales Waters	Commonwealth Waters
• **Wolf Rock off Rainbow Beach** • **Cherubs Cave off Moreton Island** • **Henderson's Rock off Moreton Island** • **Flat Rock off North Stradbroke Island**	• Julian Rocks near Byron Bay • North Solitary Island (Anemone Bay) • South Solitary Island (Manta Arch) • Green Island near South West Rocks • Fish Rock near South West Rocks • Mermaid Reef near Laurieton • The Pinnacle near Forster • Big Seal, Seal Rocks • Little Seal, Seal Rocks • Little Broughton Island near Port Stephens • Magic Point at Maroubra, Sydney • Tollgate Islands near Batemans Bay • Montague Island near Narooma	• Pimpernel Rock off Brooms Head (northern section of Solitary Islands Marine Park) • Cod Grounds off Laurieton

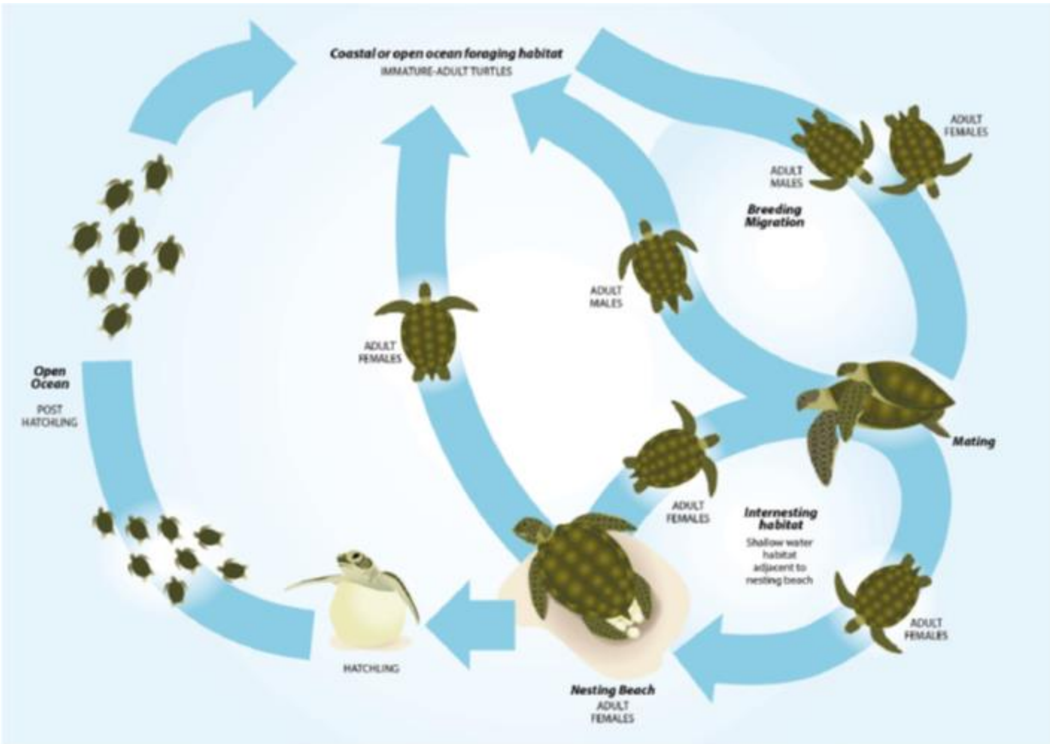
Notes:
1. 'Key Aggregation Sites' defined as being locations where five or more Grey Nurse Sharks were consistently found throughout the year (DoE, 2014).

3.13 Marine Reptiles

There are six marine turtles, 13 sea snakes, and one crocodile species (or species habitat) that may occur within the Environment Sectors; this includes species classified as threatened and migratory (Table 3.15). A list of the relevant conservation advice and/or recovery plans is also provided in Table 3.15, with relevant management actions in Figure 3-14. The type of presence varies between species and location, and includes important behaviours (e.g. foraging, breeding) for some species (Table 3.15).

3.13.1 Marine Turtles

Adult marine turtles spend the majority of their lives in the ocean, typically only coming onshore to nest (Figure 3-30). Females can lay (on average) between two and six clutches per season (DEE, 2017k); with the period between clutches known as the internesting period. Female turtles typically remain close to the same nesting site during an internesting period. Egg incubation varies between species, but is typically approximately two months (DEE, 2017k). Hatchlings disperse into oceanic currents, and the juveniles will stay in pelagic waters until large enough to settle into coastal feeding habitats. Leatherback turtles are an exception to these general patterns, often exhibiting larger internesting zones, and travelling vast distances to forage rather than settling in a coastal habitat (DEE, 2017k). Flatback turtles also lack an oceanic phase and remain in the surface waters of the continental shelf.



(Source: DEE, 2017k)

Figure 3-30: Generalised life cycle of a Marine Turtle

The loggerhead turtle has a global distribution throughout tropical, sub-tropical and temperate waters; and in Australia typically occurs in the waters of coral and rocky reefs, seagrass beds, or muddy bays throughout eastern, northern and western Australia (DEE, 2017l). While the species has a broad foraging range throughout Australian waters, nesting is known to occur (from two different genetic stocks) on sandy beaches on the central western and eastern coasts (Figure 3-31) (DEE, 2017l). Nesting on the east coast typically occurs between October and March each year (Table 3.17). A BIA, for nesting and internesting, has also been identified for this species in this area (Figure 3-32). More recent information released in the Recovery Plan (DEE, 2017k) presents draft critical habitat areas for the loggerhead turtle; some of which overlap with previously defined BIAs (Figure 3-32). The eastern Australian population is smaller than the western Australian population; and has also undergone a decline from approximately 3,500 nesting females in 1977, to approximately 500 nesting females in 2000 (DEE, 2017l).

Important local foraging areas for the species, include the Great Barrier Reef area and Moreton Bay (DEE, 2017l). Loggerhead turtles are carnivorous, feeding primarily on benthic invertebrates (DEE, 2017l).

Green turtles are found in tropical and subtropical waters throughout the world; usually occurring within the 20°C isotherms, although individuals can stray into temperate waters (DEE, 2017m). Within Australia, green turtles typically nest, forage and migrate across tropical northern Australia (Figure 3-31) (DEE, 2017m). There is one nesting stock for green turtles within the Environment Sectors, with nesting typically occurring between October and April; and peaking in January (Figure 3-31, Table 3.17). A BIA, for nesting, internesting, and foraging, has also been identified for this species in this area (Figure 3-32). More recent information released in the Recovery Plan (DEE, 2017k) presents draft critical habitat areas for the Green Turtle; some of which overlap with previously defined nesting BIAs (Figure 3-32). The total Australian population of green turtles is approximately 70,000 individuals, with approximately 8,000 of these found in the Southern Great Barrier Reef area (DEE, 2017m). Adult green turtles consume mainly seagrass and algae, although they will occasionally eat mangroves, fish-egg cases, jellyfish, and sponges; juvenile green turtles are typically more carnivorous, and will also consume plankton during their pelagic stage (DEE, 2017m).

The leatherback turtle has the widest distribution of any marine turtle, occurring in tropical to sub-polar oceans (TSSC, 2008c). In Australia, the leatherback turtle has been recorded foraging in all Australian states, but no large nesting populations have been recorded (Figure 3-31) (TSSC, 2008c). Small numbers of nesting females have previously been recorded in central Queensland, northern NSW, and the Northern Territory; however, no nesting has been recorded in eastern Australian since 1996 (TSSC, 2008c). There is a BIA established, for nesting and internesting, for a small area in central Queensland (Figure 3-32). The leatherback turtle is a highly pelagic species, venturing close to shore mainly during the nesting season (DEE, 2017n). Adults feed mainly on pelagic soft-bodied creatures such as jellyfish, tunicates, salps, squid (DEE, 2017n).

The flatback turtle is found in tropical waters of northern Australia, and is one of only two species of sea turtle without a global distribution (DEE, 2017o). All known nesting locations for this species are within Australia (Figure 3-31) (DEE, 2017o). A BIA for nesting has been identified for this species, with the southern extent of this occurring within the 'SE Queensland' Environment Sector (Figure 3-32); the majority of flatback turtle nesting in Queensland occurs further north. More recent information released in the Recovery Plan (DEE, 2017k) presents draft critical habitat areas for the flatback turtle; some of which overlap with previously defined BIAs (Figure 3-32). In Queensland nesting occurs between October and March, with a peak in December (Table 3.17) (DEE, 2017o). Nesting trends at Mon Repos and Curtis Island show no signs of decline (DEE, 2017o). Flatback turtles are primarily carnivorous, feeding on soft-bodied invertebrates; juveniles eat gastropod molluscs, squid, siphonophores (DEE, 2017o). Limited data also indicate that cuttlefish, hydroids, soft corals, crinoids, molluscs and jellyfish may also form part of their diet (DEE, 2017o).

The hawksbill turtle is found in tropical, subtropical and temperate waters all around the world (DEE, 2017p). Nesting within Australia for the hawksbill turtle occurs outside the Environment Sectors; however, their known range does extent into the temperate waters of southern Queensland and New South Wales (Figure 3-31). Hawksbill turtles are omnivorous, feeding on sponges, hydroids, cephalopods (octopus and squid), gastropods (marine snails), cnidarians (jellyfish), seagrass and algae (DEE, 2017k, 2017p). During their pelagic phase (while drifting on ocean currents), young hawksbill turtles will feed on plankton (DEE, 2017p). Hawksbill turtles that forage on the Great Barrier Reef migrate to neighbouring countries including Papua New Guinea, Vanuatu, and the Solomon Islands; it is not known from which stock hawksbill turtles foraging in New South Wales originate (DEE, 2017k).

The Olive Ridley turtle is found in waters across northern Australia and to the southern Queensland border (Figure 3-31). No nesting for Olive Ridley turtles occurs within the Environment Sectors (Figure 3-31) (DEE, 2017q). Olive Ridley Turtles are primarily carnivorous, feeding on soft-bodied invertebrates such as sea pens, soft corals, sea cucumbers, and jellyfish (DEE, 2017k). Both juveniles and adults have been observed foraging over shallow benthic habitats from northern Western Australia to south-east Queensland; although occurrences in pelagic foraging habitats also occur (DEE, 2017q). The Great Barrier Reef area is an important foraging area for this specie (DEE, 2017q).

Table 3.15: Marine Reptile species or species habitat that may occur within the Environment Sectors

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Turtles															
Caretta caretta	Loggerhead Turtle	E	✓	✓	*	[1]	BLO	FKO	BLO		LO	BKO	BKO*[n,i]	LO	LO
Chelonia mydas	Green Turtle	V	✓	✓	*	[1]	MO	FKO	FKO	MO	MO	FKO	BKO *[n,i,f]	LO	LO
Dermochelys coriacea	Leatherback Turtle	E	✓	✓	*	[1], [2]	FKO	FKO	FKO	BLO	LO	FKO	BKO*[n,i]	LO	LO
Eretmochelys imbricata	Hawksbill Turtle	V	✓	✓		[1]			FKO			FKO	FKO	LO	LO
Lepidochelys olivacea	Olive Ridley Turtle	E	✓	✓		[1]							FKO		
Natator depressus	Flatback Turtle	V	✓	✓	*	[1]			FKO			FKO	BKO*[n]	LO	LO
Sea Snakes															
Acalyptophis peroni	Horned Seasnake			✓									MO		
Aipysurus duboissi	Dubois' Seasnake			✓									MO		
Aipysurus eydouxii	Spine-tailed Seasnake			✓									MO		
Aipysurus laevis	Olive Seasnake			✓									MO		
Astrotia stokesii	Stoke's Seasnake			✓									MO		
Disteiria kingii	Spectacled Seasnake			✓									MO		
Disteira major	Olive-headed Seasnake			✓									MO		
Emydocephalus annulatus	Turtle-headed Seasnake			✓									MO		
Hydrophis elegans	Elegant Seasnake			✓								MO	MO		

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Lapemis hardwickii	Spine-bellied Seasnake			✓									MO		
Laticauda colubrina	a sea krait (1092)			✓									MO		
Laticauda laticaudata	a sea krait (1093)			✓									MO		
Pelamis platurus	Yellow-bellied Seasnake			✓								MO	MO		
Crocodile															
Crocodylus prorsus	Salt-water Crocodile		✓	✓									LO		

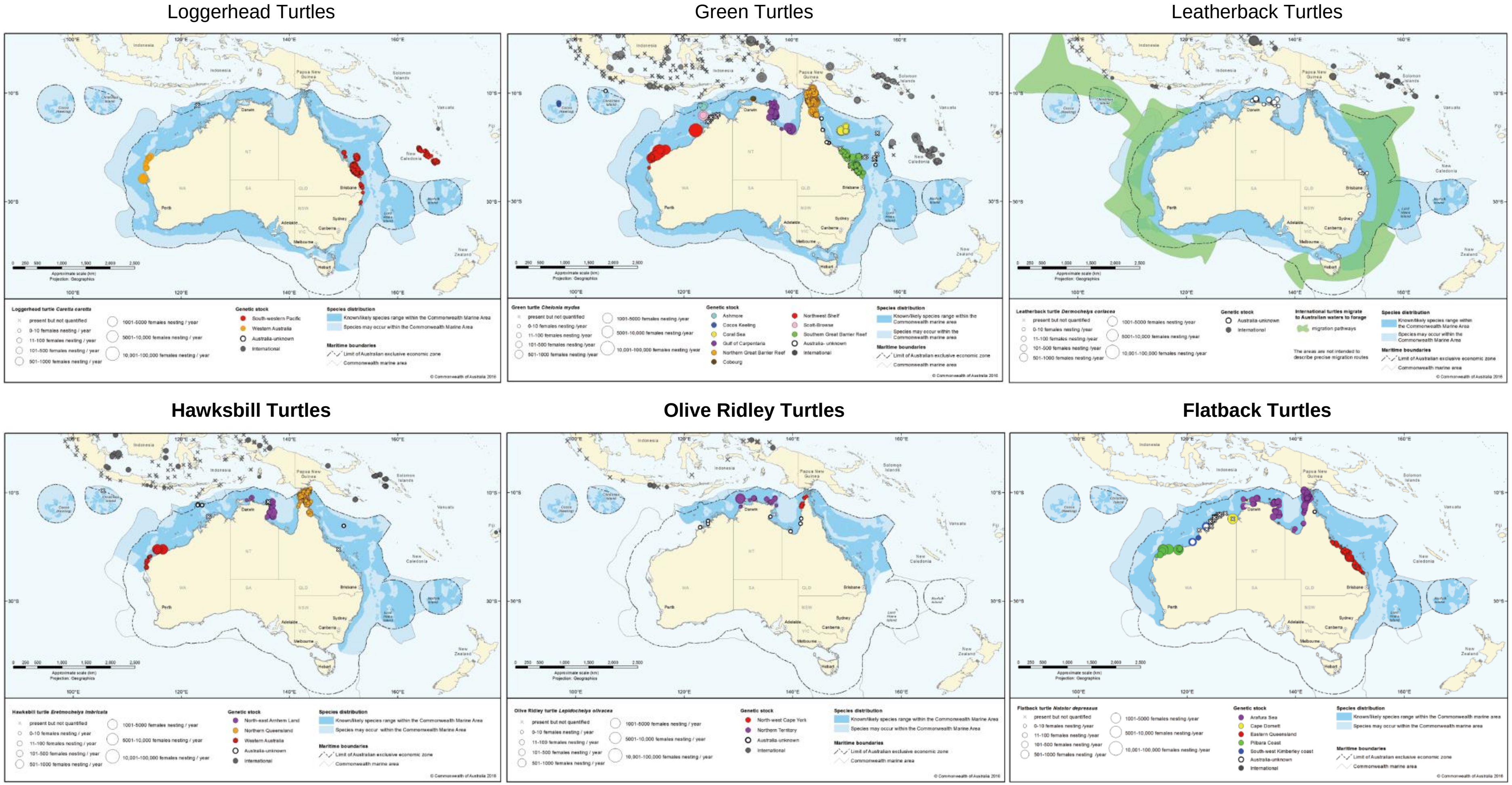
Threatened Species:
V *Vulnerable*
E *Endangered*
Biologically Important Area
*** *BIA Present*
f *Foraging*
i *Internesting*
n *Nesting*

Type of Presence:
MO *Species of species habitat may occur within area*
LO *Species or species habitat likely to occur within are*
KO *Species or species habitat known to occur within area*
FKO *Foraging, feeding or related behaviour known to occur within area*
BLO *Breeding likely to occur within area*
BKO *Breeding known to occur within area*

Plan Reference:
[1] *Recovery Plan for Marine Turtles in Australia, 2017-2027 (DEE, 2017k)*
[2] *Approved Conservation Advice for Dermochelys coriacea (Leatherback Turtle) (TSSC, 2008c)*

Table 3.16: Marine Reptile threatened species management advice relevant to petroleum activities under this EP

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under this EP
Marine Turtles			
• **Loggerhead Turtle** • **Green Turtle** • **Leatherback Turtle** • **Hawksbill Turtle** • **Olive Ridley Turtle** • **Flatback Turtle**	Recovery Plan for Marine Turtles in Australia, 2017-2027 (DEE, 2017k)	• Marine debris • Chemical discharge • Light pollution • Habitat modification • Vessel disturbance • Noise interference	• **Marine pollution:** Evaluate risk of oil spill impact to marine turtles and, if required, appropriate mitigation measures are implemented • **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented • **Noise interference:** Evaluate risk of noise impacts to marine turtles and, if required, appropriate mitigation measures are implemented • **Light interference:** Evaluate risk of light impacts to marine turtles and, if required, appropriate mitigation measures are implemented • **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Leatherback Turtle**	Approved Conservation Advice for *Dermochelys coriacea* (Leatherback Turtle) (TSSC, 2008c)	• Ingestion of marine debris • Boat strike • Degradation of foraging areas and changes to breeding sites	• See above (for Recovery Plan for Marine Turtles in Australia, 2017-2027)



(Source: DEE, 2017k)

Figure 3-31: Marine Turtle nesting sites in Australia and surrounding regions

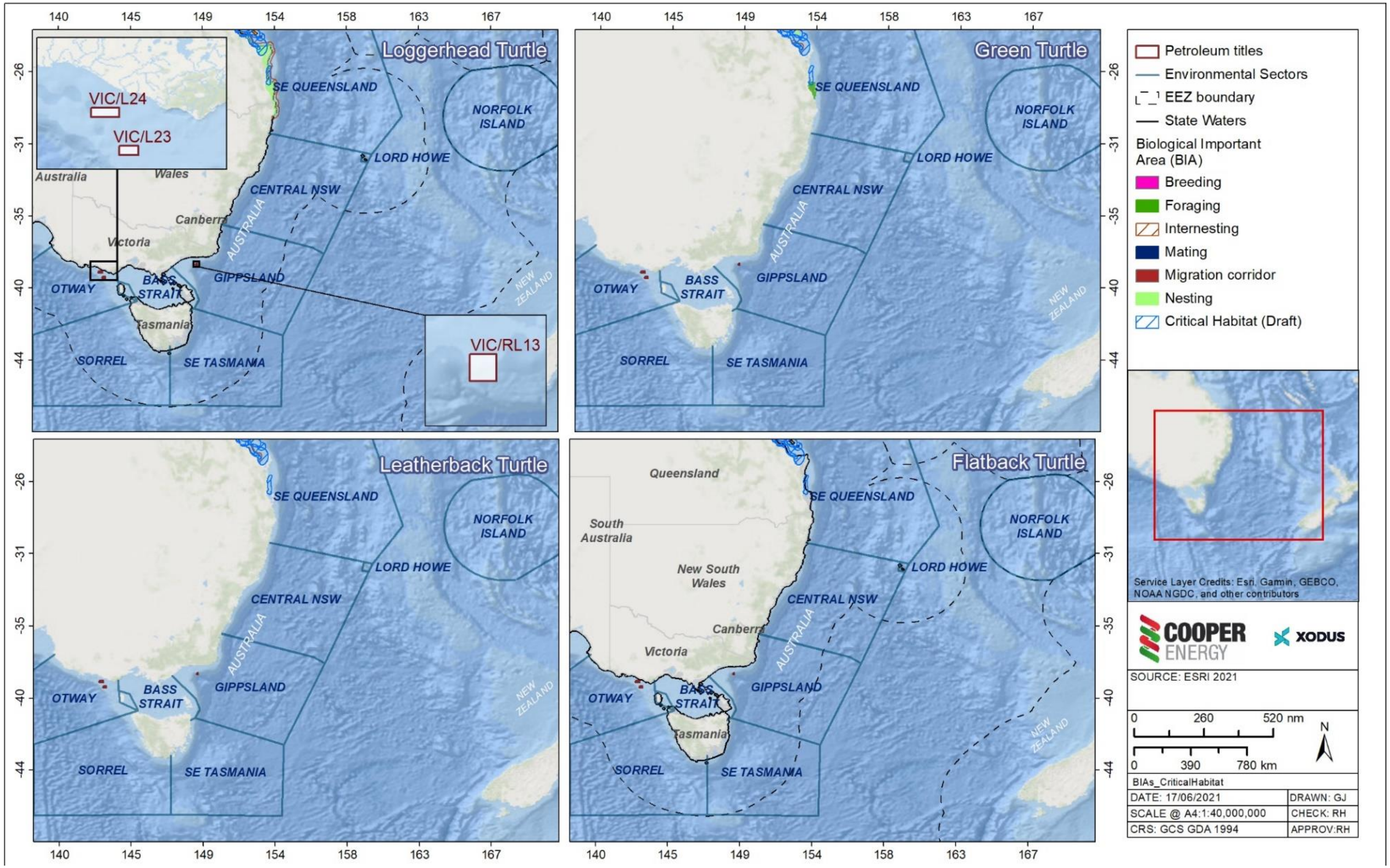


Figure 3-32: BIAs and Critical Habitat for the Loggerhead, Green, Leatherback and Flatback Turtles

Table 3.17: Nesting and internesting areas identified as Critical Habitat[1] for Marine Turtles present within the Environment Sectors

Species (Genetic Stock)	Nesting Locations	Internesting Buffer	Time of Year
Loggerhead Turtles (South-west Pacific)	Coastal beaches from Elliot River to Bustard Head, Swain Reefs. Tryon, Capriconia-Bunker Group, Pumistone Passage to Double Island Point.	20 km	Oct–Mar
Green Turtles (Southern GBR)	Islands of the Capriconia-Bunker Group, Wreck Rock to Burnett Head	20 km	Oct–Apr
Flatback Turtles (Eastern Queensland)	Curtis Island, Mon Repos	60 km	Oct–Mar

Notes:

1. Critical habitat to the survival of a marine turtle species was determined by a panel of experts and includes habitat for at least 70% of nesting for the stock (DEE, 2017k).

3.14 Marine Mammals

There are four pinniped, one sirenian, 26 whales, 18 dolphins, and one porpoise species (or species habitat) that may occur within the Environment Sectors; this includes species classified as threatened and migratory (Table 3.19). A list of the relevant conservation advice and/or recovery plans is also provided in Table 3.19, with relevant key threats and management actions further discussed in Table 3.20. The type of presence varies between species and location, and includes important behaviours (e.g. foraging, breeding) for some species (Table 3.19).

3.14.1 Pinnipeds

The New Zealand fur-seal (long-nosed fur-seal) and the Australian fur-seal have the widest range of the pinnipeds, occurring in coastal regions from South Australia through to New South Wales (Table 3.19). While breeding for the New Zealand fur-seal does occur along the coasts of Victoria and southern Tasmania (Table 3.18, Figure 3-33), the main breeding sites (accounting for over 80% of the national population) are located further east in Western and South Australia (i.e. outside of the define Environment Sectors) (TSS, 2017; Kirkwood et al, 2009; DSEWPaC, 2012c). Conversely, the main breeding locations for the Australian fur-seal are within the Environment Sectors, typically on islands within Bass Strait (Table 3.18, Figure 3-34) (DEE, 2017r; Kirkwood *et al.*, 2010).

New Zealand fur-seal breeding colonies are typically found in rocky habitat with jumbled boulders; Australian fur-seal prefer flatter rocky shelves (Shaughnessy, 1999). Colonies for both species are typically occupied year-round, with greater activity during breeding seasons (Shaughnessy, 1999; DEE, 2017r). Numbers of Australian fur-seals on Montague Island (New South Wales), fluctuate through the year, with peak numbers occurring in September and October; this reflects the northward migration over the winter, and the subsequent return to the breeding colonies of the Bass Strait in late spring (DEE, 2017r). The Australian and New Zealand fur-seals have been recorded using Beware Reef (approximately 40 km north-west of the Sole wells, and 50 km north-northeast of the BMG wells) as a haul-out site (Parks Victoria, 2017).

Reports by Arnould and Kirkwood (2008 and 2011) tracked the foraging habits of female Australian fur seals from four breeding sites in northern Bass Strait during the winters of 2001-2003. The studies found that all individuals foraged over the shallow continental shelf of Bass Strait and none of the foraging trips recorded any individuals venturing beyond the continental shelf-edge of Bass Strait. This data supports earlier studies that suggested the species is an exclusively benthic forager, although will opportunistically hunt throughout their transit to feeding grounds. Analysis of habitat use indicated that individuals selected areas with depths of 60–80 m and sea surface temperature of 16.0-16.8^{o}C with several areas regularly frequented and considered ‘hot spots’, while others with similar bathymetries were never entered by the individuals in this study. Furthermore, while there was substantial inter-individual variation, most seals displayed some degree of foraging site fidelity (Arnould and Kirkwood, 2008 and 2011).

Hoskins et al (2015) considered the role of intensive foraging zones for Australian fur seal, finding that foraging intensity ‘hot spots’ occur in a mosaic throughout the Bass Basin (within the Bass strait), primarily to the SW of the known colonies. Diving data suggests that individuals were maximising their time within the benthic foraging zone.

Arnould and Kirkwood (2011) also evaluated the degree of overlap between foraging sites of female Australian fur seals and marine reserves. Foraging areas of seals tracked in this study overlapped with only two reserves of the South-east Commonwealth Marine Reserve Network for <1% of the time-at-sea. Very little overlap in foraging habitat use by lactating females and the network of reserves suggests that several important habitats in south-eastern Australian waters may be poorly represented in the current marine reserve network.

McIntosh et al. (2018) undertook a critical analysis of existing population data for Australian fur seal, which identified a drop in live pup numbers which could indicate stabilisation or decline in the population within the study area (SE Australia). The study concluded that further data was necessary to understand the reasons behind and implications of this perceived drop in live pup numbers, however stressed the importance of accurate population statistics for management.

The Australian sea-lion is the only endemic, and least abundant, pinniped that breeds in Australia (DoE, 2015a). All current breeding populations are outside of the Environment Sectors, being located from the Abrolhos Islands (Western Australia) to the Pages Islands (South Australia) (Table 3.19, Table 3.18). The Australian sea-lion uses a variety of shoreline types but prefer the more sheltered side of islands and typically avoid rocky exposes coasts

(Shaughnessy, 1999). The Australian sea-lion is considered to be a specialised benthic forager; i.e. it feeds primarily on the sea floor (DSEWPaC, 2013b). The Australian sea-lion feeds on the continental shelf, most commonly in depths of 20–100 m, with adult males foraging further and into deeper waters (DSEWPaC, 2013b). They typically forage up to 60 km from their colony but can travel up to 190 km when over shelf waters (Shaughnessy, 1999).

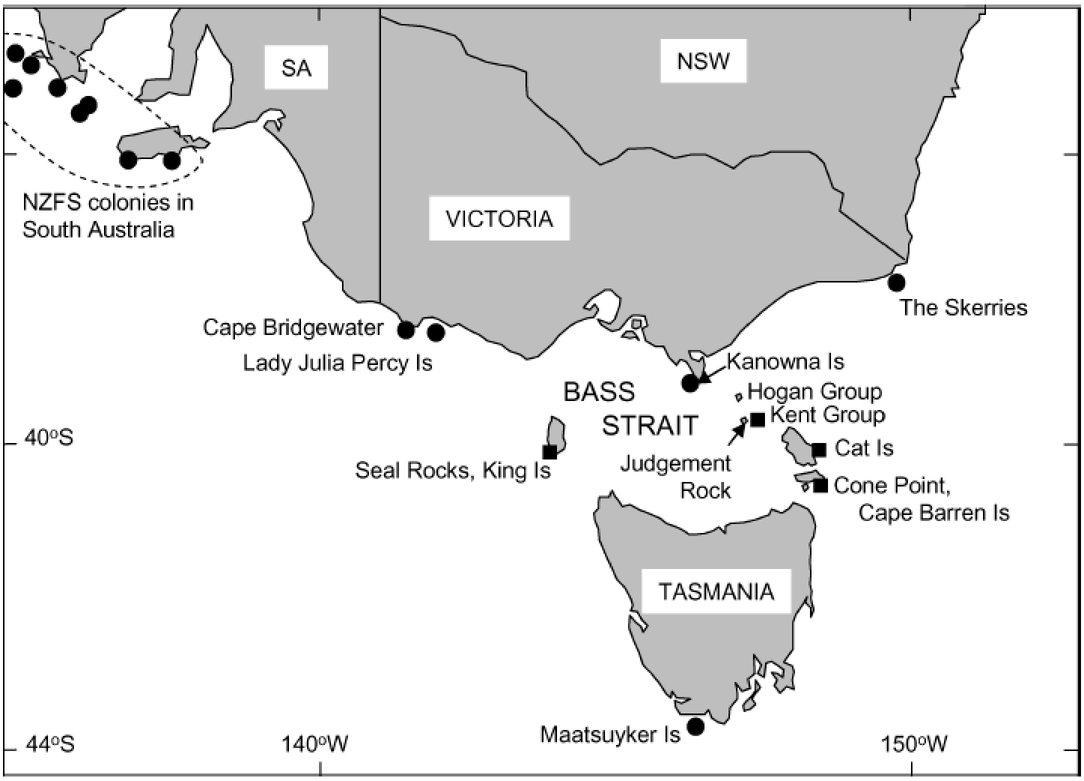
Southern elephant seals are the largest of all seals and have a nearly circumpolar distribution. Main breeding colonies in Australian waters are located outside of the define Environment Sectors at Heard and Macquarie Islands; however occasional pupping has been recorded on Maatsuyker Island, off the southern Tasmanian coast (Table 3.18) (Shaughnessy, 1999). Southern elephant seals spend most of their lives at sea and prefer to haul-out on gently sloping sandy and cobblestone beaches (but will also utilise sea ice, snow and rocky terraces) (TSSC, 2016h).

During site specific habitat surveys of BMG subsea infrastructure within the BMG field (Ierodiaconou et al 2020), Australian fur-seals (*Arctocephalus pusillus doriferus*) were observed actively foraging along flowline infrastructure. Fur seals are also frequently reported by vessel crews during offshore projects in both the Otway and Gippsland Regions. Marine mammals observed during Cooper Energy activities are reported to the Australian Marine Mammal Centre.

Australian fur-seal populations are in a phase of slow recovery following near-extinction after commercial sealing during 18th and 19th centuries (Shaughnessy, 1999), with current populations thought to be <60% of estimated pre-exploitation levels (Arnould et al., 2015). All but one of the known 20 breeding colonies (total number quoted in McIntosh, 2018) occur on islands within Bass Strait, characterised by a shallow continental shelf region with a relatively uniform bathymetry (average depth 60 m) with few features and is considered to be a region of low primary productivity (Arnould et al., 2015). The Australian Fur-seal is considered to be ICUN “Lower Risk, conservation dependent” species due to the cessation of a “habitat specific conservation program” which due to the species’ slow recovery rate could lead to it be becoming Threatened if disturbance of breeding sites during the breeding season is ongoing (Shaughnessy, 1999). Critical habitat for Australian seals comprises breeding colonies of the terrestrially breeding species in Australian mainland waters (Shaughnessy, 1999) The largest breeding colonies are at Lady Julia Percy Island and Seal Rocks in Victoria (McIntosh, 2018).

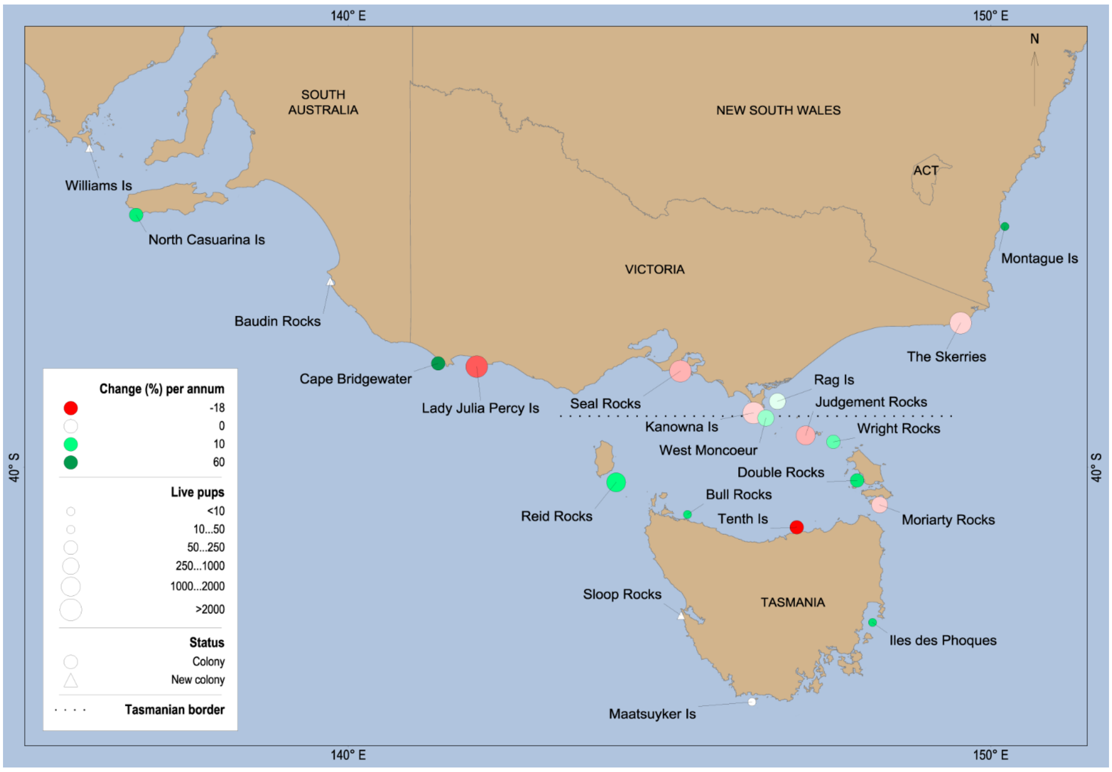
Table 3.18: Known breeding locations (within the Environment Sectors) for Pinnipeds

Species	Location	Pupping Season
New Zealand Fur-seal	Remote islands off southern coast of Tasmania; the largest breeding colonies occur at Flat Witch, Maatsuyker and Tasman Islands. Kanowna Island, Lady Julia Percy Island, The Skerries and Cape Bridgewater off the Victorian coast	Nov–Jan
Australian Fur-seal	There are 20 breeding colonies, all located at islands within Bass Strait; the largest colonies occurring at Lady Julia Percy Island and Seal Rocks off the Victorian coast (McIntosh, 2018).	Oct–Dec
Australian Sea-lion	None identified	Asynchronus
Elephant Seal	Occasional pupping has been recorded on islands off the southern coast of Tasmania (Maatsuyker Island).	Sep–Nov



(Source: Kirkwood et al., 2009)

Figure 3-33: Historic (■) and current (●) breeding colonies for the New Zealand Fur-seal



(Source: McIntosh et al, 2018)

Figure 3-34: Range of the Australian fur seal with change (%) per annum between the 2007 census and the 2013 census

3.14.2 Whales

3.14.2.1.1 Southern right whale

Southern right whales generally occur along the southern coast of Australia, and can occur as far north as Perth (Western Australia) and Sydney (New South Wales); they typically occur within two kilometres of the coast and grouped together in aggregation areas (Figure 3-36) (DSEWPaC, 2012d). Known calving and aggregation grounds in the south-east region are Warrnambool, Port Fairy, Port Campbell and Portland in Victoria, and Encounter Bay in South Australia (DSEWPaC, 2012d; DoE 2015a). Nursery grounds are occupied from May to October, with female-calf pairs generally staying in the area for two to three months (DSEWPaC, 2012d; Charlton, 2017). Calving itself usually occurs in very shallow (<10 m depth) waters. Other population classes stay in the nursery grounds for shorter and variable periods of time; there is typically a lot of movement along the coast, and thus habitat connectivity is important for this species. The summer offshore distribution and migration routes of Southern Right Whales is largely unknown but is known to include directly southern and western migration pathways (Burnell, 2001; Mackay et al., 2015). A BIA for the southern right whale, for migration, breeding, connecting habitat and aggregation area exists within southern Australian waters (Figure 3-40).

There is the potential for southern right whales to be transiting through the area offshore Victoria during May-June and September-October as they move to and from coastal aggregation areas. Occasionally entry to coastal waters happens as early as April and exit as late as November (DSEWPaC 2012). Very few southern right whales move through the Gippsland region, movements tend towards western aggregation areas in the Otway and south coast. There are no known aggregation areas in the Gippsland.

A sighting of two southern right whales was reported during Cooper Energy projects in the Otway region in 2018. Sighting cues were body and blow; the whales were observed from a moored semi-submersible MODU at the Casino-5 well location; sighting cues were body and blow within 500m of the MODU. The sighting was in April, which may seem unusually early for southern right whale occurrence in the region, though is not unprecedented; the ALA reports eight southern right whale sightings in April between 2000 and 2019. Whales observed during Cooper Energy activities were reported to the Australian Marine Mammal Centre.

3.14.2.1.2 Humpback whale

Humpback whales have a near global distribution, migrating annually between high latitude feeding areas and low latitude breeding and calving areas; the Australian migration period is from May to November each year (Figure 3-37) (TSSC, 2015k). Peak migration time occurs between June and July each year (northern migration); there has been no such peak observed during the southern migration (Figure 3-37) (TSSC, 2015k). Predominantly humpback whales migrate within 50 km of the coast of mainland Australia (TSSC, 2015k). There are some narrow corridors along the migration pathways where the whale population passes within 30 km of the coast, including east of Moreton Island (Queensland) and Cape Byron (New South Wales). Known calving areas for Humpback Whales within the Environment Sectors are within the Great Barrier Reef area (approximately 14–27°S), and less frequently, along the migratory pathways (TSSC, 2015k). Predictive habitat modelling has identified two core areas for calving: the region east of Mackay, and the Capricorn and Bunker Island groups off Gladstone (Figure 3-37) (TSSC, 2015k). After breeding and calving during the winter months, the humpback whales migrate south. Resting areas are used by cow-calf pairs and attendant males during this southern migration; locations include Hervey Bay and Moreton Bay (Queensland), and Twofold Bay and Jervis Bay (New South Wales) (Figure 3-37, Figure 3-38). A BIA for the humpback whale, for migration and breeding, has been identified along the east coast of Australia (Figure 3-40). Humpback whales in the southern Hemisphere primarily feed on Antarctic krill (*Euphausia superba*) (TSSC, 2015k). While most feeding grounds are south of Australian waters, there are some feeding grounds that are regularly used on the southern migration in Australian coastal waters: off the coast of Eden in New South Wales, and east coast of Tasmania (TSSC, 2015k).

Humpback whales have been sighted during Cooper Energy projects in the Gippsland region, including multiple sightings 2018 and 2019. Whales were observed close to pipelay vessels; sighting cues included swimming, breaches and diving. Sightings were reported to the Australian Marine Mammal Centre.

3.14.2.1.3 Blue whale

There are two subspecies of blue whale that occur within Australian waters: Antarctic blue whale and the pygmy blue whale. There are populations of pygmy blue whale that are known to visit Australian waters; Indo-Australian (IA) pygmy blue whales occupying or passing through waters from Indonesia to western and southern Australia, and the Tasman-Pacific pygmy blue whale occupying or passing through waters in south east Australia and the Pacific (DoE 2015d). Blue whales have the highest known prey requirements, consuming up to two tonnes of krill per day (DoE, 2015d). Blue whale sightings in Australia are widespread, and much of the shelf and coastal waters are unlikely to hold significance for this species with the exception of some foraging locations. Australia has two known seasonal feeding aggregations of pygmy blue whales; one occurs adjacent to the Bonney Upwelling system off South Australia and Victoria (Figure 3-39).

The IA Pygmy blue whale population shows three migratory stages around Australia, a “southbound migratory stage” where whales travel southwards from Indonesian waters down the WA coast, mostly over October to December but possibly into January of the following year, a protracted “southern Australian stage” (January to June) where animals spread across southern waters of the Indian Ocean and south of Australia, then a northbound migratory stage (April to August) where whales meander north back to Indonesia again (McCauley et al., 2018).

Pygmy blue whale (TP blue whale population) are identified as possibly exhibiting foraging behaviours within the Gippsland Environmental Sector. The pygmy blue whale possible foraging BIA has been identified where evidence for feeding is based on limited direct observations or through indirect evidence, such as occurrence of krill in close proximity of whales, or satellite tagged whales showing circling tracks. Blue whales travel through on a seasonal basis, possibly as part of their migratory route (Commonwealth of Australia, 2015c). Blue whale feeding grounds are typically in areas of high primary productivity that can support sufficient densities of krill, such as oceanographic upwelling or frontal systems (DoE, 2015d). Typically, blue whale migrate between breeding grounds (low latitudes) where mating and calving take place in the winter, to feeding grounds (high latitudes) where foraging occurs in the summer.

IA Pygmy blue whale typically forage off eastern South Australia and Victoria (e.g. between Robe, SA and Cape Otway, Vic) between January and April (DoE, 2015d), with some studies suggesting foraging could occur for an extended season of November to May (Gill et al., 2002; Gill et al., 2011). The abundance of whales in the area varies within and between seasons and is closely in-sync with the strength of the Bonney Upwelling (DoE, 2015d., Gill et al., 2011, McCauley et al., 2018). This has been confirmed by ongoing studies from 2002-2011, which conclude that blue whales are twice as likely to be found to the west of Portland (Western side of the Bass strait) than to it’s east (Gill, 2011). Blue whale presence in the Bonney Upwelling is associated with several seascape variables, but with sea surface temperature appearing to play a major role (Gill et al., 2011). Prey availability is also key, with krill likely responding to prevailing environmental conditions from previous seasons (Szesciorka et al., 2020). This makes upwelling events and subsequent foraging presence difficult to predict.

The Bonney Upwelling is located approximately 300 km from the activity location. Outside of these main feeding areas, foraging areas for pygmy blue whale include the Bass Strait, and diving and presumably feeding at depth off the west coast of Tasmania (DoE, 2015d). There is a paucity of data to support predictions of presence in these areas adjacent to the key feeding grounds of the Bonney Upwelling, and even less data available for waters in the Gippsland region. Three groups of blue whale - Eastern Indian Ocean pygmy blue, South West Pacific Ocean pygmy blue, and Antarctic blue, have been recorded acoustically in the Bass Strait (McCauley et al. 2018), with scientists now considering the Bass Strait to be the boundary between the East Indian Ocean and South West Pacific Ocean populations. No East Indian Ocean pygmy blues have been recorded on Australia’s east coast (Balcazar et al. 2015) or in New Zealand, where South West Pacific Ocean pygmy blue gather to forage in the South Taranaki Bight west of Cook Strait (Barlow et al. 2018).

The unique song of TP pygmy blue whales feeding in New Zealand predominates in the western South Pacific (Balcazar et al., 2015; Barlow et al., 2018). New Zealand subpopulations of pygmy blue whale are typically found in New Zealand waters year round, with studies indicating that individuals do not move far from feeding grounds in the South Taranaki Bight (Barlow et al., 2020).

Sightings of NZ pygmy blue whale have been recorded in the SE region, and Antarctic blue whale have been recorded on noise loggers. It is possible that Antarctic blue whales and TP pygmy blue whales may be present within the Gippsland offshore region. Based on current knowledge of patterns of behaviour elsewhere, it can be assumed that if blue whale are sighted, they are most likely foraging (Peter Gill pers comms July 2021).

Sightings of blue whales in the Gippsland region have been reported recently in June 2020 (2 sightings, CGG pers comms), and historically, individual sightings in October and November (ALA database)). The ALA holds <10 sightings records since the 1970’s, though based on historical catch data (Cwth Australia 2015), the low sightings may in part be a function of lower levels of monitoring compared to the Otway. Contemporary acoustic recording of blue whales in the region are considered to be more reliable than historic sightings; based on their migration patterns (as described above), and acoustic detection of both TP and Antarctic blue whale populations within the

Bass Strait (McCauley et al., 2018), blue whales may be more likely to be moving through the region in April, May and June; outside of this time period, presence is very unlikely. April and June are considered shoulder times given detections of both Antarctic Blues and TP pygmy in central Bass Strait blues between April-June followed by detections of whales moving north, off mid NSW and Tonga from June/July (Balthazaer *et al.* 2015) (*Figure 3-35*). McCauley *et al*. (2018) indicates that in some years there is evidence physical mechanisms drive productive water into the Bass Strait over April to May inferring this period as being potentially favourable for foraging in the region.

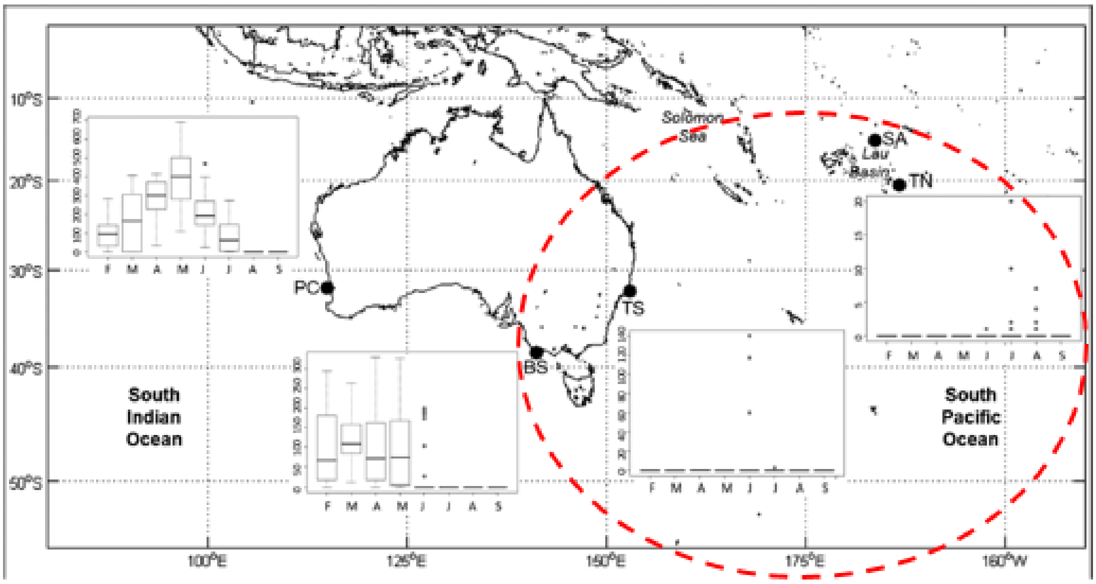


Fig. 2.—Box plots represent the median (with 0.25 and 0.75 quantile) number of calls detected per month (February to September) for AUSB at the PC = Perth Canyon and BS = Bass Strait and NZB at the TS = Tasman Sea and TN = Tonga. No AUSB or NZB whale calls were detected off SA = Samoa. Bars indicate maximum and minimum values and outliers are plotted as individual points.

Figure 3-35: Acoustic detections of blue whale populations in the Indian ocean and Pacific ocean (Balcazar et al. 2015).

3.14.2.1.4 Sei whale

Sei whales have been infrequently recorded in Australian waters; however occasional sightings have been recorded off Tasmania, New South Wales, Queensland and within the Great Australian Bight (DEE, 2017s). Sei whales typically feed between the Antarctic and Subtropical convergences, and their diet is planktonic crustacea, in particular copepods and amphipods (DEE, 2017s). However, sei whales have also been observed feeding on the continental shelf in the Bonney Upwelling region during November and May, suggesting the area may be used for opportunistic feeding (DEE, 2017s).

3.14.2.1.5 Fin whale

The distribution of fin whales in Australian waters is uncertain, but they have been recorded in Commonwealth waters off most States (the species is rarely found in inshore waters) (DEE, 2017t). Fin whales frequently lunge or skim feed, at or near the surface, feeding on planktonic crustacea, some fish and cephalopods (DEE, 2017t). Fin whales generally feed in high latitudes, however depending upon prey availability and locality, it may also feed in lower latitudes. Fin whales have been observed in waters off the Bonney Upwelling during November and May, suggesting the region may be used for opportunistic feeding (DEE, 2017t). Fin whales have also been detected acoustically south of Portland, Victoria (Erbe *et al*., 2016).

3.14.2.1.6 Pygmy right whale

Records of pygmy right whales in Australian waters are distributed between 32°S and 47°S but are not uniformly spread around the coast (DEE, 2017u). Areas of coastal upwelling events appear to be an important component regulating pygmy right whale distribution. Pygmy right whales have primarily been recorded in areas associated with upwellings and with high zooplankton abundance, particularly copepods and small euphausiids which constitute their main prey (DEE, 2017u). There is some evidence to indicate that the area south of 41°S is important for weaned pygmy right whales, possibly because of the higher prey abundance in these waters (DEE, 2017u).

3.14.3 Dolphins

The Indo-Pacific humpback dolphin is found in coastal and estuarine waters of Queensland and New South Wales. Species have been recorded in the Great Sandy Strait, and Moreton Bay (Queensland), and further south to Cabarita Beach (northern New South Wales) (DSEWPaC, 2012e). They inhabit a variety of inshore (<20 m water depth) habitats including, inshore reefs, tidal and dredged channels, mangroves and river mouths. It is a generalist feeder, preying on bottom-dwelling and pelagic fish and cephalopods (DSEWPaC, 2012e). A BIA for both foraging and breeding has been identified in Queensland waters (Figure 3-41).

The Indian Ocean bottlenose dolphin is distributed continuously around Australia (DEE, 2017v). The Indian Ocean bottlenose dolphin occurs mainly in riverine and shallow coastal waters (on the shelf or around oceanic islands) (DSEWPaC, 2012e). Known populations include Jervis Bay, Twofold Bay, and Port Phillip Bay (New South Wales), and Moreton Bay and Hervey Bay (Queensland) (DSEWPaC, 2012e). Calving peaks occur in spring and summer or spring and autumn (DEE, 2017v). Gestation lasts approximately 12 months, so peak mating period coincides with peak calving period in each location (DEE, 2017v). A BIA for both breeding has been identified within Queensland and New South Wales coastal waters (Figure 3-41).

A new species of dolphin, the Burrunan dolphin, has been identified and is considered endemic to south-eastern Australian waters (Charlton-Robb *et al*., 2011). The current distribution of the Burunnan dolphin ranges from South Australia, east to Victoria and south to Tasmania (Charlton-Robb *et al*., 2011). Resident populations have been found in Port Philip Bay (approx. 90 animals) and Gippsland Lakes (approx. 50 animals) (Charlton-Robb *et al*., 2011). A tentative sighting of a Burrunan dolphin was recorded during vessel transit for a Cooper Energy project in September 2018 off Bullock Island Quay, Lakes Entrance. The sighting was reported to the Australian Marine Mammal Centre. This dolphin species does not yet appear in the DEE Species Profile and Threats Database (or consequently the Protected Matters Search tool) but has been added to the species listed within Table 3.19. In May 2013 the Burrunan dolphin was listed as threatened under Victoria's Flora and Fauna Guarantee Act 1988.

Table 3.19: Marine Mammal Species or Species Habitat that may occur within the Environment Sectors

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Pinnipeds															
Arctocephalus forsteri	New Zealand Fur-seal			✓			MO	MO	MO	BKO	MO	MO			
Arctocephalus pusillus	Australian Fur-seal			✓			BKO	BKO	BKO	MO	MO	MO			
Neophoca cinerea	Australian Sea-lion	V		✓	*	[1]	KO								
Mirounga leonina	Southern Elephant Seal	V		✓		[2]				BMO					
Sirenians															
Dugong dugon	Dugong		✓	✓								MO	KO		
Whales and other cetaceans															
Whales															
Balaenoptera acutorostrata	Minke Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Balaenoptera bonaerensis	Antartic Minke Whale		✓				LO		LO	LO	LO	LO	LO	LO	LO
Balaenoptera borealis	Sei Whale	V	✓			[3]	FKO	FLO	FLO	FLO	FLO	FLO	FLO	LO	LO
Balaenoptera edeni	Bryde's Whale		✓				MO	MO	MO		MO	LO	LO	LO	LO
Balaenoptera musculus	Blue Whale	E	✓		*	[4]	FKO*[d,f]	FKO*[f]	LO*[f]	LO*[f]	LO*[f]	MO	MO	MO	MO
Balaenoptera physalus	Fin Whale	V	✓			[5]	FKO	FLO	FLO	FLO	FLO	FLO	FLO	LO	LO
Berardius arnuxii	Arnoux's Beaked Whale						MO	MO	MO	MO	MO	MO			MO
Caperea marginata	Pygmy Right Whale		✓				FLO	FMO	FLO	FMO	FMO	FLO			
Eubalaena australis	Southern Right Whale	E	✓		*	[6]	BKO*[m,a]	KO*[m,c]	KO*[m]	KO*[c]	KO*[b,c]	KO	LO	MO	MO
Globicephala macrorhynchus	Short-finned Pilot Whale						MO	MO	MO	MO		MO	MO	MO	MO

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Globicephala melas	Long-finned Pilot Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Hyperoodon planifrons	Southern Bottlenose Whale						MO		MO	MO	MO	MO	MO		
Koogia breviceps	Pygmy Sperm Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Koogia simus	Dwarf Sperm Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Megaptera novaeangliae	Humpback Whale		✓		*	[7,8]	KO	KO	FKO*[f]	KO	FKO	KO*[f,m]	BKO*[f,mr]	MO	MO
Mesoplodon bowdoini	Andrew's Beaked Whale						MO	MO	MO	MO	MO	MO		MO	MO
Mesoplodon densirostris	Blainville's Beaked Whale						MO		MO	MO	MO	MO	MO	MO	MO
Mesoplodon ginkgodens	Gingko-toothed Beaked Whale								MO			MO	MO		MO
Mesoplodon grayi	Gray's Beaked Whale						MO		MO	MO	MO	MO	MO	MO	MO
Mesoplodon hectori	Hector's Beaked Whale						MO	MO	MO	MO	MO	MO			
Mesoplodon layardii	Strap-toothed Beaked Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Mesoplodon mirus	True's Beaked Whale						MO	MO	MO	MO	MO	MO		MO	MO
Peponocephala electra	Melon-headed Whale											MO	MO	MO	MO
Physeter macrocephalus	Sperm Whale		✓				MO	MO	MO	MO	MO	MO	MO	MO	MO
Tasmacetus shepherdi	Shepherd's Beaked Whale						MO		MO	MO	MO	MO			
Ziphius cavirostris	Cuvier's Beaked Whale						MO	MO	MO	MO	MO	MO	MO	MO	MO
Dolphins															
Delphinus delphis	Common Dolphin						MO	MO	MO	MO	MO	MO	MO	MO	MO
Feresa attenuata	Pygmy Killer Whale											MO	MO	MO	MO

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Grampus griseus	Risso's Dolphin						MO	MO	MO	MO	MO	MO	MO	MO	MO
Lagenodelphis hosei	Fraser's Dolphin												MO		MO
Lagenorhynchus cruciger	Hourglass Dolphin									MO	MO				
Lagenorhynchus obscurus	Dusky Dolphin		✓				LO	MO	LO	LO	LO	LO			
Lissodelphiss peronii	Southern Right Whale Dolphin						MO	MO	MO	MO	MO	MO	MO	MO	MO
Orcaella brevirostris	Irrawaddy Dolphin		✓										KO		
Orcinus orca	Killer Whale		✓				LO	LO	LO	LO	LO	LO	MO	MO	MO
Pseudorca crassidens	False Killer Whale						LO	MO	LO	LO	LO	LO	LO	LO	LO
Sousa chinensis	Indo-Pacific Humpback Dolphin		✓		*							LO	BKO*[b,f]		
Stenella attenuata	Spotted Dolphin											MO	MO	MO	MO
Stenella coeruleoalba	Striped Dolphin											MO	MO	MO	MO
Stenella longirostris	Long-snouted Spinner Dolphin											MO	MO	MO	MO
Steno bredanensis	Rough-toothed Dolphin											MO	MO	MO	MO
Tursiops aduncus	Indian Ocean Bottlenose Dolphin				*		LO	LO	LO*[b]			LO*[b,f]	LO*[b]		
Tursiops australis sp. nov.[1]	Burrunan Dolphin[1]							KO[1]	KO[1]						MO
Tursiops truncatus s. str.	Bottlenose Dolphin						MO	MO	MO	MO	MO	MO	MO	MO	MO
Phocoena dioptrica	Spectacled Porpoise		✓							MO	MO				
Threatened Species:	*Type of Presence:*					*Plan Reference:*									

		Threatened Species	Migratory Species	Listed Marine Species	BIA	Conservation/ Recovery Plan	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island

V	*Vulnerable*	*MO*	*Species of species habitat may occur within area*	*[1]*	*Recovery Plan for the Australian Sea Lion (Neophoca cinereal) (DSEWPaC, 2013b)*
E	*Endangered*	*LO*	*Species or species habitat likely to occur within area*	*[2]*	*Approved Conservation Advice for Mirounga leonine (Southern Elephant Seal) (TSSC, 2016h)*
Biologically Important Area		*KO*	*Species of species habitat known to occur within area*	*[3]*	*Approved Conservation Advice for Balaenoptera borealis (Sei Whale) (TSSC, 2015l)*
*	*BIA Present*	*FLO*	*Foraging, feeding or related behaviour likely to occur within area*	*[4]*	*Conservation Management Plan for the Blue Whale, 2015-2025 (DoE, 2015d)*
a	*Aggregation*	*FKO*	*Foraging, feeding or related behaviour known to occur within area*	*[5]*	*Approved Conservation Advice for Balaenoptera physalus (Fin Whale) (TSSC, 2015m)*
b	*Breeding*	*BMO*	*Breeding may occur within area*	*[6]*	*Conservation Management Plan for the Southern Right Whale, 2011-2021 (DSEWPaC. 2012d)*
c	*Connecting habitat*	*BKO*	*Breeding known to occur within area*	*[7]*	*Approved Conservation Advice for Megaptera novaeangliae (Humpback Whale) (TSSC, 2015k)*
f	*Foraging*			*[8]*	*Lisitng Advice for Megaptera novaeangliae (Humpback Whale) (TSSC, 2022)*
m	*Migration*				
r	*Resting*				

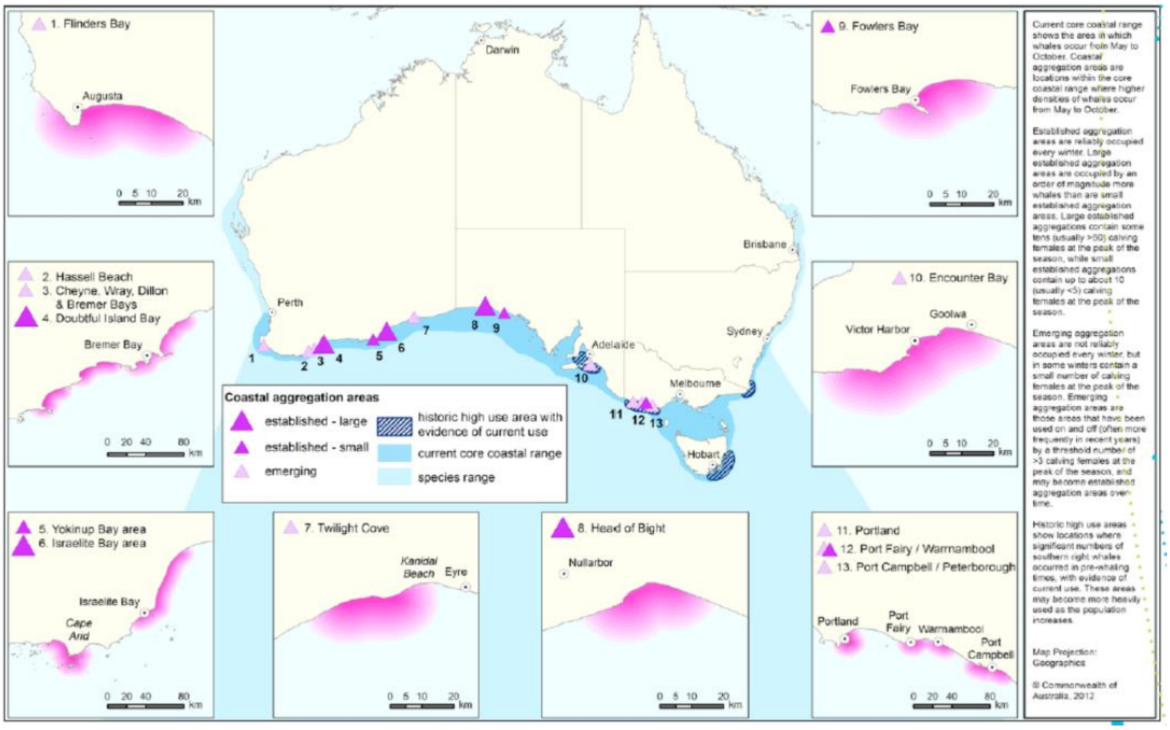
Note: 1. Burrunan Dolphin is not included in the DEE Species Profile and Threats Database; and has been manually added to this table of results. Distribution of the dolphin has been identified from Charlton-Robb et al. 2011.

Table 3.20: Marine Mammal threatened species management advice relevant to petroleum activities under this EP

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under tis EP
Pinnipeds			
• **Australian Sea-lion**	Recovery Plan for the Australian Sea Lion (*Neophoca cinereal*) (DSEWPaC, 2013b)	• Marine debris • Pollution and oil spills	• **Marine pollution:** Evaluate risk of oil spill impact to pinnipeds and, if required, appropriate mitigation measures are implemented • **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented • **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented

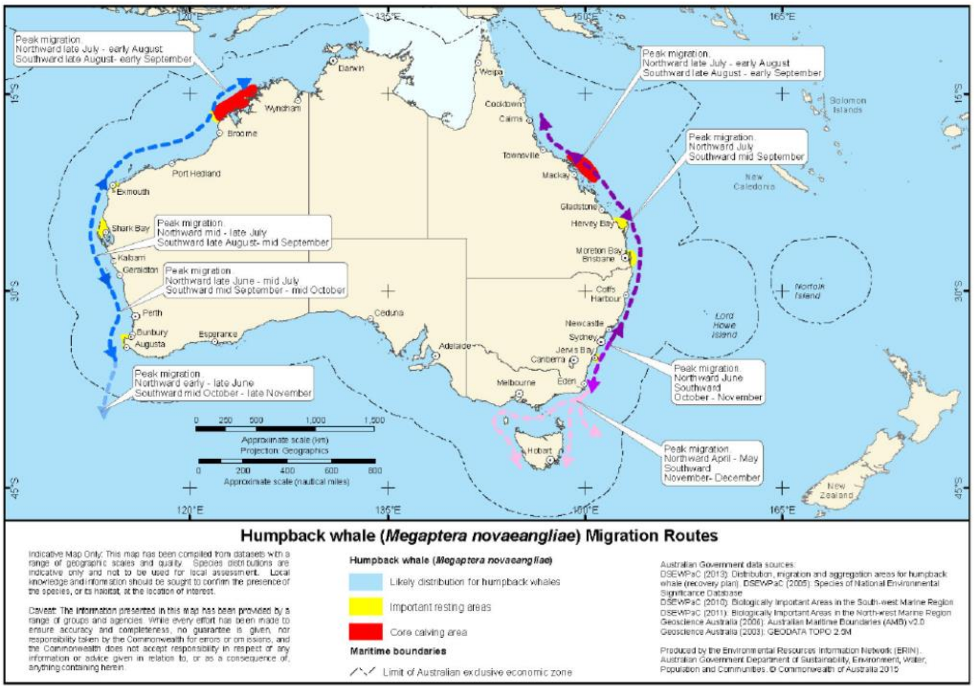
Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under tis EP
• **Southern Elephant Seal**	Approved Conservation Advice for *Mirounga leonine* (Southern Elephant Seal) (TSSC, 2016h)	• Pollution (including marine debris)	• **Marine pollution:** Evaluate risk of oil spill impact to pinnipeds and, if required, appropriate mitigation measures are implemented • **Marine debris:** Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented
Whales and other Cetaceans			
• **Sei Whale**	Approved Conservation Advice for *Balaenoptera borealis* (Sei Whale) (TSSC, 2015l)	• Anthropogenic noise and acoustic disturbance • Habitat degradation including pollution • Pollution (persistent toxic pollutants) • Vessel strike	• **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Blue Whale**	Conservation Management Plan for the Blue Whale, 2015-2025 (DoE, 2015d	• Noise interference • Habitat modification from marine debris or chemical discharge • Vessel strike	• **Noise interference:** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented • **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Fin Whale**	Approved Conservation Advice for *Balaenoptera physalus* (Fin Whale) (TSSC, 2015m)	• Anthropogenic noise and acoustic disturbance • Pollution (persistent toxic pollutants) • Vessel strike	• **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Southern Right Whale**	Conservation Management Plan for the Southern Right Whale, 2011-2021 (DSEWPaC. 2012d)	• Entanglement • Vessel strike • Noise Interference • Habitat modification	• **Noise interference:** Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation measures are implemented • **Vessel disturbance:** Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented
• **Humpback Whale** (removed from Threatened species	Listing Advice for *Megaptera novaeangliae* (Humpback Whale) in effect from 26 February 2022.	• Noise interference • Habitat degradation • Entanglement	**Current impacts*:** • **Noise interference**: Evaluate risk of noise impacts to cetaceans and, if required, appropriate mitigation

Species	Conservation Advice / Recovery Plan	Key Threats relevant to Petroleum Activities	Management Actions relevant to activities under tis EP
list as of 26 February 2022).		• Vessel disturbance and strike	measures are implemented Vessel disturbance: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. • **Marine debris**: Evaluate risk of marine debris (including risk of entanglement and/or ingestion) and, if required, appropriate mitigation measures are implemented. **Current impacts* and future threats:** • **Vessel disturbance**: Evaluate risk of vessel strikes and, if required, appropriate mitigation measures are implemented. • **not threatening or preventing population growth* (DAWE 2022)).



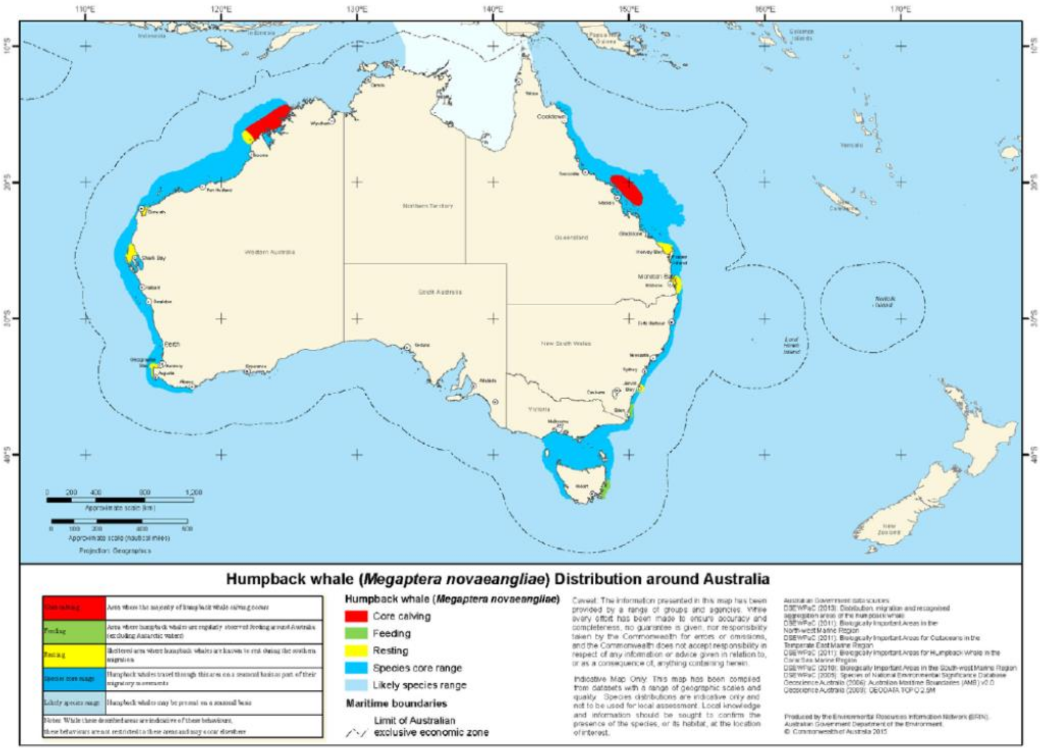
(Source: DSEWPaC, 2012d)

Figure 3-36: Range and coastal aggregation areas for the Southern Right Whale



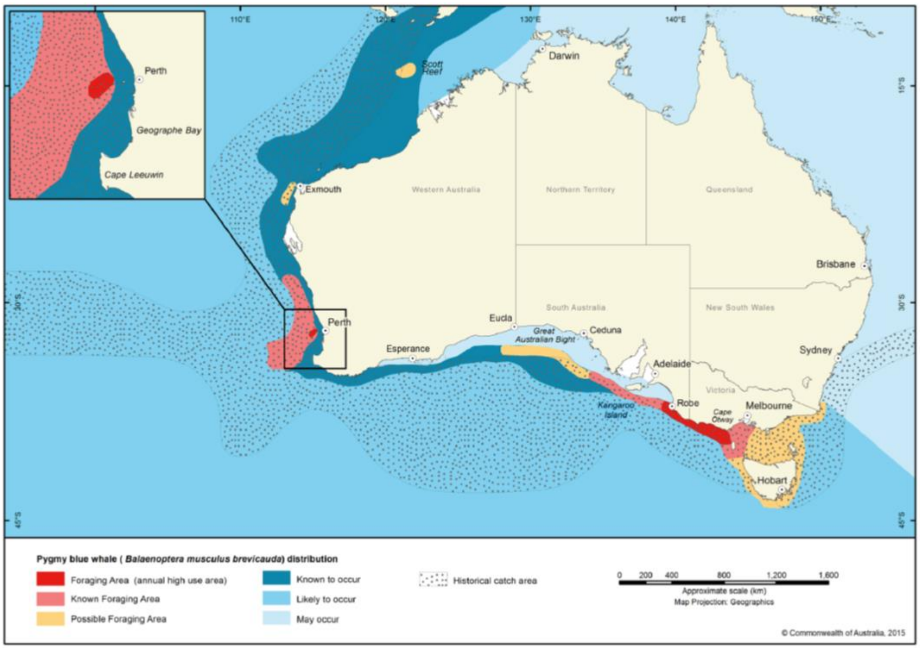
(Source: TSSC, 2015k)

Figure 3-37: Migration routes for Humpback Whales around Australia



(Source: TSSC, 2015k)

Figure 3-38: Distribution of Humpback Whales around Australia



(Source: DoE, 2015d)

Figure 3-39: Distribution and foraging areas for the Pygmy Blue Whale

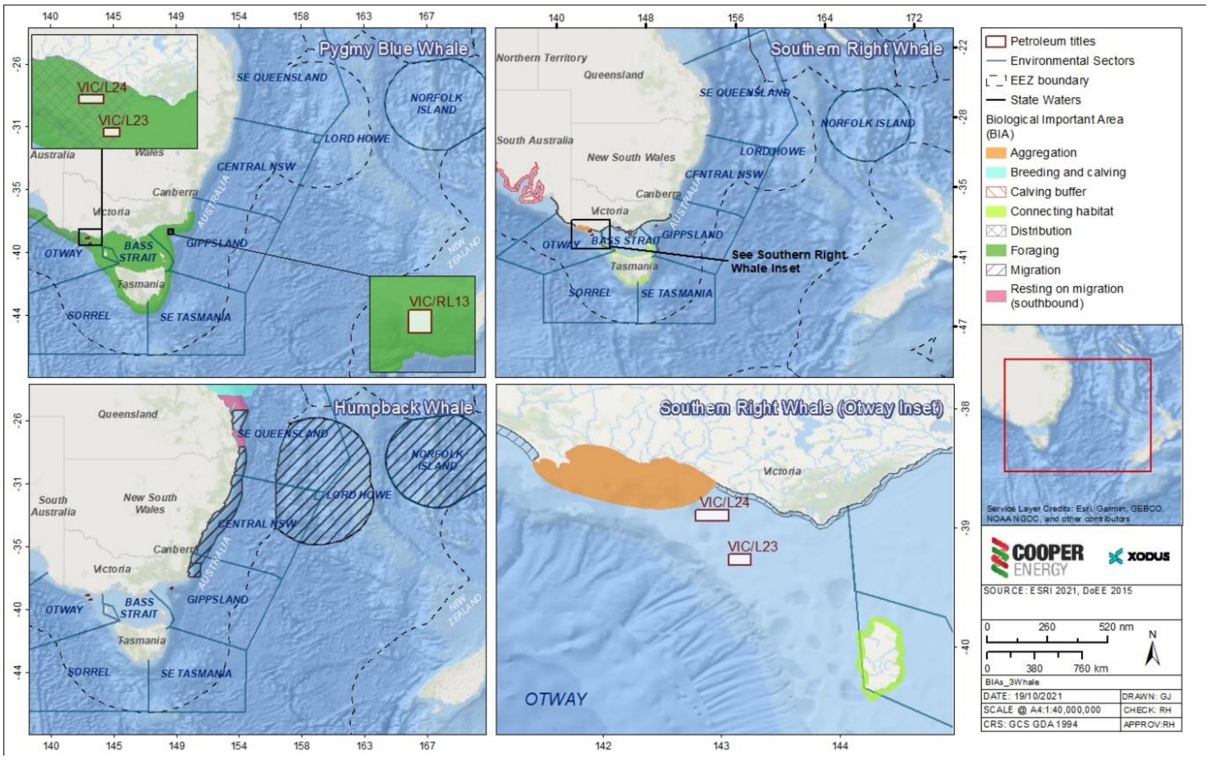


Figure 3-40: BIAs for the Pygmy Blue, Southern Right and Humpback Whale

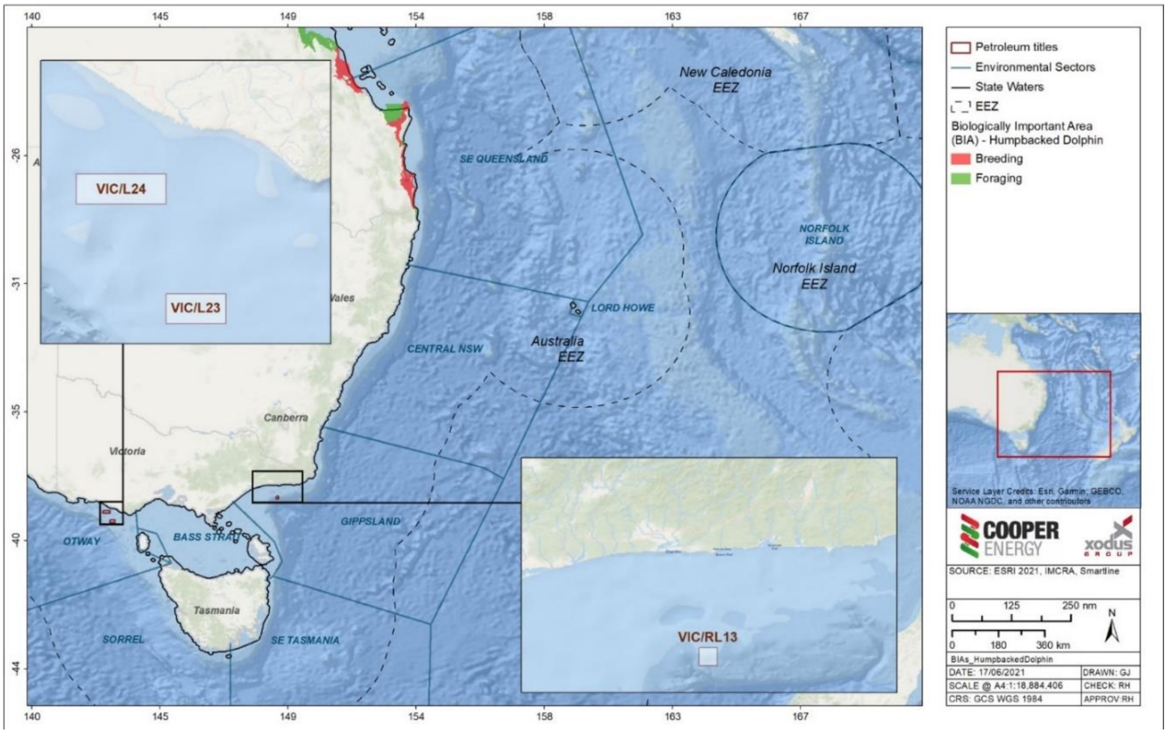


Figure 3-41: BIAs for the Humpback Dolphin

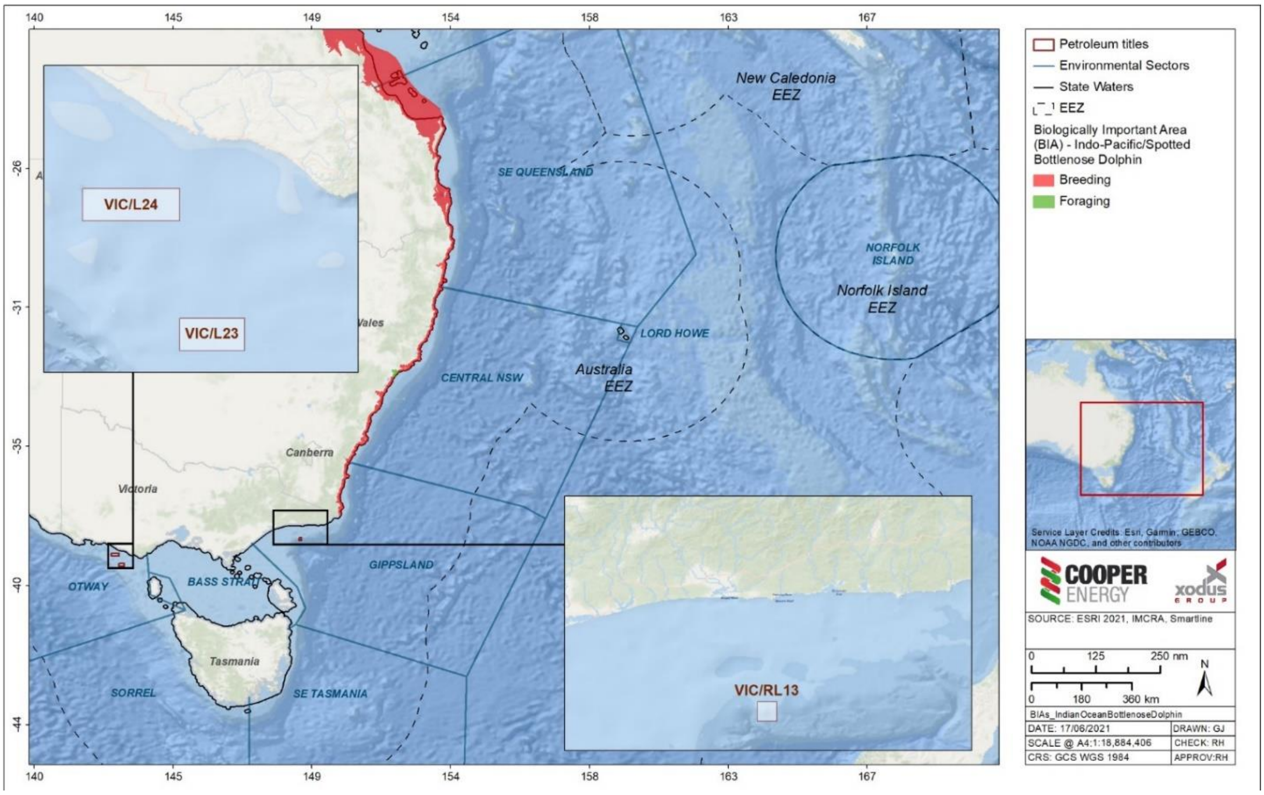


Figure 3-42: BIAs for the Indo-Pacific Humpback Dolphin

3.15 Marine Pests

Estuarine and marine non-native species are typically introduced and spread through coastal waters by vessel movements and, to a lesser extent, the aquarium trade and aquaculture (Clark and Johnston, 2017). Over 250 introduced marine plants and animals have been recorded in Australian waters (DAFF, 2017). Marine pests are non-native plants or animals which can have a detrimental impact on native marine ecosystems. Not all non-native species become pests, but, when they do, they are classified as invasive. Invasive species often occur in high proportions on artificial substrates (Clark and Johnston, 2017).

The Australian Government National Introduced Marine Pest Information System (NIMPIS) provides information on marine pests in Australian Waters (Table 3-21). Two locations identified on NIMPIS are in the same regions as Cooper Energy Operational Areas: Portland (Otway Region), and Melbourne (Gippsland Region). Both have multiple IMS established.

The introduced conical New Zealand screw shell (*Maoricolpus roseus*) are approximately 40 mm long and 14 mm diameter at the base. The density of screw shells on the seabed was highly variable, but they formed dense beds covering 100% of the available seabed in some places. The New Zealand screw shell, which feeds by filtering particles from the water and seabed surface, was the most abundant visible living animal on the seabed at these depths along the pipeline corridor. The New Zealand Screw Shell (*Maoricolpus roseus*) was previously (2018) considered common generally in water depths greater than 40 m along the Sole and PB pipeline corridors, offshore of Marlo in the Gippsland Basin. However recent habitat survey conducted by Ierodiaconou et al. (2020) did not identify invasive species within the vicinity of BMG subsea structure during opportunistic habitat surveys conducted.

Table 3-21 IMS Recorded in Victorian Waters[3]

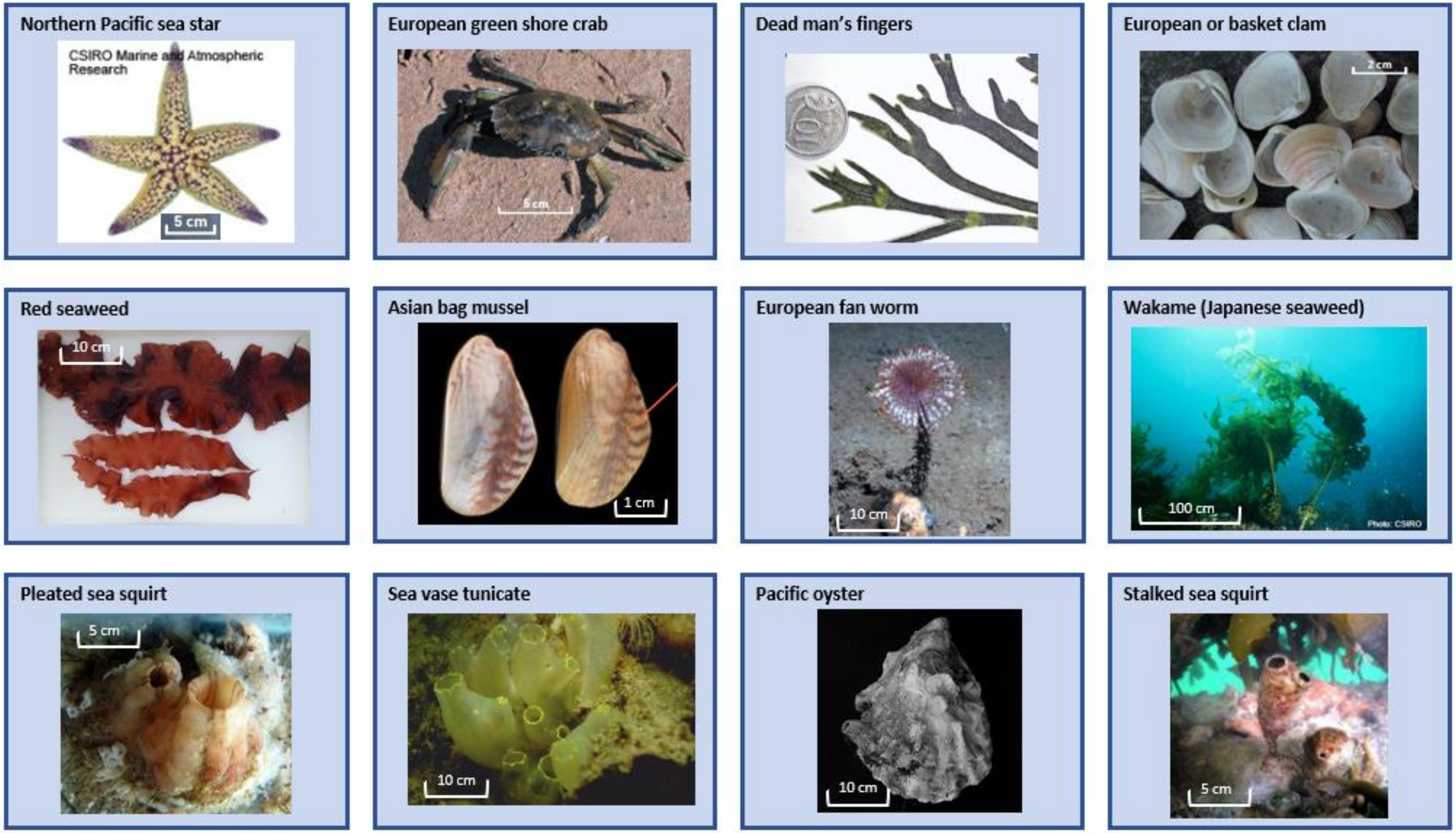
Scientific name	Common Name	Gippsland Lakes / surrounds	Corner Inlet / surrounds	Western port	Port Phillip Bay	Apollo Bay	Portland Harbour
Asterias amurensis	Northern Pacific sea star	Y	Y	Previous	Y		
Carcinus maenas	European green shore crab	Y	Y	Y	Y		
Codium fragile (subsp. fragile)	Dead man's fingers	Y		Y	Y		Y
Varicorbula gibba	European or basket clam			Y	Y		Y
Magallana gigas	Pacific oyster	Y	Y	Y	Y		
Grateloupia turuturu	Red seaweed				Y		
Maoricolpus roseus	New Zealand screwshell[4]	Y	Y				
Arcuatula senhousia	Asian bag mussel	Y		Y	Y		Y
Sabella spallanzanii	European fan worm			Y	Y		Y
Undaria pinnatifida	Wakame[5]		Y		Y	y	
Styela Clava	Stalked sea squirt	Y		Y	Y		
Styela plicata	Pleated sea squirt	Y		Y	Y		
Ciona intestinalis	Sea vase tunicate	Y		Y	Y		

[3] Information provided by the DJPR (*pers comms* Richard Stafford Bell March 2019).

[4] New Zealand Screw Shell (*Maoricolpus roseus*) – somewhat widespread in Gippsland. No records of it occurring in Port Philip Bay or elsewhere in Victoria. It remains an IMS for the Melbourne region.

[5] Japanese Kelp (*Undaria pinnatifida*) – widespread in Port Phillip Bay and recently detected in Port Welshpool (roughly 7km from Barry Beach marine terminal). Reducing the potential spread of this species is a priority.

Figure 3-43 Images of IMS recorded in Victorian marine environment



4 Conservation Values and Sensitivities

4.1 World Heritage Properties

World heritage properties within the environmental sectors are listed in Table 4.1. There are no world heritage properties in the Gippsland region. There is one declared property in the Otway region (Budj Bim Cultural Landscape), located near Portland, VIC. The property is located entirely inland.

Table 4.1: World Heritage Properties within the Environment Sectors

	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Australian Convict Sites (Cascades Female Factory and Buffer Zone)					✓				
Australian Convict Sites (Coal Mines Historic Site and Buffer Zone)					✓				
Australian Convict Sites (Cockatoo Island Convict Site and Buffer Zone)						✓			
Australian Convict Sites (Darlington Probation Station and Buffer Zone)					✓				
Australian Convict Sites (Hyde Park Barracks and Buffer Zone)						✓			
Australian Convict Sites (Kingston and Arthurs Vale Historic Area)									✓
Australian Convict Sites (Port Arthur Historic Site and Buffer Zone)					✓				
Budj Bim Cultural Landscape	✓								
Fraser Island							✓		
Gondwana Rainforests of Australia						✓			
Gondwana Rainforests of Australia							✓		
Great Barrier Reef							✓		
Lord Howe Island Group						✓		✓	
Sydney Opera House						✓			
Tasmanian Wilderness				✓					

4.2 National Heritage Places

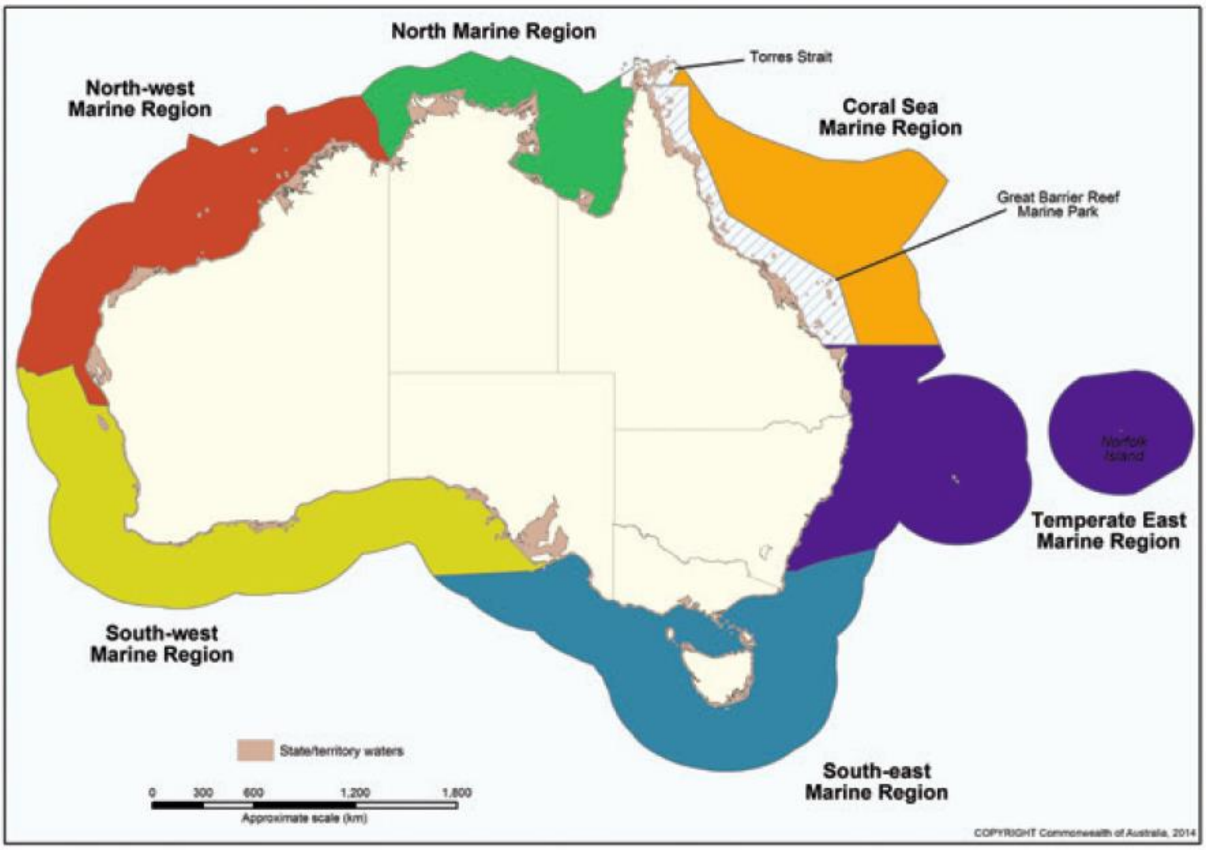
Listed national heritage places within the environmental sectors are mostly onshore / coastal sites. There are none listed in the Gippsland region. In the Otway region, national heritage places include indigenous listed places (Budj Bim National Heritage Landscape - Mt Eccles Lake Conda Area, Budj Bim National Heritage Landscape - Tyrendarra Area) and the Great Ocean Road and scenic environs.

4.3 Australian Marine Parks

Six marine regions have been identified in Commonwealth waters around Australia (Figure 4-1). Three of these regions (South-east, Temperate East and Coral Sea), as well as the Great Barrier Reef Marine Park, intersect with the Environment Sectors. Key conservation values for each of the marine regions are listed in Table 4.2.

Within each region is a series of Australian Marine Parks (AMP) which are managed for the primary purpose of conserving the biodiversity found in them, while also allowing for sustainable use of natural resources. Under the EPBC Act, once a marine park has been proclaimed, a management plan must be developed by the Director of National Parks. The management plans describe the activities allowed within the park and must be consistent with the relevant Australian IUCN Reserve Management Principles (Table 4.3). Management plans are in place for each marine region.

AMPs which intersect with the Environment Sectors and shown in Figure 4-2 and described in Table 4.4.



(Source: DoE, 2015a)

Figure 4-1: Australia's Commonwealth Marine Regions

Table 4.2: Key Conservation Values for the South-east, Temperate East and Coral Sea Marine Regions

Region	Key Conservation Values[1]
South East Marine Region (SEMR) (DNP, 2013)	• Features with high biodiversity and productivity, such as the east Tasmania subtropical convergence zone, Bass Cascade, Upwelling east of Eden, Seamounts south and east of Tasmania, Bonney coast upwelling. • Breeding and resting areas for Southern Right Whale. • Migration areas for Blue, Fin, Sei, Southern Right and Humpback whales. • Foraging areas for Australian Sea-lion, White Shark, Harrison's dogfish, Killer and Sei whales, Australasian Gannet, Fairy Prion, Black-faced Cormorant, Little Penguin, Crested Tern, and several species of seal, penguin, albatross, petrel, shearwater and gulls. • Wrecks of *MV City of Rayville*, *SS Cambridge* and ketch *Eliza Davies*. • 10 provincial bioregions and 17 seafloor types are represented in the network.

Region	Key Conservation Values[1]
Temperate East Marine Region (TEMR) (DNP, 2018a)	• Important habitat for the critically endangered Grey Nurse Shark (east coast population) • Important offshore reef habitat at Elizabeth and Middleton Reefs, Lord Howe Island and Norfolk Island that support the threatened black cod. • Significant seamount ridges that run parallel to the coast and support hundreds of species, including some previously unknown to science. The seamounts rise from seafloor depths of approximately 4800 metres to up to 130 metres from the surface—more than twice the height of Mt Kosciuszko—and are home to deepwater shark species that are only found in Australia. • The Temperate East network provides additional protection to a number of species listed as endangered or vulnerable under Commonwealth legislation or international agreements, including the White Shark, Bleekers devil fish, the Little Tern and other seabirds. • Unique subtropical corals considered the southernmost coral reefs in the world. • Seven Key Ecological Features including shelf rocky reefs, Tasmantid and Lord Howe seamount chains, Elizabeth and Middleton Reefs, Norfolk Ridge, Canyons on the eastern continental slope, and the Tasman Front. • Seven provincial bioregions, three meso-scale bioregions, 73 depth ranges within provincial bioregions, and 15 seafloor types are represented in the network.

Coral Sea Marine Region (CSMR) (DNP, 2018b)	• Habitat and important areas for a range of species have been identified in the region, including for:
	  ○ Humpback whales during their annual migration along the east coast of Australia;
	  ○ Nesting and inter-nesting sites for Green Turtles;
	  ○ Breeding and foraging areas for multiple seabird species including noddies, terns, boobies, frigatebirds, and tropic birds;
	  ○ White Shark distribution and Whale Shark aggregation.
	• Transient populations of highly migratory pelagic species, including small fish schools, billfish, tuna and sharks.
	• The East Australian Current forms in the region and is considered a major pathway for mobile predators such as billfish and tunas. Black marlin undergo seasonal movements into the Queensland Plateau area.
	• Includes three Key Ecological Features: the reefs, cays and herbivorous fish of the Queensland Plateau and the Marion Plateau, and the northern extent of the Tasmantid seamount chain.
	• Heritage values include several historic shipwrecks including three World War II shipwrecks from the Battle of the Coral Sea.
	• The reserve represents the full range of seafloor features found in the region, including numerous reefs ranging from Ashmore and Boot Reefs in the north of the region to Cato Island and surrounding reefs in the south. The reserve includes canyons, troughs and plateaux, including Bligh Canyon approximately 200 kilometres off the coast from Lockhart River and the Townsville Trough, which separates the Queensland and Marion Plateaux. The reserve extends into the deeper waters of the Coral Sea Basin in the north, and provides protection for the pinnacles of the northern extent of the Tasmantid seamount chain.
	• Six provincial bioregions, 94 depth ranges, and 16 seafloor types are represented.

Table 4.3: IUCN categories and management principles

IUCN Category Number	IUCN Category Name	IUCN Category Description	IUCN Reserve Management Principles
IA	Strict Nature Reserve	Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or	• The reserve or zone should be managed primarily for scientific research or environmental monitoring based on the following principles. • Habitats, ecosystems and native species should be preserved in as undisturbed a state as possible. • Genetic resources should be maintained in a dynamic and evolutionary state. • Established ecological processes should be maintained. • Structural landscape features or rock exposures should be safeguarded. • Examples of the natural environment should be secured for scientific studies, environmental monitoring and education, including baseline areas from which all avoidable access is excluded.

IUCN Category Number	IUCN Category Name	IUCN Category Description	IUCN Reserve Management Principles
		environmental monitoring.	• Disturbance should be minimised by careful planning and execution of research and other approved activities. • Public access should be limited to the extent it is consistent with these principles.
II	National Park	Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for this and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area, and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.	• The reserve or zone should be protected and managed to preserve its natural condition according to the following principles. • Natural and scenic areas of national and international significance should be protected for spiritual, scientific, educational, recreational or tourist purposes. • Representative examples of physiographic regions, biotic communities, genetic resources, and native species should be perpetuated in as natural a state as possible to provide ecological stability and diversity. • Visitor use should be managed for inspirational, educational, cultural and recreational purposes at a level that will maintain the reserve or zone in a natural or near natural state. • Management should seek to ensure that exploitation or occupation inconsistent with these principles does not occur. • Respect should be maintained for the ecological, geomorphologic, sacred and aesthetic attributes for which the reserve or zone was assigned to this category. • The needs of indigenous people should be taken into account, including subsistence resource use, to the extent that they do not conflict with these principles. • The aspirations of traditional owners of land within the reserve or zone, their continuing land management practices, the protection and maintenance of cultural heritage and the benefit the traditional owners derive from enterprises, established in the reserve or zone, consistent with these principles should be recognised and taken into account.
IV	Habitat/Species Management Area	Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species	• The reserve or zone should be managed primarily, including (if necessary) through active intervention, to ensure the maintenance of habitats or to meet the requirements of collections or specific species based on the following principles. • Habitat conditions necessary to protect significant species, groups or collections of species, biotic communities or physical features of the environment should be secured and maintained, if necessary through specific human manipulation. • Scientific research and environmental monitoring that contribute to reserve management should be facilitated as primary activities associated with sustainable resource management. • The reserve or zone may be developed for public education and appreciation of the characteristics of habitats, species or collections and of the work of wildlife management. • Management should seek to ensure that exploitation or occupation inconsistent with these principles does not occur. • People with rights or interests in the reserve or zone should be entitled to benefits derived from activities in the reserve or zone that are consistent with these principles. • If the reserve or zone is declared for the purpose of a botanic garden, it should also be managed for the increase of knowledge, appreciation and enjoyment of Australia's plant heritage by establishing, as an integrated resource, a collection of living and herbarium specimens of Australian

IUCN Category Number	IUCN Category Name	IUCN Category Description	IUCN Reserve Management Principles
			and related plants for study, interpretation, conservation and display.
VI	Managed Resource Protected Areas	Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.	• The reserve or zone should be managed mainly for the sustainable use of natural ecosystems based on the following principles. • The biological diversity and other natural values of the reserve or zone should be protected and maintained in the long term. • Management practices should be applied to ensure ecologically sustainable use of the reserve or zone. • Management of the reserve or zone should contribute to regional and national development to the extent that this is consistent with these principles.

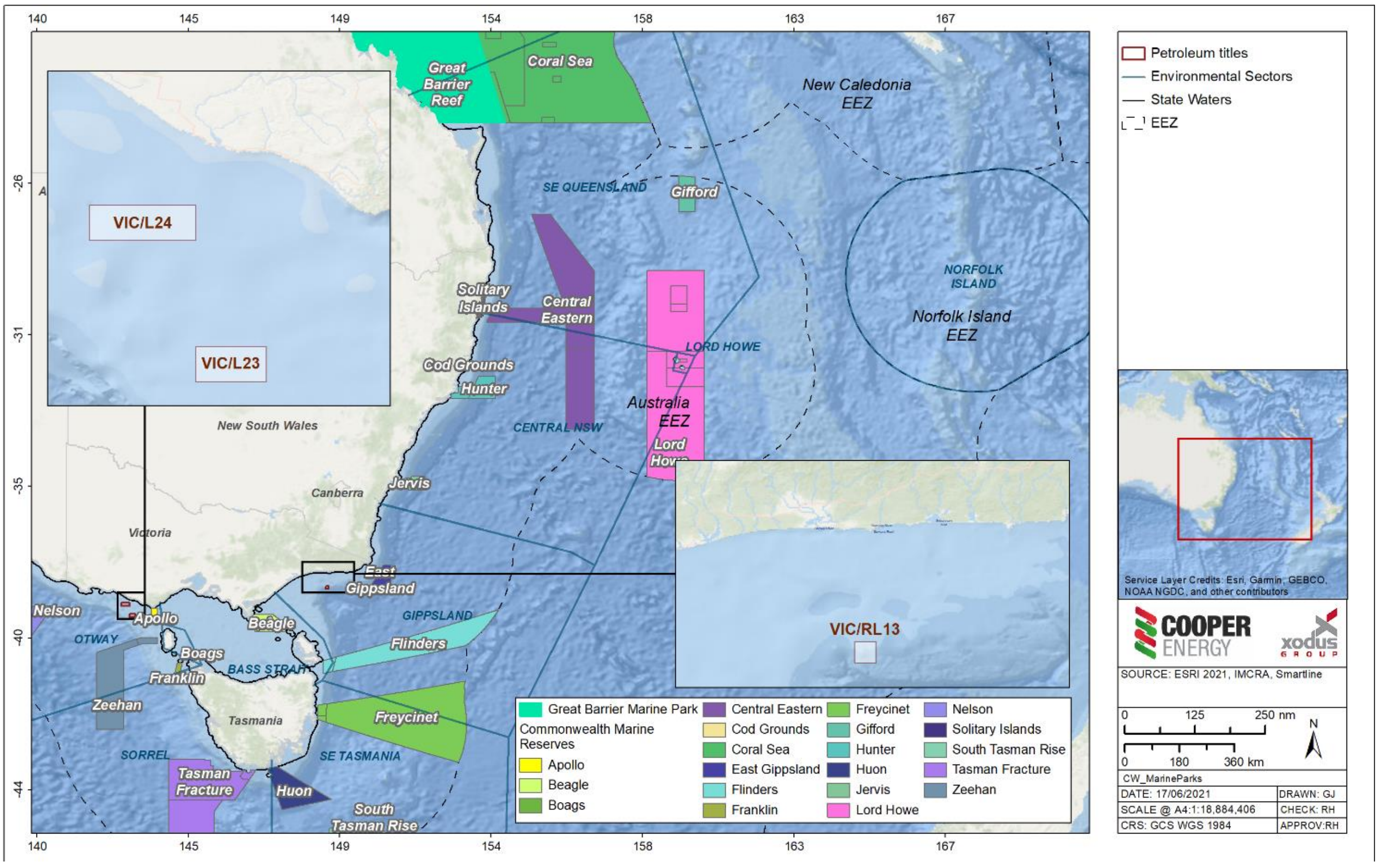


Figure 4-2: Australian Marine Parks present within the Environment Sectors

4.3.1 Great Barrier Reef Marine Park

The Great Barrier Reef was World Heritage listed in 1981 on the basis of its outstanding universal value (GBRMPA, 2014). It is the largest coral reef system in the world, stretching over 2,300 km and containing coral reefs, islands and other habitats (e.g. mangroves, seagrass, algal and sponge gardens, open water) (GBRMPA, 2014). These habitats support many threatened or migratory species listed under the EPBC Act (GBRMPA, 2014). The variety of marine species in the area includes 600 types of hard and soft corals, over 100 species of jellyfish, 3,000 varieties of molluscs, 500 species of worms, 1,625 types of fish, 133 varieties of sharks and rays, and more than 30 species of whales and dolphins (GBRMPA, 2017). The Great Barrier Marine Park was declared in sections between 1979 and 2001; and amalgamated in 2003. The Marine Park includes all waters seaward of low water mark (excluding internal waters), and approximately 70 Commonwealth Islands[6] .

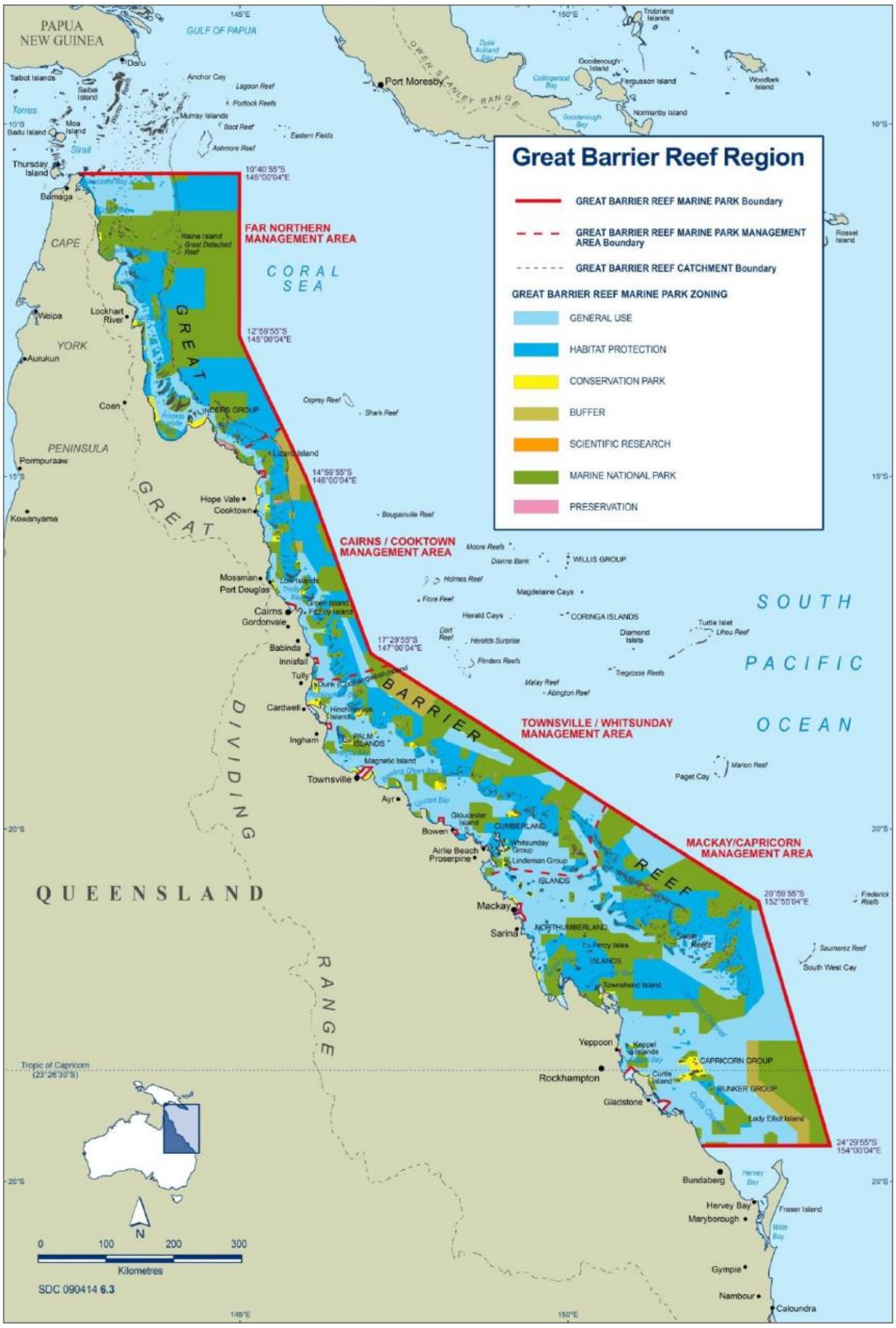
The Great Barrier Reef Marine Park extends into the northern part of the 'SE Queensland' Environment Sector (Figure 4-2). The following management zones are present within the Environment Sectors (Figure 4-3):

- General Use – IUCN Category VI
- Habitat Protection – IUCN Category VI
- Conservation Park – IUCN Category IV
- Buffer – IUCN Category IV
- Scientific Research – IUCN Category IA
- Marine National Park – IUCN Category II
- Preservation – IUCN Category IA

One Commonwealth island, Lady Elliot Island (IUCN Category II) is also present within the Environment Sectors.

Aboriginal and Torres Strait Islander peoples are the Traditional Owners of the Great Barrier Reef area, and they maintain a continuing connection to the Reef and adjacent coastal areas (GBRMPA, 2014). There are approximately 70 Aboriginal and Torres Strait Islander Traditional Owner clan groups whose customary estates include land and sea country within the Great Barrier Reef (GBRMPA, 2014).

[6] The Marine Park does not include the approximately 980 Queensland islands (although these are included in the Great Barrier Reef World Heritage Area).



(Source: GBRMPA, 2014)

Figure 4-3: Great Barrier Reef Zoning Plan

Table 4.4: Australian Marine Parks present within the Environment Sectors

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Apollo	• Multiple Use Zone - IUCN Category VI	• 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 albatross, Australasian Gannet, Short-tailed Shearwater, and Crested tern • Cultural and heritage site: wreck of the *MV City of Rayville*	✓	✓							
Beagle	• Multiple Use Zone - IUCN Category VI	• 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 on migration area for: southern right whale • Important foraging area for: Australian fur seal, killer whale, white shark, shy albatross, Australasian gannet, short-tailed shearwater, pacific and silver gulls, crested tern, common diving petrel, fairy prion, black-faced cormorant and little penguin • Cultural and heritage sites: the wreck of the steamship *SS Cambridge* and the wreck of the ketch *Eliza Davies*.		✓							
Boags	• Multiple Use Zone - IUCN Category VI	• Ecosystems, habitats and communities associated with the Bass Strait Shelf Province and associated with the sea-floor features: plateau and tidal sandwave/sandbank • Important foraging area for: shy albatross, Australasian gannet, short-tailed shearwater, fairy prion, black-faced cormorant, common diving petrel and little penguin		✓							
East Gippsland	• Multiple Use Zone - IUCN Category VI	• 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			✓						

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		• Important foraging area for: wandering, black-browed, yellow-nosed and shy albatrosses; great-winged petrel; wedge-tailed shearwater; and cape petrel • Important migration area for: humpback whale									
Flinders	• Marine National Park Zone - IUCN Category II • Multiple Use Zone - IUCN Category VI	• 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 petrel, Gould's petrel and cape petrel, killer whale, white shark and Harrison's dogfish • Important migration area for: humpback whale.		✓	✓		✓				
Franklin	• Multiple Use Zone - IUCN Category VI	• 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 albatross, short-tailed shearwater, Australasian gannet, fairy prion, little penguin, common diving petrel, black-faced cormorant and silver gull	✓	✓		✓					
Freycinet	• Marine National Park Zone - IUCN Category II • Recreational Use Zone - IUCN Category IV • Multiple Use Zone - IUCN Category VI	• 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 albatross, cape petrel and fairy prion, sei whales and killer whales • Important migration and resting on migration area for: southern right whale • Important migration area for: humpback whale.			✓		✓				

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Huon	• Habitat Protection Zone - IUCN Category IV • Multiple Use Zone - IUCN Category VI	• 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 • Important foraging area for: black-browed, Buller's and shy albatrosses, great-winged petrel, short-tailed shearwater, fairy prion, Australian fur seal and killer whale • Important migration area for: humpback whale.				✓	✓				
Murray	• Marine National Park Zone - IUCN Category II • Special Purpose Zone - IUCN Category VI • Multiple Use Zone - IUCN Category VI	• 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 lion, wandering, black-browed, yellow-nosed and shy albatrosses, great-winged petrels, flesh-footed and short-tailed shearwaters, and white-faced storm petrel • Important breeding area for: southern right whale • Important migration area for: humpback whale	✓								
Nelson	• Special Purpose Zone - IUCN Category VI	• 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 whale, blue, fin and sei whales (likely migration)	✓								
South Tasman Rise	• Special Purpose Zone - IUCN Category VI	• 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					✓				

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		• Important foraging areas for: wandering and black-browed albatross, short-tailed shearwater, white-headed and white-chinned petrels.									
Tasman Fracture	• Marine National Park Zone - IUCN Category II • Special Purpose Zone - IUCN Category VI • Multiple Use Zone - IUCN Category VI	• 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 whale • Important foraging areas for: white shark, New Zealand fur seal, wandering, black-browed and shy albatross, white-chinned petrel, common diving petrel, short-tailed shearwater and fairy prion				✓					
Zeehan	• Special Purpose Zone - IUCN Category VI • Multiple Use Zone - IUCN Category VI	• 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	✓	✓		✓					
Central Eastern	• Marine National Park - IUCN Category II • Habitat Protection Zone - IUCN Category IV • Multiple Use Zone - IUCN Category VI	• Biologically important areas for the protected humpback whale, vulnerable white shark and a number of 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 seafloor 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) interact with currents and ocean gyres resulting in upwellings that influence biological productivity.						✓	✓		

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		• Upwellings attract aggregations of tune, whales, albatrosses and support over 50 fish species endemic to the area. • Tasmantid seamount chain (known breeding and feeding areas for a number of open ocean species such as billfish and marine mammals)									
Cod Grounds	• Marine National Park Zone - IUCN Category II	• Established in May 2007 in Commonwealth waters just south of Port Macquarie in NSW, 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 a number of migratory seabirds • Examples of the ecosystems of the Central Eastern Shelf Transition 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 seafloor feature.						✓			
Gifford	• Habitat Protection Zone - IUCN Category IV	• Biologically important areas for protected humpback whales and a number of migratory seabirds • Examples of the ecosystems of the Lord Howe Province • Represents seafloor features including basin, plateau and seamount/guyot (Gifford Tablemount)							✓		
Hunter	• Multiple Use Zone - IUCN Category VI • Special Purpose Zone (Trawl) - IUCN Category VI	• Important habitat for the critically endangered east coast population of grey nurse sharks • Biologically important areas for the protected humpback whale, vulnerable white sharks and a number of 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 seafloor 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)						✓			

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island

Jervis	• Multiple Use Zone - IUCN Category VI
	• Special Purpose Zone (Trawl) - IUCN Category VI
		• Biologically important areas for protected humpback whales, grey nurse sharks and a number of migratory seabirds
		• Some canyons incise the mid-slope at depths of 1500-3500 metres and some extend to a depth of 5000 metres
		• Seafloor features represented in the park 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
								✓			

Lord Howe	• Marine National Park Zone - IUCN Category II
	• Recreational Use Zone - IUCN Category IV
	• Habitat Protection Zone (Lord Howe) - IUCN Category IV
	• Habitat Protection Zone - IUCN Category IV
	• Multiple Use Zone - IUCN Category VI
		• Biologically important areas for protected humpback whales and a number of migratory seabirds
		• A major seabird breeding area, with 14 species found on the islands including masked boobys, grey ternlets, red-tailed tropic birds, black-winged petrels and Kermadec petrels
		• Key location for the black cod and the Galapagos shark
		• Due to the convergence of warmer tropical and cooler temperate waters in the area of the park, 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 seafloor 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).
								✓	✓	✓	

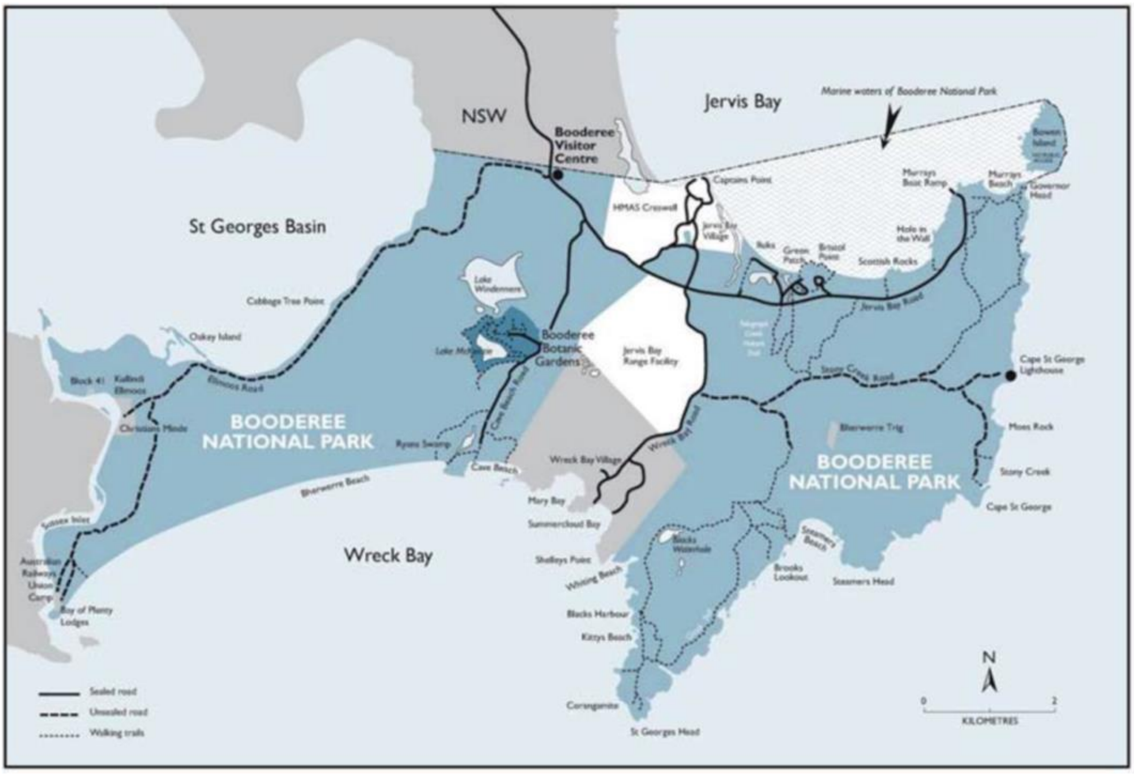
Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		◦ Tasman Front and eddy field (high productivity; aggregations of marine life; biodiversity and endemism)									
Norfolk Marine Park	• Marine National Park Zone - IUCN Category II • Habitat Protection Zone - IUCN Category IV • Special Purpose Zone (Norfolk) - IUCN Category VI	• Significant because it contains habitats, species and ecological communities associated with the Norfolk Island Province. • Breeding and foraging habitat for seabirds • Migratory pathway for humpback whales • Includes two key ecological features: ◦ the Norfolk Ridge (support relatively productive and diverse benthic habitats, and are thought to act as steppingstones for faunal dispersal, connecting deep-water fauna from New Caledonia to New Zealand). ◦ Tasman Front and Eddy Field (increased nutrients and plankton aggregations, and enhanced productivity that attracts mobile species such as turtles, cetaceans, tuna and billfish.)									✓
Solitary Islands	• Marine National Park Zone - IUCN Category II • Multiple Use Zone - IUCN Category VI • Special Purpose Zone (Trawl) - IUCN Category VI	• Important habitat for the critically endangered east coast population of vulnerable grey nurse sharks • Biologically important areas for the protected humpback whale, vulnerable white shark, number of migratory seabirds and the Indo-Pacific (spotted) dolphin. • Many species found are at, or close to, their southern or northern geographical limits. • Examples of the ecosystems of the Central Eastern Shelf Transition and the Tweed-Moreton meso-scale bioregion • Representation of the shelf seafloor feature						✓	✓		

Park	Zoning[1]	Major Conservation Values[1]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Coral Sea	• Marine National Park Zone - IUCN Category II • Habitat Protection Zone - IUCN Category IV • Habitat Protection Zone (Reefs) – IUCN Category IV • Special Purpose Zone (Trawl) – IUCN Category VI	• Habitat and important areas for a range of species have been identified in the region, including for: • humpback whales during their annual migration along the east coast of Australia; • nesting and inter-nesting sites for green turtles; • breeding and foraging areas for multiple seabird species including noddies, terns, boobies, frigatebirds, and tropic birds; • white shark distribution and whale shark aggregation. • Transient populations of highly migratory pelagic species, including small fish schools, billfish, tuna and sharks. • The East Australian Current forms in the region and is considered a major pathway for mobile predators such as billfish and tunas. Black marlin undergo seasonal movements into the Queensland Plateau area. • South Equatorial Current, Hiri Current and East Australian current form a barrier to reduce mixing of species between the north and south, forming distinct ecological communities. • Includes three Key Ecological Features: the reefs, cays and herbivorous fish of the Queensland Plateau and the Marion Plateau and the northern extent of the Tasmantid seamount chain. • Heritage values include several historic shipwrecks including three World War II shipwrecks from the Battle of the Coral Sea. • The park represents the full range of seafloor features found in the region, including numerous reefs ranging from Ashmore and Boot Reefs in the north of the region to Cato Island and surrounding reefs in the south. The park includes canyons, troughs and plateaux, including Bligh Canyon approximately 200 kilometres off the coast from Lockhart River and the Townsville Trough, which separates the Queensland and Marion Plateaux. The reserve extends into the deeper waters of the Coral Sea Basin in the north, and provides protection for the pinnacles of the northern extent of the Tasmantid seamount chain. • Six provincial bioregions, 94 depth ranges, and 16 seafloor types are represented in the park.							✓		

4.3.2 Commonwealth Terrestrial Reserves

One Commonwealth National Park is located within the Environment Sectors: Booderee National Park. The Booderee National Park was established in 1992 and is jointly managed by Parks Australia and Wreck Bay Aboriginal Community Council (DNP, 2015). The Park stretches across 6,379 ha at Jervis Bay, and includes 875 ha of marine environment, and 80 ha of Botanic Garden (Australia's only Aboriginal-owned and managed Botanic Gardens). Booderee National Park is considered both nationally and regional significant for its natural and cultural values; and the Park contains many species that are at the limits of their bio-geographical range (DEE, 2017x).

The marine environment of Booderee National Park is characterised by a wide range of tidal and subtidal habitats including shallow rock reefs and sand zones, seagrass meadows, deeper silty sand flats and deep-water rocky reefs, cliffs, platforms, blocks, boulders and caves (DEE, 2017x). The intertidal rock platforms of Bowen Island host a variety of intertidal species including large numbers and varieties of sea urchins, crabs, abalone, and oysters (DEE, 2017x). Bowen Island also supports a colony of Little Penguin, and breeding colonies of three species of shearwater; making it of high conservation significance. The Park area also includes the largest seagrass meadows in New South Wales; *Posidionia* species are dominant, but *Zostera* and *Halophila* sp. are also present. These areas provide habitat for a diversity and abundance of fish and macroinvertebrates. Subtidal and intertidal platforms support a diversity of rocky reef algae with *Hormosira*, *Ecklonia*, *Sargassum*, *Phyllospora* and *Cystophora* being the dominant genera. The littoral communities of the National Park are of both local and state-wide significance and include: mangrove communities along Sussex Inlet and south of Whiting Beach; saltmarsh communities at Flat Rock Creek and on the southern section of Bowen Island; and intertidal rocky platforms (DEE, 2017x). The mangrove communities provide habitat for a number of intertidal estuarine organisms, fish and terrestrial species. Saltmarsh communities are of high conservation value as bird feeding areas. The area also supports a population of bottlenose dolphins (DEE, 2017x). The Park protects coastal dune systems and their associated habitats, which are otherwise disturbed or potentially threatened in the region; the preservation as a southern representative of the sandstone ecosystems is highly important (DEE, 2017x).



(Source: DNP, 2015)

Figure 4-4: Location of Booderee National Park

4.4 Wetlands

4.4.1 Wetlands of International Importance

Under the Ramsar Convention, wetland types have been defined to identify the main wetland habitats represented at each site. The classification system uses three categories (with a number of wetland types within each): (i) Marine/Coastal Wetlands; (ii) Inland Wetlands; and (iii) Human-made Wetlands. The classification of a marine/coastal wetland is extensive and includes those wetlands that while predominantly based inland have some form of connection with the coast and/or marine waters.

Twenty one marine/coastal Wetlands of International Importance have been identified within the Environment Sectors (Table 4.5, Figure 4-5). A summary of key features of the wetlands is provided in Appendix 1.

Table 4.5: Marine/Coastal Zone Wetlands of International Importance within the Environment Sectors

Wetland	Otway	Bass Strait	Gippsland	Sorell[1]	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
South Australia									
Piccaninnie Ponds Karst Wetlands	✓								
Victoria									
Corner Inlet		✓							
Edithvale-seafood wetlands		✓							
Floor plain lower Ringarooma river		✓							
Gippsland Lakes			✓						
Glenelg Estuary and Discovery Bay	✓								
Port Phillip Bay (Western Shoreline) and Bellarine Peninsula		✓							
West district lakes		✓							
Western Port		✓							
Tasmania									
Apsley Marshes					✓				
East Coast Cape Barren Island Lagoons		✓	✓						
Flood Plain Lower Ringarooma River		✓							
Jocks Lagoon					✓				
Lavinia		✓							
Little Waterhouse Lake		✓							
Logan Lagoon		✓	✓						
Moulting Lagoon					✓				
Pitt Water-Orielton Lagoon					✓				
New South Wales									
Hunter Estuary Wetlands						✓			
Myall Lakes						✓			
Towra Point Nature Reserve						✓			
Queensland									
Great Sandy Strait							✓		
Moreton Bay							✓		

Wetland	Otway	Bass Strait	Gippsland	Sorell[1]	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
External Territories									
Elizabeth and Middleton Reefs Marine National Nature Reserve							✓		

Notes:

1. No Wetlands of International Importance are present within Sorell, Lord Howe or Norfolk zones.

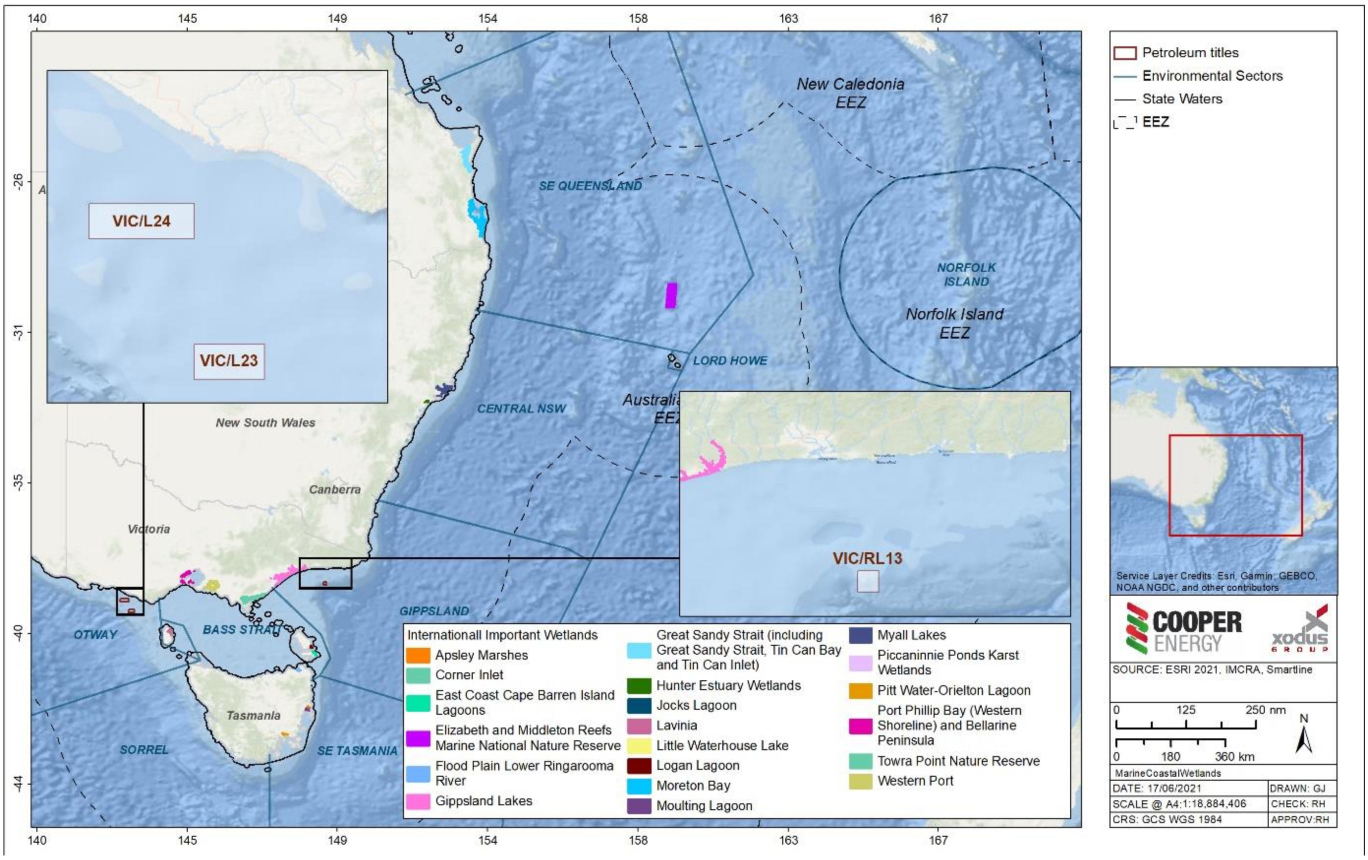


Figure 4-5: Marine/Coastal Wetlands of International Importance within the Environment Sectors

4.4.2 Wetlands of National Importance

A classification system based on that used by the Ramsar Convention, but modified to suit the Australia, has been used to classify Wetlands of National Importance. The classification system uses three categories (with a number of wetland types within each): (i) Marine and Coastal Zone wetlands; (ii) Inland wetlands; and (iii) Human-made wetlands. The classification of a marine and coastal zone wetland is extensive and includes those wetlands that while predominantly based inland have some form of connection with the coast and/or marine waters.

One hundred and forty-seven (147) marine and coastal zone Wetlands of National Importance have been identified within the Environment Sectors (Table 4.6). A summary of key ecological and social features is provided in Appendix 2.

Table 4.6: Marine and Coastal Zone Wetlands of National Importance within the Environment Sectors

Wetland	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
South Australia									
Piccaninnie Ponds	✓								
South East Coastal Salt Lakes	✓								
Victoria									
Anderson Inlet		✓							
Corner Inlet		✓	✓						
Ewing's Marsh			✓						
Glenelg Estuary	✓								
Jack Smith Lake State Game Reserve		✓	✓						
Lake Bunga			✓						
Lake Connewarre State Wildlife Reserve		✓							
Lake King Wetlands			✓						
Lake Tyers			✓						
Lake Victoria Wetlands			✓						
Lake Wellington Wetlands			✓						
Long Swamp	✓								
Lower Aire River Wetlands	✓								
Lower Merri River Wetlands	✓								
Lower Snowy River Wetlands System			✓						
Mallacoota Inlet Wetlands			✓						
Mud Islands		✓							
Point Cook & Laverton Saltworks		✓							
Powlett River Mouth		✓							
Princetown Wetlands	✓								
Shallow Inlet Marine & Coastal Park		✓							
Sydenham Inlet Wetlands			✓						
Swan Bay & Swan Island		✓							
Tamboon Inlet Wetlands			✓						
Werribee-Avalon Area		✓							
Western Port		✓							
Yambuk Wetlands	✓								
Tasmania									
Blackmans Lagoon		✓							
Boullanger Bay – Robbins Passage		✓							
Calverts Lagoon					✓				
D'Arcy's Lagoon					✓				
Earlham Lagoon					✓				
Fergusons Lagoon		✓							
Flyover Lagoon 1		✓							
Flyover Lagoon 2		✓							
Freshwater Lagoon					✓				

Wetland	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
Hogans Lagoon		✓							
Jocks Lagoon					✓				
Lavinia Nature Reserve		✓							
Little Thirsty Lagoon		✓							
Little Waterhouse Lake		✓							
Logan Lagoon		✓							
Maria Island Marine Reserve					✓				
Moulting Lagoon					✓				
Orielton Lagoon					✓				
Pearshape Lagoon 1		✓							
Pearshape Lagoon 2		✓							
Pearshape Lagoon 3		✓							
Pearshape Lagoon 4		✓							
Rocky Cape Marine Area		✓							
Sellars Lagoon		✓	✓						
South East Cape Lakes				✓					
Syndicate Lagoon		✓							
The Chimneys		✓							
Tregaron Lagoons 1		✓							
Tregaron Lagoons 2		✓							
Unnamed Wetland TAS008		✓			✓				
Unnamed Wetland TAS009		✓							
Unnamed Wetland TAS010		✓							
Unnamed Wetland TAS011		✓							
Unnamed Wetland TAS012		✓							
Unnamed Wetland TAS013		✓							
Unnamed Wetland TAS014		✓							
Unnamed Wetland TAS038					✓				
Unnamed Wetland TAS051		✓							
Unnamed Wetland TAS052		✓							
Unnamed Wetland TAS081				✓					
New South Wales									
Avoca Lagoon						✓			
Beecroft Peninsula						✓			
Bondi Lake			✓						
Brisbane Water Estuary						✓			
Bundjalung National Park							✓		
Clarence River Estuary							✓		
Clybucca Creek Estuary						✓			
Clyde River Estuary			✓			✓			
Cockrone Lagoon						✓			

Wetland	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
Coila Creek Delta			✓						
Coomaditchy Lagoon						✓			
Coomonderry Swamp						✓			
Cormorant Beach						✓			
Crowdy Bay National Park						✓			
Cudgen Nature Reserve							✓		
Cullendulla Creek and Embayment						✓			
Durras Lake						✓			
Eve St. Marsh, Arncliffe						✓			
Five Islands Nature Reserve						✓			
Jervis Bay						✓			
Jervis Bay Sea Cliffs						✓			
Killalea Lagoon						✓			
Kooragang Nature Reserve						✓			
Lagoon Head						✓			
Lake Illawarra						✓			
Lake Hiawatha and Minnie Water							✓		
Limeburners Creek Nature Reserve						✓			
Merimbula Lake			✓						
Meroo Lake Wetland Complex						✓			
Minnamurra River Estuary						✓			
Moruya River Estuary Saltmarshes			✓						
Myall Lakes						✓			
Nadgee Lake and tributary wetlands			✓						
Nargal Lake			✓						
Nelson Lagoon			✓						
Pambula Estuarine Wetlands			✓						
Port Stephens Estuary						✓			
Shoalhaven/Crookhaven Estuary						✓			
Solitary Islands Marine Park							✓		
St Georges Basin						✓			
Swan Lagoon						✓			
Swan Pool/Belmore Swamp						✓			
Tabourie Lake						✓			
Termeil Lake Wetland Complex NSW						✓			
Terrigal Lagoon						✓			
Towra Point Estuarine Wetlands						✓			
Tuggerah Lake						✓			
Tuross River Estuary			✓						
Twofold Bay			✓						
Ukerebagh Nature Reserve							✓		

Wetland	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe[1]	Norfolk Island
Waldrons Swamp			✓						
Wallaga Lake			✓						
Wallagoot Lagoon			✓						
Wallis Lake and adjacent estuarine islands						✓			
Wamberal Lagoon						✓			
Wollumboola Lake						✓			
Wooloweyah Lagoon							✓		
Queensland									
Bribie Island							✓		
Burrum Coast							✓		
Bustard Bay Wetlands							✓		
Colosseum Inlet – Rodds Bay							✓		
Deepwater Creek							✓		
Fraser Island							✓		
Great Barrier Reef Marine Park							✓		
Great Sandy Strait							✓		
Lake Coombabah							✓		
Lake Weyba							✓		
Lower Mooloolah River							✓		
Moreton Bay Aggregation							✓		
Noosa River Wetlands							✓		
North Stradbroke Island							✓		
Northeast Curtis Island							✓		
Pine River and Hays Inlet							✓		
Port Curtis							✓		
Pumicestone Passage							✓		
The Narrows							✓		
Upper Pumicestone Coastal Plain							✓		

Notes:
1. No Wetlands of National Importance are present within the Lord Howe or Norfolk Island sectors.

4.5 State Parks and Reserves

4.5.1 Marine Protected Areas

State marine protected areas are declared under each individual state's legislation and are managed by state authorities. There are 73 state marine protected areas within the Environment Sectors (Table 4.7).

Table 4.7: State Marine Protected Areas within the Environment Sectors

Marine Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
South Australia									
Upper South East Marine Park	✓								
Lower South East Marine Park	✓								
Victoria									
Barwon Bluff Marine Sanctuary		✓							
Beware Reef Marine Sanctuary			✓						
Bunurong Marine National Park		✓							
Cape Howe Marine National Park			✓						
Churchill Island Marine National Park		✓							
Corner Inlet Marine & Coastal Park		✓							
Corner Inlet Marine National Park		✓							
Discovery Bay Marine National Park	✓								
Eagle Rock Marine Sanctuary		✓							
French Island Marine National Park		✓							
Jawbone Marine Sanctuary		✓							
Marengo Reefs Marine Sanctuary		✓							
Merri Marine Sanctuary	✓								
Mushroom Reef Marine Sanctuary		✓							
Ninety Mile Beach Marine National Park			✓						
Nooramunga Marine & Coastal Park		✓							
Point Addis Marine National Park		✓							
Point Cooke Marine Sanctuary		✓							
Point Danger Marine Sanctuary		✓							
Point Hicks Marine National Park			✓						
Port Phillip Heads Marine National Park		✓							
Ricketts Point Marine Sanctuary		✓							
Shallow Inlet Marine & Coastal Park		✓							
The Arches Marine Sanctuary	✓								
Twelve Apostles Marine National Park	✓								
Wilsons Promontory Marine National Park		✓							
Wilsons Promontory Marine Park		✓							
Wilsons Promontory Marine Park		✓							
Yaringa Marine National Park		✓							
Tasmania									
Blackman Rivulet Marine Conservation Area					✓				
Central Channel Marine Conservation Area					✓				
Cloudy Bay Marine Conservation Area					✓				
Governor Island Marine Park					✓				
Hippolyte Rocks Marine Conservation Area					✓				
Huon Estuary Marine Conservation Area					✓				
Kent Group Marine Park		✓							

Marine Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Maria Island Marine Park					✓				
Monk Bay Marine Conservation Area					✓				
Ninepin Point Marine Park					✓				
Opossum Bay Marine Conservation Area					✓				
Port Cygnet Marine Conservation Area					✓				
Port Davey Marine Park				✓					
River Derwent Marine Conservation Area					✓				
Roberts Point Marine Conservation Area					✓				
Simpsons Point Marine Conservation Area					✓				
Sloping Island Marine Conservation Area					✓				
South Arm Marine Conservation Area					✓				
Tinderbox Marine Park					✓				
Waterfall–Fortescue Marine Conservation Area					✓				
New South Wales									
Barrenjoey Head Aquatic Reserve						✓			
Batemans Marine Park			✓			✓			
Boat Harbour Aquatic Reserve						✓			
Bronte-Coogee Aquatic Reserve						✓			
Bushranger's Bay Aquatic Reserve						✓			
Cabbage Tree Bay Aquatic Reserve						✓			
Cape Banks Aquatic Reserve						✓			
Cape Byron Marine Park							✓		
Cook Island Aquatic Reserve							✓		
Jervis Bay Marine Park						✓			
Long Reef Aquatic Reserve						✓			
Lord Howe Island Marine Park								✓	
Narrabeen Head Aquatic Reserve						✓			
North (Sydney) Harbour Aquatic Reserve						✓			
Port Stephens Great Lakes Marine Park						✓			
Shiprock Aquatic Reserve						✓			
Solitary Islands Marine Park						✓	✓		
Towra Point Aquatic Reserve						✓			
Queensland									
Great Barrier Reef Coast Marine Park							✓		
Great Sandy Marine Park							✓		
Moreton Bay Marine Park							✓		
External Territories									
Norfolk Marine Park									✓

4.5.2 Terrestrial Protected Areas

State terrestrial protected areas are declared under each individual state's legislation and are managed by state authorities. There are 148 state terrestrial protected areas within the Environment Sectors (Table 4.8).

Table 4.8: State Terrestrial Protected Areas within the Environment Sectors

Terrestrial Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
South Australia									
Beachport Conservation Park	✓								
Canunda National Park	✓								
Douglas Point Conservation Park	✓								
Ewens Ponds Conservation Park	✓								
Lake St Clair Conservation Park	✓								
Little Dip Conservation Park	✓								
Piccaninnie Ponds Conservation Park	✓								
Victoria									
Cape Nelson State Park	✓								
Croajingolong National Park			✓						
French Island National Park		✓							
Great Otway National Park	✓	✓							
Mornington Peninsula National Park		✓							
Point Nepean National Park		✓							
Port Campbell National Park	✓								
The Lakes National Park			✓						
Wilsons Promontory National Park		✓							
Tasmania									
Freycinet National Park					✓				
Kent Group National Park		✓							
Maria Island National Park					✓				
Mt William National Park					✓				
Narawntapu National Park		✓							
Rocky Cape National Park		✓							
South Bruny National Park					✓				
Southwest National Park				✓					
Strzelecki National Park		✓							
Tasman National Park					✓				
New South Wales									
Arakoon National Park						✓			
Arakwal National Park							✓		
Awabakal Nature Reserve						✓			
Bandicoot Island Nature Reserve						✓			
Bell Bird Creek Nature Reserve			✓						
Belowla Nature Reserve						✓			

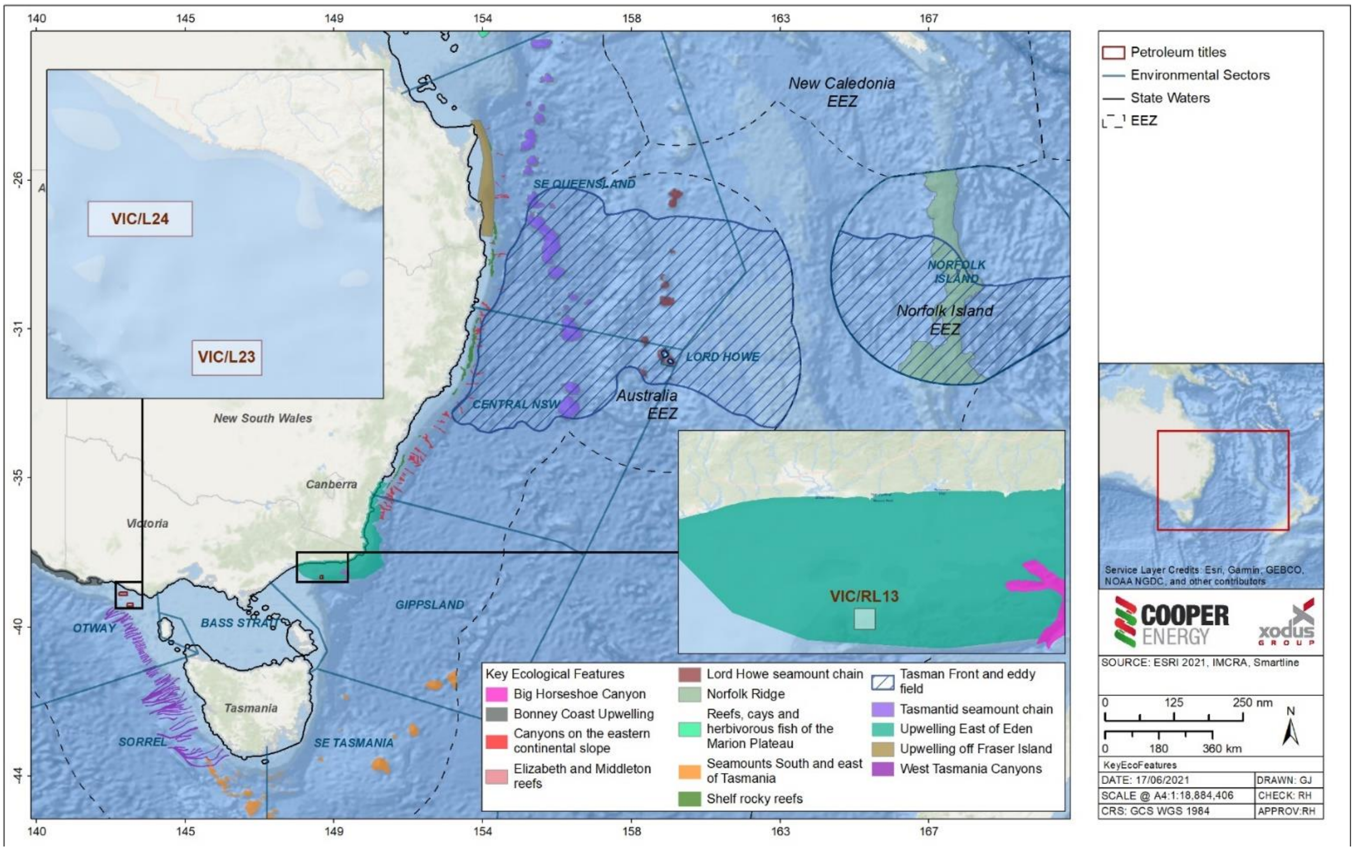
Terrestrial Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Ben Boyd National Park			✓						
Berkeley Nature Reserve						✓			
Billinudgel Nature Reserve							✓		
Bird Island Nature Reserve						✓			
Bongil Bongil National Park						✓			
Boondelbah Nature Reserve						✓			
Booti Booti National Park						✓			
Bouddi National Park						✓			
Bournda National Park			✓						
Brisbane Water National Park						✓			
Broadwater National Park							✓		
Broken Head Nature Reserve							✓		
Broulee Island Nature Reserve			✓						
Brunswick Heads Nature Reserve							✓		
Brush Island Nature Reserve						✓			
Bundjalung National Park							✓		
Cape Byron State Conservation Area							✓		
Clyde River National Park			✓						
Cockle Bay Nature Reserve						✓			
Coffs Coast Regional Park						✓	✓		
Comerong Island Nature Reserve						✓			
Conjola National Park						✓			
Corramy Regional Park						✓			
Corrie Island Nature Reserve						✓			
Crowdy Bay National Park						✓			
Cudgen Nature Reserve							✓		
Cullendulla Creek Nature Reserve			✓						
Darawank Nature Reserve						✓			
Eagles Claw Nature Reserve			✓						
Eurobodalla National Park			✓						
Five Islands Nature Reserve						✓			
Gaagal Wanggaan (South Beach) National Park						✓			
Glenrock State Conservation Area						✓			
Goolawah National Park						✓			
Gulaga National Park			✓						
Hat Head National Park						✓			
Jagun Nature Reserve						✓			
Jervis Bay National Park						✓			
John Gould Nature Reserve						✓			
Julian Rocks Nguthungulli Nature Reserve							✓		
Kamay Botany Bay National Park						✓			

Terrestrial Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Kattang Nature Reserve						✓			
Ku-ring-gai Chase National Park						✓			
Lake Macquarie State Conservation Area						✓			
Limeburners Creek National Park						✓			
Lion Island Nature Reserve						✓			
Little Broughton Island Nature Reserve						✓			
Long Island Nature Reserve						✓			
Malabar Headland National Park						✓			
Marramarra National Park						✓			
Meroo National Park						✓			
Mimosa Rocks National Park			✓						
Montague Island Nature Reserve			✓						
Moon Island Nature Reserve						✓			
Moonee Beach Nature Reserve						✓			
Munmorah State Conservation Area						✓			
Muogamarra Nature Reserve						✓			
Murramarang National Park						✓			
Muttonbird Island Natures Reserve						✓			
Myall Lakes National Park						✓			
Nadgee Nature Reserve			✓						
Narrawallee Creek Nature Reserve						✓			
North Rock Nature Reserve							✓		
North Solitary Island Nature Reserve							✓		
North West Solitary Island Nature Reserve							✓		
Pelican Island Nature Reserve						✓			
Richmond River Nature Reserve							✓		
Rileys Island Nature Reserve						✓			
Royal National Park						✓			
Saltwater National Park						✓			
Saratoga Island Natures Reserve						✓			
Sea Acres National Park						✓			
Seal Rocks Nature Reserve						✓			
Seven Mile Beach National Park					✓				
South West Solitary Island Nature Reserve						✓			
Spectacle Island Nature Reserve						✓			
Split Solitary Island Nature Reserve						✓			
Stormpetrel Nature Reserve						✓			
Sydney Harbour National Park						✓			
Tollgate Islands Nature Reserve			✓						
Tomaree National Park						✓			
Towra Point Nature Reserve						✓			

Terrestrial Protected Area	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Tyagarah Nature Reserve							✓		
Wallarah National Park						✓			
Wamberal Lagoon Nature Reserve						✓			
Wooyung Nature Reserve							✓		
Worimi Regional Park						✓			
Wyrrabalong National Park						✓			
Yarriabini National Park						✓			
Yuragir National Park							✓		
Queensland									
Bribie Island National Park and Recreation Area							✓		
Broadwater Conservation Park							✓		
Burleigh Head National Park							✓		
Burrum Coast National Park							✓		
Capricornia Cays National Park							✓		
Coololla Great Walk							✓		
Cooloola Recreation Area, Great Sandy National Park							✓		
Curtis Island National Park and Conservation Park							✓		
Deepwater National Park							✓		
Eurimbula National Park							✓		
Ex-HMAS Brisbane Regional Park							✓		
Fort Lytton National Park							✓		
Fraser Island, Great Sandy National Park							✓		
Inskip Peninsula Recreation Area							✓		
Joseph Banks Conservation Park							✓		
Mon Repos Regional Park							✓		
Moretone Island National Park and Recreaton Area							✓		
Mouth of Kolan River Conservation Park							✓		
Naree Budjong Djara National Park							✓		
Noosa National Park							✓		
Pine Ridge National Park							✓		
Southern Moreton Bay Islands National Park							✓		
St Helena Island National Park							✓		
Teerk Roo Ra National Park							✓		
Woody Island and Little Woody Island, Great Sandy National Park							✓		
External Territories									
Norfolk Island National Park									✓

4.6 Key Ecological Features

Key Ecological Features (KEF) are elements of the Commonwealth marine environment that are considered to be of regional importance for either a region's biodiversity or its ecosystem function and integrity. Seventeen KEFs occur within the Environment Sectors (Figure 4-6, Table 4.9).



Note: Not all features can be spatially mapped, refer to below table for full list of features.

Figure 4-6: Key Ecological Features within the Environment Sectors

Table 4.9: Key Ecological Features present within the Environment Sectors

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
South-east Marine Region[1]										
Bass Cascade	**High productivity** The Bass Cascade refers to the "underwater waterfall" effect 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			✓						

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	cascading water also concentrates nutrients and some fish and whales are known to aggregate along its leading edge. The Bass Cascade occurs during winter months only.									
Big Horseshoe Canyon	**High productivity, aggregations of marine life** 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*.			✓						
Bonney Coast Upwellling	**High productivity, aggregations of marine life** 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. It is one of 12 widely recognised and well-known areas worldwide where blue whales are known to feed in relatively high numbers. The area is significant as one of the largest and most predictable upwellings in south-eastern Australia. This is not the only upwelling in southeast Australia driven by the prevailing south-easterly winds, but it is the most prominent. 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.	✓								
East Tasmania Subtropical Convergence Zone	**High productivity, aggregations of marine life** This zone of enhanced pelagic productivity occurs where eddies of the East Australian Current interact with subantarctic waters driven by westerly winds. The northern and southern extent of the feature are approximately level with the north-east tip of Tasmania and the Tasman Peninsula. This is a complex feature that is characterised by autumn and spring phytoplankton blooms that form the basis of a productive food chain which supports cetaceans, seals, sharks and seabirds. The phytoplankton blooms also attract migratory commercial fish stocks such as Southern bluefin tuna, barracouta, and jack mackerel. Phytoplankton blooms are important for krill, which in turn form an important component of the diet of many pelagic species.					✓				

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Seamounts South and East of Tasmania	**High productivity, aggregations of marine life** 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 south east of southern Tasmania). 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 seafloor. 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.				✓	✓				
Shelf Rocky Reefs and Hard Substrates	**High productivity, aggregations of marine life** Rocky reefs and hard grounds are located in all areas of the South-east Marine Region continental shelf including Bass Strait, from the sub-tidal zone shore to the continental shelf break. The continental shelf break generally occurs in 50 m to 150–220 m water depth. The shallowest depth at which the rocky reefs occur in Commonwealth waters is approximately 50 m. 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.	✓	✓	✓	✓	✓				
Upwelling East of Eden	**High productivity, aggregations of marine life** 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. 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.			✓						
West Tasmania Canyon	**High productivity, aggregations of marine life** 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	✓			✓					

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	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 hotspots. For example, plumes of sediment and nutrient-rich water can be seen at or near the heads of canyons. Sponges are concentrated near the canyon heads, with the greatest diversity between 200 m and 350 m depth. Sponges are associated with abundance of fishes and the canyons support a diversity of sponges comparable to that of seamounts.									
Temperate East Marine Region[2]										
Canyons on the Eastern Continental Slope	**Unique sea-floor feature with ecological properties of regional significance** Canyon systems have a marked influence on the diversity and abundance of species, 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). Canyons also create localised changes in productivity in the water column above them, providing feeding opportunities for a range of species, many of which are commercially important or threatened.			✓			✓	✓		
Elizabeth and Middleton Reefs	**Aggregations of marine life; biodiversity and endemism** Elizabeth and Middleton reefs are small, isolated, oceanic platform reefs that occur on top of the volcanic seamounts of the Lord Howe seamount chain. The reefs are impacted by the East Australian Current, exposing the area to its warm waters as well as the surrounding cooler ocean. This key ecological feature supports tropical and temperate marine life, including both warm and cold-water corals and over 300 fish species. The lagoons of both reefs are important areas for populations of black cod and the Galapagos shark.								✓	
Lord Howe Seamount Chain	**High productivity; aggregations of marine life; biodiversity and endemism** The Lord Howe seamount chain runs for approximately 1000 km along the western margin of the Lord Howe Rise, extending from Lord Howe Island in the south to Nova Bank in the north. It supports tropical shallow coral reefs and deep cold-water corals.								✓	
Shelf Rocky Reefs	**Unique sea-floor feature with ecological properties of regional significance**			✓			✓	✓		

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	Along the continental shelf south of the Great Barrier Reef, communities associated with the shift from algae-dominated sea-floor communities to those dominated by attached invertebrates (including large sponges, moss animals and soft corals). This shift generally occurs at a depth of 45 m. 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.									
Tasman Front and Eddy Field	**High productivity; aggregations of marine life; biodiversity and endemism** The Tasman Front 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. The front is located between 27º S and 33º S, moving north during winter and south in summer. It is associated with warm-core eddies, a number of which are semipermanent features.						✓	✓	✓	✓
Tasmantid Seamount Chain	**High productivity; aggregations of marine life; biodiversity and endemism** 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 hotspots 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.						✓	✓		
Upwelling off Fraser Island	**High productivity; aggregations of marine life** In two areas near Fraser Island, upwellings of cold, deep waters mix with surface waters. Tides, wind and currents draw these nutrient-rich waters onto the shelf, where they generate blooms of phytoplankton that support animals higher in the food chain, including a number of commercially valuable and threatened species.							✓		
Norfolk Ridge	**Enhanced ecological functioning and integrity, and biodiversity, which apply to both its benthic and pelagic habitats** Stretching across the Temperate East Marine Region, the Norfolk Ridge provides a rich biological source of benthic									✓

Key Ecological Feature	Values and Description[1,2,3]	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	biodiversity and endemism. Similarly, to the Lord Howe chain, the ridge also generates localised oceanographic changes which create sites of enhanced productivity and aggregate marine species.									
Coral Sea Marine Region[3]										
Reefs, cays and herbivorous fish of the Marion Plateau	Marion Plateau lies to the south of the Queensland Plateau and is separated from it by the deep water of the Townsville Trough. This feature supports reefs and cays, most notably Marion and Saumarez Reefs. As with the reefs of the Queensland Plateau, these sites support diverse and abundant invertebrate and fish communities. Due to the flow of the East Australian Current, it is thought that these communities may be distinct from their Queensland Plateau neighbours.							✓		

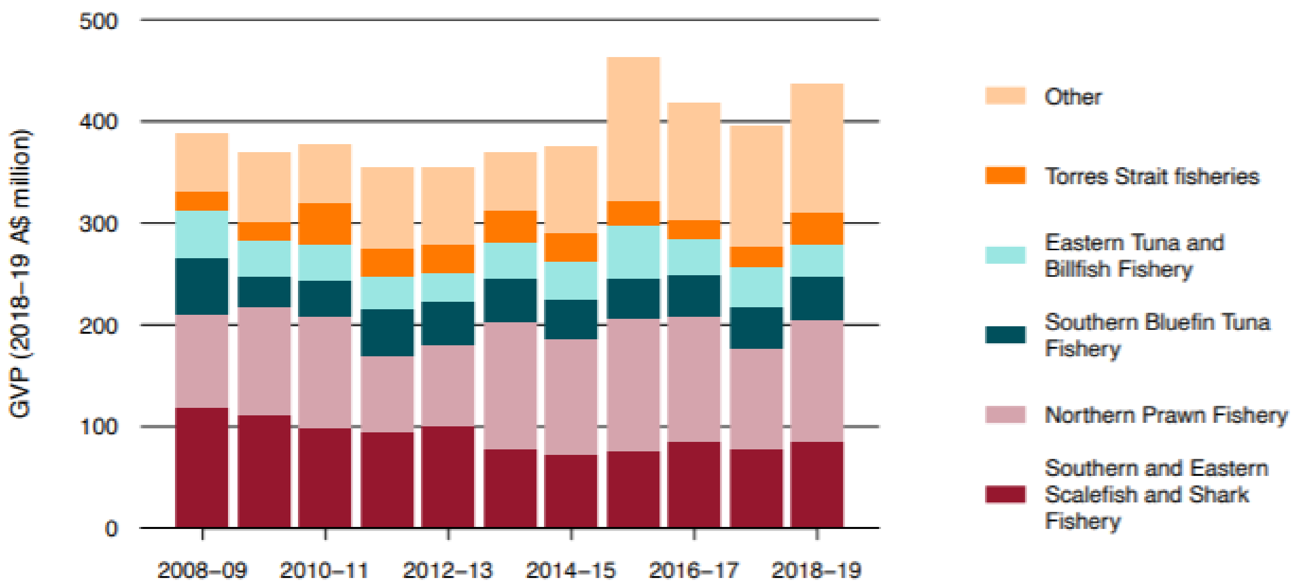
Notes:
1. Values and Descriptions as provided in DoE, 2015a.
2. Values and Descriptions as provided in DSEWPaC, 2012f.
3. Values and Descriptions as provided in DNP, 2018b.

5 Social Environment

5.1 Commercial Fisheries

5.1.1 Commonwealth-managed Fisheries

Commonwealth fisheries are managed by the Australian Fisheries Management Authority (AFMA), with the fisheries typically operating within 3 nm to 200 nm offshore (i.e. to the extent of the Australian Fishing Zone). In 2018-19 the Gross Value of Production (GVP) from Commonwealth fisheries was estimated at $437 million; contribution 24% of Australia's wild catch fisheries GVP (Figure 5-1) (Patterson *et al.*, 2020).



(Source: Patterson *et al.*, 2020)

Figure 5-1: 2016-2017 Gross Value of Production of Commonwealth Fisheries

There are ten commonwealth-managed commercial fisheries occurring within the Environment Sectors (Table 5.1):

- Bass Strait Central Zone Scallop
- Coral Sea Fishery
- Eastern Tuna and Billfish Fishery
- Norfolk Island Fishery
- Skipjack Tuna East Fishery
- Small Pelagic Fishery
- Southern and Easter Scalefish and Shark Fishery
- Southern Bluefin Tuna Fishery
- Southern Squid Jig Fishery, and
- Western Tuna and Billfish Fishery.

Cooper Energy recently commissioning SETFIA (the South East Trawl Fishing Industry Association) undertake a study into the commercial fishing effort (Commonwealth and State) within the BMG field area (SETFIA, 2020); located within the Gippsland Environmental Sector. Results of this study are included in the sections below where relevant.

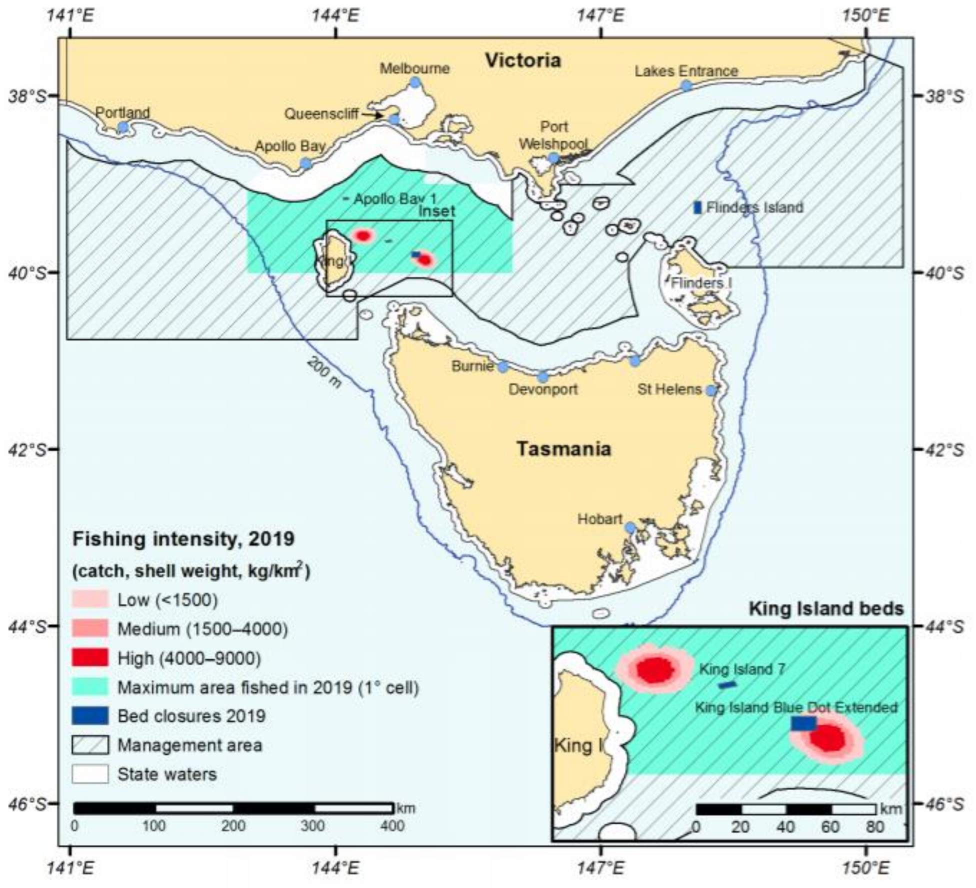
Table 5.1: Commonwealth-managed Commercial Fisheries within the Environment Sectors

Fishery	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Bass Strait Central Zone Scallop	✓	✓	✓						
Coral Sea Fishery							✓		
Eastern Tuna and Billfish Fishery	✓	✓	✓	✓	✓	✓	✓	✓	
Norfolk Island Fishery									✓
Western Skipjack Fishery	✓								
Small Pelagic Fishery	✓	✓	✓	✓	✓	✓	✓	✓	
Southern and Eastern Scalefish and Shark Fishery	✓	✓	✓	✓	✓	✓	✓	✓	
Southern Bluefin Tuna Fishery	✓	✓	✓	✓	✓	✓	✓	✓	
Southern Squid Jig Fishery	✓	✓	✓	✓	✓	✓	✓	✓	
Western Tuna and Billfish Fishery	✓								

5.1.1.1 Bass Strait Central Zone Scallop Fishery

The Bass Strait Central Zone Scallop Fishery operates in Commonwealth waters between Victoria and Tasmania (Figure 5-2). The default fishing season is 1 April to 31 December each year (note, the exact dates can vary each year) (DSEWPaC, 2013c); and the target species is Commercial Scallop (*Pecten fumatus*). Scallop spawning occurs from winter to spring (June to November); however, the timing is dependent on environmental conditions such as wind and water temperature (Sause *et al.*, 1987). Fishing method is via scallop dredge. Primary landing ports are Devonport and Stanley (Tasmania); Apollo Bay, Melbourne, Queenscliff and San Remo (Victoria). The primary market for commercial scallops is domestic (Marton *et al.,* 2012).

During 2019, fishing was concentrated on beds east of King Island (a similar area to that fished since 2014) (Figure 5-2). The fishery has a history of boom and bust, with the catch peaks (1982 to 1983, 1994 to 1996, 2003 and 2018) generally becoming progressively smaller with time. These peaks (Patterson *et al.*, 2020). Comparison of the fishery's gross value of production (GVP) before and after the most recent closure (2006 to 2008) reveals a considerable increase immediately following reopening of the fishery. GVP has increased annually from 2013–14 to 2017–18. In 2018–19, GVP is estimated to have declined by 6% to $6.3 million (Patterson *et al.*, 2020).



Source: (Patterson *et al.*, 2020)

Figure 5-2: Bass Strait Central Zone Scallop Fishery Management Area and 2019 Relative Fishing Intensity

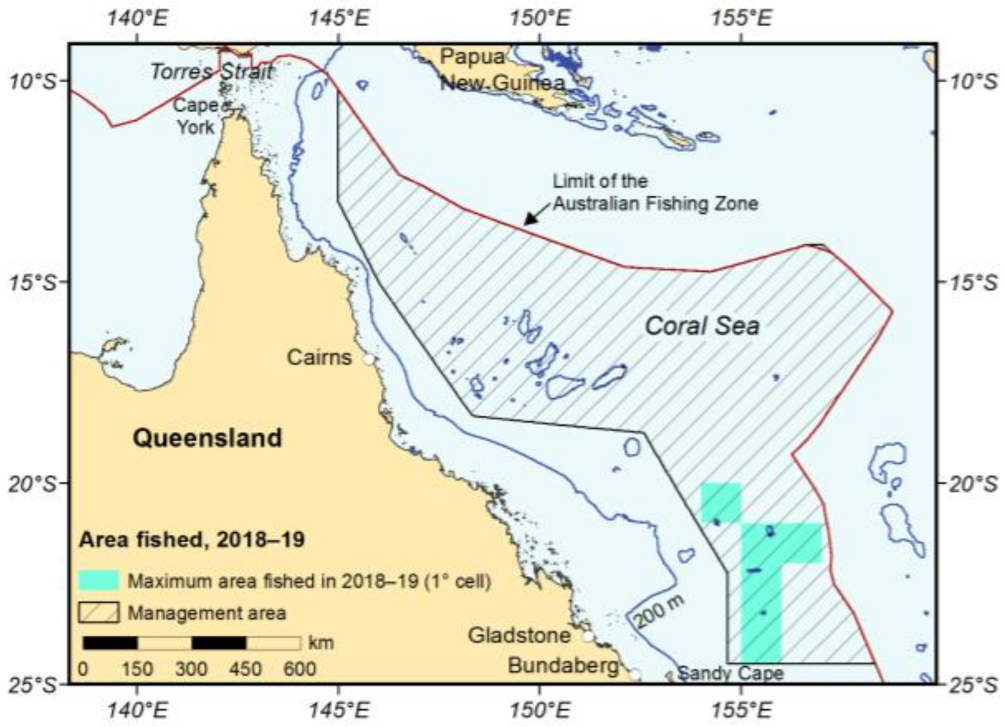
5.1.1.2 Coral Sea Fishery

The Coral Sea Fishery operates in Commonwealth waters extending from Sandy Cape to Cape York in Queensland (Figure 5-3). The Coral Sea Fishery is a multi-species fishery, with target species including:

- Black teatfish (Holothuria whitmaei)
- Prickly redfish (Thelenota ananas)
- Surf redfish (Actinapyga mauritiana)
- White teatfish (Actinapyga mauritiana)
- Other sea cucumber species (~ 11 species)
- Greenfish (Stichopus chloronotus)
- Lollyfish (Holothuria atra)
- Aquarium fishes (Osteichthyes sp.)
- Tropical rock lobster (Panulirus ornatus)
- Trochus (Trochus niloticus)

There is a 12 month fishing season, commencing 1 July. Primary landing ports are Bowen, Innisfail, Mooloolaba (Queensland). Fishing methods include hand collection (includes barbless hooks and line, scoop, cast and seine nets), with or without the use of breathing apparatus and line (demersal longline, dropline and trotline). Approximately 25.7 t of fish products (excluding the Aquarium Sector, where catch is recorded as the number of individuals) was taken in the Coral Sea Fishery during the 2018–19 season, representing a sizeable decrease from the 64.7 t taken in the 2017–18 season. All this catch was finfish.

During 2018-2018, fishing was concentrated in two areas offshore of southern Queensland (Figure 5-3). No commercial value of the fishery is publicly available (Patterson *et al.*, 2020).



Source: (Patterson *et al.*, 2020)

Figure 5-3: Coral Sea Fishery Management Area and 2018-2019 Relative Fishing Intensity

5.1.1.3 Norfolk Island Fishery

The Norfolk Island Fishery currently consists of an inshore recreational and charter-based line fishery. The catch is dominated by redthroat emperor (*Lethrinus miniatus*), known locally as 'trumpeter', but around 40 commercial species have been identified from the inshore fishery. Other important demersal species (or species groups) are cods and groupers (Serranidae), Queensland grouper (*Epinephelus lanceolatus*), yellowtail kingfish (*Seriola lalandi*) and snapper (*Chrysophrys auratus*). Important pelagic species include yellowfin tuna (*Thunnus albacares*), trevally (Pseudocaranx spp.) and skipjack tuna (*Katsuwonus pelamis*).

No stock assessments or biomass estimates for species taken within the inshore fisheries have been made. No stock status classifications have been given to this fishery, since there are no defined stocks for management purposes.

An offshore exploratory commercial trawl-and-line fishery operated between 2000 and 2003. Limited effort in the fishery during this period meant that the permit holders failed to meet the 50 days of fishing over 3 years required by the permit. Low catches of orange roughy (*Hoplostethus atlanticus*) and alfonsino (*Beryx splendens*) indicated that small stocks of these species could occur in the Australian Exclusive Economic Zone around Norfolk Island. Bass groper (*Polyprion americanus*), hapuku (*P. oxygeneios*) and blue-eye trevalla (*Hyperoglyphe antarctica*) dominated hook catches.

The offshore fishery is currently closed to commercial fishing. All permits for the fishery have expired, and no valid fishing concessions exist.

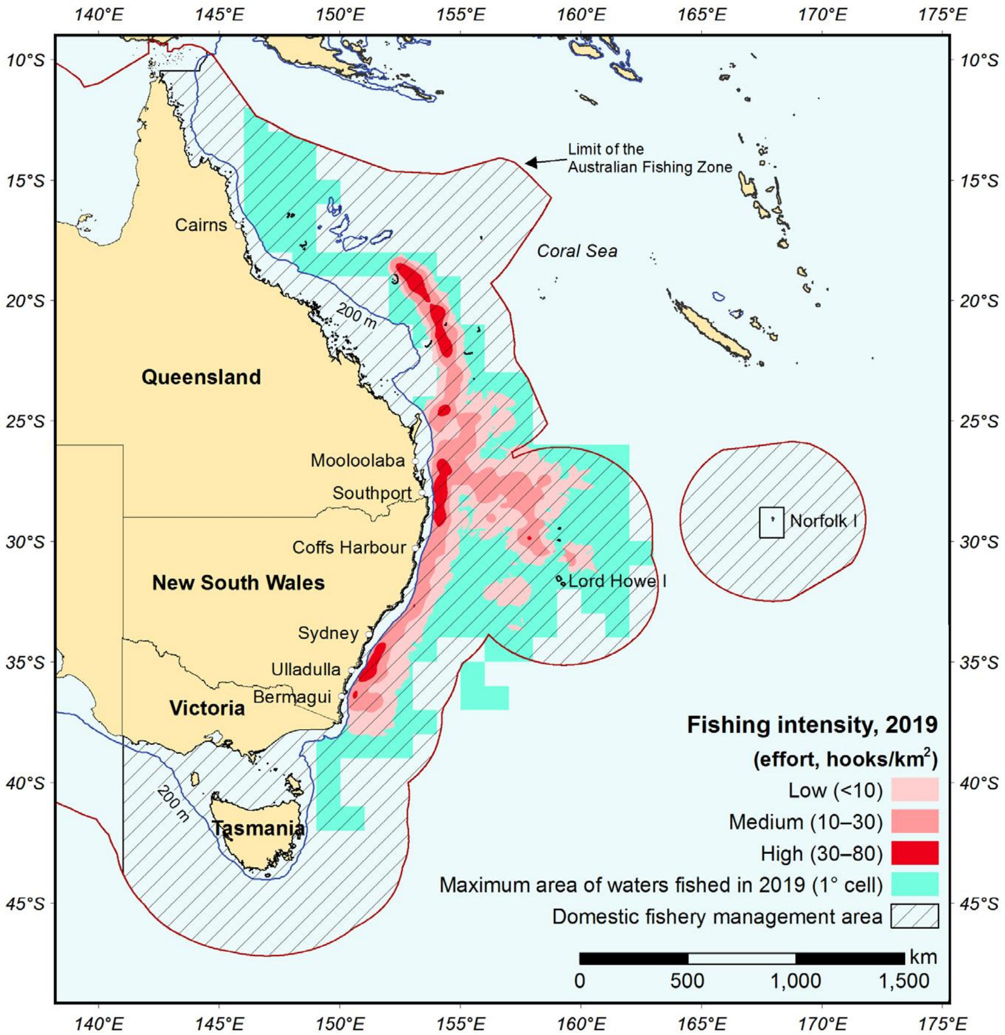
5.1.1.4 Eastern Tuna and Billfish Fishery

The Eastern Tuna and Billfish Fishery operates in Commonwealth waters from Cape York (Queensland) to the Victoria – South Australia border (Figure 5-4). It is a 12-month fishing season, commencing 1 March each year. Primary target species are:

- Albacore Tuna (*Thunnus alulunga*)
- Bigeye Tuna (*Thunnus obesus*)
- Yellowfin Tuna (*Thunnus albacares*)
- Broadbill Swordfish (*Xiphias gladius*)
- Striped Marlin (*Tetrapturus audux*)

Primary landing ports for the Eastern Tuna and Billfish Fishery are Bermagui, Coffs Harbour, Ulladulla (New South Wales), and Cairns, Mooloolaba, Southport (Queensland). Fishing methods include pelagic longline, and minor line (trolling, rod and reel, handline).

During 2017, fishing was concentrated offshore of New South Wales and southern/central Queensland coasts (Figure 5-4). The number of active vessels in the fishery have decreased over the last decade from approximately 150 in 2002 to 37 in 2019 (Patterson et al., 2020). The value of the fishery in 2019 was $32.1 million (Patterson *et al.*, 2020).



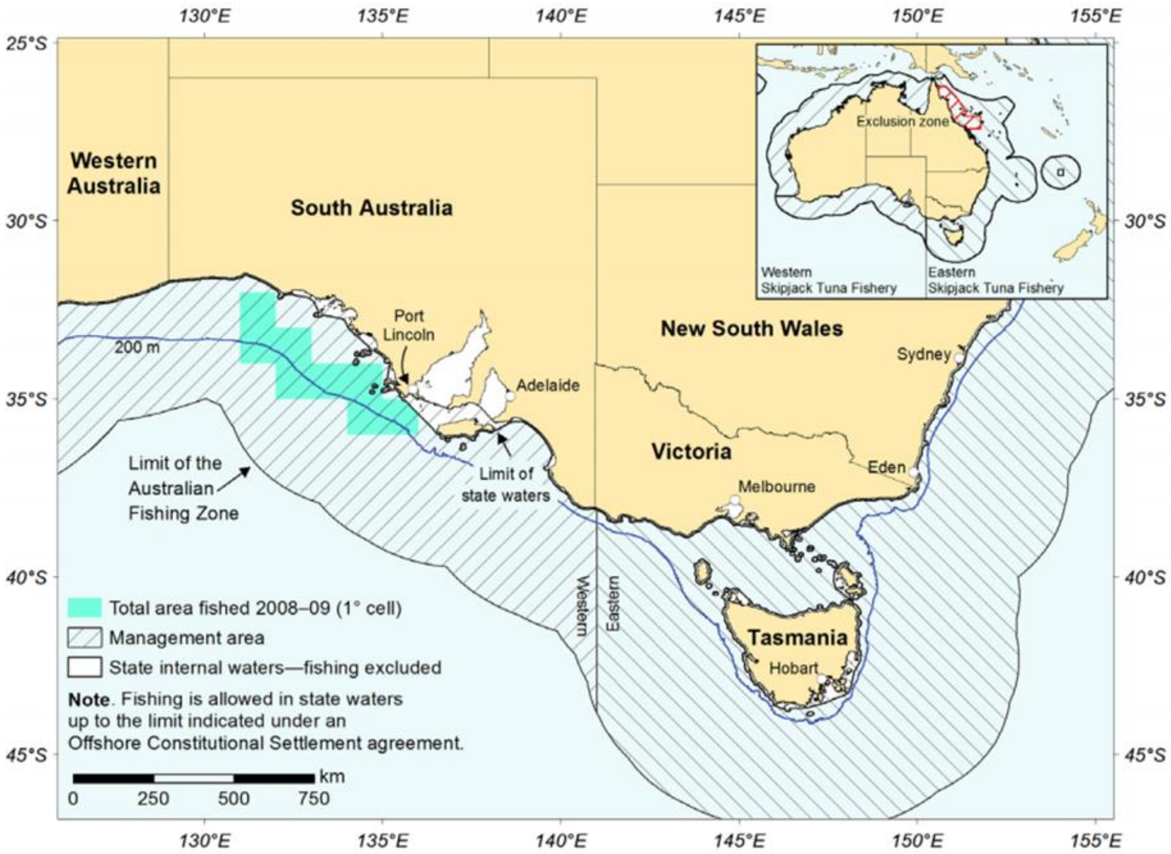
Source: (Patterson *et al.*, 2020)

Figure 5-4: Eastern Tuna and Billfish Fishery Management Area and 2019 Relative Fishing Intensity

5.1.1.5 Skipjack Tuna Fishery (Western)

There has been no fishing effort in the Skipjack Tuna Fishery since the 2008-2009 fishing season, due to availability of target species and prices received for the product. The management area for the STF covers the entire sea area around Australia to 200 nm offshore; and is split into two sub-fisheries: eastern and western (Figure 5-5).

The Skipjack Tuna Fishery would previously operate on a 12-month fishing season, commencing 1 February each year. Primary target species were Skipjack Tuna (*Katsuwonus pelamis*).



Source: (Patterson *et al.*, 2020)

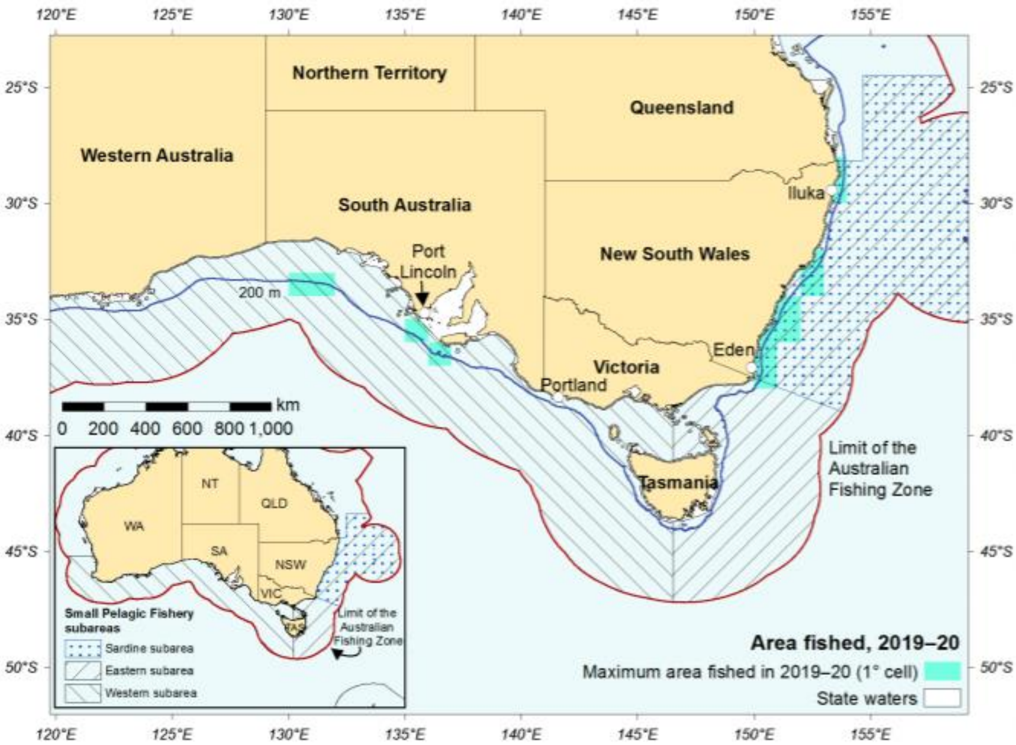
Figure 5-5: Skipjack Tuna Fishery Management Area, 2007–08 to 2018-19

5.1.1.6 Small Pelagic Fishery

The Small Pelagic Fishery operates in Commonwealth waters from southern Queensland to southern Western Australia (Figure 5-6). It is split into three subareas for management purposes. Most historical fishing efforts has occurred of the east and west coasts of Tasmania. It is a 12-month fishing season, commencing 1 May each year. Primary target species are:

- Australian sardine (*Sardinops sagax*)
- Blue mackerel (*Scomber australasicus*)
- Jack mackerel (*Trachurus declivis, T. murphyi*)
- Redbait (*Emmelichthys nitidus*)

Primary landing ports is Iluka, Ulladulla (New South Wales). Fishing methods include purse seine and midwater trawl; midwater trawl has been the main method since 2002. Until recently, minimal catch and effort in the small pelagic fishery have reflected a lack of markets and processing facilities. The operation of a factory freezer trawler in the 2014–15, 2015–16 and 2016–17 fishing seasons led to increased catches, reaching a peak of around 12,000 t in 2015–16. After the factory freezer trawler left the fishery during the 2016–17 season, total catch decreased. Since then, catch has increased to 16,094 t in 2019–20, due to increasing catches of eastern blue mackerel, eastern jack mackerel and eastern redbait. (Patterson et al., 2020)



Source: (Patterson *et al.*, 2020). (NB: Some effort data are not shown on this map for confidentiality reasons).

Figure 5-6: Small Pelagic Fishery Management Area and 2019-2020 Fishing Footprint

5.1.1.7 Southern and Eastern Scalefish and Shark Fishery

The Southern and Eastern Scalefish and Shark Fishery (SESSF) is a multisector, multigear and multispecies fishery, targeting a variety of fish, squid and shark stock (Figure 5-7). Primary target species include:

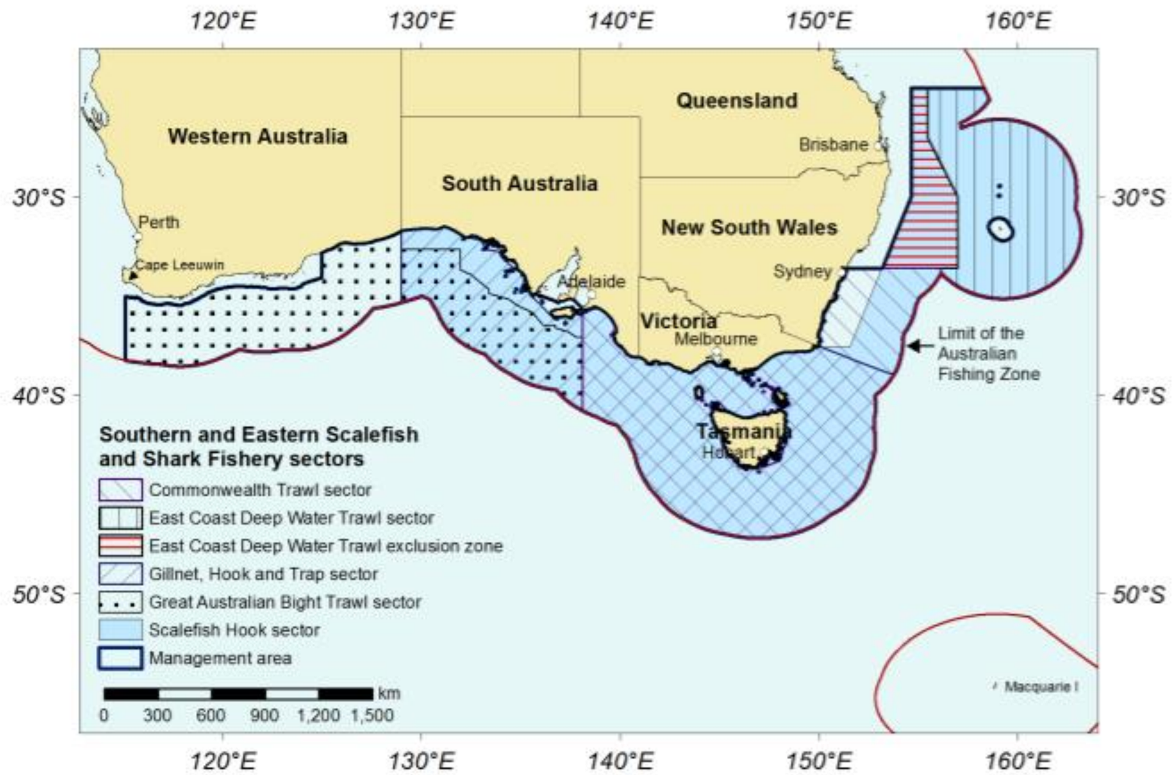
- Blue grenadier (Macruronus novaezelandiae)
- Tiger flathead (Neoplatycephalus richardsoni)
- Silver warehou (Seriolella punctata)
- Gummy shark (Mustelus antarcticus)
- Pink ling (Genypterus blacodes)

In 2018–19, the gross value of production (GVP) of the SESSF was $87 million, accounting for 20% of the GVP of Commonwealth fisheries. It is a 12-month fishing season, commencing 1 May each year. Primary ports include Eden (New South Wales), Lakes Entrance, Portland, Port Welshpool (Victoria), and Devonport and Hobart (Tasmania).

In the 2019–20 fishing season, total landings in the Commonwealth Trawl Sector (CTS), the Gillnet, Hook and Trap Sector (GHTS), the Great Australian Bight Trawl Sector (GABTS) and the East Coast Deepwater Trawl Sector (ECDTS) were 14,920.1 t, 2,707.0 t, 1,600.0 t and 7.8 t, respectively, for a total 19,234.8 t (Patterson *et al.*, 2020).

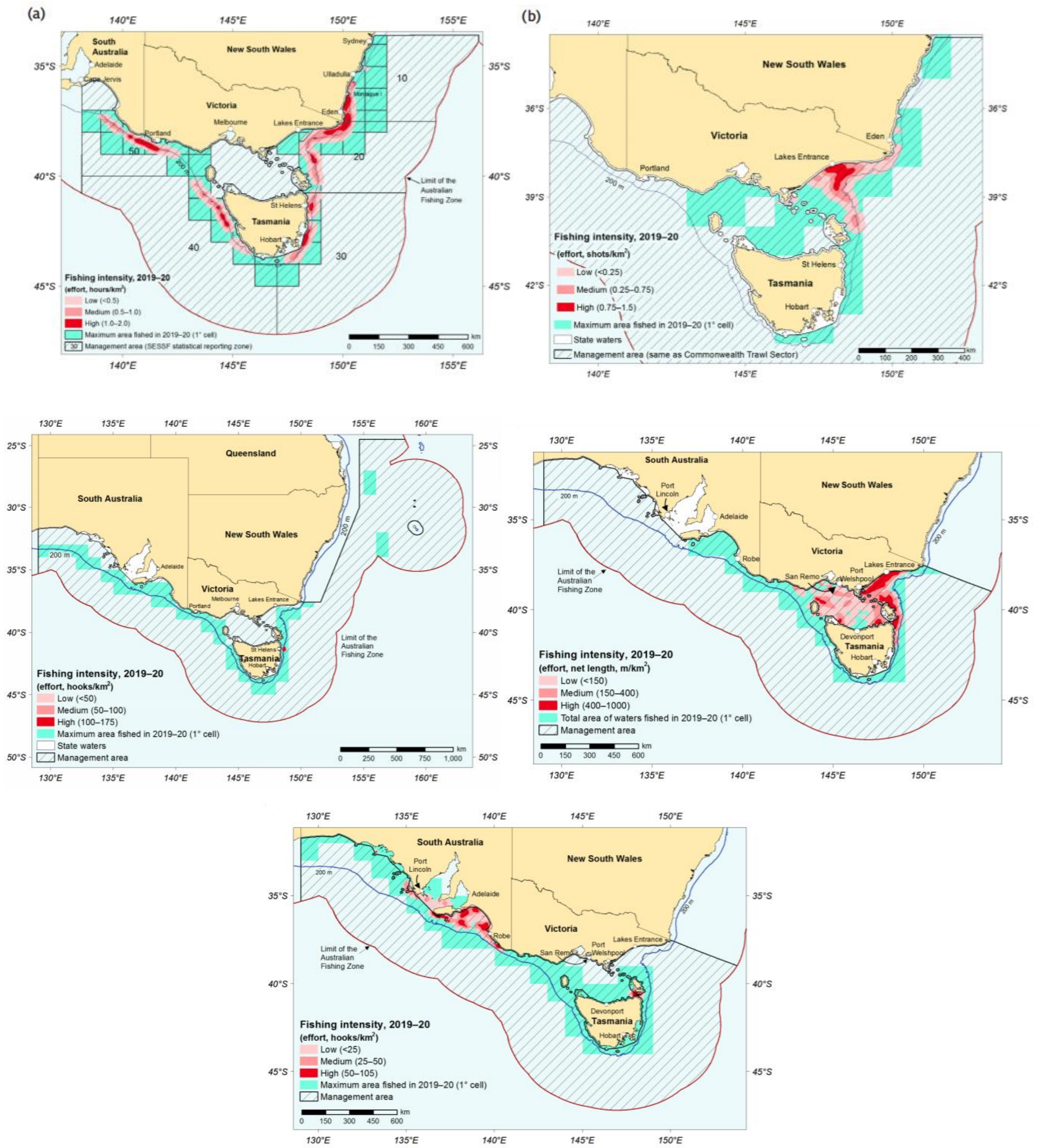
The Commonwealth Trawl Sector (CTS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) extends south from Fraser Island off Queensland to east of Kangaroo Island off South Australia. The Scalefish Hook Sector (SHS) is managed as part of the Gillnet, Hook and Trap Sector (GHTS) of the SESSF but is reported in this chapter because it shares many target species with the CTS. The SHS extends around south-eastern Australia to the border of South Australia and Western Australia. The CTS and the SHS contributed approximately 49% of total SESSF GVP ($86.85 million) in 2018–19. From 2008–09 to 2012–13, real GVP for the 2 sectors averaged $65.82 million (in 2018–19 dollars). By 2013–14, GVP had fallen, and has remained below $50 million since (Patterson *et al.*, 2020). A decline in catch has been observed in the Gillnet, Hook and Trap (GHaT) sectors (which includes the Shark Gillnet and Shark Hook sector, and the Scalefish Hook sector) since the mid-1980s (SETFIA, 2016).

The Shark Gillnet and Shark Hook sectors (SGSHS) of the Southern and Eastern Scalefish and Shark Fishery (SESSF) extend south from the New South Wales – Victoria border, around Tasmania, and west to the South Australia – Western Australia border. Most fishing occurs in waters adjacent to the coastline and throughout Bass Strait. The real gross value of production (GVP) in the SGSHS for the 4 shark species taken in the GHTS declined from a peak of $28.2 million in 2008–09 to $17.21 million in 2013–14 and then recovered to $23.66 million by 2018–19 (Patterson *et al.*, 2020).



Source: (Patterson *et al.*, 2020)

Figure 5-7: SESSF Management Area



Source: (Patterson *et al.*, 2020)

Figure 5-8: 2019-2020 Relative Fishing Intensity in the Commonwealth Trawl Sector for (a) otter board trawl and (b) Danish-seine, (c) Scalefish Hook Sector, (d) Shark Gillnet Sector, and (e) Shark Hook Sector

According to research undertaken by Boag and Koopman 2021, though multiple different fisheries have rights to fish around BMG, it is only the SESSF managed fisheries that actively fish around BMG; these are:

- SESSF Commonwealth Trawl sector (Otter trawl and Danish seine)
- SESSF Shark Gillnet and Shark Hook sectors
- SESSF Scalefish Hook sector

As reported by Boag and Koopman 2021, high levels of otter trawl effort and medium to low levels of Danish seine were reported around BMG during 2018‑2019. A total of 12 CTS Danish seine vessels fished within a 5 km radius of BMG from July 2010‑June 2020, undertaking 51 shots and landing 4.7 t of fish valued at about $30,000. The main species caught was flathead (81%). A total of 13 CTS otter trawl vessels fished within a 5 km radius of BMG from July 2010‑June 2020, undertaking 573 shots and landing 195 t of fish valued at about $1.09 million. Main species caught included flathead (27%), Pink Ling (19%) and Squids (9%).

Average annual catch of fish in the area (a 5km polygon surrounding BMG) equates to approximately $112,000. This is a very small amount of fish and value relative to the size of the SESSF fishery. The two largest SESSF sectors only rely on the area around BMG for only 0.26% and 0.01% of their annual catch from this area. The BMG polygon is probably as important as any other area of that size (relatively small) to the trawl fishery.

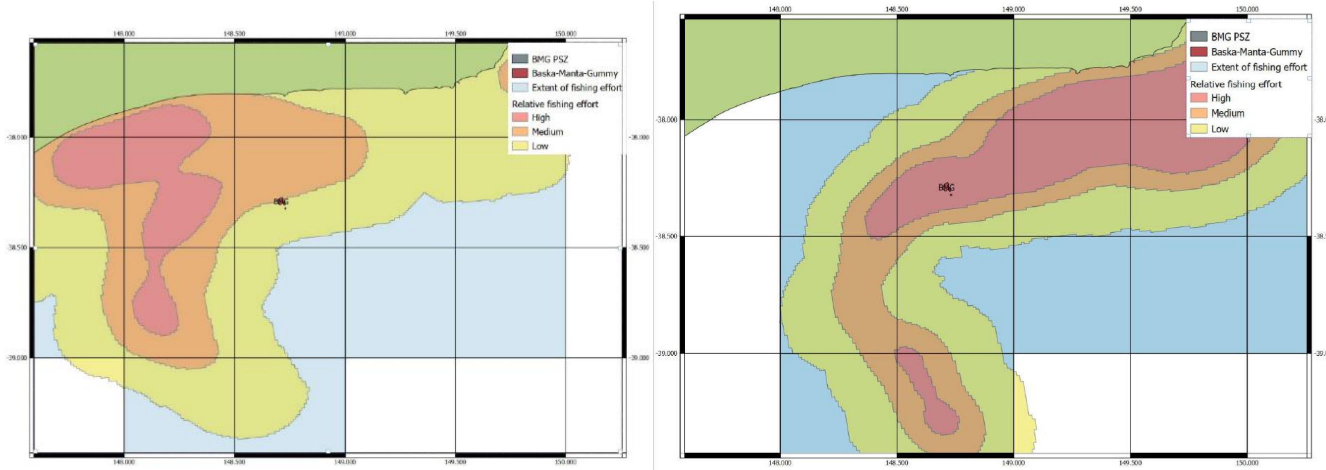
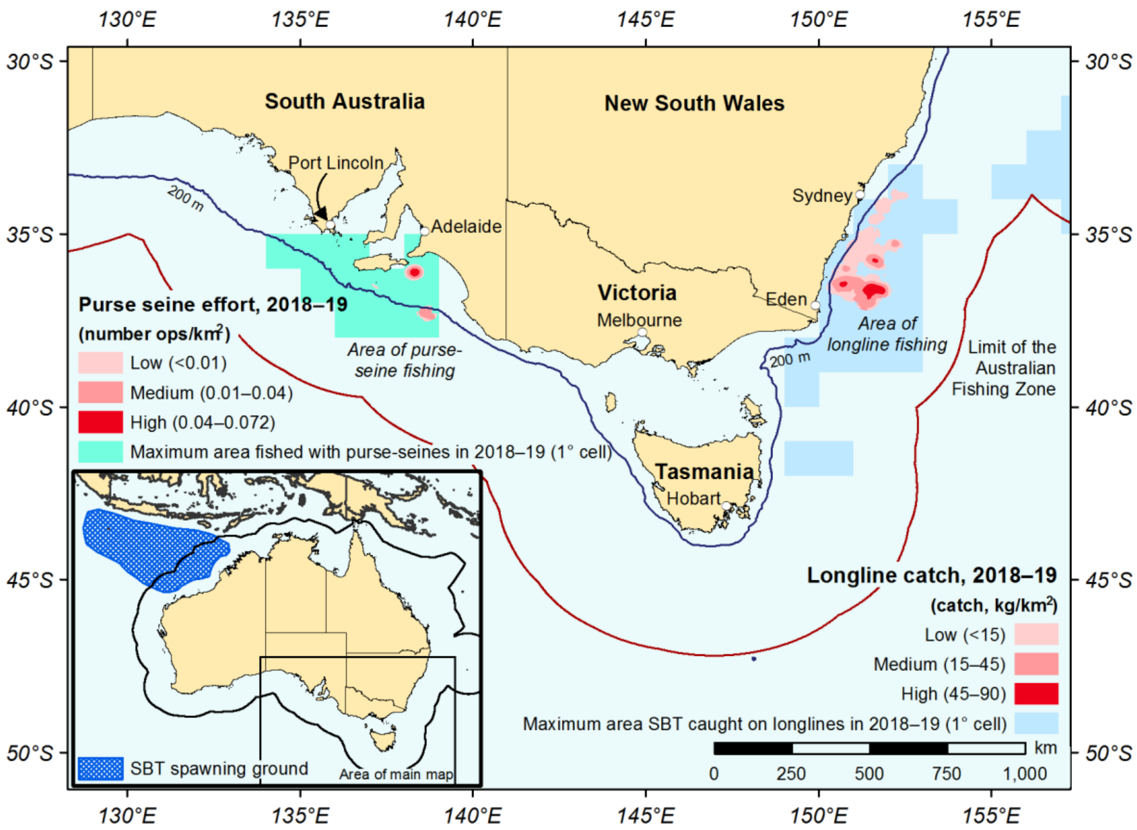


Figure 5-9 Relative fishing intensity and total area fished by the CTS relative to BMG (2018-2019). Left: Trawl Board Sector. Right: Danish Seine Sector. Boag and Koopman 2021.

5.1.1.8 Southern Bluefin Tuna Fishery

The Southern Bluefin Tuna Fishery operates within the Australian Fishing Zone. It is a 12-month fishing season, commencing 1 December each year. Primary target species is the Southern Bluefin Tuna (*Thunnus maccoyii*).

The majority of the catch is taken in the Great Australian Bight (i.e. outside of the Environment Sectors) by purse-seine vessels. Longline fishing is used off the east coast, and the number of vessels and fishing intensity is variable (Figure 5-10). The value of the fishery during 2018-19 financial year was $43.41 million (Patterson *et al.*, 2020).



Source: (Patterson *et al.*, 2020)

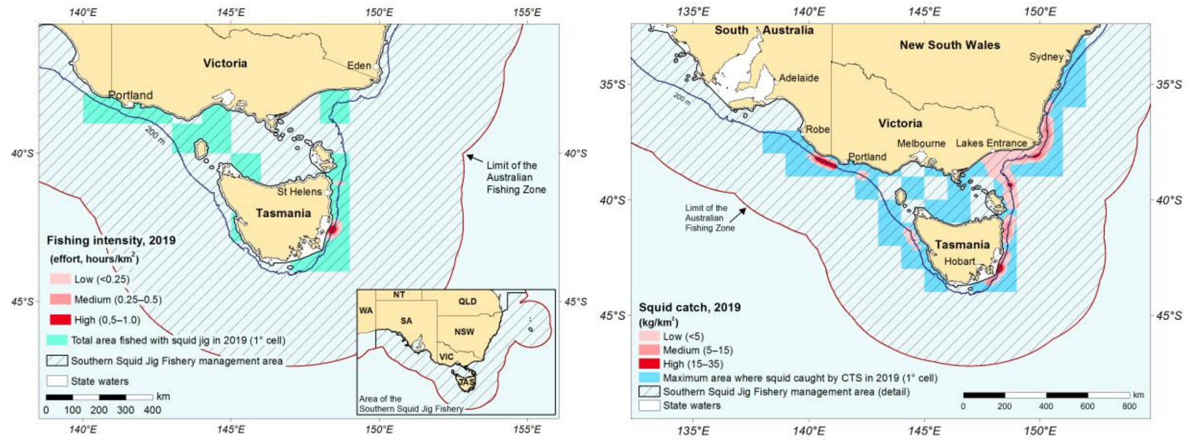
Figure 5-10: Purse-seine effort and longline catch in the Southern Bluefin Tuna Fishery, 2018–19 fishing season

5.1.1.9 Southern Squid Jig Fishery

The Southern Squid Jig Fishery is located in waters off New South Wales, Victoria, Tasmania and South Australia, and in a small area off southern Queensland. The Southern Squid Jig Fishery is a single-method (jigging) fishery, primarily targeting the Gould's squid (*Nototodarus gould*) (SETFIA, 2016). Vessels typically operate at night in continental shelf waters between 60–120 m water depth. Squid are also caught in the Commonwealth Trawl Sector and GAB Trawl Sector of the Southern and Eastern Scalefish and Shark Fishery.

Gould's Squid is a short-lived species that is characterised by highly variable recruitment from year to year, resulting in a "boom and bust" fishery (SETFIA, 2016).

It has a 12-month fishing season, commencing 1 January each year. Most direct fishing effort occurs off Lakes Entrance (Victoria) (Figure 5-11(a)), however in recent years a greater catch has come from the Trawl Sectors (Figure 5-11(b)). The value of the Southern Squid Jig Fishery during the 2018-19 financial year is $2.89 million (Patterson *et al*., 2020).



Source: (Patterson *et al.*, 2020)

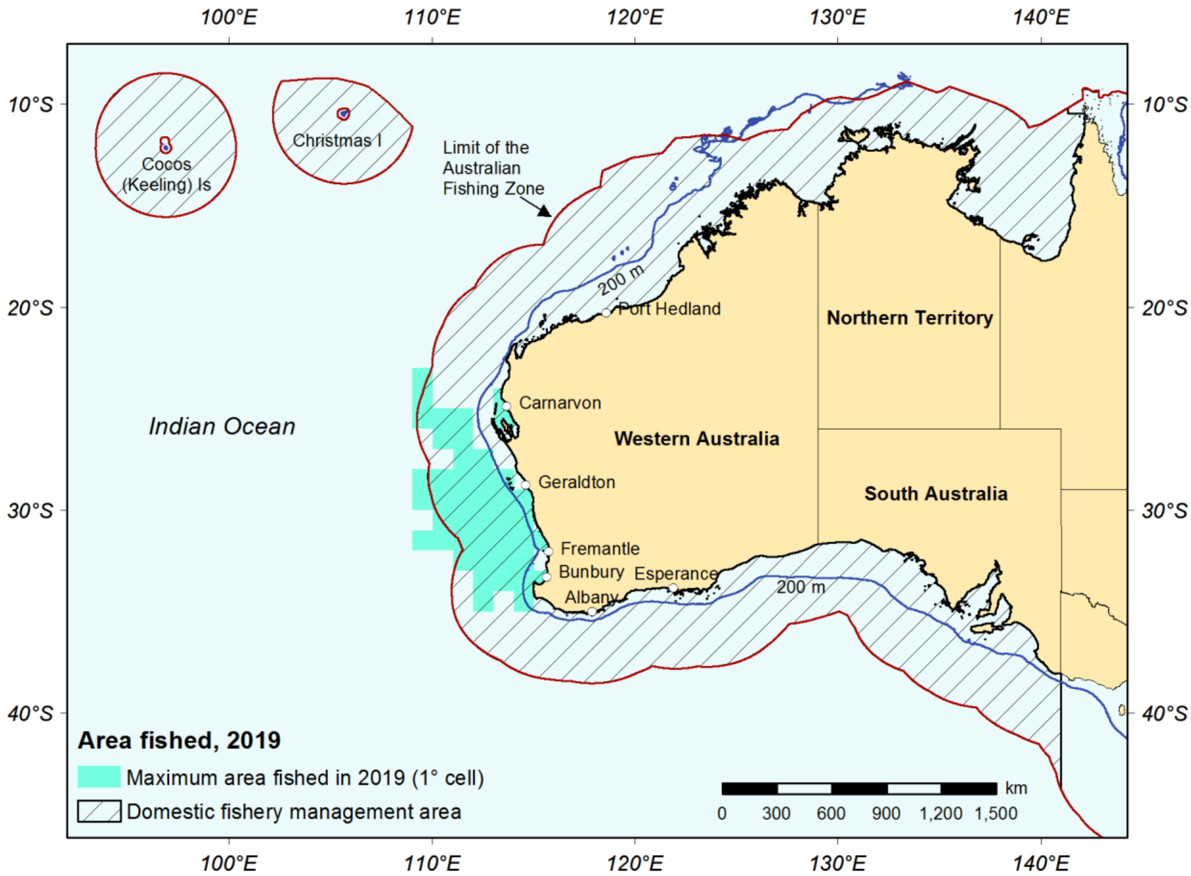
Figure 5-11: (a) Fishing intensity in the Southern Squid Jig Fishery and (b) Commonwealth Trawl Sector squid catch, 2019

5.1.1.10 Western Tuna and Billfish Fishery

The Western Tuna and Billfish Fishery operates in waters extending west from the South Australia – Victoria border (Figure 5-12). It has a 12-month season, commencing 1 February each year. Primary target species include:

- Bigeye tuna (*Thunnus obesus*)
- Yellowfin tuna (*Thunnus albacares*)
- Broadbill swordfish (*Xiphias gladius*)
- Striped marlin (*Tetrapturus audux*)

Fishing methods in the Western Tuna and Billfish Fishery are predominantly pelagic longline, with some minor-line fishing. In recent years, effort has concentrated off south-west Western Australia (Figure 5-12). Since 2005, fewer than five vessels have been active in the fishery each year (Patterson *et al.*, 2020). Commercial value of the fishery is confidential (Patterson *et al.*, 2020).



Source: (Patterson *et al.*, 2020)

Figure 5-12: Western Tuna and Billfish Fishery Management Area and 2019 Fishing Area

5.1.2 State-managed Fisheries

The Offshore Constitutional Settlement (OCS) allows for individual fisheries to be managed under relevant State government, with fishing areas extending into both Commonwealth and State waters. In terms of state management, Tasmanian fisheries are managed under the Living Marine Resources Management Act 1995; in South Australia under the Fisheries Management Act 2007; in Victoria under the Fisheries Act 1995; in New South Wales under the Fisheries Management Act 1994, and in Queensland under the Fisheries Act 1994.

There are 35 state-managed commercial fisheries occurring within the Environment Sectors (Table 5.2).

Table 5.2: State-managed Commercial Fisheries within the Environment Sectors

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
South Australia (PIIRSA 2021)												
Abalone Fishery	The commercial sector of the South Australian Abalone Fishery has been managed as three separate fishery management zones known as the Southern, Central and Western Zone Abalone fisheries (Figure 5-13(a)). Within these fishery management zones, there are some aquatic reserves, which have prohibitions and restrictions on what species can be taken, including abalone.	Yes	• Greenlip Abalone (*Haliotis laevigate*) • Blacklip Abalone (*Haliotis rubra*)	✓								
Blue crab fishery	The blue crab fishery takes blue swimmer crabs. Other species may be landed and sold as by-products or used as personal bait. The blue crab fishery uses crab pots and bait nets. Most of the South Australian commercial catch is sold to Sydney and Melbourne markets.	No	• Blue swimmer crab (*Portunus armatus*)	✓								
Charter Boat Fishery	The South Australian Charter Boat Fishery is a commercial platform for recreational fishing activities; as such, all catch from the fishery is regarded as recreational catch. The charter boat fishery is managed through a licensing and registration system. The Charter Boat Fishery operates within South Australian marine waters, from the Western Australian border to the Victorian border. The South Australian marine waters are divided into marine fishing areas, which are used to distinguish harvest locations and enable spatial research and management of the fishery: West Coast; Spencer Gulf / Coffin Bay; Gulf St. Vincent / Kangaroo Island; Victor Harbor / South East; Other (offshore areas). The fishery is generally managed at a	No	Primary Species: • Snapper (*Pagrus auratus*) • King George Whiting (*Sillaginodes punctatus*) Other Species: • Western Australian Salmon (*Arripis truttacea*) • Bight Redfish (*Centroberyx gerrardi*) • Snook (*Sphyraena novaehollandiae*)	✓								

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	whole-of-state level with size and catch limits in place for individual species, although there are some specific management arrangements that apply to particular regions of the fishery.		• Yellowtail Kingfish (*Seriola lalandi*) • Samsonfish (*Seriola hippos*)									
Marine Scalefish Fishery	The commercial Marine Scalefish Fishery is a multi-species and multi-gear fishery. There are over 60 species of marine scalefish taken commercially. The Marine Scalefish Fishery operates in all coastal waters of South Australia between the Western Australian and Victorian border; however, for some species the OCS extends the fishery area out to 200 nm (Figure 5-13(b)). The fishing area includes gulfs, bays and estuaries (excluding the Coorong).	Yes (only for some species)	Primary Species: • King George Whiting (*Sillaginodes punctata*) • Southern Garfish (*Hyporhamphus melanochir*) • Snapper (*Pagrus auratus*) • Southern Calamari (*Sepioteuthis australis*) Other Species: • Vongole spp. • Australian Herring • Western Australian Salmon • Yellowfin Whiting • Shark spp.	✓								
Miscellaneous Fishery	The Miscellaneous fishery includes: • species that are not in management arrangements of existing commercial fisheries • specialised fisheries • multiple types of fishing gear. Many of the fisheries included are low production, low value, or both. Biological information on most of the miscellaneous species is limited.	No	• Sea urchins • Scallop • Native oyster • Giant crab • Western Australian salmon • Beachcast seagrass and macro-algae • Eyre golden perch • Welch's grunter • Barcoo grunter	✓								

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Rock Lobster Fishery	The South Australian Rock Lobster fishery is based on the capture of Southern Rock Lobster, however other species (including giant crabs and octopus) are permitted to be landed and sold. The Rock Lobster fishery is separated into a Southern Zone and Northern Zone (Figure 5-13(c)).	Yes	• Southern Rock Lobster (*Jasus edwardsii*)	✓								
Sardine Fishery	The Sardine Fishery is a component of the Marine Scalefish Fishery; access to the sardine fishery is provided through a licence for the Marine Scalefish Fishery with a sardine net endorsement. The area of the fishery includes all South Australian waters out to the 200 nautical mile Australian Exclusive Economic Zone.	Yes	• Australian Sardine (*Sardinops sagax*) • Australian Anchovy (*Engraulis australis*)	✓								
Victoria (Victorian Fisheries Authority 2021)												
Abalone Fishery	Abalone are caught along the majority of the Victorian coastline. Abalone diving activity typically occurs close to the shoreline (generally up to water depths of 30 m). The fishery is quota managed, with a total allowable commercial catch set annually based on the outcomes of a stock assessment process. There are three (Western, Central and Eastern) management zones (Figure 5-14(a)).	Yes	• Greenlip Abalone (*Haliotis laevigate*) • Blacklip Abalone (*Haliotis rubra*)	✓	✓	✓						
Sea Urchin	Sea urchins inhabit coastal subtidal reefs in 6-10m of water although *Heliocidaris erythrogramma* has been reported at water deptsh between 10-40m in the coastal waters of NSW. The Sea Urchin Fishery occurs in waters adjacent to Victoria (State coastal waters only, with exclusions). The commercial fishery is managed spatially on the basis of four separate management zones: the Eastern Zone	No	• White sea urchin (*Heliocidaris erythrogramma*) • Black, long-spined sea urchin (*Centrostephanus rodgersii*)	✓	✓	✓						

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	(EZ), Port Phillip Bay Zone (PPBZ), Central Zone (CZ) and Western Zone (WZ). Fishing season is open all year and the fishery is managed under a conservative Total Allowable Commercial Catch and divers may only collect sea urchin by hand.											
Eel Fishery	Eel are harvested in Victorian coastal river basins south of the Great Dividing Range. Short-finned eels are found across the State, while long-finned eels are only found in eastern Victoria (Figure 5-14(b)).	No	• Short-finned eel (*Anguilla australis*) • Long-finned eel (*Anguilla reinhardtii*)	✓	✓	✓						
Giant Crab Fishery	The commercial fishery has two management zones, the Western Zone and Eastern Zone, a division which reflects the zonal boundaries of the rock lobster fishery (Figure 5-14(c)). The fishery is based in the Western Zone; at the time of writing there was no giant crab fishing in the Eastern Zone. Giant crabs inhabit the continental slope at approximately 200 m depth and are most abundant along the narrow band of the shelf edge.	Yes	• Giant crab (*Pseudocarcinus gigas*)	✓								
Pipi Fishery	Pipi is the common name given to the small bivalve which is found on high-energy sandy beaches in the intertidal zone. The fishery covers the entire Victorian coastline, with the exception of Port Phillip Bay and Marine National Parks where shellfish cannot be harvested in the intertidal region. However, the fishery is only currently open at Discovery Bay (targeted primarily by commercial fishers) and Venus Bay (primarily a recreational fishery) (Figure 5-14(d)). Most of the Pipi harvest to date has been taken under Ocean Fishery Access Licences.	No	• Pipi (*Donax deltoids*)	✓	✓							

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Rock Lobster Fishery	The Rock Lobster fishery expands the length of the Victorian coast. The fishery is divided into two separately managed zones: Eastern and Western (Figure 5-14(e)). The Eastern Zone extends west from the New South Wales border to Apollo Bay; the Western Zone extends from Apollo Bay west to the border with South Australia. The main ports in the Eastern Zone are Queenscliff, San Remo and Lakes Entrance. In the Western Zone, most catch is landed through Portland, Port Fairy, Warrnambool, Port Campbell and Apollo Bay. Southern Rock Lobsters are found to depths of 150 m, with most of the catch coming from inshore waters less than 100 m deep.	Yes	• Southern rock lobster (*Jasus edwardsii*)	✓	✓	✓						
Scallop Fishery	The Victorian Scallop Fishery is one of three scallop zones in the Bass Strait and extends out from the coastline to 20 nm (Figure 5-14(f)). Historically, the majority of the fishing activity in the Victorian zone has occurred in the eastern waters of the State, with most vessels launching from the ports of Lakes Entrance and Welshpool.	Yes	Primary: • Commercial scallop (*Pecten fumatus*) Other: • Doughboy scallop (*Chlamys asperrimus*)	✓	✓	✓						
Wrasse Fishery	The commercial fishery extends along the entire length of the Victorian coastline and out to 20 nm offshore, except for marine parks. Most wrasse is harvested by hook and line although commercial rock lobster fishers who also hold a commercial wrasse licences can keep those fish that they catch in their rock lobster pots.	Yes	Primary targets: • Bluethroat Wrasse (*Notolabrus tetricus*) • Purple Wrasse (*N. fucicola*) Other: • Rosy Wrasse (*Pseudolabrus psittaculus*) • Senator Wrasse (*Pictilabrus laticlavius*)	✓	✓	✓						

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
			• Southern Maori Wrasse (*Ophthalmolepis lineolatus*)									
Bays and Inlet Fisheries	Victorian bay, inlet and estuarine finfish fisheries are multi-species, multi-method fisheries. The fishery area includes Western Port, Port Phillip Bay, Corner Inlet/Nooramunga and the Gippsland Lakes.	No	Multiple species	✓		✓						
Tasmania (DPIPWE 2021)												
Abalone Fishery	The Tasmanian wild abalone industry is a major contributor to the Tasmanian economy; and is the largest wild abalone fishery in the world, providing approximately 25% of the annual harvest. The fishery is managed as zones: eastern blacklip; western blacklip; central western blacklip; northern blacklip; Bass Strait blacklip; and greenlip.	Yes	• Greenlip Abalone (*Haliotis laevigate*) • Blacklip Abalone (*Haliotis rubra*)		✓		✓	✓				
Commercial Dive Fishery	A number of different species are collected by the Commercial Dive Fishery. The Commercial Dive Fishery is divided into five zones: south eastern, central eastern, north eastern, northern and western.	Yes	Primary targets: • Sea Urchin (*Heliocidaris erythrogramma*) • Periwinkles Other: • Pacific Oyster • Wakame (*Undaria pinnatifida*) • Whelks		✓		✓	✓				
Giant Crab Fishery	A comparatively small fishery but is of relatively high value. The fishery has been commercially targeted since the early 1990's, changing from being open access to	Yes	• Giant crab (*Pseudocarcinus gigas*)		✓		✓	✓				

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	limited entry and is now managed by individual transferable quota.											
Rock Lobster Fishery	The rock lobster fishery is a major Tasmanian industry providing significant benefits from exports from the commercial fishery. The rock lobster lives in a variety of habitats ranging from shallow rocky inshore pools out to the continental shelf. The fishery has two catch areas with individual cap limits; east coast catch cap and north east catch cap. Season opening varies for male and females; females 1 May, Male 1 September for waters south of St Helens Pt to Sandy Cape and 1 October for all other State waters.	Yes	• Southern Rock Lobster (*Jasus edwardsii*)		✓		✓	✓				
Scalefish Fishery	The Tasmanian Scalefish Fishery is a multi-species and multi-gear fishery that is predominantly made up of small owner operated commercial businesses and a large and diverse recreational fishery.	No	Some of the species commercially targeted include: • Banded Morwong • Southern Calamari • Octopus • Tiger Flathead • School Whiting • Southern Garfish • Wrasse • Gould's Squid • Bastard Trumpeter • Blue Warehou • Silver Warehou • Flounder • Silver Trevally • Striped Ttrumpeter.		✓		✓	✓				
Scallop Fishery	The fishery is managed under the provisions of the Living Marine Resources Management Act 1995 and Fisheries (Scallop) Rules 2011. It is primarily based on	No	Primary: • Commercial scallop (*Pecten fumatus*)		✓		✓	✓				

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	the harvest of the commercial scallop. Although commercial fishers can legally take the doughboy scallop and the queen scallop; these species have only minor commercial significance in Tasmania.		Other: • Doughboy scallop (*Chlamys asperrimus*) • Queen scallop (*Aequipecten opercularis*)									
Seaweed Fishery	The main components of this fishery are the collection of cast bull kelp and harvesting of the introduced seaweed, Undaria. In addition, there are several minor components, including a single operation harvesting red and brown seaweeds and several small operations collecting cast seaweed from specific beaches around the State.	No	• Bull Kelp • Undaria		✓		✓	✓				
Shellfish Fishery	The commercial shellfish fishery includes clams in Georges Bay (two licences), cockles in Ansons Bay (3 licences), native oysters in Georges Bay (two licences), and wild Pacific oysters (no licence cap).	No	• Katelysia cockles • Venerupis clams • Native oysters • Wild Pacific oysters		✓		✓	✓				
New South Wales (DPI 2021)												
Abolone Fishery	The blacklip abalone forms the basis of the abalone fishery in NSW. Abalone are commercially harvested from rocky reefs by divers typically using surface-supplied air or scuba. In practice, most commercial abalone fishing takes place on the south coast of NSW, primarily from Jervis Bay to the Victorian border, with most abalone found close to the shore. New size limits and endorsement conditions in force from 10 July 2018.	No	• Blacklip abalone (*Haliotis rubra*)			✓			✓	✓		
Estuary General Fishery	The Estuary General Fishery is a diverse multi-species multi-method fishery that may operate in 76 of the NSW's estuarine systems. This fishery is a significant contributor	No	Catch includes: • Sea Mullet (*Mugil cephalus*)			✓			✓	✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	to regional and state economies providing high quality seafood and bait to the community. On average, the 10 species that make up over 80% of landings by weight are sea mullet (40%), luderick (8%), yellowfin bream (8%), school prawn (5%), blue swimmer crab (4%), dusky flathead (4%), sand whiting (3%), pipi (3%), mud crab (3%) and silver biddy (2%).		• Luderick (*Girella tricuspidata*) • Yellowfin bream (*Acanthopagrus australis*) • School Prawn (*Metapenaeus macleayi*) • Blue Swimmer Crab (*Portunus pelagicus*) • Dusky Flathead (*Platycephalus fuscus*) • Sand Whiting (*Sillago ciliata*) • Pipi (*Donax deltoides*) • Mud Crab (*Scylla serrata*) • Silver Biddy (*Gerres subfasciatus*)									
Estuary Prawn Trawl Fishery	The fishery uses otter trawl nets in three estuaries in NSW, (the Clarence, Hawkesbury and Hunter Rivers). With the exception of the Hawkesbury River, the fishery operates for defined seasons (generally October to May) and within each estuary is confined to specific times and areas. The majority of prawn catches are landed during the 'dark' of the moon (between the last and first quarter), on either run out or 'slack' tides.	No	• School Prawns • Eastern King Prawns						✓	✓		
Lobster Fishery	The NSW Lobster Fishery is small but valuable. The Fishery extends from the Queensland border to the Victorian border and includes all waters under jurisdiction of NSW to around 80 miles from the coast.	Yes	Primary: • Eastern rock lobster (*Sagmaraisus verreauxi*) Other catch:			✓			✓	✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	It is characterised by inshore and offshore sectors. Inshore fishers use small beehive or square traps in waters up to 10 metres in depth, whilst offshore fishers use large rectangular traps.		• Southern Rock Lobster (*Jasus edwardsii*) • Tropical Rock Lobster (*Panulirus longipes* and *P. ornatus*).									
Ocean Hauling Fishery	The Ocean Hauling Fishery is broken up into seven regions along the NSW coast and targets approximately 20 finfish species using commercial hauling and purse seine nets from sea beaches and in ocean waters within 3 nautical miles of the coast.	No	Catch includes: • Pilchards (*Sardinops sagax*) • Sea Mullet (*Mugil cephalus*) • Australian Salmon (*Arripis trutta*) • Blue Mackerel (*Scomber australasicus*) • Yellowtail Scad (*Trachurus novaezelandiae*) • Yellowfin Bream (*Acanthopagrus australis*)			✓			✓	✓		
Ocean Trap & Line Fishery	The Ocean Trap and Line fishery is a multi-method, multi species fishery targeting demersal and pelagic fish along the entire NSW coast, in continental shelf and slope waters. The Ocean Trap and Line Fishery is a share management fishery. This means that commercial fishers must hold sufficient shares to be eligible for an endorsement to operate in the fishery. An endorsement authorises the use of specific gear to take fish for sale from certain waters. There are six types of Ocean Trap and Line endorsements in NSW; line fishing western	Yes	Primary catch: • Snapper • Yellowtail kingfish • Leatherjackets • Bonito • Silver trevally Other: • Rubberlip (grey) Morwong • Blue-eye Trevalla • Sharks • Bar Cod			✓			✓	✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	zone, line fishing eastern zone, demersal fish trap, school and gummy shark, spanner crab northern zone and spanner crab southern zone.		• Yellowfin Bream • Spanner Crabs									
Ocean Trawl Fishery	There are two sectors to the Ocean Trawl Fishery: the prawn trawl sector and the fish trawl sector. Both sectors use otter trawl nets. The fishery is a share management fishery; meaning commercial fishers must hold sufficient shares to be eligible for an endorsement to operate in the fishery. An endorsement authorises the use of specific gear to take fish for sale from certain waters. Many of the fishers endorsed for fish trawling are also endorsed for prawn trawling.	Yes	Primary catch: • School whiting (comprising of stout whiting and red spot whiting) • Eastern King, School and Royal Red prawns • Tiger Flathead • Silver Trevally • Various species of sharks and rays, squid, octopus and bugs			✓			✓	✓		
Sea Urchin & Turban Shell Restricted Fishery	The NSW Sea Urchin and Turban Shell restricted fishery is relatively small with few divers participating. The main constraint on development is high processing costs and limited domestic markets. Fishing for sea urchins is generally constrained to that part of the year when the roe is well developed. A number of the fishing sub-regions have been closed to commercial fishing since 1994.	No	• Sea Urchin • Turban Shell			✓			✓	✓		
Queensland (Queensland Government 2021)												
Crab Fisheries	There are three fisheries (mud crab, blue swimmer crab, and spanner crab) that operated within the Queensland Crab Fishery. The fishery operates throughout the state's coastal waters, including the Gulf of Carpentaria, except for areas that are closed to fishing in general or to crabbing in particular. Fishing methods include wire-mesh or trawl-mesh crab pots, and dillies.	Yes	• Mud Crab • Blue Swimmer Crab • Spanner Crab							✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Eel Fisheries	The commercial eel fishery has two components: adults and juveniles. A commercial harvest fishery licence authorises fishers for both the adult and juvenile components. Commercial capture/harvest of adult eels is only permitted using baited eel traps or round traps.	Yes	• Long-finned eel (*Anguilla reinhardtii*) • Short-finned eel (*Anguilla australis*).							✓		
Harvest Fisheries	The Harvest Fishery includes the following individually managed fisheries: sea cucumber, marine aquarium fish, coral, trochus, tropical rock lobster, and minor harvest. These fisheries are characterised by their harvesting method, which is primarily by hand or by using hand-held implements. Commercial harvesting methods often involve the use of underwater breathing apparatus, such as scuba or hookah. On a smaller scale, commercial harvest fisheries exist in Queensland for: • beachworms, bloodworms and yabbies (i.e. the 'bait fisheries') • shells, shell grit and star sand • pearl shells • wild-caught oysters.	Yes	Sea Cucumber: • Blackfish (*Actinopyga palauensis*) • Burrowing Blackfish (*Actinopyga spinea*) • Sandfish (*Holothuria scabra*) • White Teatfish (*Holothuria fuscogilva*) Prickly Redfish (*Thelenota ananas*) Marine Aquarium: • Damselfish (family Pomacentridae) • Butterflyfish and Bannerfish (family Chaetodontidae) • Angelfish (family Pomacanthidae) • Wrasses (family Labridae) • Surgeonfish (family Acanthuridae) • Gobies (family Gobiidae) Coral:							✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
			• Live corals, such as Euphyllidae, Zoanthida, Corallimorpharia and Fungidae families • Sea Anemones • Oornamental (non-living) corals, such as Acroporidae and Pocilloporidae families • Live rock (dead coral skeletons with algae and other organisms living on them) • Coral rubble (coarsely broken up coral fragments) • Coral sand (finely ground-up particles of coral skeleton) Trochus: • Giant Top Shell (*Trochus niloticus*) Tropical Rock Lobster: • Tropical Spiny Rock Lobster (*Panulirus ornatus*) Minor Harvest: • Bait fisheries, such as beachworms, bloodworms and yabbies • Marine specimen shells • Pearl shells									

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
			• Wild-caught oysters									
Line Fishing	Line fishing is one of Queensland's main forms of commercial fishing, producing approximately 2200 t of product, valued at about $34.5 million a year. There are five line fisheries: • Coral Reef Fin Fish Fishery • Rocky Reef Fin Fish Fishery • Pelagic Fishery • Gulf of Carpentaria Fin Fish Fishery • Deepwater Multiple-Hook Fishery. The line fisheries operate in specified tidal waters out to the Queensland OCS boundary. All five fisheries use fishing lines, with a restriction on the number of lines and hooks that can be used. Boats used range from fleets with sophisticated equipment to small dinghies.	Yes	Primary catch: • Coral Trout • Spanish Mackerel • Red-throat Emperor Other catch: • Snapper • Jobfish • Red Emperor • Nannygai • Trevally • Spotted Mackerel							✓		
Net Fisheries	Net fishing is one of Queensland's main forms of commercial fishing, producing approximately 6670 t of product valued at about $31.9 million each year. There are two commercial net fisheries: • Gulf of Carpentaria Inshore Fin Fish Fishery • East Coast Inshore Fin Fish Fishery The net fisheries are multi-species fisheries, with fishers targeting different species at different times of the year. The net fisheries operate along the entire Queensland coastline as far out as the Queensland OCS boundary.	Yes	East Coast Inshore Fin Fish Fishery (southern): • Mullet • Tailor • Whiting • Flathead • Bream • Mulloway • School Mackerel							✓		
Trawl Fishery	The trawl fishery is Queensland's largest commercial fisheries, producing up to 7800 t of product worth about $99 million each year. It has four main trawl fisheries: • East Coast Otter Trawl Fishery	Yes	Primary catch: • Prawns (Tiger Prawn, Endeavour Prawn, Red Spot King Prawn, Banana Prawn,							✓		

Fishery	Area / Description	Extends into Commonwealth Waters	Target Species	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	• Moreton Bay Otter Trawl Fishery • River and Inshore Beam Trawl Fishery • Fin Fish (Stout Whiting) Trawl Fishery. The trawl fisheries cover all tidal waters out to the Queensland East Coast OCS boundary between Cape York and the New South Wales border.		Eastern King Prawn, Bay Prawn) • Scallops • Whiting • Moreton Bay Bugs • Squid (Pencil Squid, Tiger Squid, Arrow Squid) Other catch: • Blue Swimmer Crabs • Barking Crayfish • Cuttlefish • Mantis Shrimp • Octopuses • Pinkies • Pipefish • Red Spot Crabs • Balmain Bugs									

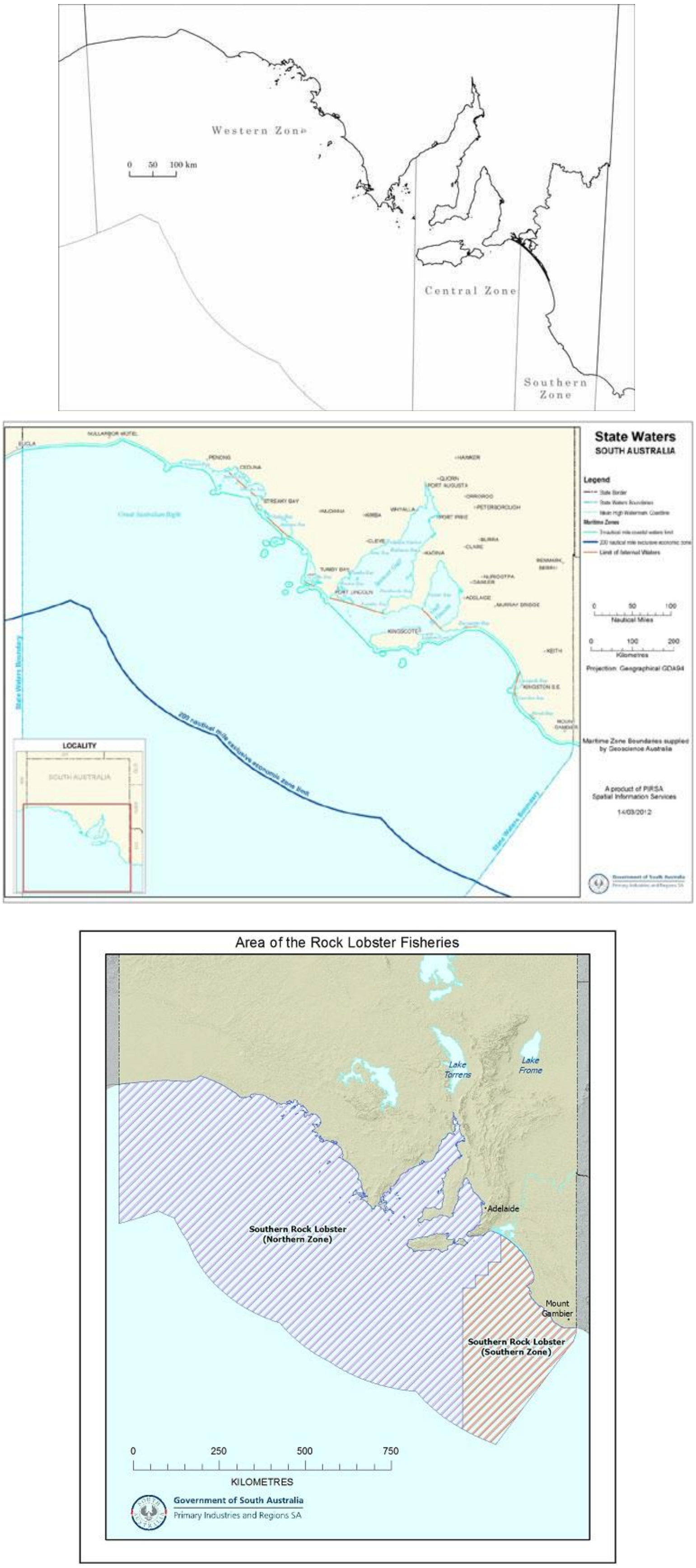
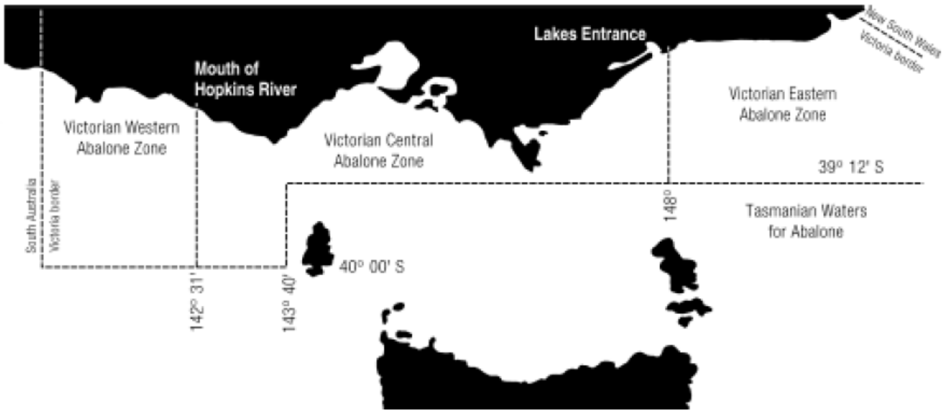
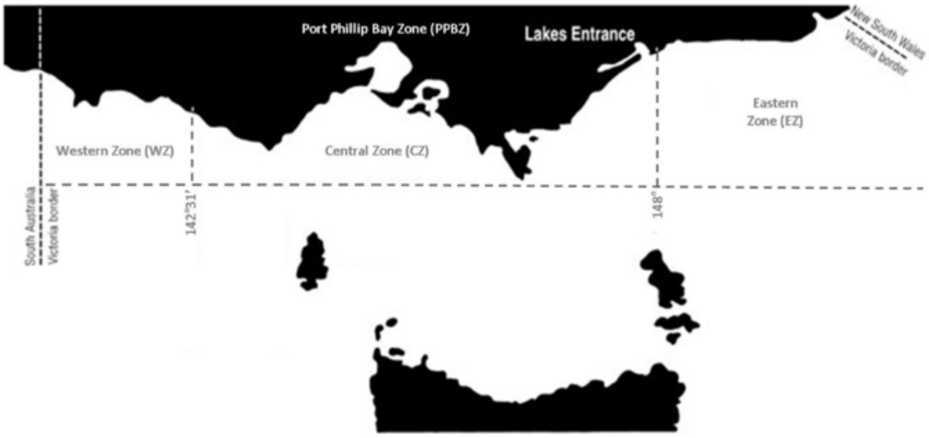


Figure 5-13: South Australian Commercial Fisheries (a) Abalone, (b) Marine Scalefish Fishery, (c) Rock Lobster (d) Sea urchin

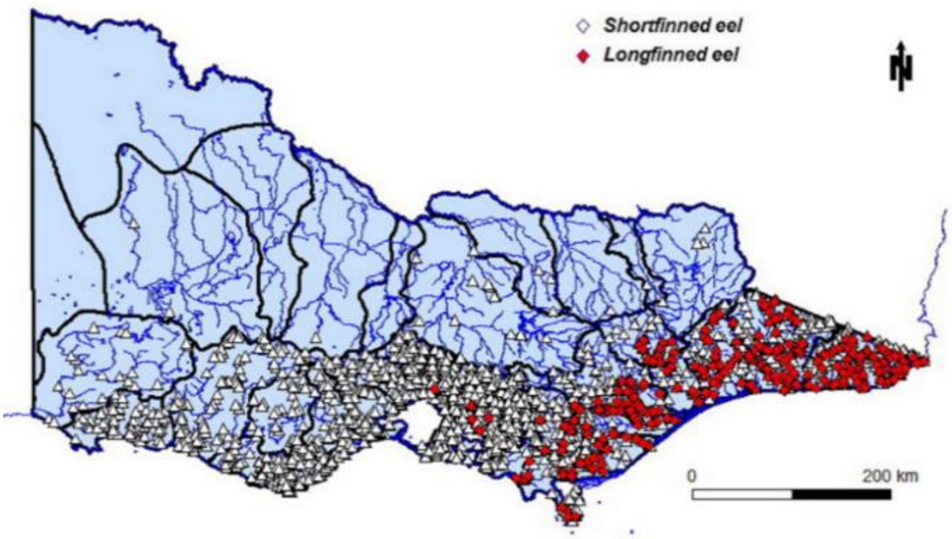
a)


Lakes Entrance
New South Wales
Victoria border
Mouth of
Hopkins River
Victorian Eastern
Abalone Zone
Victorian Western
Abalone Zone
Victorian Central
Abalone Zone
39° 12' S
South Australia
Victoria border
148°
Tasmanian Waters
for Abalone
40° 00' S
142° 31'
143° 40'

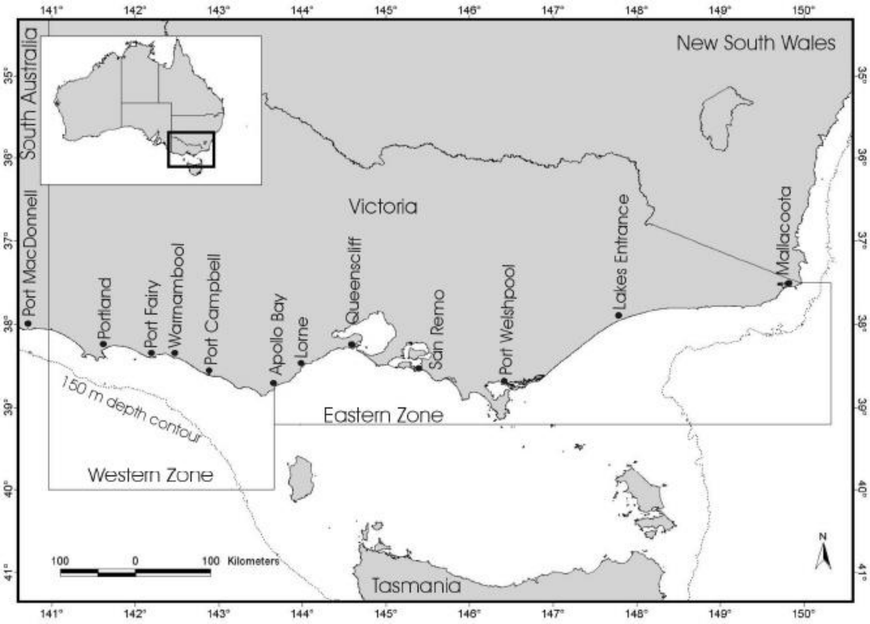
b)


Port Phillip Bay Zone (PPBZ)
Lakes Entrance
New South Wales
Victoria border
Eastern
Zone (EZ)
Western Zone (WZ)
Central Zone (CZ)
South Australia
Victoria border
142°31'
148°

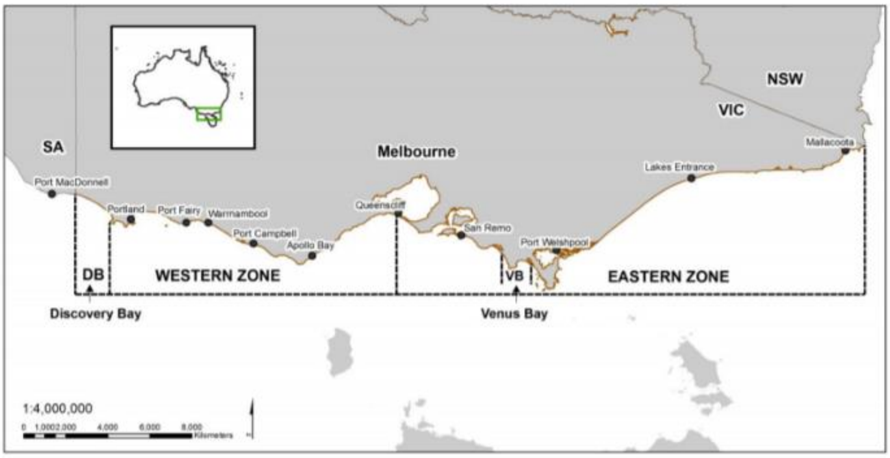
c)


Shortfinned eel
Longfinned eel
N
0
200 km

d)


New South Wales
South Australia
Victoria
Port MacDonnell
Portland
Port Fairy
Warrnambool
Port Campbell
Apollo Bay
Lorne
Queenscliff
San Remo
Port Welshpool
Lakes Entrance
Mallacoota
150 m depth contour
Eastern Zone
Western Zone
Tasmania
100 Kilometers

e)


SA
VIC
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Melbourne
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Port Fairy
Warrnambool
Port Campbell
Apollo Bay
Queenscliff
San Remo
Port Welshpool
Lakes Entrance
Mallacoota
DB
WESTERN ZONE
VB
EASTERN ZONE
Discovery Bay
Venus Bay
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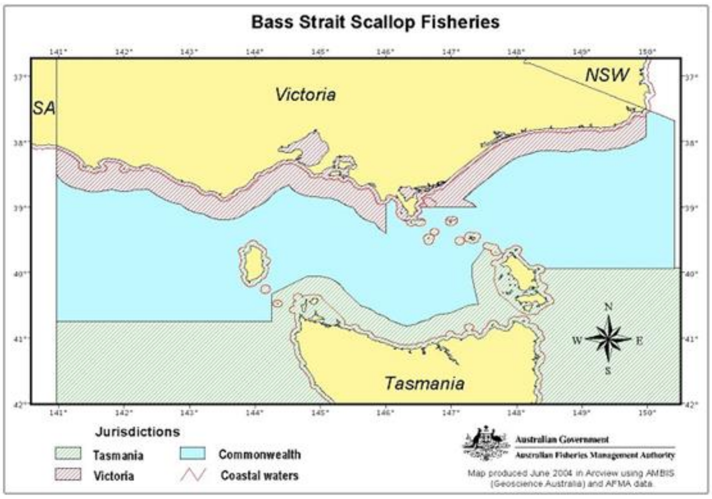
f)

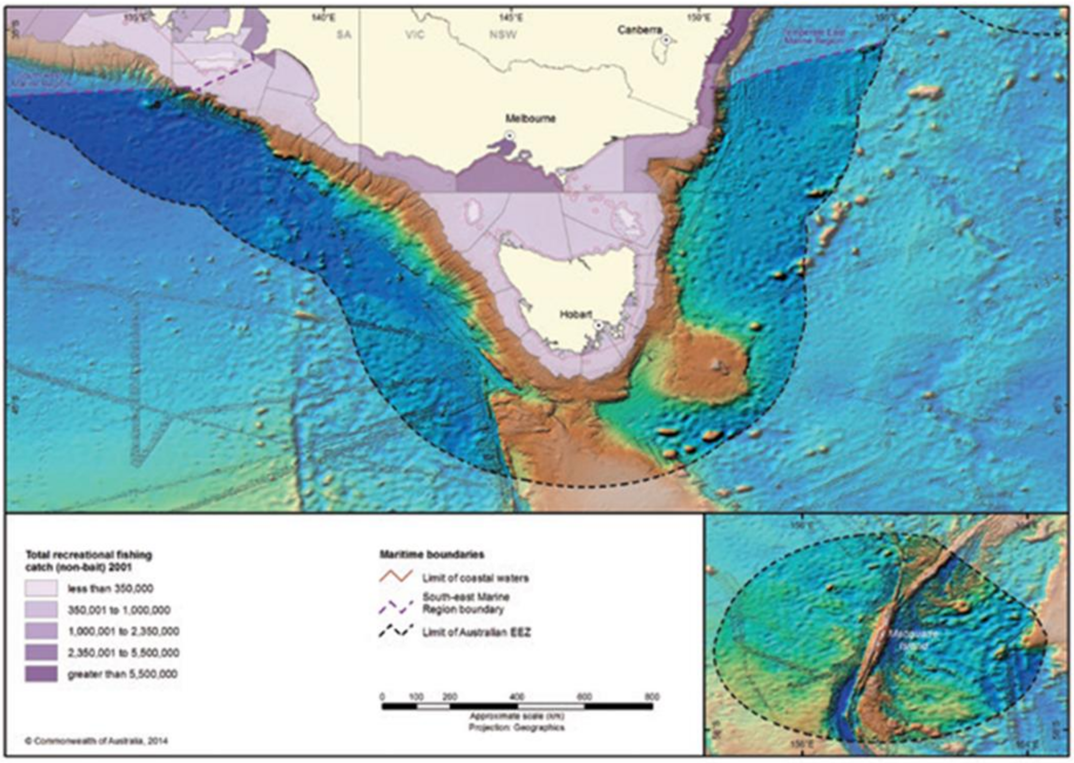

Bass Strait Scallop Fisheries
Victoria
NSW
SA
Tasmania
Jurisdictions
Tasmania
Victoria
Commonwealth
Coastal waters
Australian Government
Australian Fisheries Management Authority
Map produced June 2004 in Arcview using AMBIS (Geoscience Australia) and AFMA data.

g)

Figure 5-14: Victorian Commercial Fisheries (a) Abalone, (b) Sea Urchin, (c) Eel, (d) Giant Crab, (e) Pipi, (f) Rock Lobster, and (g) Scallop

5.2 Recreational Fisheries

Recreational fishing in Australia is a multi-billion dollar industry. Most recreational fishing typically occurs in nearshore coastal waters (shore or inshore vessels), and within bays and estuaries; offshore (>5 km) fishing only accounts for approximately 4% of recreational fishing activity in Australia. Charter fishing vessels are likely to account for the majority of offshore fishing activity. The variation in recreational fishing intensity along the coast is illustrated in Figure 5-15. Common recreational fish species include tiger flathead, bream, snapper, Australian salmon, and lobster; and offshore catches can include mackerel, tuna, groper and shark.



(Source: DoE, 2015a)

Figure 5-15: Recreational Fishing Catch in South-eastern Marine Region

5.3 Coastal Settlements

Australian's have a strong affinity to the coast, with over 80% of the population living within 50 km of the coast (Hugo *et al.*, 2013). Some of the Australia's most populated places occur on the coast within the Environment Sectors. Based on the top ten highest population places in each state, the 22 places listed in Tabelx x-x occur along the coast of the Environment Sectors.

The communities of Orbost, Newmerella and Marlo (within the Shire of East Gippsland) are the closest coastal settlements to Cooper Energy's BMG and Sole assets. At the 2016 Australian census, the estimated resident population for East Gippsland was 44,542 (an increase from 42,926 in 2011) (.id Consulting, 2017a). The Shire of East Gippsland has an aging population (.id Consulting, 2017a).

Port Campbell is the nearest town to Cooper Energy's Casino assets. At the 2016 Australian census, the estimated resident population for Colac Otway was 21,359 (an increase from 20,799 in 2011) (.id Consulting, 2017b). Other coastal communities along the Colac Otway coast include Apollo Bay, Princetown, Peterborough, Warrnambool, Port Fairy and Portland; all provide services to the commercial and recreational fishing industries in southwest Victoria. Portland is Victoria's western-most commercial port and is a deep-water port with breakwaters sheltering a marina and boat ramp. The Port of Warrnambool has a breakwater and yacht club and provides shelter for commercial fishing boats. Port Fairy has both harbour and fish processing facilities, but is not suitable for use by large vessels, nor is Port Campbell.

Table 5.3: Highest Population Places occurring on the coast[1] within the EMBA

	Otway	Bass Strait	Gippsland	Sorell[2]	SE Tasmania	Central NSW	SE Queensland	Lord Howe[2]	Norfolk Island[2]
South Australia[3]									
Victoria	• Warrnambool	• Melbourne • Geelong							
Tasmania		• Launceston • Devonport • Burnie • Ulverstone • Wynyard • George Town			• Hobart • Kingston • Sorell				
New South Wales						• Sydney • Newcastle • Central Coast • Wollongong • Coffs Harbour			
Queensland							• Gold Coast-Tweed Heads • Brisbane • Sunshine Coast • Bundaberg • Hervey Bay		

Notes:
1. Top ten highest population places for each state determined from 2016 Census data (those not on the coast, or not within the Environment Sectors, are not included in this table).
2. None of the top ten highest population places occur on the coast of Gippsland, Sorell, Lord Howe or Norfolk sectors.
3. All the top ten highest population places in South Australia, are either located to the east of the 'Otway' Environment Sector, or inland (e.g. Mount Gambier).

5.4 Recreation and Tourism

The coast and marine region within the Environment Sectors provide a diverse range of recreation and tourism opportunities, including scuba diving, charter boat cruises, cruise shipping, whale and wildlife watching, sailing, snorkelling, surfing, and kayaking. Popular tourist destinations adjacent include Phillip Island, the Great Ocean Road (Victoria); Strahan and the Freycinet Peninsula (Tasmania); Merimbula, Bermagui (New South Wales); and Gold and Sunshine Coasts, and Fraser Island (Queensland). Norfolk Island is a popular tourist destination known for its history and culture, beaches and National Park.

In 2013-2014 the tourism industry contributed approximately $1.2 billion to the Gippsland economy, and $1.9 billion to the Great Ocean Road economy; and employed approximately 12,400 (12.2%) and 20,700 (12%) respectively (Figure 5-16) (Tourism Victoria, 2014a, 2014b). Overnight visitors to the Gippsland area were predominantly Australian (86% intrastate, 11% interstate), with low (3%) international visitors (Tourism Victoria, 2014a). Similarly, in Great Ocean Road area, overnight visitors were predominantly Australian (82% intrastate, 12% interstate), with low (6%) international visitors (Tourism Victoria, 2014b).

In East Gippsland, primary tourist locations are the Gippsland Lakes (the largest inland waterway in Australia), Lakes Entrance, Marlo, Cape Conran and Mallacoota. The area is renowned for its nature-based tourism (e.g. Croajingalong National Park), recreational fishing and water sports (lake and beaches) (Travel Victoria, 2017). The Great Ocean Road region includes the Shipwreck Coast, which is home to the notable rock formations including London Bridge, Lord Arch Gorgon and the 12 Apostles (Travel Victoria, 2017). These rock formations attract a high proportion of the visiting population to the area.

(Source: Tourism Victoria, 2017)

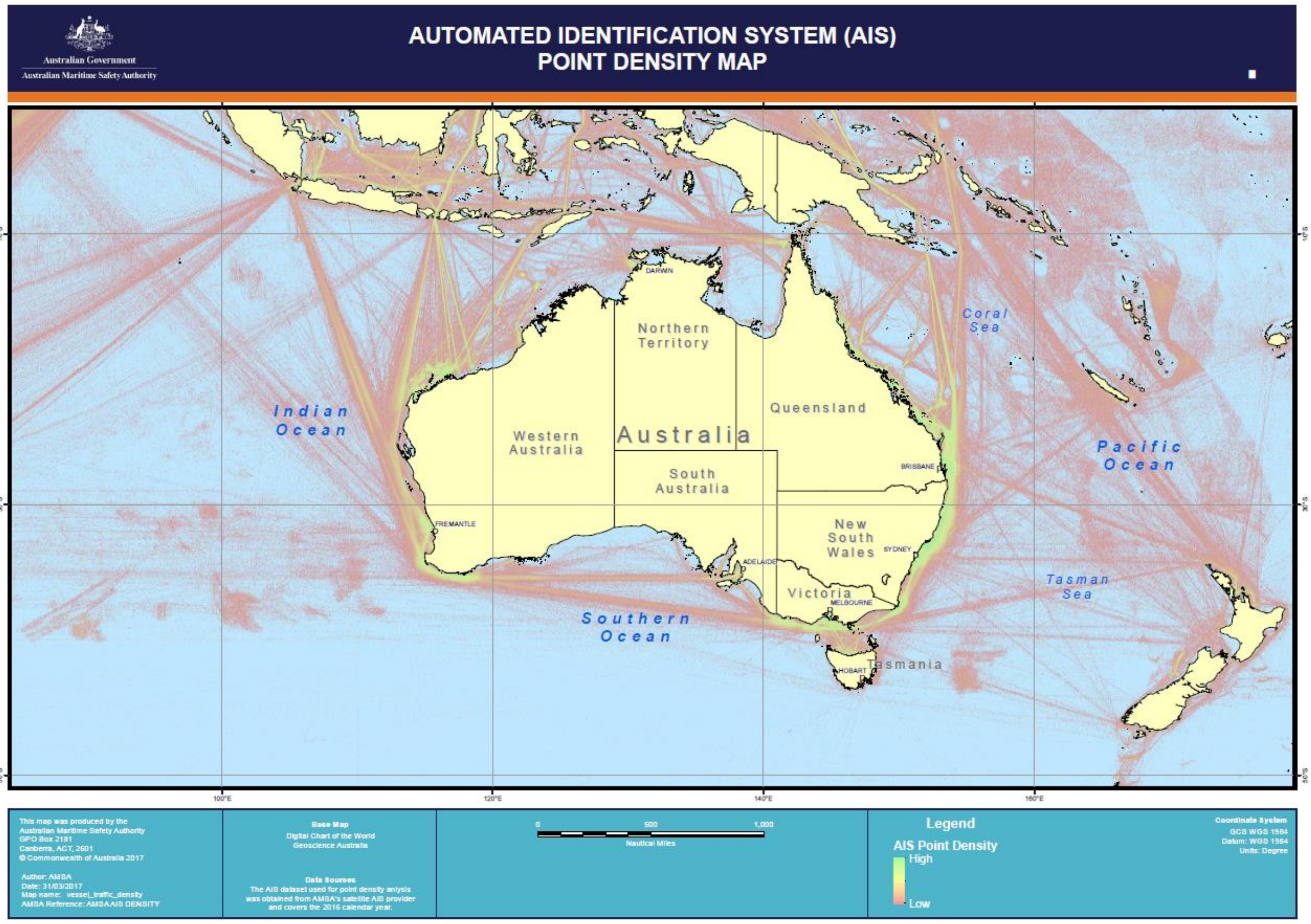
Figure 5-16: Victoria's Tourism Regions

5.5 Industry

5.5.1 Shipping

The south-east and eastern coasts are some of Australia's busiest in terms of shipping activity and volumes (Figure 5-17). This traffic includes international and coastal cargo trade, and passenger and ferry services. Major ports include Melbourne, Geelong, Western Port, Sydney and Brisbane; with other minor ports important to commercial and recreational fishing, yachts and other pleasure craft.

Cooper Energy's assets do not coincide with major routes; with higher volumes of traffic located to the south of the wells within the Petroleum Titles VIC/L24, VIC/L32 and VIC/RL13 (Figure 5-18). A shipping exclusion zone ('area to be avoided') also exists around the operating oil and gas platforms in the Gippsland Basin, whereby unauthorised vessels larger than 200 gross tonnes are excluded from entry (Figure 5-19). Two traffic separation schemes have been implemented to enhance safety of navigation around the 'Area to be Avoided' by separating shipping into one-direction lanes for vessels heading north eastwards and those heading south westwards. One separation area is located south of Wilson's Promontory, and the other south of the Kingfisher B platform.



(Source: AMSA, 2017)

Note: Point density analysis of satellite Automated Identification System data, 1 January to 31 December 2016.

Figure 5-17: Vessel Traffic Density

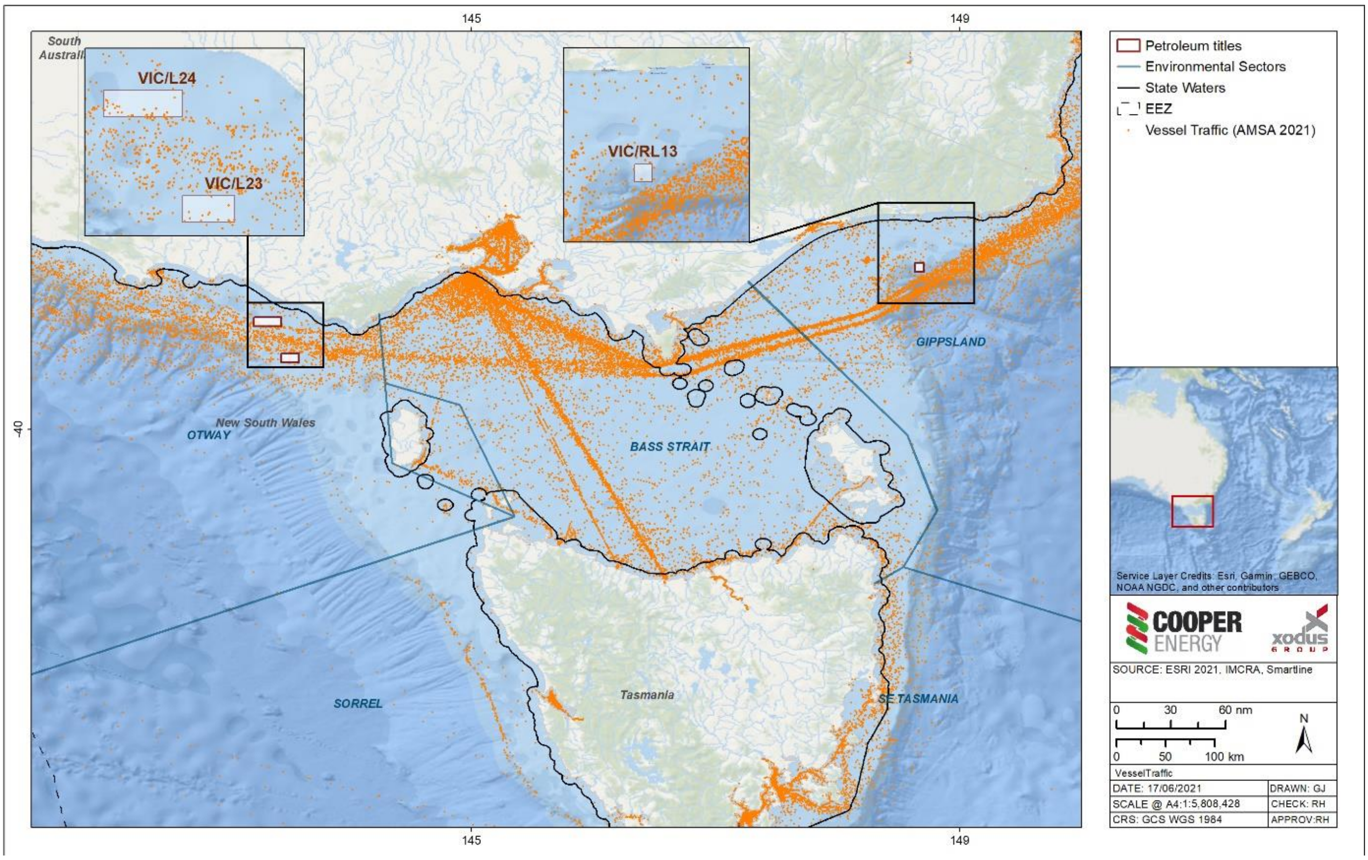
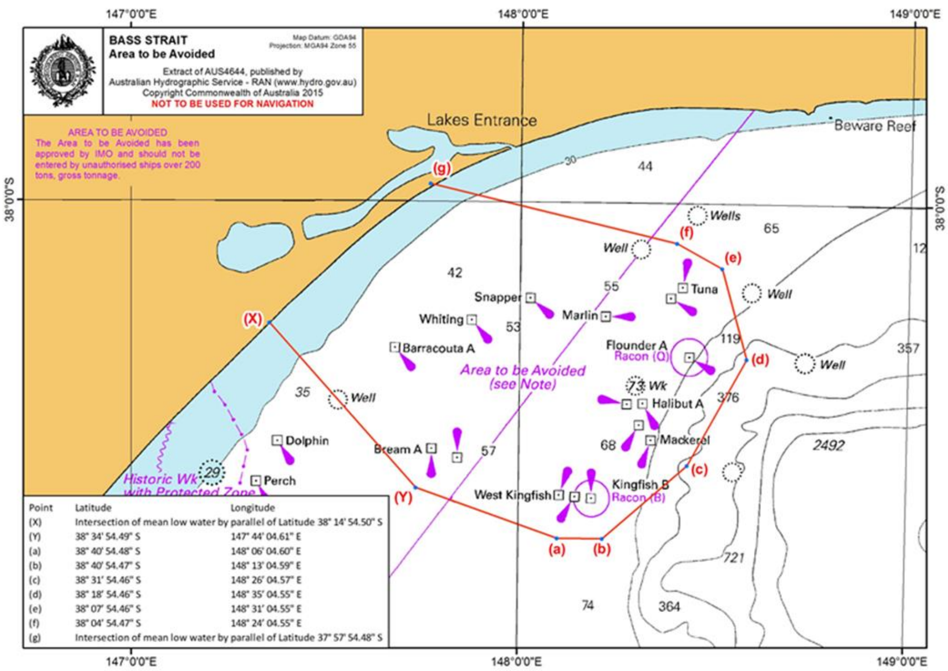


Figure 5-18: Vessel Traffic (6-hourly tracking) in the vicinity of Petroleum Titles



Point	Latitude	Longitude
(X)	Intersection of mean low water by parallel of Latitude 38° 14' 54.50" S	
(Y)	38° 34' 54.49" S	147° 44' 04.61" E
(a)	38° 40' 54.48" S	148° 06' 04.60" E
(b)	38° 40' 54.47" S	148° 13' 04.59" E
(c)	38° 31' 54.46" S	148° 26' 04.57" E
(d)	38° 18' 54.46" S	148° 35' 04.55" E
(e)	38° 07' 54.46" S	148° 31' 04.55" E
(f)	38° 04' 54.47" S	148° 24' 04.55" E
(g)	Intersection of mean low water by parallel of Latitude 37° 57' 54.48" S	

(Source: ABF, 2017)

Figure 5-19: Shipping Exclusion Zones (Area to be Avoided)

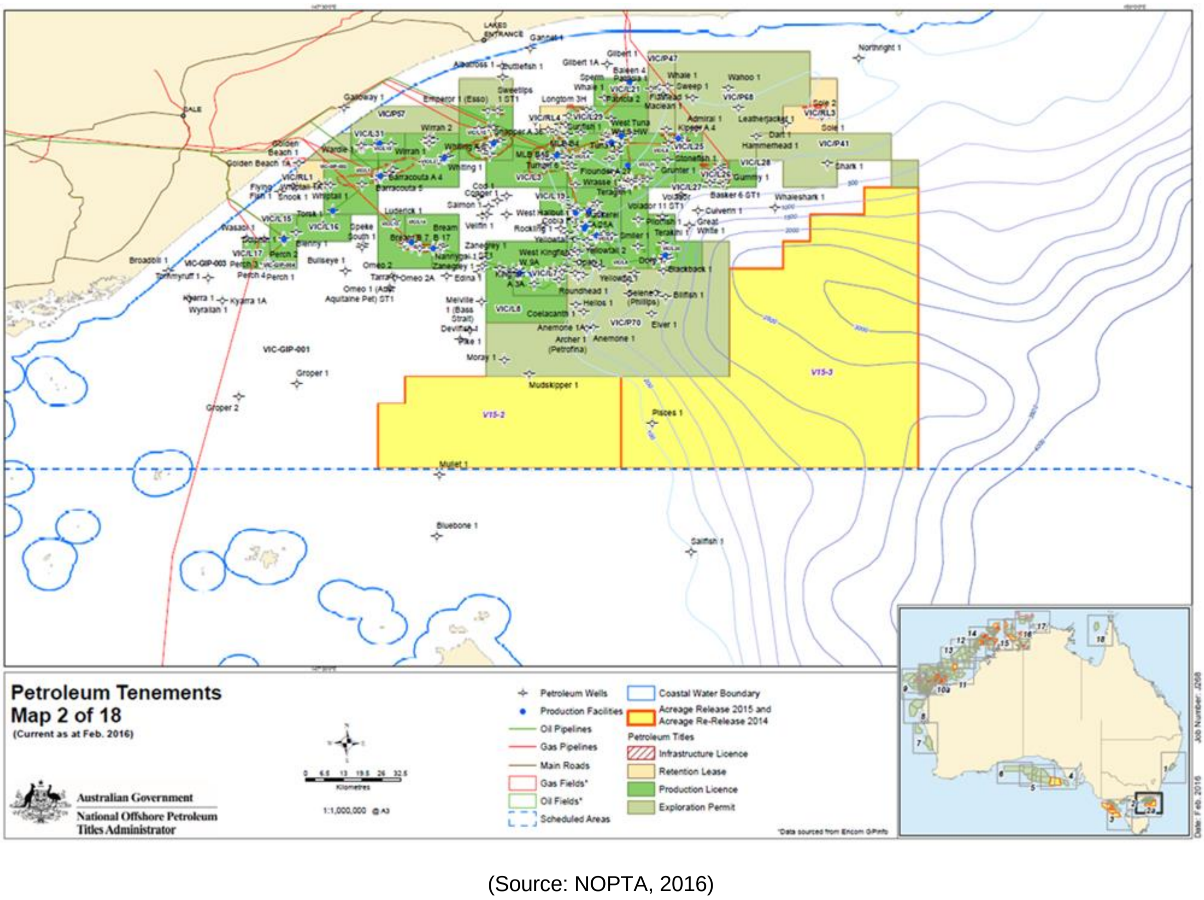
5.5.2 Oil and Gas Exploration and Production

In 2018-19, oil was the largest primary energy source in Australia providing nearly 39% of all energy consumed. Natural gas provided 26% of primary energy. Renewables accounted for just over 6% of Australia's primary energy consumption in 2018–19 (APPEA, 2021). In 2019–20, Australia recorded a A$27.9 billion surplus in the trade of oil and gas—the highest surplus since 1990. This is primarily due to $47.5 billion worth of LNG exports. LNG exports have made a significant contribution to Australia's economic growth over the last few years (APPEA, 2021).

Victoria's petroleum (oil and gas) exploration and production is concentrated in the offshore Commonwealth waters of the Otway and Gippsland basins. There are a number of current exploration and offshore production permit areas within both basins (Figure 5-20, Figure 5-21).

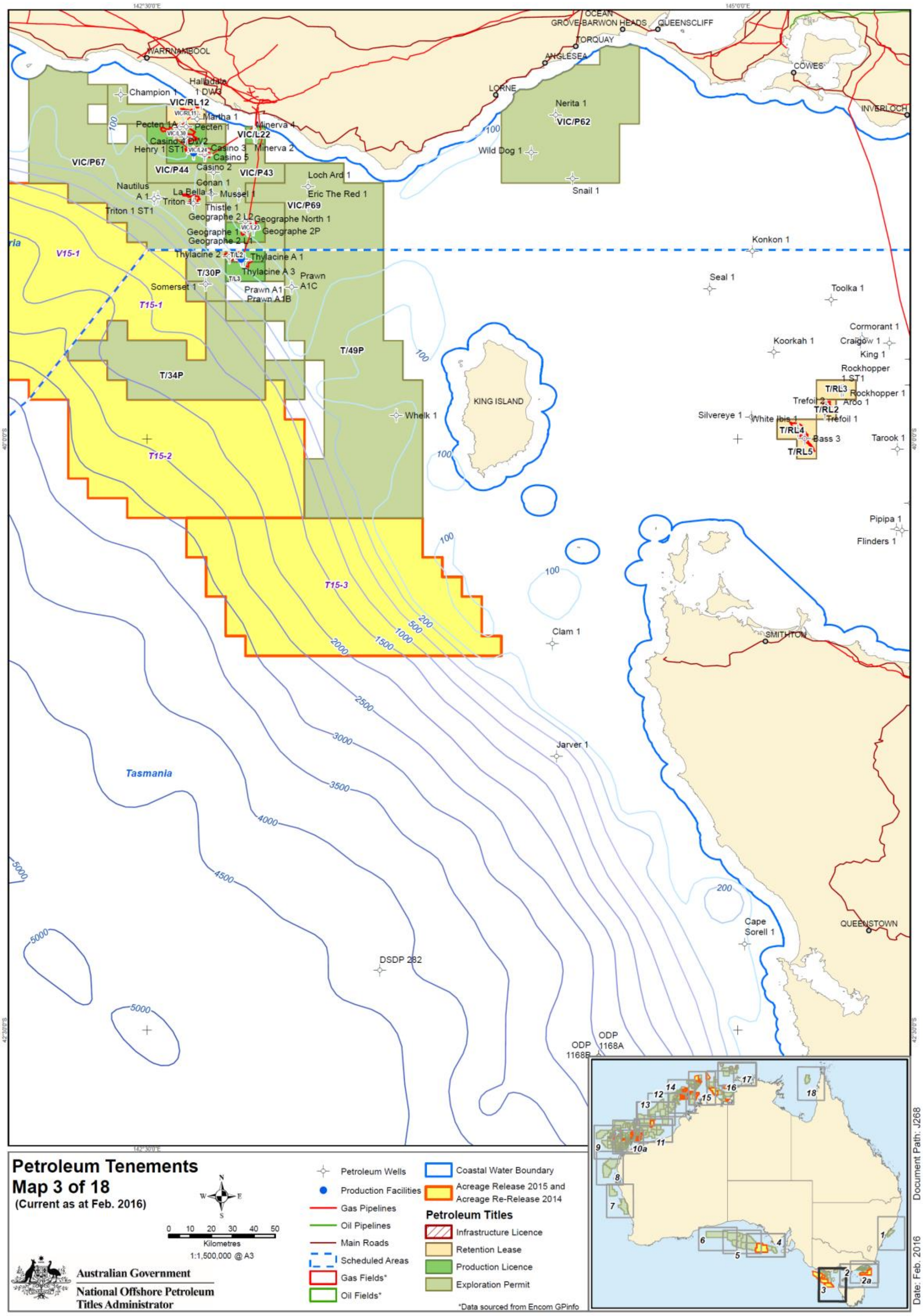
From 1967–2015, the Gippsland Basin Joint Venture alone produced 54% of Australia's crude oil and gas (DIIS, 2017). Petroleum infrastructure in Gippsland Basin is well developed, with a network of pipelines transporting hydrocarbons produced offshore to onshore petroleum processing facilities at Longford and Orbost (Figure 5-22). Overall production of crude oil and condensate from the Gippsland Basin had been declining for over three decades, while gas production remained steady. However, in recent years, hydrocarbon production has remained relatively strong due to infill drilling in the developed fields and work-overs undertaken to renew down hole equipment and to open new zones (DIIS, 2017). Total petroleum production from the Gippsland Basin was 74.8 MMboe (11.9 GL) in 2016, up from 61.4 MMboe (9.76 GL) in 2015 (DIIS, 2017).

The Otway Basin is a northwest-trending passive margin rift basin that extends from southeast of South Australia to a boundary with the contiguous Sorell Basin to the west of King Island. The Otway Basin is an established gas producing region; however, most discoveries are confined to the onshore and shallow water inboard parts of the basin. Current offshore production in the Otway Basin includes the Minerva, Thylacine, Geographe, Casino, Henry (including Netherby) fields (Figure 5-23). No production is currently occurring in the Torquay or deep-water sub-basins (DIIS, 2017).



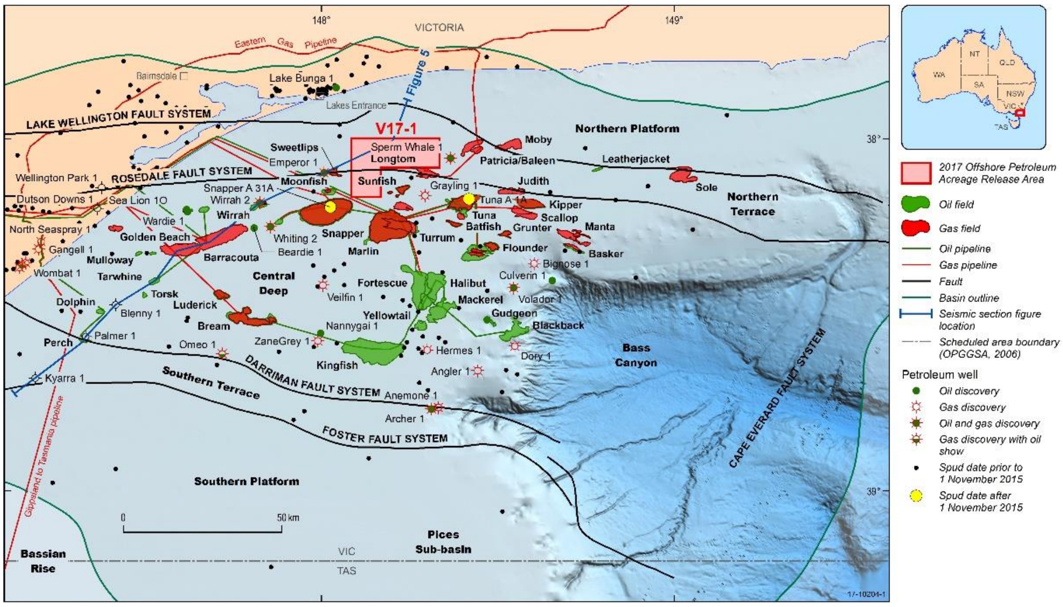
(Source: NOPTA, 2016)

Figure 5-20: Gippsland Basin Oil and Gas Fields



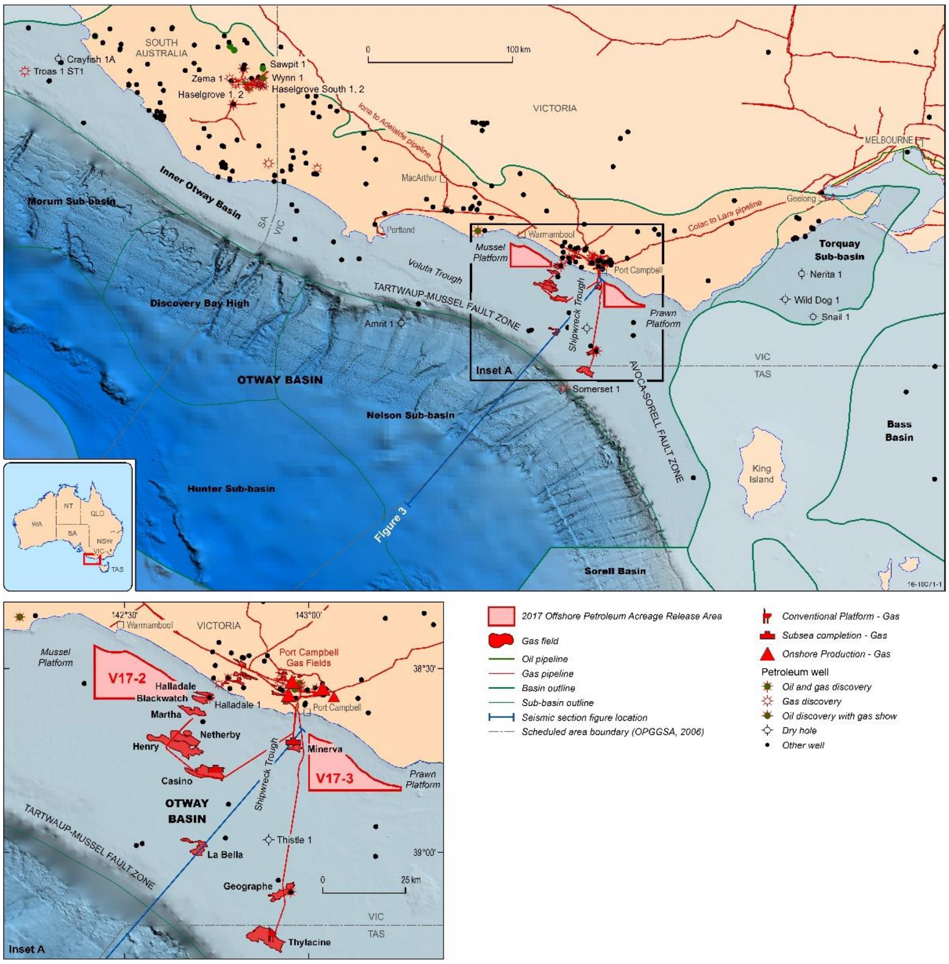
(Source: NOPTA, 2016)

Figure 5-21: Otway Basin Oil and Gas Fields



(Source: DIIS, 2017)

Figure 5-22: Gippsland Basin regional geology with petroleum fields and infrastructure



(Source: DIIS, 2017)

Figure 5-23: Otway Basin regional geology with petroleum fields and infrastructure

5.5.3 Submarine Cables and Pipelines

Submarine cables located in Bass Strait are limited to the subsea floor between Tasmania and the Australian mainland. This includes two operational submarine transmission lines (both Telstra fibre optic cables) as well as Basslink, a subsea interconnector, completed in 2006 which joins the Tasmanian and national electricity grid.

Three communication cables also extend from Sydney (the Australia-Japan Cable, Southern Cross Cable, and Tasman 2 Cable); these supporting most of the voice and data traffic vital to Australia's national infrastructure. Under the Telecommunications and Other Legislation Amendment (Protection of Submarine Cables and Other Measures) Act 2005, the Australian Communications and Media Authority has proposed protection zones over these assets of national significance (DEWHA, 2009b).

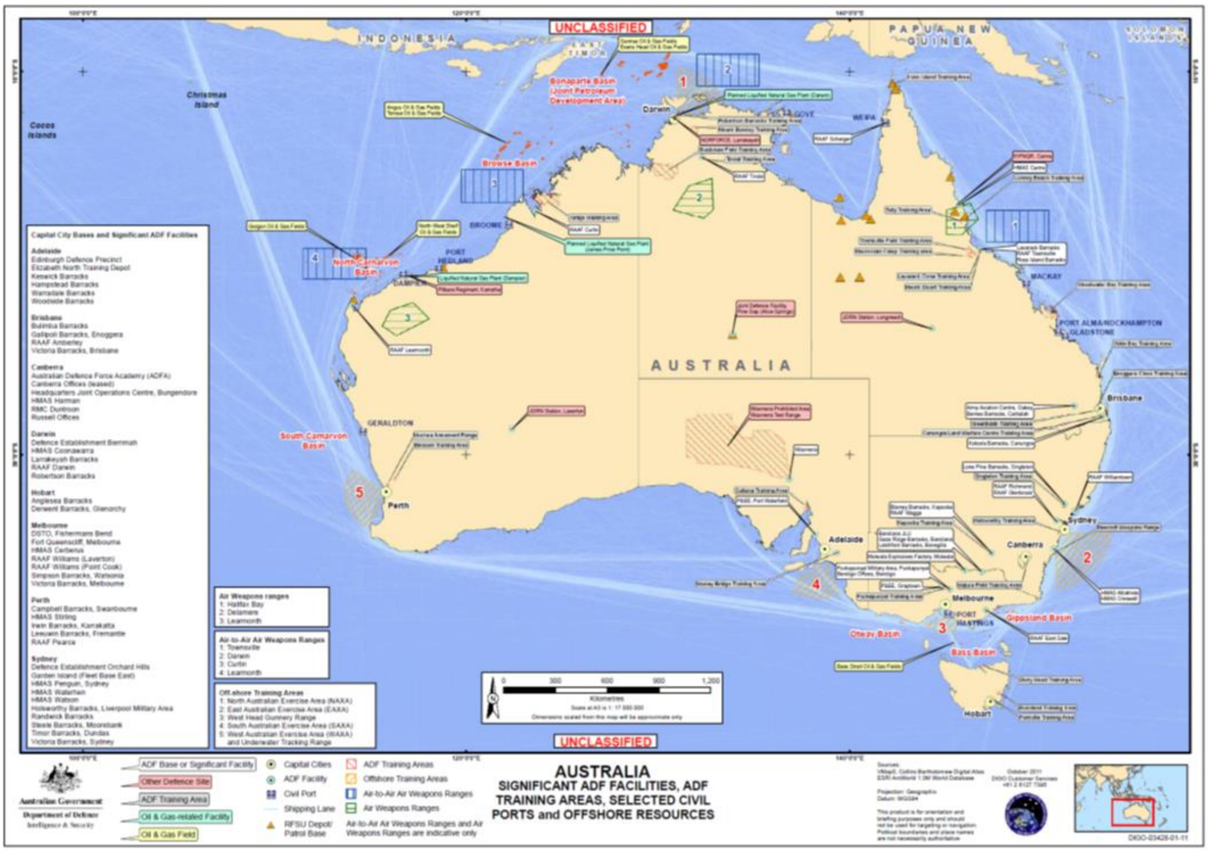
5.5.4 Defence

The Australian Defence Force conducts a range of training, research activities, and preparatory operations (Figure 5-24). Australian Defence Force activities within the Environment Sectors include transit of naval vessels, training exercises, shipbuilding and repairs, hydrographic survey, surveillance and enforcement, demolition, use of explosives, use of radar, sonar, sonobuoys, flares, sensors and other equipment, and search and rescue. Major bases within the Environment Sectors include:

- HMAS Cerberus in Western Port Bay, Melbourne (naval training)
- The multi-purpose wharf at Twofold Bay, Eden (naval operations)
- Fleet Base East in Sydney (Navy destroyers and support ships)
- HMAS Waterhen in Sydney (Navy minehunting vessels)
- Wollongong and Jervis Bay (Defence training).

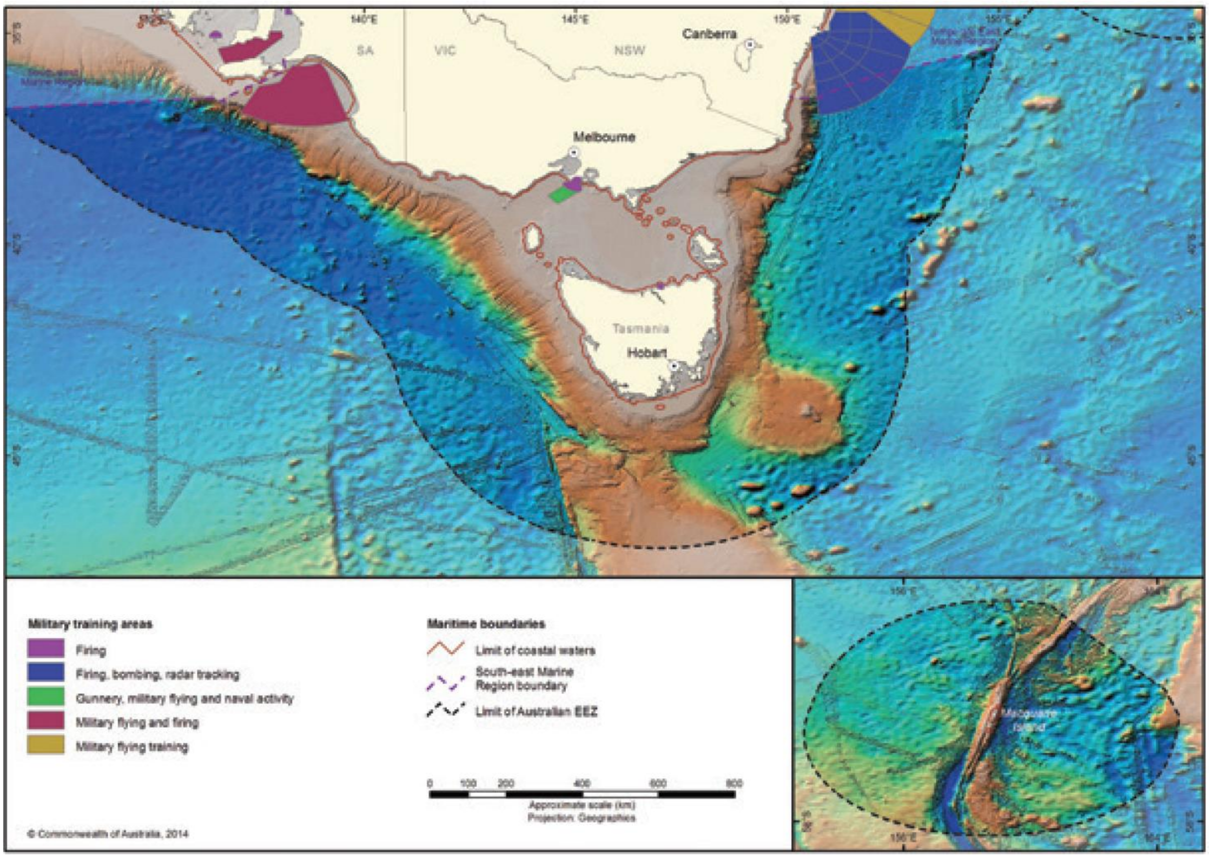
Primary training locations within the Environment Sectors include East Australia Exercise Area off the south coast of New South Wales, and the Royal Australian Air Force flying training areas and air-to-air ranges off the north coast of New South Wales (Figure 5-25).

Mine fields were laid in Australian waters during World War II. Post-war minefields were swept to remove mines and to make marine waters safe for maritime activities. There are three areas identified as dangerous due to unexploded ordnances, located south and east of Wilson's Promontory.



(Source: Department of Defence, 2014)

Figure 5-24: Significant Defence Bases and Facilities



(Source: DEWHA 2009b)

Figure 5-25: Defence Training Areas within the South-eastern Marine Regions

5.6 Heritage

5.6.1 Maritime

Australia protects its shipwrecks and their associated relics that are older than 75 years through the Historic Shipwrecks Act 1976 and Heritage (Historical Shipwrecks) Regulations 2007, administered in collaboration between the Commonwealth and the States, Northern Territory and Norfolk Island. No historic shipwrecks within VIC/L24 or VIC/L32 were identified on the Australian National Shipwreck Database (DEE, 2017y); however the database indicates that the Barque shipwreck is located within VIC/RL 13. Further consultation with DAWE in 2020 (as part of the BMG closure project) resolved that the resting location of the Barque is unknown. Numerous records exist for the wider area (Figure 5-26); the closest known shipwrecks are:

- VIC/L32 (Sole): approximately 11 km northeast to *Commissioner*, and 12 km northeast to SS *Federal*
- VIC/RL13 (BMG): approximately 33 km northwest to *Straun*
- VIC/L24 (Casino): approximately 16 km northeast to *Falls of Halladale*, *Schomberg* and *Newfield*.

Some historic shipwrecks lie within protected or no-entry zones. These zones cover an area around a wreck site, ensures that a fragile or sensitive historic shipwreck is actively managed. Seven of these protected zones do occur within inshore coastal waters of the Environment Sectors (Figure 5-27).

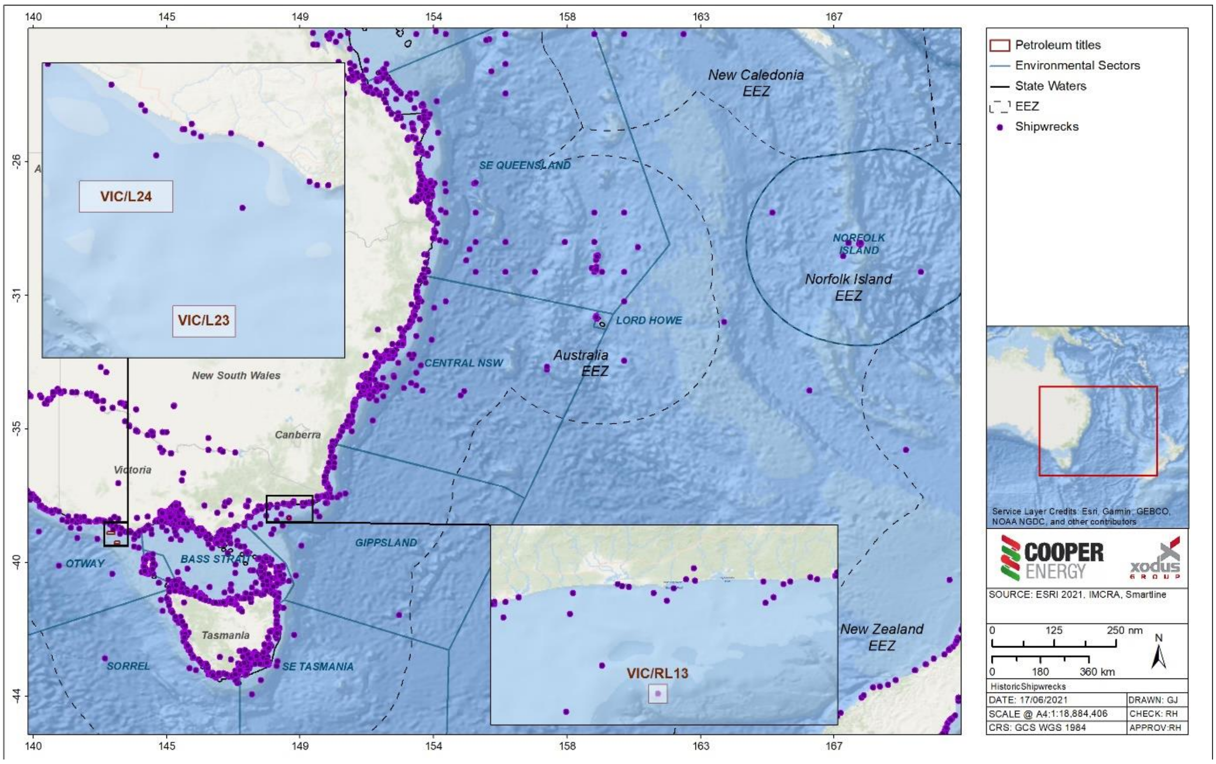
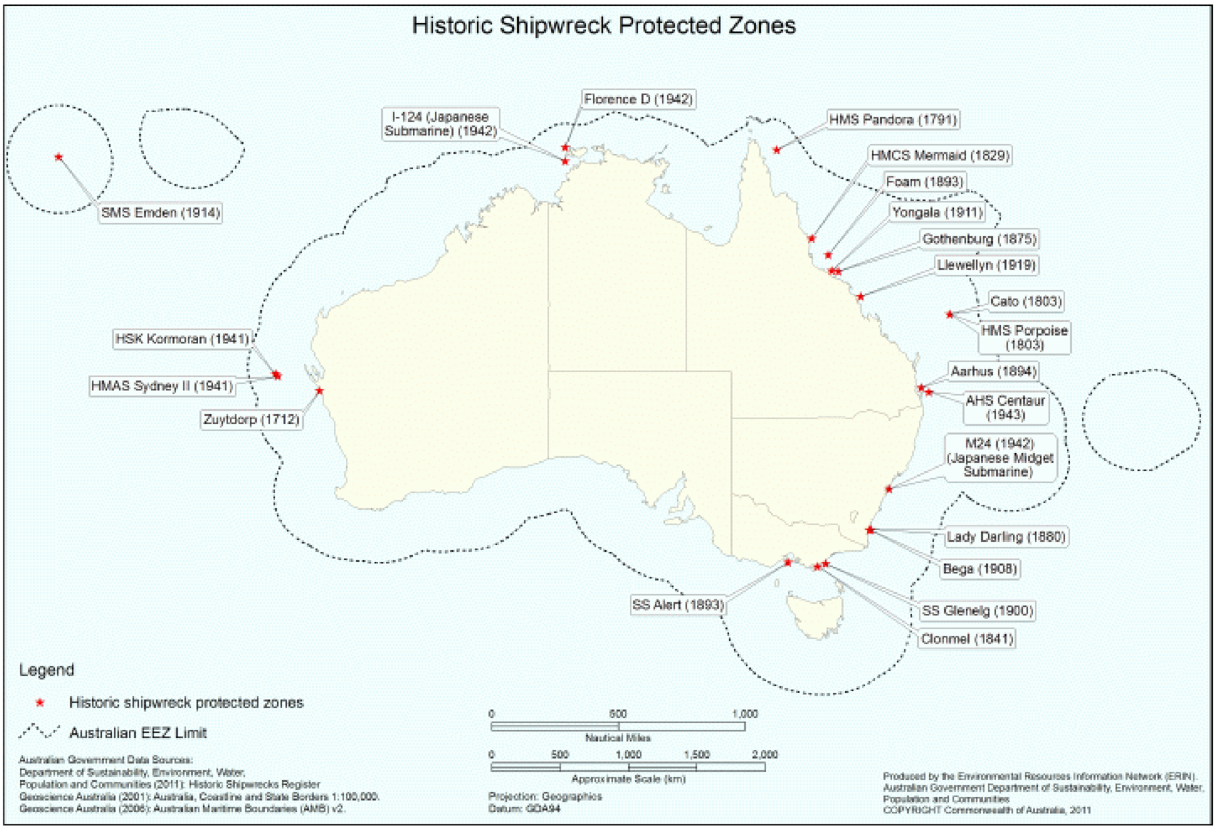


Figure 5-26: Locations of Historic Shipwrecks



(Source: DEE, 2017z)

Figure 5-27: Commonwealth Historic Shipwrecks with Protected Zones

5.6.2 Cultural

There are four World Heritage Properties, eight Commonwealth Heritage Places, and 14 National Heritage places with a marine or coastal interface within the Environment Sectors (Table 5.4). This includes places that have been listed for natural, historic and indigenous features.

Table 5.4: Cultural Heritage Places within the Environment Sectors

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Commonwealth Heritage Places	Beecroft Peninsula	The Beecroft Peninsula is the best example of a Permian cliffed coast in New South Wales. The area supports a high diversity of vegetation types within a small area including mangroves, saltmarsh, freshwater swamps, heathland, eucalypt forest and subtropical and littoral rainforest. Beecroft Peninsula retains the largest area of heath remaining on the south coast of New South Wales. This floristically rich vegetation provides important habitat for a variety of bird species, including the vulnerable ground parrot. Beecroft Peninsula occurs near the southern boundary of the Hawkesbury Sandstone geological unit. Accordingly, the place has a high number of flora and fauna species at the limit of their distribution. • Listed: 2004 • Class: Natural • Criterion: Processes, Rarity, Research, Characteristic values, Aesthetic characteristics • Other: includes indigenous heritage areas at Crocodile Head and Currarong Rockshelters						✓			
	HMAS Penguin	The HMAS Penguin site comprises a series of defence-related buildings and areas and includes the waterfront areas (and jetty complex). HMAS Penguin is highly valued by the Mosman community for its symbolic, cultural and social associations. • Listed: 2004 • Class: Historic • Criterion: Processes, Rarity, Aesthetic characteristics, Social value						✓			
	Jervis Bay Territory	The Commonwealth owned Jervis Bay Territory, occurs near the southern boundary of the Hawkesbury Sandstone. Accordingly, it has a high diversity of plants and represents a northern or southern						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		distribution limit for 33 species of plants. Dominant vegetation types include forests, woodlands, heathlands and shrublands. The place includes well preserved examples of mangrove, saltmarsh and littoral rainforest communities. The area is home to the Koori people of Wreck Bay who have always lived in, and have strong cultural ties to, the area. The place contains a large number of prehistoric Aboriginal sites. Rock shelters, stone-flaking sites and axe-sharpening grooves and shell middens demonstrate the length of Aboriginal occupation of the area. Ceremonial BUNAN or BORA grounds, used for initiation, are known only from the immediate hinterland of Wreck Bay, and nearly all known grinding groove sites are in the catchments of Mary and Summercloud Bays. These sites demonstrate past cultural practices and are important to the Wreck Bay community. • Listed: 2004 • Class: Natural • Criterion: Processes, Rarity. Research, Characteristic values, Aesthetic characteristics Other: includes indigenous heritage areas at Crocodile Head and Currarong Rockshelters									
	Malabar Headland	Malabar Headland contains two significant bushland remnants; representing one of the largest areas of essentially unmodified bushland in Sydney's eastern suburbs. The bushland is a significant part of one of two semi-natural corridors between Botany Bay and Port Jackson. The vegetation communities of Malabar Headland are of scientific and educational significance because they contain rare examples of coastal communities growing on Pleistocene sand deposits within the Sydney region. These communities have different species composition to those found elsewhere in the Sydney region.						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		• Listed: 2004 • Class: Indigenous • Criterion: Processes, Rarity, Research, Social value, Indigenous tradition									
	Point Wilson Defence Natural Area	Point Wilson is an important part of the Western Port Phillip Bay Ramsar Area, an internationally significant wetland that provides habitat for many migratory and resident wading birds and waterfowl. It is one of the most important sites in Australia for the Double-banded Plover, regularly attracting a large population in winter. Point Wilson is also visited during winter by the endangered Orange-bellied Parrot. Other birds often recorded at the place in large numbers include Pacific Golden Plovers, Ruddy Turnstones, Curlew Sandpipers, Sharp-tailed Sandpipers and Pied Oystercatchers. The low rainfall regime of the place and the adjoining Murtcaim Wildlife Area produces dry coastal salt marshes atypical of any other coastal salt marshes in Victoria. These dry salt marshes are located very close to wet salt marshes and, where these two forms coincide, they produce the most structurally and floristically diverse salt marshes in Victoria. The Point Wilson Defence Natural Area is an important cultural site for the Wathaurong people. The cultural significance of the place arises from sites and artefacts recorded there, the land on which they rest and the ecological values of the area. • Listed: 2004 • Class: Natural • Criterion: Processes, Rarity, Characteristic values, Social value		✓							
	Snapper Island	Snapper Island, comprising the original sandstone area, fore and aft areas of made ground, a range of utilitarian buildings and maritime structures, is historically important as the primary expression of the Navy League UK, established at Drummoyne in 1921 by Len Forsythe, who saw the need to establish a voluntary training scheme						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		for young boys, as naval cadets. Snapper Island is highly valued by Sydney's naval cadet groups and the local communities for its symbolic, cultural, educational and social associations. • Listed: 2004 • Class: Historic • Criterion: Processes, Characteristic values, Aesthetic characteristics, Social value, Significant people									
	Swan Island and Naval Waters	Swan Island is the largest emergent sand accumulation feature in Port Phillip Bay. The island, which has been built principally by wave actions rather than by aeolian forces, has played a major role in determining the pattern of sedimentation in Swan Bay and preserves geomorphological evidence of changing Quaternary sea levels. The eastern and northern shores of the eastern arm of Swan Island are of regional significance as an example of active coastal depositional and erosional processes. The patterns of erosion and accretion on these shores provide a good indicator of sand movements into Port Phillip Bay. Swan Island and Naval Waters is an integral part of Swan Bay, an internationally significant wetland which is important as wader and waterfowl habitat, and provides important habitat for 46 water bird species: of which 26 species are listed under the Japan-Australia and China-Australia migratory bird agreements; and 8 species are listed under the Bonn Convention on Migratory Species. • Listed: 2004 • Class: Natural • Criterion: Processes, Rarity, Research, Characteristic values		✓							
	Tasmanian Seamounts Area	The Tasmanian pinnacle seamounts support intact benthic communities that differ markedly from the sediment dwelling faunas of the surrounding deep-sea floor. The seamounts are dominated by cold-water coral species and characterized by a relatively high species richness and endemism. They can be regarded as oases of					✓				

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		comparative productivity in the open ocean, with the coral matrix which provides habitat otherwise lacking in the dark and deep abyssal waters and dense schools of seamount-associated fish. The seamounts communities are very vulnerable to disturbance being dominated by long-lived species with low growth rates. Research on the Tasmanian seamounts has already substantially contributed to the nation's knowledge of deep-sea organisms and has potential to continue to do so. They are regionally unusual ecosystems that represent the principal characteristics of seamounts as species-rich, deep sea communities. • Listed: 2006 • Class: Natural • Criterion: Processes, Rarity, Research, Characteristic values									
	HMS Sirus Shipwreck	The archaeological remains of HMS Sirius represent a tangible link to the most significant vessel associated with early migration of European people to Australia. HMS Sirius was guardian of the first fleet during its epic voyage to Australia between 1787 and 1788, which brought the convicts, soldiers and sailors who became Australia's first permanent European settlers. • Listed: 2011 • Class: Historic Criterion: Processes, Rarity, Research, Social value, Significant people									✓
National Heritage Places	Bondi Beach	Bondi Beach is an urban beach cultural landscape of waters and sands, where the natural features have been altered by development associated with beach use and consisting of promenades, parks, sea baths, the surf pavilion and pedestrian bridges. The predominant feature of the beach is the vastness of the open space within an urban setting. Bondi Beach is significant in the course of Australia's cultural history as the site of the foundation of						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		Australia's first recognised surf lifesaving club in 1907. Bondi Beach is one of the world's most famous beaches and is of important social value to both the Australian community and to visitors. • Listed: 2008 • Class: Historic • Criterion: Events, Processes, Social value • Other: includes the Bondi Beach Surf Pavilion									
	Cockatoo Island	Cockatoo Island is highly significant for its associations with convicts and the nature and extent of its remains demonstrate the principal characteristics of a dual use convict site where incarceration is combined with hard labour. Cockatoo Island is also important to the nation as a pre and post Federation shipbuilding complex. • Listed: 2007 • Class: Historic • Criterion: Events, Processes, Research, Principal characteristics of a class of places						✓			
	Fraser Island	See description under World Heritage Properties.							✓		
	Great Barrier Reef	See description under World Heritage Properties.							✓		
	Great Ocean Road and Scenic Environs	The geomorphological features of the Port Campbell Limestone Coast are rare in their diversity, and it is the definitive place in Australia to observe limestone geomorphology and coastal erosion processes on rocky coasts. The Cretaceous coast of the Otway's displays geomorphological processes that are contributing to research into the origins of significant shore platforms that illustrate the environment prior to the breakup of Gondwana. Recreational tourism was among the purposes for the road's construction, and the cultural and natural tourism experiences it offers, including the iconic Twelve Apostles and the treacherous Shipwreck Coast, are greatly valued by the Australian community. The iconic Bells Beach is valued by Australia's surfing community for its place in Australian	✓	✓							

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		surfing. It was the world's first Surfing Recreation Reserve and remains the location of the world's longest running international surfing carnival and home to one the most prestigious trophies in surfing. • Listed: 2011 • Class: Historic • Criterion: Events, Processes, Rarity, Research, Principal characteristics of a class of places, Aesthetic characteristics, Social value, Significant people									
	HMVS Cerberus	The HMVS Cerberus is important as evidence of the development of Australia as a nation and as part of the British Empire. The British Parliament passed the Colonial Naval Defence Act 1865 giving the colonies the power to make laws to provide for their own naval defence. The construction of HMVS Cerberus (1867-1870) reflects a period in Australia's history when the colonies were thought vulnerable to coastal attack and invasion. • Listed: 2005 • Class: Historic • Criterion: Events, Processes, Rarity		✓							
	Ku-ing-gai Chase National Park, Lion, Long and Spectacle Island Nature Reserves	Ku-ring-gai Chase National Park and Long Island, Lion Island and Spectacle Island Nature Reserves contain an exceptional representation of the Sydney region biota, a region which is recognised as a nationally outstanding centre of biodiversity. The place contains a complex pattern of 24 plant communities, including heathland, woodland, open forest, swamps and warm temperate rainforest, with a high native plant species richness of over 1000 species and an outstanding diversity of bird and other animal species. This diversity includes an outstanding representation of the species that are unique to the Sydney region, particularly those restricted to the Hawkesbury Sandstone landform. • Listed: 2006						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		• Class: Natural • Criterion: Events, Processes									
	Kurnell Peninsula Headland	Kurnell Headland (comprising Botany Bay National Park and the Sydney Water land at Potter Point), Kurnell Peninsula, is of outstanding heritage value to the nation as the site of first recorded contact between Indigenous people and Britain in eastern Australia. 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. The story of Cook's first landing on the east coast of Australia is nationally important and an integral part of Australian recorded history and folklore. • Listed: 2004 • Class: Historic • Criterion: Events, Processes, Rarity, Social value, Significant people						✓			
	Lord Howe Island Group	See description under World Heritage Properties.						✓			
	North Head (Sydney)	North Head is important as the northern expression of the seaward entrance to Sydney Harbour (Port Jackson) and played a major role in the cultural and military life of the colony of New South Wales, following the arrival of the First Fleet in 1788. The 'Heads', have signified arrival and departure at Port Jackson since 1788 and are recognised as important, iconic, national landmarks. • Listed: 2006 • Class: Historic • Criterion: Events, Processes, Rarity, Research, Principal characteristics of a class of places, Aesthetic characteristics						✓			

Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	Point Nepean Defence Sites and Quarantine Station Area	Point Nepean is the site of the oldest, surviving, purpose-built, barracks-style, quarantine accommodation buildings in Australia, as well as fortifications demonstrating the primary importance of coastal defence to the Australian colonies. Point Nepean is an historic landscape, which features a range of values relating to both Victorian and national quarantine processes from the 1850s and to the history of coastal defence from the 1870s. • Listed: 2006 • Class: Historic • Criterion: Events, Processes, Rarity, Research, Principal characteristics of a class of places, Significant people		✓							
	Recherche Bay (North East Peninsula) Area	The north-east peninsula of Recherche Bay has an important association with the French scientific and exploratory expedition of Rear Admiral Bruni D'Entrecasteaux. It stopped at Recherche Bay in 1792 and in 1793 for about seven weeks in total. The relatively extensive, well-documented encounters on the coast of the north-east peninsula of Recherche Bay, compared to those in other places and involving other expeditions, between the expedition members and the Tasmanian Aborigines, provided a very early opportunity for meetings and mutual observation. The recordings, from the French perspective, of these encounters, are important observations of the lives of the Tasmanian Aboriginal people. • Listed: 2005 • Class: Historic • Criterion: Events, Processes, Research, Creative or technical achievement, Social value, Significant people					✓				
	Tasmanian Wilderness	See description under World Heritage Properties.				✓	✓				
	Western Tasmania Aboriginal Cultural Landscape	The Western Tasmania Aboriginal Cultural Landscape represents the best evidence of an Aboriginal economic adaptation which included the development of a semi-sedentary way of life with				✓					

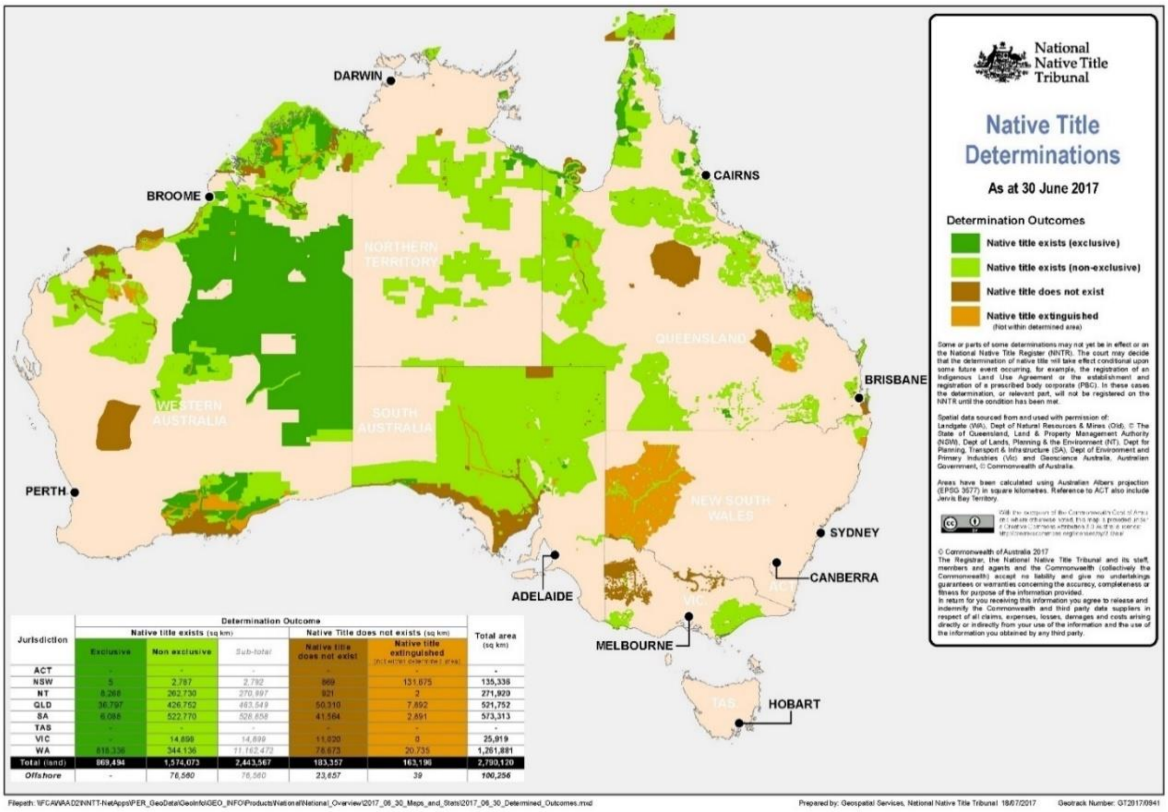
Type	Name	Description	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		people moving seasonally up and down the north-west coast of Tasmania. This way of life began approximately 1 900 years ago and lasted until the 1830s. Dotted along the wind-swept coastline of the Western Tasmania Cultural Landscape are the remains of numerous hut depressions found in Aboriginal shell middens. These huts and middens are the remnants of an unusual, specialised and more sedentary Aboriginal way of life which was based on the hunting of seals and land mammals, and the gathering of shellfish. • Listed: 2013 • Class: Indigenous • Criterion: Events, Processes									

5.6.3 Indigenous

Indigenous occupation of coastal areas dates back at least 40,000 years (DoE, 2015a). The coastal area of south-east Australia was amongst the most densely populated regions of pre-colonial Australia; these areas provided an abundance of marine and other resources that were not available away from the coast and oceans (NOO, 2002). Contemporary indigenous interests in the region are diverse; with Indigenous people living within major cities, regional centres, small towns and on Indigenous land (NOO, 2002). Indigenous communities of the South-east and Temperate East Marine Regions continue to have a strong cultural and spiritual connection to the ocean, and to use ocean resources for food, traditional purposes and income (DoE, 2015a; DEWHA, 2009b).

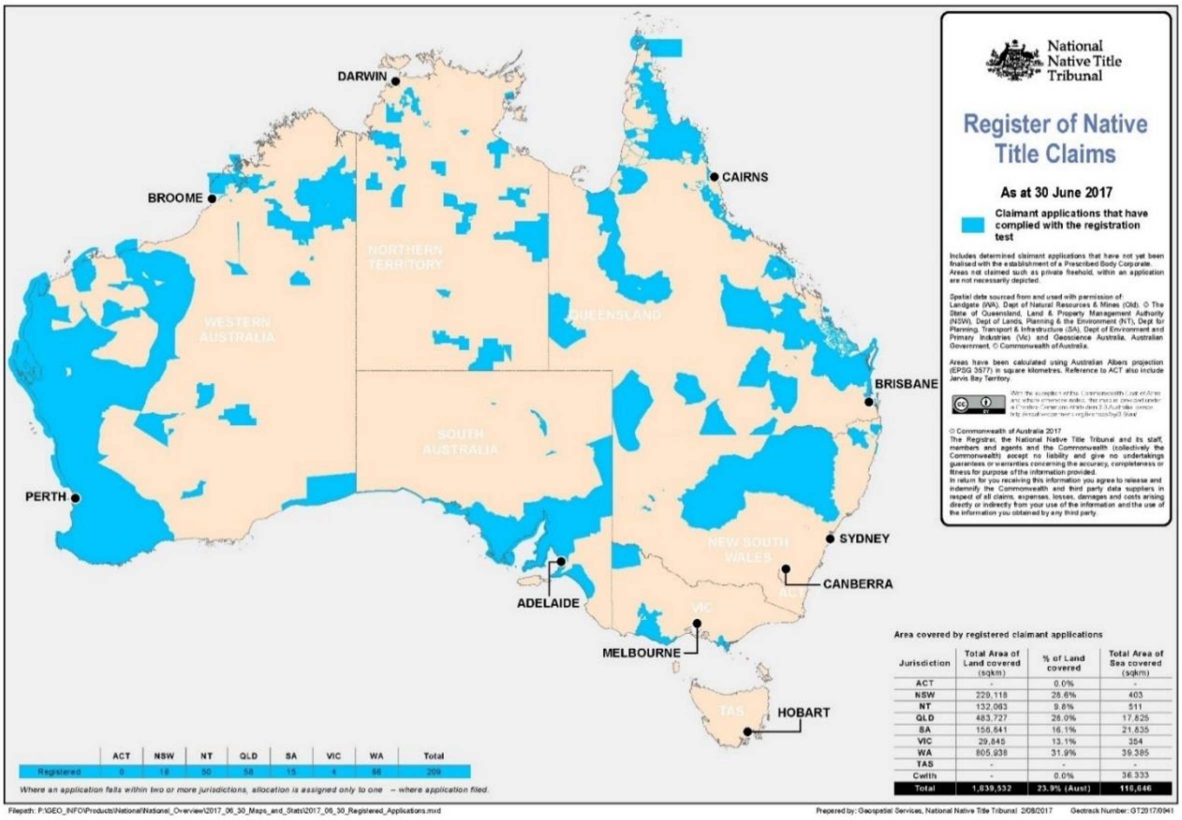
There are current Native Title determinations, with non-exclusive Native Title established, in areas of the Victorian, northern New South Wales, and southern Queensland coast, within the Environment Sectors (Figure 5-28). The Gunaikurnai people hold one of these native titles over an area extending from West Gippsland in Warragul, east to the Snowy River and north to the Great Dividing Range; and it also extends 200 m offshore. There are also further Native Title claims along sections of the coast within the Environment Sectors (Figure 5-29).

The Victorian coast is of significance with respect to aboriginal cultural heritage. This includes areas where there may be no physical evidence of past cultural activities but includes places of spiritual or ceremonial significance, places where traditional plant or mineral resources occur or trade and travel routes (Aboriginal Victoria, 2008). Along the Victorian coast, encounter with areas containing coastal shell middens, charcoal and hearth stones from fires, and items such as bone and stone artefacts, is possible. These areas are typically located within sheltered positions in the dunes, coastal scrub and woodlands, within rock shelters or on exposed cliff tops with good vantage points (Aboriginal Victoria, 2008). Coastal shell middens are found as layers of shell exposed in the side of dunes, banks or cliff tops or as scatters of shell exposed on eroded surfaces. Threats to coastal shell middens include exposure by wind and water erosion; degradation by human or animal interference; burrowing animals; people destabilizing ground using unregulated tracks or off-road vehicles



(Source: NNTT, 2017)

Figure 5-28: Native Title Determinations



(Source: NNTT, 2017)

Figure 5-29: Native Title Registered Claims

6 Summary

The following tables show the presence of ecological (Table 6.1) and social (Table 6.2) receptors that may occur within each of the Environment Sectors (Figure 1-1).

Examples of values and sensitivities associated with each of the ecological or social receptors have been included in the tables. These values and sensitivities have been identified based on:

- Presence of listed threatened or migratory species, or threatened ecological communities
- Presence of BIAs
- Presence of important behaviours (e.g. foraging, roosting or breeding) by fauna, including those identified in the EPBC Protected Matter searches
- Provides an important link to other receptors (e.g. nursery habitat, food source, commercial species), or
- Provides an important human benefit (e.g. community engagement, economic benefit).

For a summary of the receptors present within operational areas and EMBAs, refer to the relevant Environment Plans.

Table 6.1: Presence of Ecological Receptors within the Environment Sectors

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Habitat	Shoreline	Cliff	• Foraging habitat (e.g. birds) • Nesting or Breeding habitat (e.g. birds)		✓		✓	✓	✓	✓	✓	✓
		Rocky	• Foraging habitat (e.g. birds) • Nesting or Breeding habitat (e.g. birds, pinnipeds) • Haul-out sites (e.g. pinnipeds)	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Gravel/Cobble	• Foraging habitat (e.g. birds) • Nesting or Breeding habitat (e.g. birds, pinnipeds) • Haul-out sites (e.g. pinnipeds)	✓	✓		✓	✓	✓	✓		
		Sandy	• Foraging habitat (e.g. birds) • Nesting or Breeding habitat (e.g. birds, pinnipeds, turtles) • Haul-out sites (e.g. pinnipeds)	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Muddy	• Foraging habitat (e.g. birds)		✓		✓	✓				
		Tidal Flat	• Foraging habitat (e.g. birds)		✓	✓	✓	✓	✓	✓	✓	✓
		Artificial structure	• Community engagement • Economic benefit	✓	✓	✓	✓	✓	✓	✓	✓	
	Mangroves	Mangrove strands	• Nursery habitat (e.g. crustaceans, fish)		✓	✓			✓	✓	✓	
	Saltmarshes	Saltmarsh ecosystems	• Nursery habitat (e.g. crustaceans, fish)	✓	✓	✓	✓	✓	✓	✓	✓	
			• Threatened Ecological Community	✓	✓	✓	✓	✓	✓	✓		
	Coastal Vine Thicket	Littoral Rainforest and Coastal Vine Thickets of Eastern Australia	• Threatened Ecological Community			✓			✓	✓		
	Soft Sediment	Unvegetated soft sediment substrates	• Key habitat (e.g. benthic invertebrates)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Seagrass	Seagrass meadows	• Nursery habitat (e.g. crustaceans, fish)	✓	✓	✓	✓	✓	✓	✓	✓	

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
			• Food source (e.g. dugong, turtles)									
			• Threatened Ecological Community						✓			
	Algae	Benthic Microalgae	• Food source (e.g. gastropods)	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Macroalgae beds	• Nursery habitat (e.g. crustaceans, fish) • Food source (e.g. birds, fish)	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Threatened Ecological Community		✓			✓				
	Coral	Hard and soft coral communities	• Nursery habitat (e.g. crustaceans, fish) • Breeding habitat (e.g. fish)	✓	✓	✓	✓	✓	✓	✓	✓	✓
MARINE FAUNA	Plankton	Phytoplankton and zooplankton assemblages	• Food Source (e.g. whales, turtles)	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Seabirds and Shorebirds		• Listed Marine Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Threatened Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Migratory Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• BIA – Aggregation	✓	✓		✓	✓				
			• BIA – Breeding	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• BIA – Foraging	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Behaviour - Breeding	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Behaviour - Foraging	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Behaviour - Roosting	✓	✓	✓	✓	✓	✓	✓		✓
	Marine Invertebrates	Benthic and pelagic invertebrate communities	• Food Source (e.g. whales, turtles) • Commercial Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Threatened Species				✓	✓				
	Fish	Fish	• Threatened Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Commercial Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Sharks and Rays	• Threatened Species	✓	✓	✓	✓	✓	✓	✓	✓	✓

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
			• Migratory Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• BIA – Aggregation						✓	✓		
			• BIA – Breeding		✓	✓			✓	✓		
			• BIA – Distribution	✓	✓	✓	✓	✓	✓	✓		
			• Behaviour - Breeding		✓	✓			✓	✓		
			• Behaviour – Congregation/Aggregation							✓		
			• Behaviour - Foraging	✓			✓	✓				
		Syngnathids	• Listed Marine Species	✓	✓	✓	✓	✓	✓	✓	✓	
	Marine Reptiles	Turtles	• Listed Marine Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Threatened Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Migratory Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• BIA – Foraging							✓		
			• BIA – Internesting							✓		
			• BIA – Nesting							✓		
			• Behaviour - Breeding	✓		✓	✓	✓	✓	✓		
			• Behaviour – Foraging	✓	✓	✓			✓	✓		
		Sea Snakes	• Listed Marine Species						✓	✓		
		Crocodiles	• Listed Marine Species							✓		
			• Migratory Species							✓		
	Marine Mammals	Pinnipeds	• Listed Marine Species	✓	✓	✓	✓	✓	✓			
			• Threatened Species	✓			✓					
			• BIA – Foraging	✓								
			• Behaviour - Breeding	✓	✓	✓	✓					
			• Behaviour - Foraging	✓	✓	✓	✓	✓	✓			

Receptor Group	Receptor Type	Receptor Description	Values and Sensitivities	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
		Sirenians	• Listed Marine Species						✓	✓		
			• Migratory Species						✓	✓		
		Whales	• Listed Marine Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Threatened Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Migratory Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• BIA – Aggregation	✓								
			• BIA – Breeding					✓		✓		
			• BIA – Connecting Habitat		✓		✓	✓				
			• BIA - Distribution									
			• BIA – Foraging	✓	✓	✓	✓	✓				
			• BIA – Migration	✓	✓	✓			✓	✓		
			• Behaviour - Breeding	✓						✓		
			• Behaviour - Foraging	✓	✓	✓	✓	✓	✓	✓		
		Dolphins	• Listed Marine Species	✓	✓	✓	✓	✓	✓	✓	✓	✓
			• Migratory Species	✓	✓	✓	✓	✓	✓	✓		
			• BIA – Breeding							✓		
			• BIA – Calving							✓		
			• BIA – Foraging							✓		
			• Behaviour - Breeding							✓		
		Porpoise	• Listed Marine Species				✓	✓				
			• Migratory Species				✓	✓				

Table 6.2: Presence of Social Receptors within the Environment Sectors

Receptor Group	Receptor Type	Receptor Description	Values and Sensitives	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
Natural System	Commonwealth Parks	Key Ecological Features	• Various; e.g. high productivity, aggregations of marine life • Refer to Section 4.6 for specific values and sensitivities associated with each KEF	✓	✓	✓	✓	✓	✓	✓	✓	
		Australian Marine Park	• Various; e.g. migration route, foraging areas, heritage sites • Refer to Section 4.3 for values and sensitivities associated with each AMP	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Commonwealth National Park	• Various; e.g. breeding areas, cultural sites • Refer to Section 4.3.2 for values and sensitivities associated with National Park						✓			
	State Parks and Reserves	Marine Protected Areas	• Various; e.g. foraging or breeding areas	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Terrestrial Protected Areas	• Various; e.g. shorelines	✓	✓	✓	✓	✓	✓	✓		
	Wetlands	International (Ramsar) Importance	• Various; e.g. high biodiversity, habitat for threatened species • Refer to Section 4.4.1 for values and sensitivities associated with each wetland	✓	✓	✓		✓	✓	✓		
		National Importance	• Various; e.g. high biodiversity, habitat for threatened species • Refer to Section 4.4.2 for values and sensitivities associated with each wetland	✓	✓	✓	✓	✓	✓	✓		
Human System	Commercial Fisheries	Commonwealth-managed	• Economic benefit	✓	✓	✓	✓	✓	✓	✓		✓
		State-managed	• Economic benefit	✓	✓	✓	✓	✓	✓	✓		
	Recreational Fisheries		• Community engagement	✓	✓	✓	✓	✓	✓	✓		
	Coastal Settlements		• Community engagement • Economic benefit	✓	✓	✓	✓	✓	✓	✓		✓

Receptor Group	Receptor Type	Receptor Description	Values and Sensitives	Otway	Bass Strait	Gippsland	Sorell	SE Tasmania	Central NSW	SE Queensland	Lord Howe	Norfolk Island
	Recreation and Tourism		• Community engagement • Economic benefit	✓	✓	✓	✓	✓	✓	✓	✓	✓
	Industry	Shipping	• Community engagement • Economic benefit	✓	✓	✓	✓	✓	✓	✓	✓	
		Oil and Gas Exploration and/or Operation	• Economic benefit	✓	✓	✓	✓	✓	✓			
		Submarine Cables and Pipelines	• Economic benefit		✓				✓			
		Military	• Protection and surveillance		✓				✓			
	Heritage	Maritime	• Shipwrecks	✓	✓	✓	✓	✓	✓	✓	✓	✓
		Cultural	• Commonwealth Heritage Places • World Heritage Properties • National Heritage Places	✓	✓	✓	✓	✓	✓	✓		✓
		Indigenous	• Indigenous use or connection • Native Title	✓	✓	✓	✓	✓	✓	✓		✓

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Appendix 1 - Marine/Coastal Wetlands of International Importance

The classification of a 'marine/coastal wetland' is extensive and includes those wetlands that while predominantly based inland have some form of connection with the coast and/or marine waters. The Ramsar classification for 'marine/coastal wetlands' includes:

- A — Permanent shallow marine waters in most cases less than six metres deep at low tide; includes sea bays and straits.
- B — Marine subtidal aquatic beds; includes kelp beds, sea-grass beds, tropical marine meadows.
- C — Coral reefs.
- D — Rocky marine shores; includes rocky offshore islands, sea cliffs.
- E — Sand, shingle or pebble shores; includes sand bars, spits and sandy islets; includes dune systems and humid dune slacks.
- F — Estuarine waters; permanent water of estuaries and estuarine systems of deltas.
- G — Intertidal mud, sand or salt flats.
- H — Intertidal marshes; includes salt marshes, salt meadows, saltings, raised salt marshes; includes tidal brackish and freshwater marshes.
- I — Intertidal forested wetlands; includes mangrove swamps, nipah swamps and tidal freshwater swamp forests.
- J — Coastal brackish/saline lagoons; brackish to saline lagoons with at least one relatively narrow connection to the sea.
- K — Coastal freshwater lagoons; includes freshwater delta lagoons.
- Zk(a) —Karst and other subterranean hydrological systems, marine/coastal.

The key features of the wetland sites, as described within the Australian Wetland Database, are provided in the below table.

Table A-1: Key Features of Internationally Important Wetlands

Wetland	Key Features
South Australia	
Piccaninnie Ponds Karst Wetlands	The Piccaninnie Ponds Karst Wetlands are an example of karst spring wetlands, with the largest and deepest of the springs reaching a depth of more than 110 m. The majority of the water comes from an unconfined regional aquifer and is consistently 14-15°C. The karst springs support unique macrophyte and algal associations, with macrophyte growth extending to 15 m below the surface as a result of exceptional water clarity. A number of different wetland types exist on the site, including a large area of peat fens. There are four distinct areas of the Ramsar site. Piccaninnie Ponds (also known as Main Ponds) consists of three interconnected bodies of water - First Pond, The Chasm and Turtle Pond - rounded by an area of shrub dominated swamp. Western Wetland consists of dense closed tea-tree and paperbark shrubland over shallow dark clay on limestone soils. Eastern Wetland includes the spring-fed Hammerhead Pond. Pick Swamp, on the extreme west of the site, includes areas of fen, marshes and sedgelands as well as the spring-fed Crescent Pond on peat soils. The system is an important remnant of an extensive system of wetlands that once occupied much of the south-east of South Australia. The major groundwater discharge points are Main Ponds, Hammerhead Pond and Crescent Pond. Water principally leaves the site via Outlet Creek and the Pick Swamp drain outlet, which connect the site to the sea. There are a number of fresh groundwater beach springs located on the site. The geomorphic and hydrological features of the site produce a complex and biologically diverse ecosystem which supports considerable biodiversity, including a significant number of species of

Wetland	Key Features
	national and/or international conservation value. These include the Orange-bellied Parrot, Australasian Bittern and Yarra Pygmy Perch. The site attracts 20,000 visitors annually for cave diving, snorkelling, bushwalking, educational activities and birdwatching. The site also has spiritual and cultural value. The Traditional Owners of the land, the Bunganditj (Boandik) and local Indigenous people have a strong connection with the site. Traditionally the site provided a good source of food and fresh water, and evidence of previous occupation still exists. <u>Reference</u> *Department of Agriculture, Water nd the Environment. Piccaninnie Ponds Karst Wetlands, in Australian Wetlands Database. Department of Agriculture, Water and the Environment. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=66. Accessed May 2019.*
Victoria	
Corner Inlet	The Corner Inlet Ramsar site is located on the south-east coast of Victoria. It is bounded to the west and north by the South Gippsland coastline, in the south-east by a series of barrier islands and sandy spits lying end to end and separated by narrow entrances, and to the south by the hills of Wilsons Promontory. Corner Inlet includes the chain of barrier islands, multiple beach ridges, lagoons and swamps, tidal creeks, tidal deltas, and tidal washovers. The mainland coast and several sandy islands are covered with mangroves, saltmarshes, sandy beaches and very extensive intertidal mudflats. The area contains the only extensive bed of the Broad-leafed Seagrass in Victoria. The islands of Corner Inlet, although not rich in plant diversity, are of high biogeographical significance as a result of their geological history and connectivity to the mainland during ice ages. The islands also contain significant areas of saltmarsh and mangroves, both of which are communities of very limited distribution. Corner Inlet supports more than 390 species of marine invertebrates and 390 species of native flora. The Ramsar site also has a high diversity of bird species with thirty-two wader species recorded. Corner Inlet provides extensive tidal flats that are exposed at low tide, which are important feeding areas for waders. It is estimated that nearly 50 per cent of the overwintering migratory waders in Victoria occur in Corner Inlet. The nationally threatened species utilising the Ramsar site include the Orange-bellied Parrot, Growling Grass Frog, Australian Grayling and Swift Parrot. Corner Inlet was used traditionally by Indigenous people and many archaeological sites including scarred trees, burial sites, artefact scatters, shell middens and camps have been found. Currently, the Ramsar site is used for biological conservation, ports with servicing facilities for off-shore oil and natural gas exploration, commercial fishing, recreational fishing, and other recreational activities. Diving is popular around the numerous shipwreck sites in Corner Inlet and around the barrier islands. <u>Reference</u> *Department of the Environment and Energy. 2017. Corner Inlet, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=13. Accessed 25 Jul 2017.*
Edithvale-seafood wetlands	The Edithvale-Seaford wetlands are located in the south-eastern suburbs of Edithvale and Seaford in Melbourne, Victoria. They are the last remnants of the once extensive Carrum Carrum Swamp, a large inter-dunal lagoon that was largely drained in the late 19th century. The Ramsar site is used for flood control, conservation, recreation and education. The wetlands in the Ramsar site are naturally fresh to brackish marshes and open water wetlands, underlain by peat beds that limit the entry of saline groundwater. Both wetlands receive waters from the surrounding urban and semi-rural catchment and discharge to Port Phillip Bay via drains. The wetlands provide habitat in an urban setting for remnant species, supporting a range of native and introduced vegetation. A total of 202 plant species have been recorded for the wetlands, including a significant extension to the range of the native Southern Water Ribbons.

Wetland	Key Features
	Remnant habitats support a variety of native bird, mammal, frog, reptile, fish and invertebrate populations, several of which are of regional and state conservation significance. Seaford Swamp is a site of international importance for the Sharp-tailed Sandpiper. The Carrum Carrum Swamp was part of the extensive lands traditionally occupied the Bunerong people, providing important sources of food and material. The wetlands are now in the midst of an urban environment and are managed as an integral part of the regional drainage system. They are a significant resource for passive and nature-based recreation, and offer environmental education opportunities for local schools, tertiary institutions and the wider community. *Reference* *http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=57*
Floor plain lower Ringarooma river	The Flood Plain Lower Ringarooma River Ramsar site is located on the far north-east coast of Tasmania, between Cape Portland and Waterhouse Point. The site is situated on the sandy flood plain of the Lower Ringarooma River which encompasses extensive marshlands and a number of shallow lagoons; Shantys Lagoon, Blueys Lagoon and Bowlers Lagoon. The Ringarooma River drains out into Ringarooma Bay. The hydrology of this site is influenced by tidal flows, river flows and local groundwater. The bulk of the wetland area is above the tidal limit and is largely controlled by inflows from the Ringarooma River. The Ramsar site is dominated by scrub and tussock grassland vegetation, and includes substantial areas of freshwater marsh habitat in the flood plain. The varieties of habitats support the following vegetation communities: Saltmarsh, Coastal grass and herbfield, Lowland Sedgy heathland, Wet heathland, Coastal heathland, Coastal scrub, Allocasuarina verticillata forest and Eucalyptus coastal forest. The Flood Plain Lower Ringarooma River is considered to be a good foraging area for dabbling ducks and other waterbirds due to the large area of shallow water. A number of bird species listed under international migratory conservation agreements have also been recorded at the site. These include: Cattle Egret, Great Egret, Latham's Snipe, Curlew Sandpiper, Red-necked Stint, Bar-tailed Godwit, Caspian Tern and Greenshank. Australasian Shoveler, Little Tern, Hooded Plover and Fairy Tern are also known to breed within the Ramsar site. The Ramsar site also provides habitat for threatened species, including four wetland-dependent species: • green and gold frog; • dwarf galaxias; • fairy tern; and • Australian grayling. The Flood Plain Lower Ringarooma River was traditionally used by Indigenous people. It also has a history of European occupation and mining exploitation since the early 1800s. Currently, the Ramsar site is used for duck hunting and cattle grazing.
Gippsland Lakes	The Gippsland Lakes Ramsar site is located approximately 300 km east of Melbourne on the low-lying South East Coastal Plain bioregion. Covering a vast area, the lakes are a series of large, shallow, coastal lagoons approximately 70 km in length and 10 km wide, separated from the sea by sand dunes. The surface area of the lakes is approximately 364 km^2 and the three main water bodies are Lakes Wellington, Victoria, and King. The Gippsland Lakes together form the largest navigable inland waterway in Australia and create a distinctive regional landscape of wetlands and flat coastal plains of considerable environmental significance. The Mitchell Delta of the Ramsar site is a classic form of digitate delta and ranks as one of the finest examples of this type of landform in the world. The silt jetties of the delta extend almost eight kilometres into the lake as low, narrow tongues of sediment that were formerly bordered by a wide zone of reedswamp. The Ramsar site contains 11 Ramsar wetland habitat types including most notably, coastal lagoons, subtidal seagrass and algal beds, and a range of saline, brackish and freshwater marsh environments. The site supports a broad range of ecosystem services including nationally and internationally threatened wetland species, waterbird breeding and fish spawning sites. Cultural and socio-economic

Wetland	Key Features
	values are equally diverse, noting the particular importance of the site in a regional context in terms of recreational activities such as boating, recreational fishing and holiday tourism The Gippsland Lakes support three nationally vulnerable and endangered wetland-associated flora species (Dwarf Kerrawang, Swamp Everlasting and Metallic Sun-orchid), and the nationally threatened Growling Grass Frog and Green and Golden Bell Frog . The bird diversity of the Ramsar wetland is high with 86 species of waterbirds being recorded including large numbers of the Red-necked Stint, Black Swan, Sharp-tailed Sandpiper, Chestnut Teal, Musk Duck, Fairy Tern and Little Tern. Currently, parts of the Lakes system are heavily used for commercial and recreational fisheries and boating activities, while the immediate hinterland has been developed for agricultural use, and limited residential and tourism purposes. Reference *Department of the Environment and Energy. 2017. Gippsland Lakes, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=21. Accessed 25 Jul 2017.*
Glenelg Estuary and Discovery Bay Wetlands	The Glenelg Estuary and Discovery Bay Ramsar Site is situated in western Victoria. It covers approximately 22,289 hectares and comprises portions of the Lower Glenelg National Park, the Discovery Bay Coastal Park and the Nelson Streamside Reserve. The Glenelg River estuary is the longest in the bioregion, extending 75 kilometres. The Ramsar site comprises three broad systems that support different wetland types: freshwater wetlands, the Glenelg Estuary and the beach and dune system. The site contains several regionally (and internationally) rare wetland types: intact fen peatlands and a humid dune slack system. The site: • supports the nationally vulnerable coastal saltmarsh ecological community and eight nationally / internationally listed threatened flora and fauna species. • provides habitat for 95 waterbird species including 24 species listed under international agreements: CAMBA (24), JAMBA (24), ROKAMBA (21), BONN (21). Beach nesting birds such as hooded plover (Thinornis rubricollis) and red-capped plover (Charadrius ruficapillus) are regularly recorded nesting on the dunes of the Discovery Bay Coastal Park. • supports 14 species of native fish which are diadromous, migrating between habitats for part of their lifecycle by providing food, spawning grounds and nurseries. It also acts as a migration path on which diadromous fishes of the region depend. • provides habitat for obligate aquatic species in the permanent wetlands of the Long Swamp complex and Bridgewater Lakes when the surrounding landscape is dry and during drought conditions. • supports > 1% of the population of the wetland dependent invertebrate species the Ancient greenling (Hemiphlebia mirabilis) in the Baumea sedgelands. The area is popular for recreational and tourism activities, including sightseeing, walking, camping, and recreational fishing. Importantly, the Gunditjmara Indigenous people have a living association with the Ramsar site, which has great cultural significance for them, as it is part of their Koonang (sea) and Bocara Woorrowarook (river forest) country. The ecological character of the site is defined by 10 critical components, processes and services:Components: • Hydrology • Vegetation type and extent • Fish diversity and abundance • Waterbird diversity and abundance Process: • Stratification Services: • Special features (dune slacks) • Supports a diversity of wetland types • Supports threatened species • Provides physical habitat for waterbirds • Ecological connectivity Reference

Wetland	Key Features
	Department of Agriculture, Water and the Environment. 2021. Glenelg Estuary and Discovery Bay Wetlands in Australian Wetlands Database. Department of Agriculture, Water and the Environment, Canberra. Available from: https://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=67 Accessed 14 May 2021.
Port Philip Bay (Western Shoreline) and Bellarine Peninsula	The Port Phillip Bay (Western Shoreline) and Bellarine Peninsula Ramsar site is located in the western portion of Port Phillip Bay, near the city of Geelong in Victoria. The site comprises six distinct areas that include Point Cook/Cheetham, Werribee/Avalon, Point Wilson/Limeburners Bay, Swan Bay, Mud Islands, and the Lake Connewarre Complex. The Ramsar site is a low-lying area and a natural discharge point for the rivers draining southern central Victoria. The tidal amplitude within the bay is reduced compared with Bass Strait due to the narrow opening of the Bay (Port Phillip Heads). Port Phillip Bay (Western Shoreline) and Bellarine Peninsula support a variety of wetland types ranging from shallow marine waters to seasonal freshwater swamps and extensive sewage ponds. Wetland areas include freshwater lakes, estuaries, some with White Mangrove, saltmarshes, intertidal mudflats and seagrass beds. The Ramsar site supports some plants species threatened in Victoria, such as Small Scurf-pea and Rare Bitter-bush. This Ramsar site is the sixth most important area in Australia for migratory waders and the most important in Victoria. Large numbers of bird species including Pied Oystercatchers, Banded Stilts, Red-necked Stint, Sharp-tailed Sandpiper, Fairy Tern, Australasian Shoveler, Red-necked Avocets, Blue-billed Duck, and Freckled Duck, have been recorded at the site. Furthermore, the Melbourne Water Corporation Sewage Farm and Western Treatment Plant at Werribee support many waterbirds on its retention ponds. Port Phillip Bay (Western Shoreline) and Bellarine Peninsula provides important habitat for threatened species such as the Little Tern and Striped Legless Lizard. In particular, large numbers of the nationally threatened Orange-bellied Parrot utilise Port Phillip Bay during the winter after their summer migration to Tasmania to breed. Swan Bay and Limeburners Lagoon are also valuable fish breeding grounds for many of the commercial species caught in Port Phillip Bay. There are a number of important indigenous sites within the wetlands, including burial sites, middens and artefacts, with the oldest midden in the area being at least 5,000 years old. Currently over three million people live around Port Phillip Bay, which is used intensively for recreation, nature conservation, sewage treatment, aquaculture, fishing, and salt production. Reference *Department of the Environment and Energy. 2017. Port Phillip Bay (Western Shoreline) and Bellarine Peninsula, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=18. Accessed 25 Jul 2017.*
West district lakes	The Western District Lakes Ramsar site is located within the western volcanic plains region of Victoria, near the township of Colac. It lies within the landlocked Lake Corangamite catchment and is comprised of nine separate lakes. The lakes vary in size, depth and salinity, depending on their method of formation, catchment area and outlet. Lake Corangamite is the largest, covering approximately 25 000 hectares. The only significant river in the region, the Woady Yallock River, drains into this lake. The Ramsar site is roughly equivalent to the high-water mark of the nine lakes and vegetation within the site is therefore limited. Approximately 10-20% of the lake margins are vegetated, mostly with saltmarsh communities. A total of five submerged aquatic plant species have been recorded. Two nationally threatened species, the salt-lake tussock-grass (Poa sallacustris) and spiny peppercress (*Lepidium aschersonii*) occur within the Ramsar site. The Ramsar site provides habitat for approximately 70 waterbird species, 20 of which are listed under international migratory species treaties and 11 of which breed within the Ramsar site. Some species congregate there in large numbers, including the Australian shelduck, chestnut teal, Australasian shoveler, Eurasian coot and banded stilt.

Wetland	Key Features
	Six native species of fish have been recorded within the lakes of the Ramsar site. Of the invertebrates recorded, molluscs dominate most of the saline and mesosaline lakes whilst Lake Colongulac is dominated by oligochaetes. Hydrology is variable across the site. Some of the lakes are permanent whilst others are seasonal or intermittent. All are connected to saline, surficial groundwater and all except Lakes Beeac and Cundare are groundwater flow-through lakes. Most of the water is received through direct rainfall and lost via evaporation. All lakes are highly turbid and have high nutrient levels. The region is spiritually and culturally significant for the Djargurd Wurrung and Gulidjan Indigenous groups. There are several important archaeological sites in the Ramsar site, which was particularly significant for the provision of food.
Western Port	Western Port is a large bay in southern Victoria incorporating around 260 km of coastline, connected to Bass Strait by a wide channel between Flinders and Phillip Island, and a narrow channel between San Remo and Phillip Island. Six rivers from the north and east of the catchment flow into the northern and eastern shores of Western Port and several minor rivers and creeks on the eastern slopes of the Mornington Peninsula drain into the western shores. The Ramsar site has a wide variety of habitat types, ranging from deep channels, seagrass flats, intertidal mudflats, extensive mangrove thickets and saltmarsh vegetation. The white mangrove communities within Western Port are the most well-developed and extensive in Victoria and are the only large communities situated so far from the Equator. Threatened plant species that are found within the Ramsar site include Dense Leek-orchid, Creeping Rush, and Tiny Arrow Grass. Western Port is one of the three most important areas for waders in Victoria and the site supports numerous migratory species listed under international migratory bird conservation agreements. High numbers of Eastern Curlew, Whimbrel, Bar-tailed Godwit, Grey-tailed Tattler, Greenshank and Terek Sandpiper have been recorded at the site. Nationally threatened species that utilise Western Port include the Orange-bellied Parrot, Swift Parrot, Helmeted Honeyeater, Little Tern, Southern Right Whale, and listed migratory Humpback Whale. The site supports the globally threatened Fairy Tern which is listed as vulnerable on the IUCN Red List of Threatened Species. A number of Indigenous cultural heritage sites on the shores of Western Port have been identified. Currently, Western Port is used for commercial fishing and recreational activities such as boating, swimming and fishing. <u>Reference</u> *Department of the Environment and Energy. 2017. Western Port, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=18. Accessed 25 Jul 2017.*
Tasmania	
Apsley Marshes	The Apsley Marshes Ramsar site covers the freshwater marshes at the mouth of the Apsley River, located on the east coast of Tasmania. The Apsley Marshes stores and filters flood waters from the Apsley River for slow release into the adjacent Moulting Lagoon Ramsar wetland. Both these wetlands are geologically significant as they were formed in a long-lived graben system, which is possibly related to the break up of Gondwanaland. The Apsley Marshes contain large areas of woody vegetation dominated by Swamp Paperbark. Saltmarsh communities occur in the southern section near Moulting Lagoon. Parts of the site are important for swan nesting, and it is an important feeding and breeding area for waterfowl which require a freshwater habitat. The marshes have a long history of human use, including use by Indigenous communities. The land is private freehold and used for grazing. <u>Reference</u> *Department of the Environment and Energy. 2017. Apsley Marshes, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=7. Accessed 25 Jul 2017.*

Wetland	Key Features
East Coast Cape Barren Island Lagoons	The East Coast Cape Barren Island Lagoons Ramsar site is located on the east coast of Cape Barren Island, one of the Furneaux Group of islands which lie in Bass Strait to the north-east of Tasmania. The site extends from just north of Tar Point down to Jamieson's Bay and extends westwards from the coast for a distance varying from one to four kilometres. It comprises a complex of freshwater, brackish, saline and sometimes hypersaline lagoons, wetlands and estuaries that owe their existence to a dune system which has been slowly developing in an easterly direction, leaving shallow sandy soils, depressions and intermittently flowing water courses. The vegetation of the site is characterised by a tussock grassland of the exotic species Marram Grass on the foredunes, with a closed-scrub of Coastal Wattle, Prickly Moses and Marram Grass stabilising the hind dunes. Coastal Wattle, Silver Banksia and Southern Grass Tree form an open scrub on the sand plains behind these dunes, with further inland areas dominated by Manna Gum, Swamp Gum and Smithton Peppermint. This extensive system of shallow coastal lagoons contains a number of species that are considered to be of special botanical interest, including the Scarce Centrolepis which is rare at both a state and national level. Pointed Centrolepis, Sharpleaf Rush, Water Milfoil, Sago Pondweed, and Round-leaf Wilsonia are also found within the site. Locally significant numbers of duck species for the Flinders bioregion utilise this area. In addition, the Ramsar site is of great importance for the Hooded Plover. This area is of cultural importance to the local Indigenous community, who manage the freehold title to part of Cape Barren Island, including the Ramsar site. Access is currently restricted, keeping the site largely undisturbed, with a single bush track for 4WD vehicles providing access for duck hunters to Flyover Lagoon. Reference *Department of the Environment and Energy. 2017. East Coast Cape Barren Island Lagoons, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=8. Accessed 25 Jul 2017.*
Flood Plain Lower Ringarooma River	The Flood Plain Lower Ringarooma River Ramsar site is located on the far north-east coast of Tasmania, between Cape Portland and Waterhouse Point. The site is situated on the sandy flood plain of the Lower Ringarooma River which encompasses extensive marshlands and a number of shallow lagoons; Shantys Lagoon, Blueys Lagoon and Bowlers Lagoon. The Ringarooma River drains out into Ringarooma Bay. The hydrology of this site is influenced by tidal flows, river flows and local groundwater. The bulk of the wetland area is above the tidal limit and is largely controlled by inflows from the Ringarooma River. The Ramsar site is dominated by scrub and tussock grassland vegetation, and includes substantial areas of freshwater marsh habitat in the flood plain. The varieties of habitats support the following vegetation communities: Saltmarsh, Coastal grass and herbfield, Lowland Sedgy heathland, Wet heathland, Coastal heathland, Coastal scrub, Allocasuarina verticillata forest and Eucalyptus coastal forest. The Flood Plain Lower Ringarooma River is considered to be a good foraging area for dabbling ducks and other waterbirds due to the large area of shallow water. A number of bird species listed under international migratory conservation agreements have also been recorded at the site. These include: Cattle Egret, Great Egret, Latham's Snipe, Curlew Sandpiper, Red-necked Stint, Bar-tailed Godwit, Caspian Tern and Greenshank. Australasian Shoveler, Little Tern, Hooded Plover and Fairy Tern are also known to breed within the Ramsar site. The Ramsar site also provides habitat for threatened species, including four wetland-dependent species: Green and Gold Frog; Dwarf Galaxias; Fairy Tern; and Australian Grayling. The Flood Plain Lower Ringarooma River was traditionally used by Indigenous people. It also has a history of European occupation and mining exploitation since the early 1800s. Currently, the Ramsar site is used for duck hunting and cattle grazing. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Flood Plain Lower Ringarooma River, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=9. Accessed 25 Jul 2017.
Jocks Lagoon	The Jocks Lagoon Ramsar Site is located about five kilometres south-east of the township of St Helens on the north-east coast of Tasmania. It is one of a chain of lagoons, swamps and wetlands occurring along St Helens Point. Jocks Lagoon is a small freshwater lagoon which is fed from surface runoff and groundwater. The site is located in sands and clays separated from the sea by a beach and sand dunes. The dominant vegetation community within the lagoon itself is freshwater aquatic sedgeland and rushland, with several beds of tall sedges and waterribbons as emergent plants. Spreading Swordsedge open sedgeland and Jointed Twigsedge dominate a small edge zone on the south-west side in a mixture with scrub. Melaleuca swamp forest dominates along the eastern side of the lagoon. On higher ground these communities become coastal heathland and Acacia coastal scrub with some areas dominated by the introduced Marram Grass. Most of the vegetation communities on the site are threatened in Tasmania. The site also contains two regionally rare plant species, the Jointed Twigsedge and Erect Marshflower. The lagoon supports microcrustaceans and macrocrustaceans, including Burrowing Freshwater Crayfish. The Brown Froglet and Eastern Banjo Frog also occur within the site. Most of the site is private freehold land, with a small section at the south-east end falling within the St Helens Point Conservation Area. The site is mainly used for conservation and recreation. Reference *Department of the Environment and Energy. 2017. Jocks Lagoon, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=10. Accessed 25 Jul 2017.*
Lavinia	The Lavinia Ramsar site is located 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. The shifting sands of the Sea Elephant River's mouth have caused a large back-up of brackish water in the site, creating the saltmarsh which extends up to five kilometres 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 present on the site 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 which 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. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Lavinia, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=5. Accessed 25 Jul 2017.
Little Waterhouse Lake	Little Waterhouse Lake is located seven kilometres south-west of Waterhouse Point, and lies between the towns of Bridport and Tomahawk on the north-east coast of Tasmania. The site forms part of the Waterhouse Point wetlands complex which incorporates Blackmans Lagoon, lakes, marshlands, and creeks with active sand dunes along the coast. The lake is a coastal freshwater lagoon that has formed in a depression between two sand dune systems after drainage to the sea was blocked by some mobile coastal dunes. Little Waterhouse Lake is brackish and has a maximum depth of 2-4 m. Lake levels fluctuate depending on rainfall, with water losses controlled by the rate of surface flow in the outflow stream, seepage through the sand, and evaporation. Little Waterhouse Lake has dense aquatic growth and high species richness. Around the fringes of the lake, freshwater aquatic sedgeland and rushland vegetation communities are dominant. Other vegetation communities at the site include open Coastal scrub, Marram grassland, Sharp Clubsedge sedgeland and *Acacia longifolia* coastal scrub. Tiny Duckweed also occurs on the site and has limited distribution in Tasmania. The Ramsar site provides habitat for the threatened Dwarf Galaxias, and the lake has a high diversity of crustacean species, such as the Burrowing Freshwater Crayfish. Three of Tasmania's eleven frog species are known to occur in the site. The area around the Little Waterhouse Lake was significant to Indigenous groups. The North East people used the heaths and plains behind the coast, which they kept open and clear by burning. The Ramsar site is currently used for various recreational activities, particularly fishing for the introduced Brown Trout and Rainbow Trout. <u>Reference</u> *Department of the Environment and Energy. 2017. Little Waterhouse Lake, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=12. Accessed 25 Jul 2017.*
Logan Lagoon	The Logan Lagoon Ramsar site is enclosed within the Logan Lagoon Conservation Area and is located on the south-east corner of Flinders Island in Bass Strait, Tasmania. The site is an excellent, regionally representative example of a coastal estuarine wetland system and includes Logan, Syndicate and Wilsons Lagoons, Pot Boil Point and part of Planters Beach. The catchment of Logan Lagoon is low lying, with the water table very close to the soil surface, and water flows into the lagoons mainly from groundwater. The water level in Logan Lagoon fluctuates seasonally with rainfall, generally being high during winter and spring and low during late summer and autumn. Only one small natural watercourse, Pot Boil Creek, flows directly into Logan Lagoon. In extended dry periods the lagoon dries out and water is only contained in the southern most section of the lagoon. The dominant vegetation communities present within the site are saline aquatic herbland, saline sedgeland and rushland, succulent saline herbland, coastal grass and herbfield and *Acacia longifolia* coastal scrub. When full, the lagoon provides feeding and resting habitat for a number of migratory waders including the Red-necked Stint, Common Greenshank, Eastern Curlew, Bar-tailed Godwit and Double-banded Plover. The wetland is an important part of the East Asian - Australasian Flyway, and twenty migratory bird species listed under internationally agreements use the site. The Ramsar site is used for conservation, education, research, and recreation such as walking, sightseeing, bird watching, off-road vehicle driving and beach fishing. <u>Reference</u> *Department of the Environment and Energy. 2017. Logan Lagoon, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=4. Accessed 25 Jul 2017.*

Wetland	Key Features
Moulting Lagoon	Moulting Lagoon is situated on the central east coast of Tasmania, between the townships of Swansea and Bicheno and approximately six kilomteres north-west of the township of Coles Bay. The lagoon is a large estuary at the mouths of the Swan and Apsley Rivers. The estuary lies at the head of Great Oyster Bay where the Freycinet Peninsula extends offshore to the south. The lagoon formed with the partial closure of the mouths of the Swan and Apsley Rivers, due to the creation of a bayhead spit and associated dunefield between 10,000 and 6,000 years ago. The lagoon contains areas of both shallow and deep water and is surrounded by periodically exposed mudflats and saltmarsh. The plant communities around Moulting Lagoon reflect the wide diversity of terrain and consequent soil drainage patterns. Aquatic vegetation in the estuary is largely composed of seagrasses. Succulent saline herbland and saline sedgeland and rushland, both saltmarsh communities, surround the lagoon. Vegetation in the shallower areas, mainly Beaded Grasswort and Sea Rush, provides an important nesting, roosting and feeding habitat for the numerous resident waterfowl. The Ramsar site is an important breeding area for Black Swan and an important staging area for all the other species of waterfowl in Tasmania, with particularly large summer concentrations of Australian Shelduck and Chestnut Teal. It also supports the largest known Tasmanian flocks of Greenshank. Moulting Lagoon is part of the Moulting Lagoon Game Reserve. The area historically was used for the harvest of waterfowl and their eggs by Indigenous people who lived around the lagoon. Current use of the Ramsar site includes recreational activities such as fishing and hunting, and commercial activities such as aquaculture and tourism. Reference *Department of the Environment and Energy. 2017. Moulting Lagoon, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=3. Accessed 25 Jul 2017.*
Pitt Water-Orielton Lagoon	The Pitt Water-Orielton Lagoon Ramsar site is located on the south-east coast of Tasmania, approximately 20 km east of the city of Hobart, between the towns of Cambridge and Sorell. Pitt Water is an almost land-locked body of tidal salt water with a narrow entrance to Frederick Henry Bay. Orielton Lagoon is separated from Pitt Water by a causeway constructed in 1868. The whole area is protected from the open sea by a large mid-bay spit and associated dunefield. Most of the Ramsar site is open water fringed by saltmarsh communities, mudflats and rocky shores. The large areas of tidal mud and sand flats leaves extensive areas exposed as suitable feeding areas for wading birds. The vegetation communities present include succulent saline herbland, saline sedgeland/rushland and coastal grassland. The site provides breeding habitat for a number of beach-nesting shorebirds including the Caspian Tern and Red-capped Plover. Migratory birds that utilise the Ramsar wetland include the Eastern Curlew, Bar-tailed Godwit, Common Greenshank, Curlew Sandpiper, Double-banded Plover and Red-necked Stint. Threatened species listed in Tasmania recorded at the site include the Great-crested Grebe, Fairy Tern and Little Tern. Pitt Water-Orielton Lagoon was traditionally used by Indigenous people of the area and the Ramsar site contains some middens and other evidence of Indigenous occupation. Currently the area has a diversity of landuses including pastureland grazing, forestry, irrigated cropland, residential development, shellfish aquaculture, recreation and nature conservation. Reference *Department of the Environment and Energy. 2017. Pitt Water-Orielton Lagoon, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=6. Accessed 25 Jul 2017.*
New South Wales	
Hunter Estuary Wetlands	The Hunter Estuary Wetlands Ramsar site is comprised of two components, Kooragang and Hunter Wetlands Centre Australia. The Kooragang component of the Hunter Estuary Wetlands Ramsar site is located in the estuary of the Hunter River, approximately seven kilometres north of Newcastle on the coast of NSW. Hunter Wetlands Centre Australia is 2.5 km from Kooragang. Although the sites are not

Wetland	Key Features
	contiguous they have significant linkages, both hydrologically and by a wildlife corridor consisting of Ironbark Creek, the Hunter River and Ash Island. The Kooragang component includes Kooragang Island and Fullerton Cove, two areas that lie in the estuarine section of the Hunter River. Kooragang Island originally consisted of seven islands that were mostly separated by narrow mangrove lined channels. In the 1950s these islands were reclaimed and became "Kooragang Island". Habitat types within the Reserve include mangrove forests dominated by Grey Mangrove, Samphire saltmarsh, Paperbark and Swamp she-oak swamp forests, brackish swamps, mudflats, and sandy beaches. Hunter Wetlands Centre Australia is a small but unique complex of wetland types surrounded by urban development along three boundaries. Previously degraded, this urban wetland has been restored. Habitat types at the Hunter Wetlands Centre Australia include restored semi-permanent/seasonal freshwater ponds and marshes, natural semi-permanent/seasonal brackish ponds and marshes, freshwater swamp forests and a coastal estuarine creek. The Hunter Estuary Wetlands Ramsar site is extremely important as both a feeding and roosting site for a large seasonal population of shorebirds and as a waylay site for transient migrants. Over 250 species of birds have been recorded within the Ramsar site, including 45 species listed under international migratory conservation agreements. In addition, the Ramsar site provides habitat for the nationally threatened Green and Golden Bell Frog, Red Goshawk and Australasian Bittern. The Ramsar site was traditionally used by the Worimi, Awabakal and Pambalong peoples. There are numerous middens and campsites scattered throughout the lower Hunter River, particularly within the dunes along Stockton Bight. The Hunter Wetlands Centre Australia also contains an archaeological site that is believed to have been an area for the production of stone tools. Currently, the Kooragang component is used for recreational and nature-based activities. The Hunter Wetlands Centre Australia actively promotes wetland conservation and wise use through communication and education, passive recreation and community involvement. <u>Reference</u> *Department of the Environment and Energy. 2017. Hunter Estuary Wetlands, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=24. Accessed 25 Jul 2017.*
Myall Lakes	The Myall Lakes Ramsar wetland is located within the Myall Lakes National Park, approximately 75 km north of Newcastle on the central coast of NSW. 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 a number of distinct wetlands associated with the waterways and dune systems. The waters of the Myall Lake system are shallow and of roughly uniform depth (2.4–3.7 m) and lake level fluctuations are associated with rainfall rather than tidal influences. The main input of fresh water to the lake system is from the Myall and Crawford Rivers. The Myall Lakes comprise a series of fresh, saline and brackish water bodies of differing depths and associated vegetation types. Myall Lakes support a high plant diversity with 968 species of plants and ten TECs. The major vegetation communities associated with Myall Lakes are: swamp, swamp forest, wet heath, fringe forest and Lepironia swamp. Similarly, the animal species diversity is high and over 300 species have been recorded, with approximately two thirds being bird species. The wetlands regularly support large numbers of waterbirds and waders including ducks, swans, egrets and terns. In addition, Myall Lakes provide habitat for state-listed threatened species such as Masked Owl, Powerful Owl, Black-necked Stork, Wompoo Fruit-Dove, Turquoise Parrot, Little Tern, Little Bent-wing Bat, Tiger Quoll, Eastern Chestnut Mouse and Wallum Froglet. Myall Lakes National Park contains numerous middens, which are the major items of indigenous heritage. No canoe trees have been identified to date, although canoes were obviously used to reach Broughton and Little Broughton Islands.

Wetland	Key Features
	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. Reference *Department of the Environment and Energy. 2017. Myall Lakes, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=52. Accessed 25 Jul 2017.*
Towra Point Nature Reserve	Towra Point Nature Reserve 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 in NSW. It is the largest wetland of its type in the Sydney Basin region and represents vegetation types that are now rare in the area. It is an estuarine complex comprising a mixture of spits, bars, mudflats, dunes and beaches. The Ramsar site 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. The vegetation within Towra Point Nature Reserve is regionally significant, with the reserve containing around 40% of the remaining mangrove communities and 60% of the remaining saltmarsh communities in Sydney. Furthermore, almost 300 plant species have been recorded within the Ramsar site including the threatened Magenta Cherry. Towra Point Nature Reserve is 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 Curlew, Lesser Golden Plover, and Ruddy Turnstone have also been recorded within the Ramsar site. The state-listed threatened Little Tern and Pied Oystercatcher are known to breed within the Reserve. Middens, rock shelters, engravings, burial sites and other items of indigenous heritage have been found within Towra Point Nature Reserve. Captain James Cook anchored in Botany Bay in 1770 and Towra Point was explored, mapped and used as a source of freshwater. It was here where the ship's botanist, Sir Joseph Banks, took the first recognised botanical and zoological samples of Australian flora. The Ramsar site is part of a dedicated Nature Reserve, with activities restricted to nature-based recreation such as bird-watching and fishing. Reference *Department of the Environment and Energy. 2017. Towra Point Nature Reserve, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=23. Accessed 25 Jul 2017.*
Queensland	
Great Sandy Strait (including Great Sandy Strait, Tin Can Bay and Tin Can Inlet)	The Great Sandy Strait Ramsar site is located in south-eastern Queensland and includes Great Sandy Strait, Tin Can Bay, Tin Can Bay Inlet, parts of Fraser Island and the mainland. It is a sand passage estuary between the mainland and the World Heritage-listed Fraser Island. Fraser Island has formed sufficiently close to the mainland to block the flow of a substantial river system, creating a double-ended estuary with a shifting (though relatively stable) pattern of mangroves, sand banks and mud islands Great Sandy Strait is a large area of tidal swamps consisting of intertidal sand and mud flats, extended seagrass beds, mangrove forests, salt flats and saltmarshes, and often contiguous with freshwater Paperbark wetlands and Coastal Wallum swamps. The mangrove communities within the Strait represent a transition between essentially temperate and tropical species. The rare patterned fens have also been recorded along Great Sandy Strait. The coastal wetlands of Great Sandy Strait are also of international significance for migratory birds, with 18 species listed under international migratory bird conservation agreements recorded within the Ramsar site. The Strait is also utilised by turtle species, Dugong and Humpback Whales. Threatened fish such as Oxleyan Pygmy Perch and Honey Blue-eye are also known to inhabit the area. Great Sandy Strait holds significant cultural heritage values for local indigenous groups. Evidence of occupation in the area dates back 5,500 years and middens are frequently found in the site. The Ramsar site is currently highly valued for commercial fishing, recreational fishing, boating and tourism related activities. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Great Sandy Strait (including Great Sandy Strait, Tin Can Bay and Tin Can Inlet), in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=51. Accessed 25 Jul 2017.
Moreton Bay	The Moreton Bay Ramsar site is located in and around Moreton Bay, north-east, east and south-east of the city of Brisbane, in the state of Queensland, Australia. It is located approximately mid-way along the east coast of Australia at a latitude of between 27 and 28 degrees south. The site is in a semi-enclosed basin, bounded on its eastern side by large sand islands and a deltaic coast on the western side, where large rivers discharge to the bay from a combined catchment of approximately 22,000 km2. The bay is approximately 110 km long from north to south and 35 km at its widest east to west axis. The site meets all nine criteria for the designation of wetlands of international importance. It is notable for its large size, diversity of wetland habitats, connectivity between wetland types, as well as diverse flora and fauna that includes threatened species and ecological communities. It contains seagrass, sandy and muddy tidal flats and subtidal areas, saltmarsh, mangroves and coral communities, freshwater wetlands, as well as ocean beaches and dunes. The site includes one of the most extensive intertidal areas of seagrass, mangrove and saltmarsh communities on the eastern coast of Australia, and is valuable for supporting fisheries resources, waterbirds and marine megafauna of conservation significance. The site regularly supports more than 50,000 waterbirds, representing at least 43 species of shorebirds and at least 28 migratory shorebird species. The site is recognised as a network site under the East Asian-Australasian Flyway Partnership (site code EAAF013) and supports over 1% of the estimated flyway population of at least nine migratory shorebird species, including eastern curlew (Numenius madagascariensis) and curlew sandpiper (Calidris ferruginea), which are listed as critically endangered under national environmental legislation. The site further supports a range of internationally, nationally, state and locally significant species including the Oxleyan pygmy perch (Nannoperca oxleyana) fish, four species of acid frogs, the water mouse (Xeromys myoides), Illidge's ant-blue butterfly (Acrodipsas illidgei), and several freshwater invertebrates. In addition to its environmental values, the site provides important cultural, social, economic and recreational values Reference *Department of Agriculture, Water and the Environment. 2021. Moreton Bay in Australian Wetlands Database. Department of Agriculture, Water and the Environment, Canberra. Available from: https://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=67 Accessed 14 May 2021.*
External Territories	
Elizabeth and Middleton Reefs Marine National Nature Reserve	Elizabeth and Middleton Reefs Marine National Nature Reserve is located in the northern Tasman Sea, in Australia's East Marine Region. It is 630 km east of Coffs Harbour, NSW, and 690 km east-south-east of Brisbane, Queensland. Elizabeth and Middleton Reefs are remote coral reef atolls that occur atop isolated, oceanic sea mounts, 50 km apart from each other. They are the most southerly open ocean platform reefs in the world and their coral reef communities are influenced both by tropical and temperate ocean currents. As isolated oceanic wetlands with no permanent dry land, the Reef perimeters provide the only buffer to high-energy impacts of ocean swells and waves, and thus provide for remote sheltered wetland habitats within a vast region of oceanic waters of the western Pacific Ocean.

Wetland	Key Features
	Reef building corals and algae form the dominant components of habitat complexity and ecological features of the site. Elizabeth and Middleton Reefs support several coral species at or near their northern or southern limits of distribution, and species which can self-recruit to the same reef. Seagrass occurs only as scattered plants on the sheltered sandy lagoons at both reefs. The fish communities include seven undescribed fishes and a number of species with specialised habitats and relatively restricted geographic distributions. The Elizabeth and Middleton Reefs populations of the Galapagos Reef Shark form a single genetic stock, which is distinct from the only other Australian population, 173 km further south at Lord Howe Island. Threatened species known to utilise the site include the Green Turtle, Leatherback Turtle, and Wandering Albatross and listed migratory Humpback Whale. At least 30 ships have been recorded wrecked on the Reefs, dating back to the late 18th Century, making the area of considerable marine archaeological significance. Except for the remains of more recent wrecks, which are a conspicuous feature of the Ramsar site, the majority of wrecks have not been accurately located. The wreck *Fuku Maru* on Middleton Reef supports a small breeding colony of Sea Terns, which due to lack of suitable dry land, otherwise would not occur at the Ramsar site. Currently, Elizabeth and Middleton Reefs are mainly use for nature conservation and scientific research, with limited recreational diving and fishing also occurring. Reference *Department of the Environment and Energy. 2017. Elizabeth and Middleton Reefs Marine National Nature Reserve, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/ramsardetails.pl?refcode=60#. Accessed 25 Jul 2017.*

Appendix 2 - Marine and Coastal Zone Wetlands of National Importance

The classification of a 'Marine and Coastal Zone wetlands' is extensive and includes those wetlands that while predominantly based inland have some form of connection with the coast and/or marine waters. The category for 'Marine and Coastal Zone wetlands' includes:

1. Marine waters - permanent shallow waters less than six metres deep at low tide; includes sea bays, straits.
2. Subtidal aquatic beds; includes kelp beds, seagrasses, tropical marine meadows.
3. Coral reefs.
4. Rocky marine shores; includes rocky offshore islands, sea cliffs.
5. Sand, shingle or pebble beaches; includes sand bars, spits, sandy islets.
6. Estuarine waters; permanent waters of estuaries and estuarine systems of deltas.
7. Intertidal mud, sand or salt flats.
8. Intertidal marshes; includes salt-marshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater marshes.
9. Intertidal forested wetlands; includes mangrove swamps, nipa swamps, tidal freshwater swamp forests.
10. Brackish to saline lagoons and marshes with one or more relatively narrow connections with the sea.
11. Freshwater lagoons and marshes in the coastal zone.
12. Non-tidal freshwater forested wetlands.

The key features of the wetland sites, as described within the Australian Wetland Database, are provided in the below table.

Table B-1: Key Features of Nationally Important Wetlands

Wetland	Key Features
South Australia	
Piccaninnie Ponds	***Site description*** Large spring-fed limestone wetlands bounded by coastal dunes. The site comprises: First Pond, approximately 10 m deep; Turtle Pond, 6 m deep basin at the end of a wide channel; and a 90 m deep chasm which leads into a chamber known as the Cathedral. ***Physical features*** Landform: Water-filled limestone rift and large submerged cave surrounded by shallow swamps, found between stable coastal dunes to the south and low calcarenite dunes to the north. Geology: Tertiary marine limestone forming the Gambier Embayment of the Otway Basin partially covered by dune ridges and volcanic deposits. Soils: Highly organic alkaline peats. ***Ecological features*** Ecological role: The area contains a number of threatened plant, bird and fish species. Plant structural formations: Represents the only conserved site which supports a mixed tea-tree *Leptospermum lanigerum* and *Melaleuca squarrosa* closed shrub formation, and a reed swamp formation with *Phragmites vulgaris* and *Typha angustifolia*. This type of swamp vegetation formerly occupied extensive areas along the coastal region of the south east of the State, but most has been cleared for agriculture. ***Significance*** The ponds are a unique karst feature of the South East region and are world renowned for cave diving. The wetland is the largest rift in the Gambier Embayment. The site is the only and largest remnant of coastal peat fen reserved in South Australia, and one of a few of its type reserved in Australia. ***Social and Cultural values*** Research: The aquatic biota of Piccaninnie Ponds has been comprehensively studied by Thurgate (1992). Recreation: Popular site for cave diving and snorkelling. Reference *Department of the Environment and Energy. 2017. Piccaninnie Ponds - SA060, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from:*

Wetland	Key Features
	http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=SA060. Accessed 25 Jul 2017.
South East Coastal Salt Lakes	***Site description*** A series of four separate lakes of various depth, situated in the interdune corridor between the present and relict coastal dunes. Lake Robe (399 ha), Lake Eliza (4,683 ha) and Lake St. Clair (2,566 ha) are shallow lakes with a fringe of vegetation. Lake George is a deep estuarine lake intermittently connected to the sea, with a surface area of 5916 ha and is surrounded by a fringe of vegetation. Small freshwater ephemeral wetlands exist around the lakes. ***Physical features*** Landform: The wetlands occur on the coastal flat between a low, well-vegetated coastal dune ridge to the west and a relict coastal dune ridge to the east. Geology: Unconsolidated calcareous sands from the Pleistocene uncomformably lay over Tertiary formed calcrete. Soils: Lake beds consist of black friable loams covered by mud, clay, sand or shellgrit; the dunes surrounding the lakes support deep calcareous sands and shallow red sandy loams. ***Ecological features*** Ecological role: A group of coastal wetlands that act as a refuge for waterbirds in summer or drought. The lakes and the fresh groundwater soaks provide a diverse selection of vegetation structures and wetland habitats for waterbirds. Lake George is a spawning area for two marine fishes, the Yellow-eye Mullet and Flounder. Plant structural formations: Tea-tree scrub, samphire flat, sedgelands and coastal closed scrub. ***Significance*** Lake George and Lake Eliza are two of the remaining wintering grounds in the south east of the State for the Orange-bellied Parrot, and Lake George is an important wintering ground for the Double-banded Plover. ***Social and Cultural values*** Cultural: The coastal lakes are rich in Aboriginal heritage with many occupation sites such as middens, rock shelters and open-air campsites at the lake margins. Reference *Department of the Environment and Energy. 2017. South East Coastal Salt Lakes - SA062, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=SA062. Accessed 25 Jul 2017.*
Victoria	
Anderson Inlet	***Site description*** Anderson Inlet is one of the largest estuaries on the Victorian coast. ***Physical features*** Geological setting: Quaternary sediment between Tertiary hills and Devonian ridge. A series of spits developed across a former embayment to create the inlet which has infilled with estuarine sediment. Large areas of mudflats are exposed at low tide. ***Ecological features*** The inlet is of high value for its fauna. ***Significance*** (No data) ***Social and Cultural values*** Recreation: Anderson Inlet is very popular for recreational line-fishing. Sailing, powerboating, waterskiing, bait collection and duck hunting are other popular water based activities here. Research: The Australian Wader Study Group traps, measures and bands migratory and nomadic wading birds in the inlet for biological studies. Reference *Department of the Environment and Energy. 2017. Anderson Inlet - VIC062, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC062. Accessed 25 Jul 2017.*
Corner Inlet	***Site description*** Corner Inlet contains the most southerly tidal mudflat system of mainland Australia. ***Physical features*** Geological setting: Quaternary marine, coastal, aeolian, lacustrine and paludal sediment overlying Quaternary colluvial, alluvial, lacustrine and paludal sediments, upper Devonian granite, the lower Devonian Liptrap Formation and Cretaceous Strzelecki Group sediment. ***Ecological features*** Corner Inlet is a high value wetland for its high productivity, geomorphology and significant flora and fauna. ***Significance*** The site is of international zoological significance due to its geographical position and of national geomorphological significance as an example of barrier island formation. Both Snake Island

Wetland	Key Features
	and Clonmel Island are considered nationally important for their geomorphology. The coastal strip from the barrier ridges to Welshpool is considered regionally important for its geomorphology. Corner Inlet is the best example of a wetland enclosed by barrier islands in Victoria and it contains the most extensive intertidal flats in Victoria. Corner Inlet is a very important area as the intertidal flats provide large feeding grounds for many waterfowl and wader species. The inlet is an important feeding area for juvenile and adult waders in the non-breeding season and during migration. The mangrove and seagrass communities also provide critical habitat for juvenile fish. In addition, the seagrass beds provide extensive feeding grounds for fish populations including commercial fish species. The inlet islands are considered to be of national botanical significance. Reeves Beach and the coastline from Port Franklin to Reeves Beach are considered to be of state botanical significance. ***Social and Cultural values*** Industry: Commercial fishing. Recreation: Fishing, swimming, boating (including yachting and kayaking), bird watching, duck hunting and Hog Deer Axis porcinus hunting (on Sunday Island) are popular activities. Research: Corner Inlet has been used as a site for long term monitoring of the Chestnut Teal by the Arthur Rylah Institute. Birds Australia also uses this site for long term monitoring of waterfowl and waders. Snake Island is used annually as a field site to study floristic composition and fire ecology by Melbourne University. History: Two of the coastal port townships of Corner Inlet, Port Albert and Port Welshpool, have historically been important for shipping cattle to Gippsland from Tasmania. These ports also served as a means of opening up Gippsland for agriculture. Commercial fishing was not important in Corner Inlet until the late 1840s when the steamship services to Melbourne commenced. The numerous shipwreck sites in Corner Inlet and within the barrier Islands of Nooramunga also make this area culturally important. Aboriginal culture: There are 23 shell middens located in the area. Reference *Department of the Environment and Energy. 2017. Corner Inlet - VIC066, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC066. Accessed 25 Jul 2017.*
Ewing's Marsh (Morass)	***Site description*** Wetland Atlas number : 8522 160148. ***Physical features*** Geological setting: Ewing's Marsh formed in a long, narrow basin of Quaternary alluvium between an active barrier (extending for over 50 km between Red Bluff near Lake Tyers and Point Ricardo) and the Piedmont Downs landscape of the hinterland. The basin overlies Pleistocene-Holocene coastal and non-marine sediments and Pleistocene coastal and non-marine and Pliocene-Miocene deposit. Many dune blowouts and short parabolic dunes extend across the barrier and into Ewing's Marsh. The creeks entering the Marsh differ from others in East Gippsland in that they are completely enclosed by the barrier and have no tidal connection to estuaries at Lake Tyers or the lower Snowy River. The creek valleys have become almost completely filled with a dense reed, sedge and swamp scrub and only Hospital Creek maintains an open channel into Ewing Marsh. At the mouth of Simpson Creek, several lobate and cuspate bodies extend into Ewing Marsh. The elongated shape of some of these suggest that they have been reworked as lagoon shore spits. These are important in understanding the evolution of the Gippsland coastline, particularly Holocene changes in sea level. ***Ecological features*** Ewing's Marsh has thick shrub, sedge, rush and grass-dominated vegetation merging into heathland and forest on its inland side, and into dune shrubland on the seaward border. Dense vegetation provides habitat for a number of secretive animal species but some open water exists as habitat for waterbirds. ***Significance*** Ewing's Marsh is an important coastal wetland ecosystem which provides an important habitat for fauna, particularly water birds and supports a diversity of fauna. ***Social and Cultural values*** Recreation: Duck and deer hunting, birdwatching, bushwalking (from beach). Reference *Department of the Environment and Energy. 2017. Ewing's Marsh (Morass) - VIC132, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from:*

Wetland	Key Features
	http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC132. Accessed 25 Jul 2017.
Glenelg Estuary	***Site description*** The Glenelg Estuary is a large estuarine system consisting of the main channel of the Glenelg River and a side lagoon called the Oxbow. ***Physical features*** Geological setting: Quaternary lacustrine, paludal, alluvial and coastal sediments on Quaternary aeolian sediments. ***Ecological features*** The Glenelg Estuary is a high value wetland for its ecological features. ***Significance*** This wetland is of special geomorphological interest, being the only estuarine lagoon system in Victoria developed within a framework of dune calcarenite ridges. The Glenelg estuary contains the only remaining relatively undisturbed salt marsh community in western Victoria. Spits at river mouths such as those at Glenelg River provide valuable breeding sites for the Little Tern. This area is one of the few sites where Little Tern breed in Victoria. ***Social and Cultural values*** Recreation: The western end of Discovery Bay Coastal Park at the Glenelg Estuary is popular for fishing, boating, walking and other activities. The Major Mitchell Trail meets the coast here: the river mouth marks the end of Major Mitchell's expedition of 1836. The Great South West Walk traverses the estuary. Aboriginal culture: Several shell middens and surface scatters exists at Glenelg Estuary. <u>Reference</u> *Department of the Environment and Energy. 2017. Glenelg Estuary - VIC028, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC028. Accessed 25 Jul 2017.*
Jack Smith Lake State Game Reserve	***Site description*** This Reserve includes Jack Smith and Lambs Lake (a smaller wetland of 85 ha) and small herbfields interspersed between thickets of Swamp Paperbark Melaleuca ericifolia and subject to regular wetting and drying cycles. The Reserve's 13 km-long south-eastern boundary abuts the Ninety Mile Beach Coastal Reserve. ***Physical features*** Jack Smith Lake lies on an emerged coastal plain of Quaternary marine, fluvial, lacustrine, paludal and aeolian sediments. The form of Jack Smith Lake suggests that it was once a bay that has now been isolated from the sea by the development of a sandy barrier. ***Ecological features*** This lake is of high value for its fauna and flora. ***Significance*** (No data) ***Social and Cultural values*** Recreation: Duck hunting is the major recreational use of the Reserve. Camping occurs throughout the year peaking during the opening weekend of duck season. Fishermen gaining access to Ninety Mile Beach are another major source of visitors to the Reserve. Aboriginal culture: Archaeological significance includes unique Aboriginal shell midden deposits of a type not found elsewhere in the South Gippsland region. In addition, the Red Hill area of Jack Smith Lake is reputed to be a burial site for Aborigines killed in a massacre by early European settlers, although this has never been confirmed. <u>Reference</u> *Department of the Environment and Energy. 2017. Jack Smith Lake State Game Reserve - VIC069, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC069. Accessed 25 Jul 2017.*
Lake Bunga	***Site description*** Lake Bunga is a narrow freshwater lagoon and is the former entrance to the Gippsland Lakes. ***Physical features*** Geological setting: Quaternary lacustrine and paludal sediments overlying Quaternary marine sediments and Tertiary sediments of the Sale/Seaspray Group. ***Ecological features*** This wetland is of high value for its avifauna. ***Significance*** Lake Bunga is a high value wetland for its geological, geomorphological, botanical and ornithological features. ***Social and Cultural values*** (No data)

Wetland	Key Features
	Reference *Department of the Environment and Energy. 2017. Lake Bunga - VIC085, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC085. Accessed 25 Jul 2017.*
Lake Connewarre State Wildlife Reserve	***Site description*** The Lake Connewarre State Wildlife Reserve consists of an extensive estuarine and saltmarsh system drained by the Barwon River. It includes a large permanent freshwater lake, a deep freshwater marsh, several semi-permanent saline wetlands and an estuary. ***Physical features*** Geological setting: Quaternary alluvial sediments on Quaternary coastal and aeolian sediments, basalt flows of the Newer Volcanics and sediments of the Tertiary Moorabool Viaduct Formation. ***Ecological features*** The Lake Connewarre State Game Reserve consists of a wide variety of wetland habitats which support a large and diverse waterbird population and contain a significant area of natural vegetation in this part of the South East Coastal Plain. ***Significance*** Lake Connewarre State Game Reserve is a high value wetland for its ecological, recreational and scientific features. Lake Connewarre State Game Reserve is the largest area of native vegetation remaining on the Bellarine Peninsula. Reedy Lake is the largest natural freshwater lake in central Victoria and has outstanding significance due to its large size, floristic richness and structural diversity. The lower two thirds of the estuary is essentially unmodified. ***Social and Cultural values*** Recreation: The Reserve is used for duck hunting and is a good fishing area for Jewfish which has a limited distribution. Windsurfing and boating are popular activities on the river, especially in the estuary. Education: The wetlands are used extensively for teaching purposes. Aboriginal culture: A large oyster midden exists on Campbell Point at Lake Connewarre. Reference *Department of the Environment and Energy. 2017. Long Swamp - VIC030, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC070. Accessed 25 Jul 2017.*
Lake King Wetlands	***Site description*** The Lake King Wetlands consist of two large coastal lagoons and associated channels with surrounding salt marshes and brackish to fresh marshes. ***Physical features*** Geological setting: Quaternary lacustrine and paludal sediments on Quaternary alluvial and marine sediments overlying Tertiary sediments of the Sale/Seaspray Group. Lake King contains several islands. ***Ecological features*** These wetlands are of high value for fauna and part of a major drought refuge. ***Significance*** The Lake King Wetlands are high value for ecological, recreational, scientific, cultural and landscape features. They are fine examples of a large coastal lagoon system. The Lake King Wetlands contain two sites of geological/ geomorphological significance: the Mitchell River silt jetties (international) which are on the Register of the National Estate and the Tambo River Delta (state). Mullacky Swamp, two kilometres east of Ocean Grange, is listed as a site of special botanical significance. The Mitchell River Delta silt jetties are one of the finest examples of a digitate delta in the world; these silt jetties almost separate Jones Bay from Lake King. The Tambo River Delta is a major example of the processes of delta growth. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Lake King Wetlands - VIC071, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC071. Accessed 25 Jul 2017.*
Lake Tyers	***Site description*** Lake Tyers is a branched inlet formed by marine submergence of incised valleys. It has a well developed tidal delta with marshy islets. ***Physical features*** Geological setting: Quaternary lacustrine and paludal sediments overlying Quaternary marine sediments and Tertiary sediments of the Sale/Seaspray Group.

Wetland	Key Features
	Ecological features This wetland is of high value for its fauna. ***Significance*** Lake Tyers is a high value wetland for its ecological, recreational, scientific, cultural and scenic features. Lake Tyers is of scenic value for its forested shores and unspoilt character. ***Social and Cultural values*** Recreation: Lake Tyers is popular for camping, fishing, sailing and power boating. Tourism: Large numbers of holiday makers arrive in summer and are exposed to the Little Tern Management Program and commercially chartered boat trips (private) with a naturalist aspect. Aboriginal culture: 18 sites of Aboriginal archaeological significance were recorded in and around Lake Tyers. The local Aboriginal community borders Lake Tyers. Reference *Department of the Environment and Energy. 2017. Lake Tyers - VIC086, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC086. Accessed 25 Jul 2017.*
Lake Victoria Wetlands	***Site description*** Lake Victoria is a large coastal lagoon with fringing saltmarsh. It is part of the Gippsland Lakes system. ***Physical features*** Geological setting: Quaternary lacustrine and paludal sediments on Quaternary coastal and aeolian sediments. ***Ecological features*** These wetlands are of high value for their fauna. ***Significance*** Lake Victoria comprises wetlands highly valued for their ecological, recreational, tourist, scientific, educational, cultural and landscape features. Lake Victoria and Blond Bay support a highly productive fish community. This also makes the lakes very important for piscivorous birds such as pelicans, cormorants and terns. Blond Bay State Game Reserve encompasses one of the largest remaining area of natural vegetation on the shores of the Gippsland Lakes. Lake Victoria has thick Swamp Paperbark scrub/closed forest fringing most of the foreshore. The intermittent wetlands making up the Blond Bay system are not common or sufficiently protected in the region. ***Social and Cultural values*** Research: The lakes are scientifically valuable for the study of haloclines and geologically, as part of the Gippsland Lakes system. Recreation: Lake Victoria abuts The Lakes National Park which has a visitor centre and bird hides. Aboriginal culture: Numerous archaeological sites, including a burial site, scarred tree, shell middens, surface scatters and isolated artefacts, occur around Lake Victoria and Blond Bay. Reference *Department of the Environment and Energy. 2017. Lake Victoria Wetlands - VIC072, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC072. Accessed 25 Jul 2017.*
Lake Wellington Wetlands	***Site description*** (No data) ***Physical features*** Geological setting: Quaternary lacustrine, paludal and alluvial sediments over a broad plain of Quaternary lacustrine, paludal, coastal and aeolian sediments. Landform: The Lake Wellington area lies on a former coastline with a 'prior' barrier to the north and an 'inner' barrier on the seaward side. Morass areas occur where erosion of barrier sediments have reached the water table. Geomorphic features in these areas include foredunes, "modern floodplains along the lower section of the rivers above the swampy plains" and "flat to undulating terrain above the floodplains, and sand sheets, ridges and dunes". ***Ecological features*** These wetlands are of high value for their fauna and act as drought refuges. ***Significance*** Lake Wellington Wetlands are high value for their ecological, recreational, scenic and cultural features. The wetlands contain excellent examples of both deep freshwater marshes and permanent saline wetlands. Dowds Morass and Victoria Lagoon are the most significant examples of each type respectively. Sale Common is an important refuge from hunting for game ducks in the Gippsland Lakes area. Heart, Clydebank and Dowd Morasses are good examples of native weed-free riparian vegetation in East Gippsland that is considered to be of the highest botanical significance because of the high levels of disturbance that have already occurred in other wetlands. Dowd Morass exhibits a process of shoreline margin succession due to siltation which has been halted elsewhere in

Wetland	Key Features
	the Gippsland Lakes by rising salinity. There are many picturesque sites with paperbark Melaleuca/sedge swamp, grasslands and River Red Gum woodland at the mouth of the LaTrobe River. The large Red Gums between the banks of the Avon River and Clydebank Morass provide the only natural setting remaining along the lower Avon River. These Red Gums may be either River Red Gum or Forest Red Gum or a hybrid of each. ***Social and Cultural values*** Research: Dowd Morass has been the subject of long term surveys by the Department of Natural Resources and Environment. In the 1990/91 breeding season, a banding study of Great Egrets and Royal Spoonbills was initiated as part of Project Egret Watch which is coordinated by the Shortland Wetlands Centre, Newcastle. Education: Heart Morass is used to demonstrate principles of salinity to school and land-holder groups. Wetland education kits have been developed for use on the Sale Common by local schools with a grant from ESSO. Sale Common has provided a focus for community wetland conservation activities, with Field and Game Australia and NRE cooperating in planting trees and providing nestboxes. Field and Game Australia also provided funds and effort for several major projects including the water control structures in Dowd Morass. Facilities at Sale Common include a bird viewing hide, board walk, lookout, walking tracks and an information shelter. The Common attracts more than 20,000 visitors per year. Aboriginal culture: Three sites within the system have archaeological value. Small isolated Aboriginal scatters are present at several sites. The Heart Morass is also the site of an Aboriginal massacre. There are many scarred trees along wetland margins and nearby rivers. Recreation: Lake Wellington is important for boating, fishing and hunting. Reference *Department of the Environment and Energy. 2017. Lake Wellington Wetlands - VIC073, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC073. Accessed 25 Jul 2017.*
Long Swamp	***Site description*** Long Swamp is an elongated freshwater wetland in the Discovery Bay barrier system. It is separated from the sea by an extensive dunefield. ***Physical features*** Geological setting: Quaternary lacustrine, paludal and some aeolian sediments. ***Ecological features*** Long Swamp is a high value wetland for its flora and fauna. ***Significance*** (No data) ***Social and Cultural values*** Recreation: Long Swamp has little recreational value due to difficulty of access but the swamp has scenic tourism value. Research: Surveys of Ground Parrots and flora have occurred. Aboriginal culture: Two shell middens and one surface scatter exists at Long Swamp. Reference *Department of the Environment and Energy. 2017. Long Swamp - VIC030, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC030. Accessed 25 Jul 2017.*
Lower Aire River Wetlands	***Site description*** These wetlands consist of three shallow freshwater lakes, brackish to saline marshes and an estuary on the Aire River floodplain. This floodplain occurs at the confluence of the Ford and Calder Rivers with the Aire River. It is surrounded by the Otway Ranges and dune-capped barrier along the ocean shoreline. ***Physical features*** Geological setting: Quaternary alluvium on Quaternary colluvium and alluvium and sediments of the Tertiary Dilwyn Formation and Cretaceous Otway Group. ***Ecological features*** The Lower Aire River Wetlands have extensive beds of Common Reed and groves of Woolly Tea-tree which can support large numbers of waterbirds. These wetlands act as a drought refuge for wildlife. ***Significance*** Lake Hordern is considered to be of State significance for its geomorphology. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Lower Aire River Wetlands - VIC091, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from:*

Wetland	Key Features
	http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC091. Accessed 25 Jul 2017.
Lower Merri River Wetlands	***Site description*** The Lower Merri River Wetlands consist of two connected wetlands developed in a swale between calcareous dune ridges and fed by the Merri River. **Physical features** Geological setting: The geology consists of Quaternary lacustrine and paludal sediments overlying colluvium and alluvium, and tuff of the Newer Volcanics. ***Ecological features*** These wetlands are of high value for their avifauna. There are large areas of Common Reed with Spiky Club-sedge, saltmarsh and mudflats. ***Significance*** The Lower Merri River Wetlands are of high value for their geomorphology and are a well preserved example of interdunal wetlands fed by a small drainage system. ***Social and Cultural values*** Recreation: The wetlands are used for hunting, walking and bird watching. The Mahogany Trail follows the edge of these wetlands. History: The Mahogany Ship is reputed to be buried under sand dunes adjacent to Saltwater Swamp. Aboriginal culture: Surface scatters exist at Kelly Swamp indicating a history of Aboriginal occupation. Reference *Department of the Environment and Energy. 2017. Lower Merri River Wetlands - VIC075, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC075. Accessed 25 Jul 2017.*
Lower Snowy River Wetlands System	***Site description*** The Lower Snowy River Wetlands consist of Lake Corringle, Lake Wat Wat, Lake Curlip, Cabbage Tree Lagoon and numerous other small wetlands on the floodplain of the Snowy and Brodribb Rivers. The area consists of extensive saltmarsh flats and reed beds, paperbark thicket, mud flats and seagrass beds and thus supports a diverse faunal assemblage. ***Physical features*** Geological setting: Quaternary colluvial, alluvial, lacustrine, paludal and marine sediments on Tertiary sediments. ***Ecological features*** These wetlands are of high value for their avifauna and fish. ***Significance*** The Lower Snowy River Wetlands are high value for their ecological, recreational, scientific, educational and scenic values. The wetlands are an excellent example of a floodplain system consisting of a diverse range of habitats and contain extensive areas of Swamp Paperbark, reed beds, salt marsh and mudflats which have been cleared or badly degraded elsewhere throughout the Snowy River floodplain. Similar areas in East Gippsland (i.e. remainder of Snowy River floodplain, Cann River floodplain and Genoa River floodplain) have all been severely degraded through clearing, drainage channels and grazing. Lakes Corringle, Wat Wat and Curlip are of significant conservation value since they support an array of wildlife that may only exist where these remnant pockets of vegetation remain undisturbed. ***Social and Cultural values*** Recreation: The area is a very popular destination for recreation fishermen and boating enthusiasts, particularly during summer months and school holidays. Tourism: Recreation is very important to the economy of Marlo and Orbost. Research: The Lower Snowy River Wetlands continue to be subject to numerous scientific research projects and investigations. The gradual infilling of a large coastal embayment to produce the extensive floodplain of the Snowy and Brodribb rivers has allowed for detailed studies in coastal and estuarine morphologies, evolution of wetland vegetation, and wetland/estuary hydrology. Other studies related to the area include wetland classification, habitat type and water bird distribution and the effect of altering hydrologic regimes. Reference *Department of the Environment and Energy. 2017. Lower Snowy River Wetlands System - VIC087, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC087. Accessed 25 Jul 2017.*
Mallacoota Inlet Wetlands	***Site description*** Wetland Atlas numbers : 8822 436430 (Mallacoota Inlet), 8822 526420 (Lake Barracouta), 8822 468412, 8822 472415, 8822 494416. ***Physical features*** Mallacoota Inlet was formed by the submergence of the Genoa and Wallagaraugh River valleys and partial closure of the resulting marine embayment by a sandy barrier and

Wetland	Key Features
	accumulation of dunes. Geological setting: Tertiary sediments and some areas of Ordovician sediments (Mallacoota Beds) and the Kuark Metamorphics underlie most of the Inlet. Islands within the Inlet and the barrier system along the coast (forming Howe Flat and Lake Barracoota) consist of Quaternary coastal and aeolian deposits. The Inlet shoreline consists of low cliffs of sedimentary rock and small sandy beaches. Quaternary swamp and lagoonal deposits occur on Howe Flat and at Lake Barracoota. ***Ecological features*** The diversity of flora and fauna in the East Gippsland and adjacent Eden region is high as this area is on the convergence of the cool and warm temperate zones of eastern Australia. The Mallacoota Inlet Wetlands also provide a variety of wetland habitats ranging from estuarine to freshwater, deep inlet waters to sedgelands, and open and closed hydrological s. ***Significance*** Mallacoota Inlet and surrounds are listed on the Register of the National Estate. The Inlet and Howe Flat-Lake Barracoota are listed as of State significance, and Tidal Delta, Goodwin Sands and Allan Head within the Inlet are listed as of Regional significance for geology and geomorphology. North and south Mallacoota Inlet are listed as of State zoological significance. Parts of the Inlet are within the Croajingolong National Park Biosphere Reserve. Lake Barracoota supports important lowland wetland ecosystems and contains a relict marine fauna. ***Social and Cultural values*** Mallacoota and the surrounding district are very popular holiday destination. Recreation: Boating, fishing, bird-watching. <u>Reference</u> *Department of the Environment and Energy. 2017. Mallacoota Inlet Wetlands - VIC133, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC133. Accessed 25 Jul 2017.*
Mud Islands	***Site description*** Mud Islands are a group of low, sandy islands located in the southern part of Port Phillip Bay. The islands are narrow, and arranged in a roughly circular configuration around a central tidal lagoon. On the southern, western and northern shores, extensive intertidal mudflats and sea-grass meadows are present. ***Physical features*** Geological setting: Quaternary coastal and aeolian sediments. ***Ecological features*** The islands have very high value for fauna since they support large numbers of migratory wading birds and breeding seabirds. ***Significance*** Mud Islands has a high value for its ecological, recreational, scientific, educational and aesthetic features. It has a very high diversity of birds, 114 species, and is an important feeding and roosting site for many migratory birds. The wetland is an unusual offshore saltmarsh island complex providing breeding habitat for many birds. Mud Islands provides a wilderness experience for visitors. ***Social and Cultural values*** Recreation: Mud Islands receives many visitors although it is only accessible by boat. However, visiting the island is not encouraged by the Department of Natural Resources and Environment. Research: The avifauna of Mud Islands has been well documented historically and the vegetation has been surveyed in detail. Bird banding has been carried out on Mud Islands since 1914. Between 1979 and 1987, 11,300 Silver Gull chicks were banded of which 2% have been recovered. A dense population of the introduced *Carcinus maenas* occurs in the lagoon. The rapidly changing geomorphology makes Mud Islands an ideal place to study plant succession. Education/tourism: Mud Islands is used for excursions by Frankston TAFE and the Victorian Institute of Marine Sciences, which also run summer holiday activities for the general public. <u>Reference</u> *Department of the Environment and Energy. 2017. Mud Islands - VIC077, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC077. Accessed 25 Jul 2017.*
Point Cook & Laverton Saltworks	***Site description*** The coastline of this area comprises rocky shoreline, sandy beaches and spits and large areas of intertidal mudflats and seagrass. Laverton Saltworks consists of shallow evaporation basins and saltmarsh. The Point Cook Coastal Park contains saltmarsh, dune vegetation, grassland, freshwater meadows, fresh to brackish marshes and a saline lake.

Wetland	Key Features
	Physical features Geological setting: Quaternary coastal, lacustrine, paludal and aeolian sediments overlying basalt flows of the Newer Volcanics. ***Ecological features*** The saltworks ponds and Point Cook Lake provide an important habitat for waders, particularly sandpipers, avocets and stilts, and other waterbirds. ***Significance*** The coastline from Point Cook to Skeleton Creek includes wetlands which are high value for their ecological, recreational, scientific, educational and cultural features. The Laverton Saltworks are a very valuable artificial wetland with a range of salinities providing habitat diversity. This salinity range is vital in maintaining the value of the habitat. The active recurving sand spits between the Skeleton Creek mouth and the Laverton Creek mouth are geomorphologically significant. Point Cook Coastal Park has been rated as a site of state botanical significance. ***Social and Cultural values*** Recreation: The Point Cook Coastal Park receives large numbers of visitors and provides recreational facilities. Research: The area has been the study site in a number of research projects such as the banding of Double-banded Plovers by the Australasian Wader Studies Group. It also has detailed historical bird survey data. History: The Point Cook Estate, Point Cook Homestead and the Stables are all listed on the Register of the National Estate, classified by the National Trust and are listed on the Register of the Historic Building Council. Reference *Department of the Environment and Energy. 2017. Point Cook & Laverton Saltworks - VIC116, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC116. Accessed 25 Jul 2017.*
Powlett River Mouth	***Site description*** (No data) ***Physical features*** Geological setting: Quaternary alluvium on Cretaceous sediment of the Strzelecki Group. ***Ecological features*** The Powlett River Mouth provides valuable habitat for the endangered Orange-bellied Parrot. ***Significance*** (No data) ***Social and Cultural values*** Research: The Powlett River mouth is covered in McMahon et al. (1994) which covers saltmarsh habitats on the Victorian coast. Reference *Department of the Environment and Energy. 2017. Powlett River Mouth - VIC078, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC078. Accessed 25 Jul 2017.*
Princetown Wetlands	***Site description*** These wetlands consist of swamps of varying salinity on the floodplains of the Gellibrand River and its tributary, the Serpentine (Latrobe) Creek. Wetlands types present are a deep freshwater marsh, semi- permanent saline marshes and a shallow freshwater marsh. ***Physical features*** The Princetown Wetlands occur in the contact area between the Port Campbell Plains, the folded Otway geology and Recent dune deposits. Geological setting: Quaternary alluvium on Tertiary Gellibrand Marl and Dilwyn Formation and Quaternary Bridgewater Formation. ***Ecological features*** The Princetown Wetlands have extensive beds of Common Reed Phragmites australis and meadows dominated by Beaded Glasswort which can support large numbers of waterbirds. **Significance** A series of relict spits adjacent to the Gellibrand Estuary and a number of levee banks at various sites have State significance for their geomorphology. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Princetown Wetlands - VIC093, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC093. Accessed 25 Jul 2017.*

Wetland	Key Features
Shallow Inlet Marine & Coastal Park	***Site description*** Shallow Inlet is a large tidal embayment with a single channel to the sea. The seaward side is enclosed by a sandy barrier complex of spits, bars and mobile dunes. ***Physical features*** Geological setting: Shallow Inlet consists of Quaternary coastal and aeolian sediments deposited in a basin eroded into lower Palaeozoic and Pliocene sediments and enclosed by Pleistocene and Holocene coastal barrier and dune deposits. Large areas of mudflats are exposed at low tide. ***Ecological features*** Shallow Inlet is of high value for its avifauna and flora. ***Significance*** 13 sites of State, regional and local geological and geomorphological significance has been documented for the Shallow Inlet Marine and Coastal Park. ***Social and Cultural values*** Education: Shallow Inlet is used occasionally by local schools for environmental education. Tertiary institutions have used the area as a field study site for post-graduate research, mainly in geology and geomorphology. Research: The formation of the entrance barrier of Shallow Inlet has been studied in Cummins (1989). Tourism: Shallow Inlet is a popular tourist destination offering attractive surroundings and a variety of recreational activities including fishing, sailboarding, swimming, camping and picnicking. It also provides a base for visits to other holiday locations such as Wilsons Promontory and Corner Inlet. Aboriginal culture: Detailed archaeological surveys have discovered rich sites between Shallow Inlet and Darby River. Aboriginal middens are found along the coast west of Shallow Inlet. History: Shallow Inlet and the surrounding area also have a well documented European history, including maritime history and associated shipwrecks. Reference *Department of the Environment and Energy. 2017. Shallow Inlet Marine & Coastal Park - VIC080, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC080. Accessed 25 Jul 2017.*
Swan Bay & Swan Island	***Site description*** Swan Bay is a shallow marine embayment partly enclosed by spits and barrier islands such as Swan Island. It is generally less than two metres in depth, with 700–1,000 ha of mudflats exposed at low tide, and has extensive seagrass beds. The bay is fringed with saltmarsh including some extensive flats and there are some stands of remnant woodland, particularly on Edwards Point at the northern end and on the islands on the eastern boundary of the bay. ***Physical features*** Geological setting: Quaternary coastal and aeolian sediments overlying Quaternary alluvial and coastal sediments. ***Ecological features*** The bay is of high value for its avifauna and flora. It is very productive for birds, molluscs and fish. The saltmarsh and intertidal seagrass meadows are regionally significant. The avifauna is particularly diverse, with 190 bird species recorded. ***Significance*** Swan Bay is a high value wetland for its ecological, recreational and educational features. Swan Bay is an unusual shallow embayment with a mixture of seagrass species which is relatively undisturbed and in good ecological condition. ***Social and Cultural values*** Research: Swan Bay has been well researched scientifically and is the subject of many reports. The type specimens of two isopods *Haliophasma cycneum* and *Paranthura boronia* held at the Museum of Victoria were collected in Swan Bay. The Marine Science Laboratory of the Department of Natural Resources and Environment at Queenscliff is in close proximity. History: Swan Island has value for historical military relics. Reference *Department of the Environment and Energy. 2017. Swan Bay & Swan Island - VIC081, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC081. Accessed 25 Jul 2017.*
Sydenham Inlet Wetlands	***Site description*** Wetland Atlas numbers: 8622 756184 (Sydenham Inlet), 8622 744203, 8622 764199, 8622 765191, 8622 769185, 8622 784209. ***Physical features*** Sydenham Inlet, together with Tamboon Inlet, developed in an embayment between the headlands at Pearl Point and Tamboon South. Bemm River formed a shallow tidal lagoon between two late Pleistocene-Holocene barriers behind a dune and barrier system on Ninety Mile Beach. An

Wetland	Key Features
	exposure of Noorinbee Granodiorite, which forms a small waterfall and rapids, defines the tidal extent of the Inlet. The accumulation of swamp deposits and river sediments has reduced the area and depth of the Inlet and has isolated Mud Lake and Swan Lake from the main wetland. The active cuspate delta of the Bemm River and several abandoned deltas occur on the north side of the Inlet. Geological setting: Sydenham Inlet and Mud Lake occur in a basin of Quaternary alluvium on Tertiary sand and Quaternary beach and dune deposits. Swan Lake was formed on Tertiary sand and Quaternary beach and dune deposits. ***Ecological features*** The Sydenham Inlet Wetlands include a variety of wetland types affected by fresh to saline water, provide a large area of estuarine habitat and support a high diversity of flora and fauna. ***Significance*** Sydenham Inlet is of State significance for its geology and geomorphology. The Inlet, Mud Lake, Swan Lake and the lower Bemm River are of high value for their flora and fauna. Riparian communities such as along the Bemm River near Sydenham Inlet are of high botanical significance. The diversity of fish species and the importance of the Inlet entrance barrier for roosting or nesting terns and shorebirds are particularly notable. ***Social and Cultural values*** Recreation: Fishing, boating, walking, birdwatching. Reference *Department of the Environment and Energy. 2017. Sydenham Inlet Wetlands - VIC134, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC134. Accessed 25 Jul 2017.*
Tamboon Inlet Wetlands	***Site description*** Wetland Atlas numbers : 8722 863231 (Lake Furnell), 8722 872188 (Tamboon Inlet). ***Physical features*** Tamboon Inlet, together with Sydenham Inlet, developed in an embayment between the headlands at Pearl Point and Tamboon South. Cann River formed a shallow tidal lagoon between two late Pleistocene-Holocene barriers behind a dune and barrier system on Ninety Mile Beach and bordered by a band of plutonic rock to the east. The Inlet consists of the river channel within a delta, the north and south basins separated by a sand bar and spit, the eastern channel and the entrance barrier complex. Geological setting: Quaternary beach and dune deposits underlie most of Tamboon Inlet and Devonian Noorinbee Granodiorite occurs along the east side of the Inlet. Lake Furnell was formed on Quaternary beach and dune deposits and Tertiary sediments. ***Ecological features*** The Tamboon Inlet Wetlands have a variety of wetland types affected by fresh to saline water which support a diversity of flora and fauna. The Inlet provides a large area of estuarine habitat. ***Significance*** Tamboon Inlet, Lake Furnell and the lower Cann River are of high value for their flora and fauna, particularly the diversity of fish species. Tamboon Inlet is of State significance for its geology and geomorphology. ***Social and Cultural values*** Recreation: Fishing, boating, walking, birdwatching. Reference *Department of the Environment and Energy. 2017. Tamboon Inlet Wetlands - VIC135, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC135. Accessed 25 Jul 2017.*
Werribee-Avalon Area	***Site description*** This wetland system contains a variety of habitats, including large areas of intertidal mudflat and seagrass beds, extensive areas of saltmarsh, small stands of White Mangrove *Avicennia marina*, reed beds, salt evaporation lagoons of the Avalon saltworks and the grass filtration paddocks and sewage treatment lagoons of the Werribee Treatment Complex. ***Physical features*** Natural wetlands include two inter-tidal lagoons (Limeburners Bay and The Spit), two estuaries (Little River and Werribee River), saltmarsh flats and several shallow freshwater marshes. Artificial wetlands comprise salt evaporation ponds (built from saltmarsh and embayments), sewage filtration paddocks and sewage treatment lagoons. Geological setting: Quaternary coastal, lacustrine and paludal sediments and basalt flows of the Newer Volcanics. ***Ecological features*** (No data)

Wetland	Key Features
	Significance The Port Phillip Bay Coastal Study identified Limeburners Bay as a site of geomorphological, floral and faunal interest, and The Spit and the Western Treatment Complex as sites of faunal interest. Limeburners Bay is listed as a site of special scientific interest for its vegetation and its geology and geomorphology. The Spit is also a site of geological and geomorphological scientific interest. These wetlands are of high value for ecological, recreational, tourism, scientific and educational features. They are highly productive and include diverse habitats supporting a wide range and large numbers of waders, ducks, passerines and raptors. ***Social and Cultural values*** Recreation: This wetland system has very high values for birdwatching. Although access is restricted it is within easy reach of Melbourne. The Werribee Treatment Complex is regarded as the best place in Victoria for waterbirds and is internationally-renowned. The coastline is heavily used for recreational fishing. Research: Waterbird counts at Werribee are used to monitor the populations of species listed on JAMBA and CAMBA. It is also a study site for many research projects. Orange-bellied Parrots have been extensively studied in the area. Education: The area is close to Melbourne and is used for teaching by universities. Reference *Department of the Environment and Energy. 2017. Werribee-Avalon Area - VIC121, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC121. Accessed 25 Jul 2017.*
Western Port	***Site description*** Western Port is a large bay with extensive intertidal flats, mangroves, saltmarsh, seagrass beds, several small islands and two large islands. ***Physical features*** Geological setting: Quaternary marine, coastal, alluvial, colluvial, lacustrine and paludal sediments on basalt flows of the Older Volcanics, Tertiary sandstone and Cretaceous sediments. ***Ecological features*** Western Port is of high value for its avifauna and flora. The bays seagrass flats are nursery grounds for King George Whiting and other species of fish and many birds depend on these areas. Many sites in Western Port are of special significance as breeding, roosting or feeding sites for waterbirds, including migratory waders. ***Significance*** Western Port is a high value wetland for its ecological, recreational, tourist, scientific, educational, cultural and scenic features. It is a very good example of a saltmarsh-mangrove-seagrass wetland system. ***Social and Cultural values*** History: Western Port is the site of many historical expeditions and settlements. Churchill Island, which is the site of the first planting of European crops in Victoria and the earliest known substantial building in Victoria following the settlement of Lieut. James Grant in 1801, is listed on the Register of the National Estate. A number of sites of archaeological significance have been identified around the bay. Research: Many studies have been carried out in Western Port. The Western Port study of the 1970s was a world first for such a comprehensive study of an ecosystem. Two significant reports about waterbirds have been published: Loyn (1978) and Dann et al. (1994a, 1994b). The Australasian Wader Study Group use several sites around the bay to trap, measure and band migratory and nomadic wading birds for biological studies. Education: Western Port is used extensively for teaching by schools and universities. The Victorian Institute of Marine Science has an education centre at Tooradin. Reference *Department of the Environment and Energy. 2017. Western Port - VIC083, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC083. Accessed 25 Jul 2017.*
Yambuk Wetlands	***Site description*** The Yambuk Wetlands are a network of the estuary of the Eumeralla River and Shaw River (Lake Yambuk), associated freshwater meadows and semi-permanent saline wetlands. ***Physical features*** The wetlands adjacent to Lake Yambuk and the lower Eumeralla River are floodplain depressions separated from the river by low natural levee banks. All these wetlands have formed in the

Wetland	Key Features
	swale between successive barrier complexes. Geological setting: Quaternary lacustrine, paludal, coastal and alluvial sediments on Quaternary colluvium and alluvium and Tertiary sediments. ***Ecological features*** The Yambuk Wetlands are high value for their flora and fauna and they act as drought refuges. The vegetation consists of extensive reed beds and narrow bands of saltmarsh. ***Significance*** Lake Yambuk is an excellent example of an estuary with extensive overbank swamps. ***Social and Cultural values*** Recreation: Fishing, duck hunting, boating and walking at the river mouth are the main activities. Aboriginal culture: Shell middens, surface scatters and isolated hearths exist in and around Lake Yambuk. Reference *Department of the Environment and Energy. 2017. Yambuk Wetlands - VIC084, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=VIC084. Accessed 25 Jul 2017.*
Tasmania	
Blackmans Lagoon	***Site description*** A coastal wetland, located partly within the Waterhouse Conservation Area (north-east of Tasmania). Access is possible by 2-wheel drive. ***Physical features*** A lagoon barred by the development of Holocene dunes over the last 6,000 years. It is situated at the contact between active Holocene dunes and older, possibly Pleistocene features. The soil is predominantly sand, which is light grey brown in colour with low organic content. ***Ecological features*** This wetland contains a *Lilaeopsis brownii* herbfield in which *Mimulus repens* and *Isolepis fluitans* co-dominate; the community varies in cover from closed to very open. The wetland also has a rich aquatic diversity. ***Significance*** The lagoon supports rare, poorly reserved, and scientifically valuable taxa. It is also of significance because of its physical shape and evolution which appear to differ from the other interdune lakes which have developed between transgresive dunes. ***Social and Cultural values*** The lagoon is valued as an area suitable for recreational activity. Reference *Department of the Environment and Energy. 2017. Blackmans Lagoon - TAS001, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS001. Accessed 25 Jul 2017.*
Boullanger Bay - Robbins Passage	***Site description*** Boullanger Bay - Robbins Passage is an extensive area of tidal channels and intertidal mud and sand flats lying between the northwest coastline of Tasmania, and three off-shore islands (Perkins, Robbins and Penguin islands). ***Physical features*** The site is composed of both estuarine and marine areas, including tidal mud and sand flats, intertidal channels and tidal channels. ***Ecological features*** The large area of exposed mud and sand flats at this site provides a feeding ground for resident and migratory waders. Other seabirds are also abundant in the area, using headlands, sandy beaches, dunes and saltmarshes surrounding the area for roosting and nesting. The saltmarsh areas are important for invertebrates, mainly small crustaceans, crabs and snails. ***Significance*** Boullanger Bay - Robbins Passage attracts the largest numbers of migratory waders in Tasmania, and is also a very significant habitat for non-migratory species. It supports a number of bird species which are regarded as significant both nationally and internationally. Among the many birds using the area, there are 13 species which are listed on the following international treaties, the JAMBA and the CAMBA. The area provides the most extensive feeding grounds on an important route for birds migrating across Bass Strait. It is likely that the Orange-bellied Parrot uses this area as a stop-over in its migration across Bass Strait. ***Social and Cultural values*** There is extensive anecdotal evidence of the long-term use of the area by Tasmanian Aboriginals for various purposes, including hunting and food-gathering. Although it is likely that Aboriginal values of National Estate signficance exist at this site, these have not yet been identified or documented.

Wetland	Key Features
	Reference *Department of the Environment and Energy. 2017. Boullanger Bay - Robbins Passage - TAS089, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS089. Accessed 25 Jul 2017.*
Calverts Lagoon	***Site description*** A small coastal, saline lagoon, in the south-east of Tasmania. Access is possible by 2-wheel drive. ***Physical features*** An excellent example of a Holocene dune barred lagoon with no surface outlet to the sea. Drainage is likely to occur as seepage through the dune system although evaporation is the dominant process. The soil is predominantly sand, which is white in colour and is inorganic and aerated. ***Ecological features*** Calverts lagoon supports a diverse aquatic flora. ***Significance*** The lagoon is a good example of a Holocene dune barred lagoon in this area. It supports species which are rare and vulnerable in Tasmania and nationally and birds which are listed under the JAMBA and the CAMBA. ***Social and Cultural values*** This lagoon is valued as part of a local recreational area. Reference *Department of the Environment and Energy. 2017. Calverts Lagoon - TAS055, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS055. Accessed 25 Jul 2017.*
D'Arcy's Lagoon	***Site description*** A coastal lagoon near the isthmus separating North and South Bruny Island (southeast Tasmania). Access is possible by 2-wheel drive. ***Physical features*** A wetland formed by damming behind coastal sands forming the northern end of the Bruny Island spit - a rare geomorphological phenomenon in Tasmania. The lagoon occurs within a deflation hollow with a distinct (0.5 m) lunette ridge overlaying Quaternary deposits. The soil is predominantly sand, which is grey in colour with medium organic content. ***Ecological features*** This site is an important habitat for a vulnerable species of copepod. ***Significance*** This lagoon is significant as it is the only known location in Tasmania of a copepod species. The lagoon also represents geomorphology which is rare in Tasmania. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. D'Arcy's Lagoon - TAS028, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS028. Accessed 25 Jul 2017.*
Earlham Lagoon	***Site description*** An estuarine coastal lagoon/marsh on the south-east coast of Tasmania. Access is possible by 2-wheel drive. ***Physical features*** The lagoon lies within a coastal swale, overlying Quaternary deposits. The soil is predominantly silt, which is yellow brown in colour with reducing, organic mud. ***Ecological features*** The site is surrounded by grazing land and therefore the marsh flora has become mixed with exotic grasses. ***Significance*** The lagoon supports species which are poorly reserved in Tasmania. It is also used by Red-necked Stints which are listed as important species both under the JAMBA and the CAMBA. ***Social and Cultural values*** The lagoon is valued locally as a recreational area. Reference *Department of the Environment and Energy. 2017. Earlham Lagoon - TAS033, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS033. Accessed 25 Jul 2017.*
Fergusons Lagoon	***Site description*** A transitory wetland on the north-east coast of Flinders Island in Bass Strait. Access is possible by 2-wheel drive.

Wetland	Key Features
	Physical features The lagoon occurs within a coastal swale overlaying Quaternary siliceous sands. The soil is predominantly sand, which is brown in colour with reducing, organic mud. ***Ecological features*** The wetland supports a transient aquatic flora and an *Isolepis cernua* sedgeland. The shoreline is dominated by tussocks and tea tree. ***Significance*** This lagoon supports species and communities which are rare or vulnerable in Tasmania and also a species which is considered vulnerable at a national level. The site is important as it is visited by a group of migratory birds species listed on the JAMBA and/or the CAMBA. ***Social and Cultural values*** The site is an important area for recreational activities. Reference *Department of the Environment and Energy. 2017. Fergusons Lagoon - TAS039, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS039. Accessed 25 Jul 2017.*
Flyover Lagoon 1	***Site description*** Flyover Lagoon is one of a number of shallow, saline coastal lagoons and marshes, which occur on the east coast of Cape Barren Island in the Furneaux group, Bass Strait. Collectively these lagoons are Ramsar listed as the "East-Coast Cape Barren Island Lagoons". This entry pertains to the northern section of Flyover Lagoon. Access to this area is by walking or off-road vehicles. ***Physical features*** Flyover Lagoon is a dune barred (dammed by Recent calcareous sand dunes) lagoon, which forms part of the Cape Barren dune system. The topsoil is grey sand, with some reducing organic mud. ***Ecological features*** The wetland is surrounded by heath and coastal scrub, and is largely free from invasion by exotic species. Both a *Lepilaena cylindrocarpa* and *Selliera radicans* community are present at the site. Many species of waterbirds use the area. ***Significance*** Flyover Lagoon supports a suite of species and communities which are rare, vulnerable and poorly reserved in Tasmania. The lagoon is part of the Cape Barren dune system, which is considered geologically significant, and is listed in the Tasmanian Geoconservation Database. It is also of cultural significance to the Tasmanian Aboriginal community. ***Social and Cultural values*** The area is valued as a site for various recreational activities. It is also of significance to the Aboriginal community. Reference *Department of the Environment and Energy. 2017. Flyover Lagoon 1 - TAS040, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS040. Accessed 25 Jul 2017.*
Flyover Lagoon 2	***Site description*** Flyover Lagoon is one of a number of shallow, saline coastal lagoons and marshes, which occur on the east coast of Cape Barren Island in the Furneaux group, Bass Strait. Collectively these lagoons are Ramsar listed as the "East-Coast Cape Barren Island Lagoons". This entry pertains to the southern section of Flyover Lagoon. Access to this area is by walking or off-road vehicles. ***Physical features*** Flyover Lagoon is a dune barred (dammed by Recent calcareous sand dunes) lagoon, which forms part of the Cape Barren dune system. There are deep sandy soils throughout and some areas of plain formed on Quaternary siliceous marine sands and clays. ***Ecological features*** The wetland is surrounded by heath and coastal scrub, and is free from invasion by exotic species. This basin is important for its *Eleocharis pusilla* sedgeland community. Many species of waterbirds use the area. ***Significance*** Flyover Lagoon supports a suite of species and communities which are rare, vulnerable and poorly reserved in Tasmania. The lagoon is part of the Cape Barren dune system, which is considered geologically significant, and is listed in the Tasmanian Geoconservation Database. It is also of cultural significance to the Tasmanian Aboriginal community. This site is visited by White-bellied Sea Eagles which are listed as an important species under the CAMBA. ***Social and Cultural values*** The area is valued as an area for recreational activity and also holds cultural significance for the Tasmanian Aboriginal community. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Flyover Lagoon 2 - TAS041, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS041. Accessed 25 Jul 2017.
Freshwater Lagoon	***Site description*** A coastal freshwater lagoon on the east coast of Tasmania, near Moulting Lagoon Game Reserve. Access is possible by 2-wheel drive. ***Physical features*** Freshwater lagoon is barred by a foredune overlaying Permian mudstone and sands. The soil is predominantly sand, which is grey in colour with low organic content. ***Ecological features*** A *Selliera radicans* herbfield occurs within this wetland. It varies greatly in cover and species composition, and has the following species recorded as co-dominants: *Centella cordifolia*, *Leptinella reptans*, *Pratia platycalyx*, *Sarcocornia quinqueflora*, *Samolus repens*, *Schoenus nitens*, *Villarsia reniformis*, *Wilsonia backhousei* and *Wilsonia rotundifolia*. ***Significance*** The lagoon supports species and communities which are rare and poorly reserved in Tasmania. This site is also visited by Caspian Terns which are listed as important birds under both the CAMBA and the JAMBA. ***Social and Cultural values*** The lagoon is valued for its aesthetic and recreational values. <u>Reference</u> *Department of the Environment and Energy. 2017. Flyover Lagoon 2 - TAS041, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS041. Accessed 25 Jul 2017.*
Hogans Lagoon	***Site description*** A large seasonal marsh on the north-east coast of Flinders Island (in Bass Strait). Access is by 2-wheel drive. ***Physical features*** Hogans Lagoon is a dune-barred lagoon which has developed within a parallel dune system. It is one of only two large sites showing significant sand accumulation and coastal progradation in Tasmania. The topsoil is red-brown Quaternary, siliceous sand, and is relatively rich in nutrients. ***Ecological features*** The lagoon is surrounded by a *Baumea arthrophylla* marsh with fringing herbland. ***Significance*** This site is important as it supports species which are rare and poorly reserved in Tasmania, and also a species which is vulnerable at a national level. The lagoon is visited by a group of migratory birds which are listed under the JAMBA and/or the CAMBA. It is also of geoconservation value, as it is within a parallel dune system listed in the Tasmanian Geoconservation Database. Hogans Lagoon is also included on the Geoconservation Database because it has a lunette which illustrates the geomorphological relationships with the beach ridge system. ***Social and Cultural values*** The area is valued as a location suitable for various recreational activities. <u>Reference</u> *Department of the Environment and Energy. 2017. Freshwater Lagoon - TAS034, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS034. Accessed 25 Jul 2017.*
Jocks Lagoon	***Site description*** Jocks Lagoon is a small freshwater lagoon partly in the St Helens Conservation Area (north-east coast of Tasmania). It is one of a chain of lagoons, swamps and wetlands. Access to the site is possible by 2-wheel drive. ***Physical features*** An area of Quaternary sands and clays separated from the sea by beach and sand dunes. ***Ecological features*** Jocks Lagoon is one of the very few wetlands in Tasmania containing the rare sedge, *Baumea articulata*. The lagoon has several beds of tall sedges and *Triglochin* sp. as emergent plants but also has some open water. *Lepidosperma longitudinale* open sedgeland and *Baumea articulata* dominate a small edge zone on the southwest side in a mixture with *Melaleuca squarrosa*. On higher ground these communities grade into coastal heath.

Wetland	Key Features
	Significance Jocks Lagoon supports rare and poorly reserved species and scientifically valuable species. It is also a locally important freshwater aquatic habitat in an otherwise dry area. Geomorphologically, it is a good representative example of such a lagoon at the regional scale. ***Social and Cultural values*** Potentially valuable for conservation education, recreational value. Reference *Department of the Environment and Energy. 2017. Jocks Lagoon - TAS002, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS002. Accessed 25 Jul 2017.*
Lavinia Nature Reserve (Lake Martha Lavinia, Sea Elephant Wildlife Sanctuary, Nook)	***Site description*** Lavinia Nature Reserve (King Island, Tasmania) includes the Sea Elephant River Estuary and associated mudflats, areas of coastal swamp, lagoons and areas of drier marsh inland from the coast. Access to the reserve is by 4-wheel drive. ***Physical features*** The Sea Elephant River, the largest on King Island, drains into Bass Strait midway along the east coast. The shifting sands of the Sea Elephant River mouth have resulted in a substantial back-up of brackish water, creating the saltmarsh that extends up to 5 km upstream from the mouth. The coastal strip of the reserve is comprised of dunes and beaches of Quaternary calcareous sands. Further inland are Quaternary sand plains with mostly deep, organic, sandy soils. Outcrops of Precambrian granite occur west of Lake Martha Lavinia, on the coastline near Pennys Lagoon and at the junction of Sea Elephant River and Saltwater Creek. Two distinct episodes of dune formation have occurred in the area. Nook Swamps, running parallel to the coast, occupy a flat depression that separates the new system of parallel dunes from the older parabolic dunes further inland. The topsoil is yellow-brown sand with a high peat content. The Sea Elephant River has reducing, organic mud over dark grey-brown sand and silt. ***Ecological features*** Much of King Island once supported massive eucalypt forests, however, wildfires and large-scale clearing have meant that very few mature trees remain today, the island being dominated by pasture and rapidly diminishing scrub/heathland. The Lavinia Nature Reserve is one of the few largely unaltered areas of the island and contains much of the remaining native vegetation on King Island. The major wetlands in the reserve are the Sea Elephant River estuary area, Lake Martha Lavinia, Penny's Lagoon, and the Nook Swamps. There are also numerous smaller wetland areas, most of which are seasonally inundated. The freshwater areas of the Nook Swamps are dominated by swamp forest, the closed canopy of which exceeds 30m in places. The reserve contains about 200 ha of quality feeding habitat for nationally endangered Orange-bellied Parrots. ***Significance*** The wetland area supports species and communities which are threatened in both Tasmania and/or globally. The area provides a critical feeding site for the endangered Orange-bellied Parrot during its annual migration between south-eastern Australia and Tasmania. The species Short-tailed Shearwater, also found within the reserve, is listed under the JAMBA. Several migratory birds which are listed under the CAMBA visit this site. The reserve is one of the few largely unaltered areas of native vegetation remaining on the island and is therefore a very important refuge for both flora and fauna. ***Social and Cultural values*** The largely unspoiled nature of this reserve and its variety of interesting features, makes it an important area for scientific study, recreation and education. It is thought that there may be archaeological sites connected with colonial whaling and sealing operations in the area around Cowper's Point. Two sites of Aboriginal significance are located within the Lavinia Nature Reserve, one is located near Martha Lavinia and the other at Pennys Lagoon. Reference *Department of the Environment and Energy. 2017. Lavinia Nature Reserve (Lake Martha Lavinia, Sea Elephant Wildlife Sanctuary, Nook - TAS075, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS075. Accessed 25 Jul 2017.*
Little Thirsty Lagoon	***Site description*** Little Thirsty Lagoon is one of a number of shallow, saline coastal lagoons and marshes, which occur on the east coast of Cape Barren Island, in the Furneaux group, Bass Strait.

Wetland	Key Features
	Collectively these lagoons are listed on the Convention on Wetlands as the "East-Coast Cape Barren Island Lagoons". Access to this area is by walking or trail bikes. ***Physical features*** The topsoil is inorganic, aerated red-brown sand. ***Ecological features*** The lagoon supports a diverse aquatic flora community and is also utilised by many migratory birds. ***Significance*** Little Thirsty Lagoon supports a suite of species and communities which are rare and poorly reserved in Tasmania and also a species which is vulnerable at a national level. The lagoon is also an important site for a number of migratory birds listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** The lagoon is of cultural significance to the Tasmanian Aboriginal community. Reference *Department of the Environment and Energy. 2017. Little Thirsty Lagoon - TAS043, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS043. Accessed 25 Jul 2017.*
Little Waterhouse Lake	***Site description*** Little Waterhouse Lake is a coastal freshwater lagoon situated in the Waterhouse Conservation Area (north-east coast of Tasmania). It is an important habitat for a group of rare and poorly reserved species. Access is possible by 2-wheel drive. ***Physical features*** This site is a classic example of a lake formed in the depression between parabolic dunes of the Waterhouse transgressive dunefield, when seaward drainage was blocked by mobile coastal dunes. Quaternary sands and clays found in this area are strongly mottled with a layer of impermeable coffee rock at a depth of 1.5 m. Topsoil is grey, Quaternary calcareous, with a low peat content. ***Ecological features*** The lagoon has dense aquatic growth and a high species richness. To the east an open scrub covers most of the area with *Banksia marginata* and *Xanthorroea australis* dominating. West of the site marram grass (*Ammophilia* sp.) occurs on the foredunes with *Acacia sophorae*, *Banksia marginata* and *Acacia verticillata*. ***Significance*** Little Waterhouse is a good example of a coastal freshwater lagoon in the Ben Lomond biogreographic area. It has a high species richness, and supports species and communities which are rare and poorly reserved in Tasmania, therefore forming an integral part of the coastal community. ***Social and Cultural values*** The area is important for the conservation of a representative coastal community and is also valued as a site for various recreational activities such as angling. Reference *Department of the Environment and Energy. 2017. Little Waterhouse Lake - TAS003, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS003. Accessed 25 Jul 2017.*
Logan Lagoon	***Site description*** Logan Lagoon is one of three large estuarine lagoons which make up a coastal lagoon system along the south-east coast of Flinders Island, Bass Strait. It is enclosed within the Logan Lagoon Conservation area. Access to the lagoon is by 4-wheel drive only ***Physical features*** The lagoon is contained entirely within Holocene alluvial deposits which, when mobilised by longshore drift, block freshwater drainage to the sea. ***Ecological features*** The area is in a relatively natural condition except for some cleared and drained agricultural land on the western shore. The lagoon is fringed with Juncus reed beds whilst the surrounding land supports a savannah grassland with scattered Eucalyptus, Allocasuarina and Banksia trees. Swans and other waterfowl breed in the Juncus tussocks during winter. Being a shallow evaporative basin the lagoon is rich in nutrients and provides abundant food for water birds. When the lagoon has been dry, nearby Cameron Inlet has been recorded as supporting the bird populations normally occupying Logan Lagoon. ***Significance*** Logan Lagoon supports large numbers of migratory waterbirds and a number of species which are rare or vulnerable in Tasmania. The site is used by three species which are listed under both the CAMBA and the JAMBA (*Calidris ruficollis*, *Numenius madagascariensis* and *Tringa nebularia*).

Wetland	Key Features
	Logan Lagoon is listed as an important site for the Double-banded Plover under The East Asian - Australasian Shorebird Site Network which links wetlands that are internationally important for shorebirds. It is an important hydrological feature in the area. It is also listed on the Tasmanian Geoconservation Database because, with other lagoons and dunes in the area, it provides an excellent example of the development of Holocene shorelines. ***Social and Cultural values*** The sanctuary is important for conservation education, scientific research, recreation and tourism. <u>Reference</u> *Department of the Environment and Energy. 2017. Logan Lagoon - TAS044, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS044. Accessed 25 Jul 2017.*
Maria Island Marine Reserve	***Site description*** The Maria Island Marine Reserve is the seaward extension of the Maria Island National Park, off the east coast of Tasmania. The reserve runs from around the shoreline out to the 20 m depth contour, about one kilometre offshore. ***Physical features*** Fossil Bay, on the island's west coast, is characteristically limestone, containing numerous large caverns, whereas rounded granite blocks with moderate cave development occur along most of the eastern coast of the island. Dolerite and folded, argillite reefs are found between these two areas. The east coast reefs drop quickly to considerable depths (40+ m) and experience maximal wave exposure. The sheltered reefs of Shoal Bay are very shallow and have a broken topography of small dolerite boulders. The sandstone reefs near Howells Point are usually submerged under sand in shallow water, but where they extend to greater depths, long gutters and ledges are found. ***Ecological features*** There are extensive seagrass beds and fish nurseries in Mercury Passage (between Maria Island and mainland Tasmania) and sandstone reefs at Howells Point. Forests of giant kelp (15-20 m), rocky reefs and large underwater caverns are found in Fossil Bay. The marine communities around Maria Island occur on a variety of substrates and have a rich diversity of flora and fauna. ***Significance*** Maria Island Marine Reserve protects a representative range of the marine communities found along Tasmania's east coast. It is one of only a few formal marine reserves in Tasmania. The marine area is the most significant representation of the Maugean biogeographic province reserved in Tasmania. It provides an important breeding refuge for species which are commercially fished. The Fossil Cliffs, part of the Marine Reserve, is a site of international geoconservation significance for it's well preserved marine fossils. The site is also used by a number of bird species which are listed under the JAMBA and the CAMBA. ***Social and Cultural values*** The Marine Reserve has significant aesthetic and recreational values, including large underwater caverns, sandstone reefs and seagrass beds of interest to the snorkeler or diver. <u>Reference</u> *Department of the Environment and Energy. 2017. Maria Island Marine Reserve - TAS036, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS036. Accessed 25 Jul 2017.*
Moulting Lagoon	***Site description*** A large estuary at the mouths of the Swan and Apsley Rivers, on the East Coast of Tasmania, adjacent to, and continuous with, another significant wetland (Apsley Marshes). The lagoon, several sections of coastal reserve surrounding it, and an additional area of dry land one kilomtre north comprise Moulting Lagoon Game Reserve. Access is possible with a 2-wheel drive vehicle. ***Physical features*** This lagoon formed with the partial closure of the mouths of the Swan and Apsley Rivers, due to the creation of a Holocene alluvial bar approximately 10,000 years ago. The underlying bedrock is predominantly Jurassic dolerite. The restriction of flow has resulted in the flooding of the surrounding low-lying land and the formation of extensive mudflats where silt carried down by the rivers has been deposited.

Wetland	Key Features
	Ecological features The lagoon contains areas of both shallow and deep water and is surrounded by periodically exposed mudflats and saltmarsh. The western shore has largely been cleared and is used for livestock grazing while the eastern shore is relatively undisturbed and covered with native vegetation. The plant communities around Moulting Lagoon reflect the wide diversity of terrain and consequent soil drainage patterns. The immediate edge of the lagoon supports an almost continuous belt of *Sarcocornia quinqueflora*. Behind that is a continuous fringe of *Juncus kraussii* and beyond in wet areas is *Melaleuca ericifolia*, *Acacia dealbata*, or small stands of *Callitris rhomboidea* with scattered Allocasuarina, *Banksia marginata* and *Acacia dealbata* on the few rocky outcrops. The vegetation in the lower areas (*Sarcocornia quinqueflora*, *Juncus kraussii*) provides important nesting, roosting and feeding habitat for the numerous resident waterfowl. Seasonal fluctuations in numbers of birds occur with changes in rainfall. The estuary is also a nursery area for many fish species and at least fifty-nine species have been recorded in or near the estuary. ***Significance*** Moulting Lagoon and the adjacent Apsley Marshes are one of the largest and most significant wetland areas in Tasmania. Moulting Lagoon supports a number of species and communities which are rare or vulnerable. This lagoon is a significant site for several species listed under both the AMBA) and the JAMBA. The area provides an important resting and breeding ground for many species of migratory birds and fish, and an important drought refuge. Having a substantial catchment, it plays a vital hydrological role in the region. The lagoon is culturally significant to both Aboriginal and European people. ***Social and Cultural values*** The lagoon is a highly valued recreation area. The reserve has commercial value to the local tourism industry and aquaculture operators. It has been used for fishing and hunting of waterfowl since European settlement, and for the harvest of waterfowl eggs by Aboriginal groups living around the lagoon for an unknown length of time prior to this. <u>Reference</u> *Department of the Environment and Energy. 2017. Moulting Lagoon - TAS037, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS037. Accessed 25 Jul 2017.*
Pearshape Lagoon 1	***Site description*** One of a group of coastal lagoons on the southwest coast of King Island (Bass Strait). Access is possible by 2-wheel drive. ***Physical features*** The lagoon has an inflowing channel. Pearshape lagoon occurs within a coastal swale overlaying Quaternary calcareous sands. The soil is predominantly sand, which is white in colour with medium organic content. ***Ecological features*** The wetland supports communities of mixed sedges and grasses, with flooded tea tree scrub in some areas. ***Significance*** This wetland is a good representative wetland for the region and is visited by a diverse range of waterbirds. ***Social and Cultural values*** This area is valued by locals as it is a suitable area for recreational shooting. <u>Reference</u> *Department of the Environment and Energy. 2017. Pearshape Lagoon 1 - TAS076, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS076. Accessed 25 Jul 2017.*
Pearshape Lagoon 2	***Site description*** One of a group of coastal lagoons on the southwest coast of King Island (Bass Strait). Access is possible by 2-wheel drive. ***Physical features*** The lagoon has an inflowing channel. The lagoon occurs within a coastal swale overlaying Quaternary calcareous sands. The soil is predominantly sand, which is white in colour, inorganic and aerated. ***Ecological features*** The wetland is occupied by communities of mixed sedges and grasses, with flooded tea tree scrub in some areas.

Wetland	Key Features
	Significance This wetland is a good representative wetland for the region, and is visited by a diverse range of waterbirds. ***Social and Cultural values*** This area is valued by locals as it is a suitable area for recreational shooting. Reference *Department of the Environment and Energy. 2017. Pearshape Lagoon 2 - TAS077, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS077. Accessed 25 Jul 2017.*
Pearshape Lagoon 3	***Site description*** One of a group of coastal lagoons on the southwest coast of King Island (Bass Strait). Access is possible by 2-wheel drive. ***Physical features*** The lagoon occurs within a coastal swale overlaying Quaternary calcareous sands. The soil is predominantly sand, which is white in colour, inorganic and aerated. ***Ecological features*** This wetland is in a relatively natural condition, with sections of native bush vegetation remaining around the perimeter and fencing to exclude cattle. ***Significance*** This wetland is a good representative wetland for the region. The lagoon is significant as it supports species and communities which are rare and/or poorly reserved in Tasmania. ***Social and Cultural values*** This area is valued by locals as it is a suitable area for recreational shooting. Reference *Department of the Environment and Energy. 2017. Pearshape Lagoon 3 - TAS078, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS078. Accessed 25 Jul 2017.*
Pearshape Lagoon 4	***Site description*** One of a group of coastal lagoons in the southwest of King Island (Bass Strait). Access is possible by 2-wheel drive. ***Physical features*** The lagoon occurs within a coastal swale overlaying Quaternary calcareous sands. The soil is predominantly sand, which is yellow brown in colour with medium organic content. ***Ecological features*** The wetland supports communities of mixed sedges and grasses. ***Significance*** This wetland is a good representative wetland for the region, and it also supports a community which is poorly reserved in Tasmania. ***Social and Cultural values*** This area is valued by locals as it is a suitable area for recreational shooting. Reference *Department of the Environment and Energy. 2017. Pearshape Lagoon 4 - TAS079, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS079. Accessed 25 Jul 2017.*
Pitt Water and Orielton Lagoon	***Site description*** Pitt Water/ Orielton Lagoon comprises an estuarine system with a large area of saltmarsh. The estuary system offers a diversity of habitats and is subsequently a species-rich environment. Access to the lagoon is possible with 2-wheel drive. ***Physical features*** Pitt Water is an almost land-locked body of tidal salt water with a narrow entrance to Fredrick Henry Bay. The area includes estuaries of four watercourses: Coal River and Sorell Rivulet into Pitt Water, Orielton Rivulet into Orielton Lagoon and Iron Creek into Iron Creek Bay. The whole area is protected from the open sea by a large sand bar (Seven Mile Beach). The site has large areas of tidal mud and sand flats and a restricted tide flow through the mouth leaves extensive areas exposed as suitable feeding areas for wading birds. The geology of the area is complex, being dominated by Holocene river alluvium, silt, fine sand, dune and windblown sand with pockets of Triassic sandstone and shale. Orielton Lagoon is separated from Pitt Water by a causeway originally constructed in 1868 and modified in 1906 and 1953. This structure constricted broad tidal flow and created a shallow

Wetland	Key Features
	(1.25 m deep) lagoon about 265 ha in area. The culverts under the causeway have recently been modified to allow freer water flow between Orielton Lagoon and Pitt Water. ***Ecological features*** Most of the site is open water fringed by saltmarsh communities and rocky shores. Extensive mudflats and saltmarsh areas are important habitat for wading birds and waterfowl. There are a number of saltmarsh communities which are significant in their own right; particularly in the north-west (north of Lands End) and surrounding Barilla Bay. The saltmarsh at the northern end of the lagoon, is dominated by *Sclerostegia arbuscula* and *Sarcocornia quinqueflora*. Altered salinity combined with nutrient input from adjacent land uses led to eutrophication, and a series of algal blooms of the species Nodularia *spumigena* in the lagoon in 1993. ***Significance*** The Pitt Water estuary often contains large populations of waterbirds, and is considered to be an important refuge in times of drought. It is the most southern major summer feeding ground for waterbirds in Australia. It is an important area for migratory waders that fly to the site from as far away as the arctic tundra. Twenty six bird species that occur in the estuary are listed on the JAMBA, and 27 bird species are listed on the CAMBA. The wetland flora contains an array of species which are considered to be rare and at risk in Tasmania. Orielton Lagoon is listed as an important site for the Double-banded Plover under The East Asian - Australasian Shorebird Site Network which links wetlands that are internationally important for shorebirds. The rocky shores of Pitt Water are also critical habitat for the endemic starfish, *Patriella vivipara*, which has a very restricted geographic range. The southern part of the site is a protected shark nursery area. ***Social and Cultural values*** Community groups are involved in the rehabilitation of Orielton Lagoon. The Pitt Water area is valued by locals as a recreational fishing area. The area is also commercially valued as an important area for shell fish aquaculture production. At the time of European arrival, Pitt Water was part of the territory occupied by the Oyster Bay Tribe. Twenty-one sites within close proximity to the site have been registered on the Tasmanian Aboriginal site index. Although few surveys have specifically focused on aboriginal sites in the area, one reasonably large midden has been located in the site and it is highly likely that more exist. Reference *Department of the Environment and Energy. 2017. Pitt Water and Orielton Lagoon - TAS067, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS067. Accessed 25 Jul 2017.*
Rocky Cape Marine Area	***Site description*** A marine area off the coast of Rocky Cape National Park, on the northwest coast of Tasmania. ***Physical features*** The rugged coastline at Rocky Cape National Park maintains its jagged nature underwater. Offshore from the headlands are rocky reefs that extend to depths greater than 20 m. The folded quartzite extends as a series of parallel ridges containing long, overhanging caves which follow the strike of the rock. The boulder beaches give way to sea grass beds in very shallow water. Wave exposure around the coast is moderate, although water clarity during calm weather can reach up to 20 m. ***Ecological features*** The extensive caves and high structural relief, together with the range of wave exposures found in the area, result in particularly high biotic diversity. The lower eulittoral zone contains bands of the seaweeds, *Hormosira banksii* and *Cystophora torulosa*. Below these species occurs a zone of *Cystophora moniliformis* which merges with *Caulerpa brownii* and a suite of other seaweeds. Numerous other species are found in the area. As a result of the relatively low wave energy and considerable cave development at Rocky Cape, a large number of fragile, erect animals grow on rock faces, even in shallow water. The Rocky Cape fish fauna contains many warm temperate species as well as numerous cool temperate species including cave dwelling species. The abundance of the slow-moving, edible Boarfish, *Pentaceropsis recurvirostris*, indicates that the area has not been spearfished extensively. ***Significance*** The Rocky Cape Marine Area is a representative wetland type. It is an important site due to its species-diverse marine communities and pollution-free waters. It also supports a species which is thought to be rare in Tasmanian waters.

Wetland	Key Features
	Social and Cultural values The area is used by the community for recreational activites such as scuba diving, snorkelling, fishing and boating. Reference *Department of the Environment and Energy. 2017. Rocky Cape Marine Area - TAS080, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS080. Accessed 25 Jul 2017.*
Sellars Lagoon	***Site description*** One of a group of wetlands on the east coast of Flinders Island (Bass Strait). Access is possible by 4-wheel drive. ***Physical features*** The lagoon occurs within a deflation hollow or local depression overlaying Quaternary deposits. The soil is predominantly sand, which is dark grey brown in colour, inorganic and aerated. ***Ecological features*** The lagoon is surrounded by a *Wilsonia backhousei* herbfield. ***Significance*** Sellars lagoon supports communities which are poorly reserved in Tasmania, and also provides an important habitat for a range of migratory waterbirds. The lagoon is an important site for a number of migratory birds listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** The site is valued as an area suitable for recreational activities such as recreational shooting. Reference *Department of the Environment and Energy. 2017. Sellars Lagoon - TAS045, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS045. Accessed 25 Jul 2017.*
South East Cape Lakes	***Site description*** Coastal perched dune lakes, on the remote southeast Cape of Tasmania. ***Physical features*** The lakes and associated marshes are situated in several swales of a Quaternary dune system. This is underlain by Jurassic dolerite and near horizontal Permian sediments. ***Ecological features*** (No data) ***Significance*** These perched dune lakes form a unique wetland type. The lakes are very significant as they are the only interdune lakes known to have formed behind a cliff top dune complex in Tasmania. ***Social and Cultural values*** The location is important for its aesthetic, conservation and recreational values. Reference *Department of the Environment and Energy. 2017. South East Cape Lakes - TAS030, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS030. Accessed 25 Jul 2017.*
Syndicate Lagoon	***Site description*** Syndicate Lagoon is part of a chain of lagoons and marshes occurring down the eastern coast of Flinders Island (Bass Strait). Access is possible by 4-wheel drive. ***Physical features*** The lagoon occurs on Quaternary calcareous sands with some reducing organic muds. ***Ecological features*** The area is relatively undisturbed and there are representative examples of coastal vegetation around the lagoon. Swans (*Cygnus atratus*) and other waterfowl breed in winter in the fringe of *Juncus* tussocks around Syndicate Lagoon. As the water recedes in summer, wading birds feed on the exposed sand and mudflats. The lagoon is rich in nutrients and provides abundant food for waterbirds. The wetland complex is a refuge for waterfowl during the shooting season, and a resting and feeding area for migratory birds. ***Significance*** Syndicate Lagoon supports communities which are poorly reserved in Tasmania, and provides an important habitat for a range of migratory waterbirds. The lagoon is visited by a number of migratory bird species listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** (No data) Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Syndicate Lagoon - TAS047, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS047. Accessed 25 Jul 2017.
The Chimneys (Lower Ringarooma River floodplain)	***Site description*** The wetland area is situated on the sandy flood plain of the Lower Ringarooma River (northern Tasmania) and is surrounded by woodland used for rough grazing. Access to the site is by 4-wheel drive. ***Physical features*** The Chimneys may represent the remnants of a once more extensive lake system. The area consists of flat plains of Quaternary clays, sands and gravels. Silty clay soil overlays a deep grey sand, with silt content decreasing with depth. The silt is derived from tin mining activity in the river catchment. ***Ecological features*** The area is dominated by scrub and tussock grassland vegetation, and includes substantial areas of freshwater marsh habitat in the floodplain. There are also lagoons and dunes which support a rich variety of invertebrate fauna. ***Significance*** This site has been listed under the Convention on Wetlands of International Importance. The area supports a number of species which are rare or vulnerable, and are poorly reserved in Tasmania. The area has a rich diversity of invertebrate fauna. The Chimneys are also an important feeding and nesting place for many species of waterbird. Its geoscientific significance relates to its age, as it could be older than other lakes in the area (having a possible Pleistocene age being situated well within known Pleistocene dunefields). If so, it is of considerable interest from a palynological and palaeobotanical perspective. The Chimneys may have important subfossil potential such as megafaunal remains. ***Social and Cultural values*** The area was used by Aboriginal people, and has a long history of European occupation and mining exploitation. Limited use is made of the area for duck shooting and cattle grazing. <u>Reference</u> *Department of the Environment and Energy. 2017. The Chimneys (Lower Ringarooma River floodplain) - TAS005, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS005. Accessed 25 Jul 2017.*
Tregaron Lagoons 1	***Site description*** A coastal lagoon, partly in the private Cape Portland Wildlife Sanctuary (north-east Tasmania). Access is possible by 2-wheel drive. ***Physical features*** Holocene dune barred lagoon situated in a restricted transgressive dunefield in relation to other parts of the region. The soil is predominantly sand (overlaying Jurassic dolerite and Quaternary deposits), which is grey in colour with medium peat content. ***Ecological features*** *Crassula helmsii* herbfield is found in this wetland, where the dominant species forms a low, closed sward with the co-dominants *Myriophyllum propinquum* and *Mimulus repens*. ***Significance*** The lagoon supports species and communities which are rare and poorly reserved in Tasmania and a species which is listed as nationally vulnerable. It is important for comparative geomorphological studies for its value in the understanding of Holocene coastline development. This site supports a group of species which are listed as important under both the CAMBA and/or the JAMBA. ***Social and Cultural values*** (No data) <u>Reference</u> *Department of the Environment and Energy. 2017. Tregaron Lagoons 1 - TAS006, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS006. Accessed 25 Jul 2017.*
Tregaron Lagoons 2	***Site description*** A coastal lagoon, part of which is reserved in the private Cape Portland Wildlife Sanctuary (north-east Tasmania). Access is possible by 2-wheel drive.

Wetland	Key Features
	Physical features Holocene dune barred lagoons situated in a restricted transgressive dunefield in relation to other parts of the region. The soil is predominantly sand (overlaying Jurassic dolerite and Quaternary deposits), which is grey in colour with medium peat content. ***Ecological features*** The lagoon is visited by a high diversity of waterbirds. The wetland contains a *Mimulus repens* herbfield, whilst the dominant emergent species include *Juncus* sp., *Triglochin* spp. and *Phragmites* sp.. ***Significance*** The lagoon supports species and communities which are rare and poorly reserved in Tasmania and a species which is listed as nationally vulnerable. It is important for comparative geomorphological studies for its value in the understanding of Holocene coastline development. The site is visited by a number of important migratory species which are listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Tregaron Lagoons 2 - TAS007, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS007. Accessed 25 Jul 2017.*
Unnamed Wetland TAS008	***Site description*** The wetland occurs within a coastal swale overlaying Quaternary deposits. Access is possible by 2-wheel drive. ***Physical features*** The soil is predominantly sand, which is grey in colour with medium organic content. ***Ecological features*** The wetland supports a salt marsh community and a diverse assemblage of fish. ***Significance*** The wetland supports species which are both rare and poorly reserved in Tasmania. It is also part of the Poole Peatland site listed on the Tasmanian Geoconservation Database. ***Social and Cultural values*** Valued as an area for recreational activities. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS008, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS008. Accessed 25 Jul 2017.*
Unnamed Wetland TAS009	***Site description*** A coastal lagoon, part of which is reserved in the private Cape Portland Wildlife Sanctuary (north-east Tasmania). Access is possible by 2-wheel drive. ***Physical features*** The wetland occurs within a deflation hollow or local depression overlaying Jurassic dolerite. This wetland appears to have evolved in a different way to the rest of the wetlands in the region most of which owe their origin to a prograding coastline. This site is an old infilled gulch. The soil is predominantly sand, which is red brown in colour with reducing, organic mud. ***Ecological features*** *Sarcocornia quinqueflora* herbfield occurs in this wetland. The community is very variable in its cover characteristics and varies in its co-dominance with *Mimulus repens*, *Schoenus nitens* and *Triglochin striata*. ***Significance*** The lagoon supports species which are rare and poorly reserved in Tasmania. As it is an unusual landform for this area, it is significant as it adds to the diversity of landforms present in Tasmania. ***Social and Cultural values*** Valued as a recreational area. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS009, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS009. Accessed 25 Jul 2017.*
Unnamed Wetland TAS010	***Site description*** A coastal lagoon, part of which lies within the private Cape Portland Wildlife Sanctuary (north-east Tasmania). Access is possible by 2-wheel drive.

Wetland	Key Features
	Physical features The wetland occurs within a coastal swale overlaying Jurassic dolerite and Quaternary deposits. The soil is predominantly sand, which is grey in colour with medium organic content. ***Ecological features*** This wetland supports a *Wilsonia rotundifolia* herbfield. ***Significance*** The wetland supports species and communities which are rare and poorly reserved in Tasmania. It forms part of a band of wetlands in the area. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS010, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS010. Accessed 25 Jul 2017.*
Unnamed Wetland TAS011	***Site description*** A coastal lagoon, part of which is in the private Cape Portland Wildlife Sanctuary (north-east Tasmania). Access is possible by 2-wheel drive. ***Physical features*** The wetland occurs within a coastal swale overlaying Quaternary deposits. The soil is predominantly sand, which is grey in colour with medium organic content. ***Ecological features*** *Wilsonia rotundifolia* herbfield, which occurs in this wetland, is usually a very open community. Co-dominant species include *Lilaeopsis brownii*, *Puccinellia stricta*, *Ruppia maritima*, *Sarcocornia quinqueflora*, *Schoenus nitens*, *Selliera radicans* and *Spergularia media*. ***Significance*** The wetland supports species and communities which are rare and poorly reserved in Tasmania. It forms part of a band of wetlands in the area. ***Social and Cultural values*** Valued as an area suitable for activities such as shooting. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS011, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS011. Accessed 25 Jul 2017.*
Unnamed Wetland TAS012	***Site description*** A coastal lagoon, part of which is in the Musselroe Bay Conservation Area (north-east Tasmania). Access is possible by 2-wheel drive. ***Physical features*** The wetland occurs within a coastal swale overlaying Quaternary deposits. The soil is predominantly sand, with high organic content. ***Ecological features*** The site supports a saltmarsh community. ***Significance*** The wetland supports species which are rare and poorly reserved in Tasmania. It has evolved as part of a bay mouth spit complex which is significant as it is both undisturbed and poorly reserved in the State. ***Social and Cultural values*** Valued as an area for recreational activities such as boating and fishing. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS012, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS012. Accessed 25 Jul 2017.*
Unnamed Wetland TAS013	***Site description*** A coastal lagoon in the Waterhouse Conservation Area (north-east Tasmania). Access is possible by walking only. ***Physical features*** The wetland occurs within a coastal swale overlaying Quaternary deposits. The soil is predominantly sand, which is grey in colour with high organic content. ***Ecological features*** A *Selliera radicans* herbfield occurs within this wetland. It varies greatly in cover and species composition, and has the following species recorded as co-dominants: *Centella cordifolia*, *Cotula repens*, *Pratia platycalyx*, *Sarcocornia quinqueflora*, *Samolus repens*, *Schoenus nitens*, *Villarsia reniformis*, *Wilsonia backhousei* and *Wilsonia rotundifolia*. ***Significance*** The wetland supports taxa and communities which are rare and poorly reserved in Tasmania. It forms part of a band of wetlands in the area.

Wetland	Key Features
	Social and Cultural values Many recreational activities are carried out both on the lagoon and in the surrounding area. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS013, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS013. Accessed 25 Jul 2017.*
Unnamed Wetland TAS014	***Site description*** A coastal lagoon in the Waterhouse Conservation Area (north-east Tasmania). Access is possible by 4-wheel drive. ***Physical features*** The wetland occurs within a coastal swale overlaying Quaternary deposits. The soil is predominantly sand, which is white in colour with low organic content. ***Ecological features*** The dominant plant community is *Scoenoplectus pungens* sedgeland. ***Significance*** The wetland supports taxa and a community which are rare and/or poorly reserved in Tasmania. ***Social and Cultural values*** Many recreational activities are carried out both on the lagoon and in the surrounding area. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS014, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS014. Accessed 25 Jul 2017.*
Unnamed Wetland TAS038	***Site description*** A small wetland on the east coast of Tasmania, near Moulting Lagoon. Access is possible by 4-wheel drive. ***Physical features*** The wetland has an outflowing channel. It occurs within a deflation hollow with distinct (0.5 m plus) lunette ridges overlaying granite and sands. The soil is predominantly sand, which is grey in colour with high organic content. ***Ecological features*** *Centella cordifolia* herbfield occurs in this wetland, in a low, open sward, with the co-dominates *Hydrocotyle muscosa*, *Isolepis fluitans*, *Agrostis avenacea* and *Goodenia humilis*. ***Significance*** This wetland supports plant communities which are rare in Tasmania. It is also part of the Poole Peatland site, which is considered to be of geoconservation significance, and is listed in the Tasmanian Geoconservation Database. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS038, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS038. Accessed 25 Jul 2017.*
Unnamed Wetland TAS051	***Site description*** This lagoon is one of a number of shallow, saline coastal lagoons and marshes, which occur on the east coast of Cape Barren Island, in the Furneaux group, Bass Strait. Collectively these lagoons are listed on the Convention on Wetlands as the "East-Coast Cape Barren Island Lagoons". Access to this area is by walking or off-road vehicle. ***Physical features*** There are deep sandy soils throughout and some areas of plain formed on granite and Quaternary siliceous marine sands and clays. This particular small, brackish wetland is perched in the coastal sand dune system. The topsoil is inorganic, aerated dark grey-brown sand. ***Ecological features*** This site is sparsely vegetated, but free from invasion of exotic species. ***Significance*** The lagoon supports species which are considered rare and poorly reserved in Tasmania and nationally, and provides an important habitat for a range of migratory waterbirds, some of which are listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** The area surrounding the wetland is valued as a site for recreational activities. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Unnamed Wetland - TAS051, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS051. Accessed 25 Jul 2017.
Unnamed Wetland TAS052	***Site description*** This lagoon is one of a number of shallow, saline coastal lagoons and marshes, which occur on the east coast of Cape Barren Island, which is in the Furneaux group in Bass Strait. Collectively these lagoons are listed on the Convention on Wetlands as the "East-Coast Cape Barren Island Lagoons". Access is possible by walking or off-road vehicles. ***Physical features*** The wetland is barred by a foredune overlaying granite and sands. The soil is predominantly sand, which is grey in colour with low organic content. ***Ecological features*** This site is important for large numbers of migratory waterfbirds. The vegetation community surrounding the margins of the lagoon is an open herbfield. ***Significance*** The lagoon supports species and communities which are considered rare and poorly reserved in Tasmania, and a species which is vulnerable on a national level. It is also used by species which are listed under the CAMBA and/or the JAMBA. ***Social and Cultural values*** The area including and surrounding this wetland has important recreational values. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS052, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS052. Accessed 25 Jul 2017.*
Unnamed Wetland TAS081	***Site description*** A coastal wetland in the far northwest of Tasmania. Access is possible by 2- wheel drive. ***Physical features*** The wetland occurs within a coastal swale overlaying metamorphosed fine grained rocks. The soil is predominantly sand, which is grey in colour with medium organic content. ***Ecological features*** A *Hydrocotyle muscosa* herbfield occurs within this wetland, where the dominant species form low, mostly closed swards and is commonly associated with *Crassula helmsii, Eleocharis acuta*, *Lilaeopsis brownii* and *Selliera radicans*. *Villarsia reniformis* aquatic community, also found in this wetland, forms a dense cover, with the co- dominant species *Myriophyllum propinquum*, *Isolepis fluitans* and *Triglochin procera*. ***Significance*** This site is an important representative wetland for the region. It is of further importance as it supports communities which are poorly reserved in Tasmania. ***Social and Cultural values*** The area is valued as an important site for recreational activities such as fishing. Reference *Department of the Environment and Energy. 2017. Unnamed Wetland - TAS081, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=TAS081. Accessed 25 Jul 2017.*
New South Wales	
Avoca Lagoon	***Site description*** A shallow, brackish lagoon with extensive *Phragmites australis* rushlands. Large *Juncus kraussii* reedlands occur in the northern arm. Swamp forests of *Melaleuca quinquenervia* and *Casuarina glauca* surround most of the northern and western arms and are also found on the island. There are dense growths of aquatic grasses and algae, especially in the northern arm. The bottom is mainly silt but is sandier near the entrance. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** In Fair Condition. There is a high nutrient input from septic tanks, urban runoff and fertilisers used in the rural part of the catchment. The narrow opening of the southern arm of the lake restricts water movement. This section of the lake is showing increased rates of eutropication. The

Wetland	Key Features
	lagoon is being dredged for sand, thus increasing turbidity and disturbance of aquatic habitats. Frequent artificial opening has unknown effects. ***Social and Cultural values*** The lake is an important tourist attraction and recreation area. It is a good nesting and feeding area for ducks, moorhens and other waterbirds. Reference *Department of the Environment and Energy. 2017. Avoca Lagoon - NSW181, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW181. Accessed 25 Jul 2017.*
Beecroft Peninsula	***Site description*** The Commonwealth component of the Beecroft Peninsula consists of the area known as the Beecroft Weapons Range and covers almost all of the Peninsula except a strip of land in the northern end that contains the township of Currarong and Abrahams Bosom Reserve, and an area to the west of the Beecroft Weapons Range that is NSW NPWS land. The vegetation is diverse (573 species) and of high conservation value (8 ROTAP species recorded). ***Physical features*** The Beecroft Peninsula forms the northern headland of Jervis Bay and is a remnant of a Permian coastal plateau that slopes north and east from high ocean cliffs to the gentler shore of the Bay. The area supports a high diversity of vegetation types within a small area including mangroves, saltmarsh and freshwater swamps, heathland, eucalypt forest and sub-tropical and littoral rainforest. On the northern boundary of the range (outside of the Commonwealth area) is Lake Wollumboola, which is the largest shallow saline lagoon on the south coast of NSW. The Lake is seldom open to the sea. Wowly Gully, in the north-west corner of the Peninsula, consists of a series of interconnected pools and is fringed by sandflats and swamps. The gully is frequently open to Jervis Bay at which time it becomes a tidal channel. ***Ecological features*** The peninsula supports a variety of wetland units with varying vegetation types, including: *Casuarina glauca* swamps with a shrub and sedge understorey; Low lying swamps supporting *Phragmites australis*, *Melaleuca ericifolia*, *Baumea teretifolia*, *Baumea articulata* and *Leptospermum juniperinum*; stream swamps occur in the catchment of Duck creek with dominant species including *Gahnia clarkei* and *Gleichenia microphylla*; swampy thicket occurs on low lying land between heathland and low lying swamp with common species being; *Allocasuarina littoralis*, *Epacris microphylla*, and *Melaleuca thymifolia*; and mangroves *Avicennia marina* found on tidal mudflats. Other habitat types include coastal scrub, wet and dry heath, small and large crowned eucalypt forests, Terpentine and rainforest. The lower saltmarsh of Lake Wollumboola is a mosaic of two communities, one dominated by the uncommon *Wilsonia backhousei* and the other is dominated by *Sarcocornia quinqueflora*. Grey mangrove *Avicennia marina* occurs in patches at Chinamans Beach but fringes Cararma inlet behind which are areas of saltmarsh. The most striking feature is the presence of the *Chenopod Sclerostegia* arbuscula which is only known from a few sites in NSW. ***Significance*** The area supports a high diversity of vegetation types within a small area and a variety of wetland types. A number of threatened flora and fauna species are present. ***Social and Cultural values*** The Point Perpendicular lighthouse includes residences and ancillary structures representing early construction methods using pre-cast concrete block masonry employing sandstone aggregate from the site. There are a large number of aboriginal sites recorded on the peninsula including art sites, middens, scarred trees and campsites. Reference *Department of the Environment and Energy. 2017. Beecroft Peninsula - NSW176, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW176. Accessed 25 Jul 2017.*
Bondi Lake	***Site description*** (No data) ***Physical features*** Bondi Lake is an example of a Simple Embayment Lake. Embayment lakes are formed in the same formative process as in drowned valley lakes, except that in this case a bay is cut off. Such lakes were formed in the Holocene marine transgression. The lake lies in a broad depression behind the frontal dune.

Wetland	Key Features
	Ecological features Bondi lake is a freshwater lake located in an area whereby the surrounding waterbodies exhibit varying degrees of salinity. The lake supports a range of freshwater flora and fauna species, little documentation exists. ***Significance*** (No data) ***Social and Cultural values*** Former school house located at the northern end of Bondi Lake Reference *Department of the Environment and Energy. 2017. Bondi Lake - NSW116, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW116. Accessed 25 Jul 2017.*
Brisbane Water Estuary	***Site description*** (No data) ***Physical features*** The estuary of Brisbane Water is a relatively small (27 km^2) broad, shallow estuary connected to Broken Bay through a narrow channel. The estuary is entirely within the City of Gosford. ***Ecological features*** Two species of mangroves occur, Grey Mangrove (*Avicennia marina*) and River Mangrove (*Aegiceras corniculatum*) and cover an area of 163 ha; Saltmarsh covers an area of 95 ha, mostly in the Cockle Bay Nature Reserve and Rileys Island Nature Reserve. Intertidal seagrass beds are extensive and are shown on the attached map. Brisbane Water is important feeding area for migratory waders and for waterbirds generally. Swans arrive in spring and summer in the estuary to feed on the extensive seagrass beds. The area is also important as a nursery and spawning ground for fish and crustaceans. ***Significance*** (No data) ***Social and Cultural values*** Around 100,000 people live around Brisbane Water, there is an important commercial fishery and oyster farming industry based in the estuary and the area is well known as an amateur fishing area. Marinas operate around the estuary and there are many sailing and motorboat clubs operating on the lakes and in the estuary. Reference *Department of the Environment and Energy. 2017. Brisbane Water Estuary - NSW132, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW132. Accessed 25 Jul 2017.*
Bundjalung National Park	***Site description*** (No data) ***Physical features*** The geology of Bundjalung National Park consists primarily of areas of Quaternary sediments including alluvium, gravel, sand, silt, clay and areas of beach and dune sand. The geology of the remaining area consists of Triassic - Jurassic sediments of the Bendamba Group including sandstone, shale, and conglomerate). Soils of Bundjalung National Park include siliceous sands, sand podzols, humus podzols, acid peats, and Quaternary estuarine deposits. These soils are sandy, poorly structured and infertile. Examples of the dune and swale complex which was formed during the Pleistocene are contained in Bundjalung National Park. ***Ecological features*** Bundjalung National Park consists of a dunal wetland system, consisting of a mosaic of wet heath, sedgeland, dry heath, forested swamp and sclerophyll forest south of Evans Head. In the southern area of the National Park swamp sclerophyll forests grade to saltmarsh and mangroves in intertidal areas. The central area comprises predominantly of wet heathland and sedgeland communities. ***Significance*** This large complex of dunal wetlands is in a relatively natural condition, and is considered to be a representative example of coastal dunal wetlands. ***Social and Cultural values*** Evidence of Aboriginal occupation of the area covered by Bundjalung National Park includes middens, campsites, mythological sites, a fish trap made of rock at Woody Head, stone tool workshops and bora ceremonial grounds. Goanna Headland which lies adjacent to Bundjalung National Park has particular mythological significance to the local Aboriginal community. There is a Native Title claim over the park and it is likely that some form of joint management will occur in the future. Bundjalung has been used for military purposes since World War II. Disused bunkers associated with target practice ranges are located in the central area of Bundjalung National Park. In the

Wetland	Key Features
	past the coastal areas of the National Park have been used for fishing, recreation, bee keeping and limited cattle grazing. A miners cottage, erected in 1923 still stands near Woody Head. Possible opportunities for scientific studies and educational purposes. Reference *Department of the Environment and Energy. 2017. Bundjalung National Park - NSW026, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW026. Accessed 25 Jul 2017.*
Clarence River Estuary	***Site description*** (No data) ***Physical features*** The geology of the area consists of Quaternary sediments including alluvium, gravel, sand silt, clay overlying the Cretaceous-Jurassic Kangaroo Creek Sandstone. ***Ecological features*** Estuary of largest coastal river in NSW (based on discharge and catchment area, and associated mangrove, seagrass and saltmarsh areas. Four species of mangrove occur within the Clarence Estuary including the River Mangrove (*Aegiceras corniculatum*), Grey Mangrove (*Avicennia marina* var. *australasica*), Black Mangrove (*Bruguiera gymnorrhiza*) and the Milky Mangrove (*Excoecaria agallocha*). Dominant species in saltmarsh include Samphire (*Sarcocornia quinqueflora*) and Salt Couch (*Sporobolus virginicus*). Rainforest trees, shrubs and vines are also a prominent feature of the estuary. ***Significance*** A number of wetlands within the Clarence Estuary are SEPP 14 wetlands; these include Freeburn, Thorny, Micalo, Dart, Hickey and Rabbit Islands. ***Social and Cultural values*** The Clarence Estuary was utilised by Aborigines for fishing and evidence of this includes oyster shell middens that have been recorded on Micalo Island. In the early 1800's Richard Craig pioneered the harvesting of extensive Red Cedar stands of the Clarence. Cropping began with sugar cane farms in 1864 on the Clarence River floodplain. Reference *Department of the Environment and Energy. 2017. Clarence River Estuary - NSW027, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW027. Accessed 25 Jul 2017.*
Clybucca Creek Estuary	***Site description*** (No data) ***Physical features*** The geology of the Clybucca Creek Estuary comprises of Quaternary sediments including alluvial, paludal and estuarine deposits, mainly sands silts and gravel. ***Ecological features*** Wetlands consisting of 520 ha of mangroves, 191 ha of seagrasses, and 365 ha of saltmarsh. Mangrove species within the estuary include Grey Mangrove (*Avicennia marina*), River Mangrove (*Aegiceras corniculatum*), Milky Mangrove (*Excoecaria agallocha*). The saltmarsh community include species such as Couch (*Sporobolus virginicus*), Sedge (*Cyperus polystachyos*), Sea Rush (*Juncus kraussii*), the Sedge *Fimbristylis ferruginea*, Seaberry Saltbush (*Rhagodia candolleana* ssp. *candolleana*) and, Ruby Saltbush (*Enchylaena tomentosa*). Freshwater swamp forest also occurs along the estuary and includes species such as Paperbark (*Melaleuca quinquenervia*), Willow Bottlebrush (*Callistemon salignus*) and Swamp Oak (*Casuarina glauca*). Fauna species recorded within the estuary include the Australian White Ibis (*Threskiornis molucca*), Straw-necked Ibis (*Threskiornis spinicollis*), Pied Oystercatcher (*Haematopus longirostris*), Pelican (*Pelecanus conspicillatus*), Whimbrel (*Numenius phaeopus*), White-bellied Sea-eagle (*Haliaeetus leucogaster*), Pied Cormorant (*Phalacrocorax varius*), Little Pied Cormorant (*Phalacrocorax melanoleucos*), Welcome Swallow (*Hirundo neoxena*), Azure Kingfisher (*Alcedo azurea*), Willie Wagtail (*Rhipidura leucophrys*), Jacky winter (*Microeca fascinans*), Red-bellied Black Snake (*Pseudechis porphyriacus*), and the Echidna (*Tachyglossus aculeatus*). ***Significance*** (No data) ***Social and Cultural values*** Evidence of Aboriginal occupation of the wetland includes midden sites at Stuarts Point and Shark Island. The Macleay middens are unique as a surviving complex and are probably the largest deposits of their sort still intact. Other Aboriginal sites which occur within the estuary include burial sites, ceremonial grounds and carved trees. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Clybucca Creek Estuary - NSW028, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW028. Accessed 25 Jul 2017.
Clyde River Estuary	***Site description*** (No data) ***Physical features*** The geology of the Clyde River estuary consists primarily of Ordovician sediments including siltstone, claystone, sandstone, quartzite and chert. with some areas around the mouth of the estuary consisting of Quaternary sediments including alluvium gravel, swamp deposits and sand dunes. ***Ecological features*** A relatively south coast estuary, which supports areas of mangrove including River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina*) (3200 ha), seagrass (70 ha) and saltmarsh (100 ha). Other common flora species include Common Reed (*Phragmites australis*), Sea Rush (*Juncus krausii*), Sheoaks (*Casuarina* spp.), *Eucalyptus* spp., Long-leaved Wallaby Grass (*Danthonia longifolia*). Relatively rich zooplankton fauna are found in the estuary. Many native fish are found in the estuary including Australian Smelt (*Retropinna semoni*), Australian Bass (*Macquaria novemaculeata*), and the Australian Grayling (*Prototroctes maraena*). Fauna species which occur in the area include the Common Eastern Froglet (*Crinia signifera*), Brown Striped Frog (*Limnodynastes peronii*), Brown Tree Frog (*Litoria ewingii*), Lace Monitor (*Varanus varius*), Grass Skink (*Lampropholis delicata*), Red-bellied Black-snake (*Pseudechis porphyriacus*), Striated Heron (*Butorides striatus*), Buff-banded Rail (*Gallirallus philippensis*), Purple Swamphen (*Porphyrio porphyrio*), Masked Lapwing (*Vanellus miles*), Brown Cuckoo-Dove (*Macrophygia amboinensis*), Gang-gang Cockatoo (*Callocephalon fimbriatum*), Musk Lorikeet (*Glossopsitta concinna*), Little Lorrikeet (*Glossopsitta pusilla*), Crimson Rosella (*Platycercus elegans*), Australian Owlet-nightjar (*Aegotheles cristatus*), Laughing Kookaburra (*Dacelo novaeguineae*), Sacred Kingfisher (*Todiramphus sanctus*), Striated Thornbill (*Acanthiza lineata*), Brown Thornbill (*Acanthiza pusilla*), White-throated Gerygone (*Gerygone olivacea*), Spotted Pardalote (*Pardalotus punctatus*), White-browed Scrubwren (Sericornis frontalis), Eastern Spinebill (Acanthorhynchus tenuirostris), Yellow-faced Honeyeater (*Lichenostomus chrysops*), Lewin's Honeyeater (*Meliphaga lewinii*), White-naped Honeyeater (*Melithreptus lunatus*), Scarlet Honeyeater (*Myzomela sanguinolenta*), Eastern Yellow Robin (*Eopsaltria australis*), Eastern Whipbird (*Psophodes olivaceus*), Grey Shrike-thrush (*Colluricincla harmonica*), Crested Shrike-tit (*Falcunculus frontatus*), Rufous Whistler (*Pachycephala rufiventris*), Spangled Drongo (*Dicrurus bracteatus*), Leaden Flycatcher (*Myiagra rubecula*), Grey Fantail (*Rhipidura fuliginosa*), Rufous Fantail (*Rhipidura rufifrons*), Double-barred Finch (*Taeniophygia bichenovii*), Brown Antechinus (*Antechinus stuartii*), Feathertail Glider (*Acrobates pygmaeus*), Greater Glider (*Petauroides volans*), Sugar Glider (*Petaurus breviceps*), Swamp Wallaby (*Wallabia bicolor*), Gould's Long-eared Bat (*Nyctophilus goudli*), Little Forest Eptesicus (*Vespadelus vulturnus*), Bush Rat (*Rattus fuscipes*), and Leopard Seal (*Hydrurga leptonyx*). ***Significance*** (No data) ***Social and Cultural values*** The area was populated by the Yuin group of Aborignal tribes who probably set up permanent camps near the river. Several middens have been recorded near the mouth of the estuary. The coastal areas provided plentiful food and were favoured by the Aboriginal people. Europeans have utilised the area for forestry purposes since around the 1820s. Reference *Department of the Environment and Energy. 2017. Clyde River Estuary - NSW059, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW059. Accessed 25 Jul 2017.*
Cockrone Lagoon	***Site description*** A shallow brackish lagoon with extensive *Phragmites australis* reedlands near the head waters. The Lake is fringed by *Baumea juncea*, *Juncus krausii* and *Melaleuca ericifolia* scrub. *Melaleuca quinquenervia*, *M. styphelioides* and *Casuarina glauca* occur around most of the lagoon, and thickets of *Melaleuca biconvera* extend up Cockrone Creek. The water is usually clear with *Ruppia* sp. and several species of green algae. ***Physical features*** (No data) ***Ecological features*** (No data)

Wetland	Key Features
	Significance The condition is very good. This is the best preserved of the coastla lagoons but there is some nutrient runoff and septic pollution. The foredune was affected by developments, and was blowing into the mouth of the lagoon. Dune restoration is now beginning to take effect. ***Social and Cultural values*** The lake is an important tourist attraction and recreation area. It is also a feeding and nesting area for many species of water birds. <u>Reference</u> *Department of the Environment and Energy. 2017. Cockrone Lagoon - NSW182, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW182. Accessed 25 Jul 2017.*
Coila Creek Delta	***Site description*** (No data) ***Physical features*** The delta has formed at the mouth of Coila Creek that drains to Coila Lake, a large south coast ICOLL of about 700 ha. A variety of sediments form the delta including shell-filled sands on the points of the delta, soft sandy clays on the saltmarsh, black cracking clays in pans, and black fine soft muds in the lake adjoining the delta. ***Ecological features*** Mico-relief of a few decimetres gives rise to various habitats. Low areas are dominated by a Samphire (*Sarcocornia quinqueflora*), *Wilsonia rotundifolia* saltmarsh in good condition, higher areas by rushland of Sea Rush (*Juncus krausii*) and various saltmarsh forbs including *Selliera radicans* and Creeping Monkey-flower (*Mimulus repens*), and the longest accumulated sediments flanking Coila Creek dominated by a Swamp Oak (*Casuarina glauca*) forest. The dried black cracking claypans support no visible plant life. The strandline on the northern shore comprises various sedge species and a mix of unusual forbs. The aquatic habitats are rich in aquatic plants. Algae, Sea Grass (*Zostera* sp.), Sea Tassel (*Ruppia* sp.) and Sea Wrack (*Halophila* sp.) all occur with healthy populations of Halophila adjoining the saltmarsh. ***Significance*** (No data) ***Social and Cultural values*** Bait search area for fishers. Aboriginal significance is unknown but likely. <u>Reference</u> *Department of the Environment and Energy. 2017. Coila Creek Delta - NSW117, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW117. Accessed 25 Jul 2017.*
Coomaditchy Lagoon	***Site description*** (No data) ***Physical features*** Coomaditchy Lagoon is a small coastal dunal lake, found between dunes covering the original entrance to Lake Illawarra. The climate around Coomaditchy Lagoon is described as temperate marine. Geology of the area consists of Quaternary windblown medium to fine grained marine quartz sand. The landscape is gently undulating to rolling coastal dune fields. The area adjacent to the lagoon has been mined for sand. The removed sand has since been replaced by coal wash. ***Ecological features*** Coomaditchy Lagoon is home to a great variety of birds, reptiles, frogs and fish. The lagoon contains a reed swamp and sedge swamp on the southern and western shores. These swamps are used as breeding sites for many waterbirds. ***Significance*** (No data) ***Social and Cultural values*** The lagoon and surrounding area is of cultural value to the local Aboriginal people. This area is the location of the Aboriginal camps, following the relocation of people from Hill 60 during World War II. <u>Reference</u> *Department of the Environment and Energy. 2017. Coomaditchy Lagoon - NSW135, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW135. Accessed 25 Jul 2017.*
Coomonderry Swamp	***Site description*** (No data)

Wetland	Key Features
	Physical features Coomonderry Swamp was formed by natural infilling behind the sand barrier north of Mount Coolangatta. The wetland has soils composed of friable organic peat overlying acid peats of depths greater than one metre. Below the peat, various sandy subsoils overlie Quaternary marine sands. ***Ecological features*** The swamp is dominated by sedges and aquatic herbs. In particular the eastern margin of the swamp supports a most outstanding example of freshwater wetland - woodland - sand dune transition. At the swamp edge extensive reed beds and sedgelands merge into thickets of Swamp Oak (*Casuarina glauca*), Prickly Tea Tree (*Leptospermum juniperinum*), Swamp Paperbark (*Melaleuca ericifolia*) and Snow in summer (*Melaleuca linariifolia*). Adjacent to these shrub and small tree species there are extensive stands of Swamp Mahogany (*Eucalyptus robusta*) with an understorey of native grasses and sedges. Wet meadow communities on the western and southern margins are highly dynamic and support a diversity of short-lived wetlands species. Adjacent areas of Southern Mahogany (*Eucalyptus botryoides*), and Blackbutt (*Eucalyptus pilularis*) open forest as well as littoral rainforest also occur. Sedge and reed beds cover most of the swamp and are dominated by Jointed Twig-rush (*Baumea articulata*), Baumea arthrophylla, Tall Spike-rush (*Eleocharis sphacelata*), Common Reed (*Phragmites australis*) and Broad-leaf Cumbungi (*Typha orientalis*). Open water areas are dominated by submerged plant communities of Water Millfoil (*Myriophyllum* sp.), Nardoo (*Marsilea* sp.), and Blunt Pondweed (*Potamogeton ochreatus*. ***Significance*** Good example of coastal wetland on south coast, in relatively undisturbed condition. Coomonderry Swamp is the largest freshwater coastal wetland in the southern region of NSW. It is an outstanding example of a large freshwater swamp developed inland of a parallel Quaternary dune system. ***Social and Cultural values*** (No data) <u>Reference</u> *Department of the Environment and Energy. 2017. Coomonderry Swamp - NSW076, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW076. Accessed 25 Jul 2017.*
Cormorant Beach	***Site description*** Almost completely surrounded by houses with inadequate buffer. Subject to urban runoff. Degraded margin. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** A rare wetland type heavily impacted on the margins but retaining some very important unspoilt components. It contains rare freshwater communities, some uncommon species and important faunal habitat. All four plant communities that occur in the wetland are considered to be significant, with the dunal freshwater wetland providing frog and bird habitat within the urban area. While Paperbark Shrubland and Swamp Oak forest are structurally similar to estuarine counterparts, at this site they occur in deeper standing water and herbaceous understorey plants are different. ***Social and Cultural values*** Surrounded by urban development. <u>Reference</u> *Department of the Environment and Energy. 2017. Cormorant Beach - NSW172, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW172. Accessed 25 Jul 2017.*
Crowdy Bay National Park	***Site description*** (No data) ***Physical features*** The geology of Crowdy Bay National Park consists primarily of Quaternary sediments including sand, silt, mud, gravel, quartose sand and silt. An area of Tertiary rhyolite also occurs at Diamond Head which was formed as the result of an intrusion caused by volcanic activity along the east coast of Australia. Bedrock outcrops occur throughout the park and consist of Triassic shales, tuff, tuffaceous sandstone, sandstone and conglomerate. The soils of Crowdy Bay National Park consists predominantly of unconsolidated and podsolised poor nutrient sandy soils of Holocene and Pleistocene origin including siliceous sands, sand podzols and humus podzols, acid peats, solonchaks

Wetland	Key Features
	and brown podzolics. Bedrock soils include lithosols, red and yellow earths, gleyed podzolics, soloths and dark grey-brown clay loams. ***Ecological features*** Dunal wetland system, consisting of a mosaic of wet heath, sedgeland, dry heath, forested swamp and sclerophyll forest north of Harrington. Vegetation communities within the park include Tuckeroo (*Cupaniopsis anacardioides*) and Brush Box (*Lophostemon confertus*) littoral rainforests, Grey Mangrove (*Avicennia marina*) mangrove forests and woodlands, Flooded Gum (*Eucalyptus grandis*) and Blackbutt (*Eucalyptus pilularis*) wet sclerophyll forests, Tallowwood (*Eucalyptus microcorys*), Black Sheoak (*Allocasuarina littoralis*), and Banksia (*Banksia aemula*) dry sclerophyll forests and woodlands, graminoid clay heathland, wet heathland, Samphire (*Sarcocornia quinqueflora*), Sand Couch (*Sporobolus virginicus*) chenopod shrubland, Hairy Spinifex (*Spinifex sericeus*) tussock grassland, Kangaroo Grass (*Themeda triandra*) sod grassland, various sedgelands, Sea Rush (*Juncus kraussii*) rushland, Swamp Water Fern (*Blechnum indicum*) fernland, and saltmarsh communities. ***Significance*** Crowdy Bay National Park is a large complex of dunal wetlands which remain in a relatively natural condition, and are thus considered to be a good example of this wetland type. ***Social and Cultural values*** Until the late nineteenth century the Ngamba and Birripai tribes of Aborigines occupied the area. In the summer the Birripai people lived in the lowlands of their territory near the river and the sea so that they could utilise the seasonally abundant fish and shellfish and native fruits. Aboriginal sites within the park include shell middens (approximately 6,000 years old), axe heads, stone tools and hooks. On the homeward leg of his 1818 expedition over the New England Tablelands into the Hastings Valley, John Oxley traversed the park area. Mineral sand mining occurred in various areas within the park between 1959 and 1982. Several residences within the park are the result of early European occupation of the area. Reference *Department of the Environment and Energy. 2017. Crowdy Bay National Park - NSW029, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW029. Accessed 25 Jul 2017.*
Cudgen Nature Reserve	***Site description*** (No data) ***Physical features*** Three major landforms dominate the Cudgen catchment including: Coastal sands located east of Cudgen Lake; Cudgen lagoonal lands (surrounding Cudgen Lake and including the south east of Round Mountain; and sediments of the Neranleigh-Fernvale Group which dominate the Round Mountain hills and upper catchment. Cudgen Lake is a barrier dune lake system. Sandy yellow podsols occur between the outer barrier dunes and Cudgen Lake. The Clothiers Creek and Reserve Creek floodplain soils are dark loams overlying clays. ***Ecological features*** Cudgen Nature Reserve supports 15 distinct vegetation associations, viz. littoral rainforest, lowland subtropical rainforest on Round Mountain, lowland subtropical rainforest on swamp forest margins, Swamp Paperbark (*Melaleuca quinquenervia*) swamp forest, Swamp Mahogany (*Eucalyptus robusta*) forest, Blackbutt (*Eucalyptus pilularis*) forest, Grey Gum (*Eucalyptus propinqua*) - Blackbutt (*Eucalyptus pilularis*) tall open forest, Red Gum (*Eucalyptus tereticornis*) - Pink Bloodwood (*Corymbia intermedia*) - Swamp Turpentine (*Lophostemon suaveolens*) forest, Scribbly Gum (*Eucalyptus signata*) - Wallum Banksia (*Banksia aemula*) forest, Wallum Banksia (*Banksia aemula*) heath, Wet heath, *Baumea rubiginosa* Closed Sedgeland, Water Ribbons (*Triglochin procera*) Sedgeland, *Schoenoplectus litoralis* Sedgeland, Grey Mangrove (*Avicennia marina*) Mangrove Wetland. Other vegetation communities of special significance include Swamp Banksia (*Banksia robur*) wet heathlands, Riberry (*Syzygium luehmanni*) - Broad-leaved Lilly Pilly (*Acmena hemilampra*) littoral rainforests and Swamp Banksia (*Banksia robur*) - Leptospermum liversidgei - Xanthorrhoea fulva wet heathland community. The perimeter of Cudgen Lake contain dense stands of Common Reed (*Phragmites australis*) and Lepironia articulata scattered with Cladium procerum. The shallow lake waters support a dense emergent growth of reeds Schoenoplectus litoralis and Cumbungi (*Typha* sp.) on the northern side of the lake. Other aquatic species include *Baumea rubiginosa* sedgeland and *Triglochin procera*, while intertidal and subtidal species are dominated by mangroves e.g. Grey

Wetland	Key Features
	Mangrove (*Avicennia marina*), *Bruguiera gymnorrhiza* and seagrasses e.g. Eel Grass (*Zostera capricorni*). ***Significance*** (No data) ***Social and Cultural values*** The Aboriginal people of the Cudgen area were known as the Coodjingburra. A number of Aboriginal sites have been identified in the local area including a stone quarry on the banks of Cudgen Lake. Reference *Department of the Environment and Energy. 2017. Cudgen Nature Reserve - NSW108, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW108. Accessed 25 Jul 2017.*
Cullendulla Creek and Embayment	***Site description*** (No data) ***Physical features*** Most of the area is composed of widely spaced beach ridges overlying a shallow sheet of nearshore or low tidal shelly sands. The areas between the ridges have been infilled with mud and organic debris. ***Ecological features*** A mangrove forest comprising River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina*) covers most of the tidally influenced portion of the basin and the creek margins. Mudflats are bare apart from scattered depressions in which patches of seagrasses occur. A bare zone also separates the mangrove swamp from upland Eucalypt forest. This zone consists of a hard mud pavement with intermittent coverings of blue-green algae and occasional individuals of Beaded Glasswort (*Sarcocornia quinqueflora*). Swamp She Oak (*Casuarina glauca*) grows on the beach ridges. Fauna species include Black Swan (*Cygnus atratus*), Little Pied Cormorant (*Phalacrocorax melanoleucos*), Pygmy Right Whale (*Caperea marginata*) nearby. ***Significance*** The beach chenier system (a chenier is a long, low narrow beach ridge roughly parallel to a retreating shoreline seaward of marsh and mud-flat deposits) is uncommon in NSW. These well developed cheniers provide a record of shoreline trends over the Holocene (10,000 BP to present). The embayment provides a good example of low energy deposition of beach ridge and mud flat deposits within an enclosed bay. ***Social and Cultural values*** The site is also an important sedimentological research site. The area was populated by the Yuin group of Aborignal tribes who probably set up permanent camps near the river. Several middens have been recorded near the mouth of the estuary. The coastal areas provided plentiful food and were favoured by the Aboriginal people. Cullendulla Creek was particularly a source of fin fish and shellfish such as the Sydney Rock Oyster (*Sccostrea commercialis*) and Bimbilla (*Anadara trapezia*). The beach ridges in the chenier system contain extensive middens of Bimbilla. Present use of the area as a source of seafood by the Aboriginal community indicates a long tradition of use and economy of the Cullendulla area. Evidence of the early logging trade is apparent in an old loading wharf in the upper reaches of the Creek. Logs from Benandarah State Forest were off-loaded in upper reaches of creek to barge or creek waters. Reference *Department of the Environment and Energy. 2017. Cullendulla Creek and Embayment - NSW060, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW060. Accessed 25 Jul 2017.*
Durras Lake - NSW118	***Site description*** (No data) ***Physical features*** 80% lake foreshore densely forested, 20% low lying areas covered in sedge/ saltmarsh which is periodically inundated. Lake separated from ocean by sand barrier dunes. Freshwater inflow from forested catchment. Lake shallow with depth between 1-2 m. Broadwater slightly deeper. ***Ecological features*** Excellent habitat for prawns, crustaceans and fish. Extensive seagrass beds, (*Zostera capricorni*), Swamp Oak (*Casuarina glauca*) forest adjoining sedge areas including Sea Rush (*Juncus krausii*) and Bare Twig-rush (*Baumea juncea*) with Spotted Gum (*Eucalyptus maculata*) forest

Wetland	Key Features
	surrounding most of the lake. Wetland 215b is and extensive sedgeland of Bare Twig-rush (*Baumea juncea*). ***Significance*** Main significance is the intact catchment and natural state of the lake. ***Social and Cultural values*** Area has Aboriginal significance, was one of the first sightings of Aboriginal people by Captain Cook. Numerous Aboriginal sites surround the lake. Close to south Durras lake was used in early timber industry. The area is within the Benandarah National Estate Area, recognised for its multiple-use forests. Reference *Department of the Environment and Energy. 2017. Durras Lake - NSW118, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW118. Accessed 25 Jul 2017.*
Eve St. Marsh, Arncliffe	***Site description*** (No data) ***Physical features*** Eve Street Marsh is situated on a low lying coastal floodplain, within a broad and shallow valley floor, between gently slopes and low ridges. Soils of the area consists of Quaternary alluvium, and unconsolidated sediments. ***Ecological features*** This wetland is a remnant of a once extensive brackish marsh extending eastwards from Arncliffe. The site has been rehabilitated from its previously degraded state. Changes include major earthworks to establish appropriate gradients for tidal inundation, a mangrove lined channel connecting the wetland with the Cooks River and an enlarged tidal pond area in which water level is controlled by a weir. The main area of wetland consists of islands covered with saltmarsh in an area of tidal mudflats fringed by Common Reed (*Phragmites australis*), Club Rush (B*olboschoenus caudwellii*) and Marsh Club-rush (*Bolboschoenus fluviatilis*). The saltmarsh is relatively diverse ranging from Sea Rush (*Juncus kraussii*) and Seablite (*Suaeda australis*) at the higher elevations through Samphire (*Sarcocornia quinqueflora*) to Creeping Monkey-flower (*Mimulus repens*) at the lower level. ***Significance*** The wetland has significance as one of the first Australian examples of a rehabilitated tidal marsh that provides habitat for uncommon saltmarsh communities and for migratory wading birds and resident birds. ***Social and Cultural values*** Eve Street Marsh is an important resource area for education and study of natural sciences. Reference *Department of the Environment and Energy. 2017. Eve St. Marsh, Arncliffe - NSW077, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW077. Accessed 25 Jul 2017.*
Five Islands Nature Reserve	***Site description*** (No data) ***Physical features*** The Five Islands are rocky offshore islands consisting of Big Island, Rocky Islet and Martin Islet. The climate of the area surrounding Five Islands Nature Reserve is described as temperate marine. The geology of the area is predominantly dolerite of the upper Permian age. ***Ecological features*** The Five Islands are a significant area for seabird breeding, also offering shelter to many migratory birds. The islands support many shrub and grass communities. However, the dominant species presently found on the islands includes the exotic Kikuyu Grass (*Pennisetum clandestinum*). ***Significance*** (No data) ***Social and Cultural values*** The Five Islands Nature Reserve is a site of significance to the local Aboriginal people. The Five Islands were regularly visited by local people as a place for fishing, evidence of this being the many shell middens found around the edges of Big Island. Reference *Department of the Environment and Energy. 2017. Five Islands Nature Reserve - NSW137, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW137. Accessed 25 Jul 2017.*

Wetland	Key Features
Jervis Bay	***Site description*** The Jervis Bay Territory and surrounding Jervis Bay Area contains diverse wetland areas including tidal, intertidal and estuarine wetlands, freshwater lagoons, swamp, saltmarsh, sedgeland, rocky marine shores and non-tidal freshwater forested wetlands. The area represents a site in the transition zone between warm temperate and the cool temperate biogeographic provinces and supports rich faunal and floral units. The estuarine inlet supports large areas of seagrass (900 ha) and smaller areas of mangrove (125 ha) and saltmarsh (230 ha). Important wetland sites in the Jervis Bay Territory include Lake Windermere, Lake McKenzie, Flat Rock Creek, Captains Lagoon, Bowen Island, Murrays Beach and Ryans Swamp. Wetland sites in the Jervis Bay Area are associated with six major creeks entering Jervis Bay but primarily include Currambene Creek, Moona Moona Creek, Wowly Gully and Carama Inlet. The wetland sites provide valuable habitat for waterfowl, indigenous fresh water fauna, and threatened and biogeographically important species. ***Physical features*** The geology of Jervis Bay includes three broad units; the two Snapper Point sandstone headlands which enclose the Bay, and the softer, generally low-lying Wandrawandrian siltstone comprising the catchment area to the west of the Bay. ***Ecological features*** The vegetation type is characterised by swamp communities (2.2%), wet heath (1.5%), mangroves (0.6%) and salt marsh (0.5%). The dominant mangrove species is River Mangrove (*Avicennia marina*) occurring with much smaller stands of Grey Mangrove (*Aegiceras corniculatum*). Saltmarsh found on cliff tops on Bowen Island is unusual. The marsh is dominated by the saltmarsh grass (*Sporobolus virginicus*) and soil moisture is maintained by sea spray. Estuarine areas are characterised by salt marsh and to a lesser extent, mangroves. ***Significance*** The site has highly diverse communities, with 723 species identified. Due to relatively large areas of seagrasses, mangrove, and saltmarsh, it is considered to be a good example of estuarine wetland on the south coast. The bay provides potential habitat for migratory waders. As with all estuarine wetlands, the bay provides important nursery habitats for commercial fish species. ***Social and Cultural values*** The uniqueness of the area and its waters provide a popular destination for tourists and recreationalists. The natural qualities of the area and relatively pristine condition give the area a high conservation value. The site contains evidence of Aboriginal history in the form of middens and camps, and shipwrecks located in the waters of the bay contribute to maritime history. <u>Reference</u> *Department of the Environment and Energy. 2017. Jervis Bay - NSW078, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW078. Accessed 25 Jul 2017.*
Jervis Bay Sea Cliffs	***Site description*** (No data) ***Physical features*** Among the tallest sea cliffs on the NSW coastline. Extend for about 14 km on the Beecroft Peninsula and 11 km on the Bherwerre Peninsula. Incised inlets such as Eves Ravine and Devils Inlet. Rocky offshore islets Drum and Drum Sticks. High sandstone cliffs, marine caves, overhangs, tunnels and crevices. ***Ecological features*** Significant plant and animal communities are expected. These include fernlands and herbfields on seepages, soaks and behind waterfalls. Interstitial invertebrate communities expected on geological formations and unusual animal communities adapted to high salt and humidity environments. Significant marine habitats at the base of the cliffs. ***Significance*** (No data) ***Social and Cultural values*** Of interest for heritage value; recreation; defence. <u>Reference</u> *Department of the Environment and Energy. 2017. Jervis Bay Sea Cliffs - NSW139, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW139. Accessed 25 Jul 2017.*
Killalea Lagoon	***Site description*** (No data) ***Physical features*** The geology of the Lagoon is comprised mainly of Quaternary sediments.

Wetland	Key Features
	Ecological features Plant species present include Austral Stonecrop (*Crassula sieberiana*), Blown Grass (*Agrostis avenacea*), Branching Rush (*Juncus prismatocarpus*), Caldwell's Club-rush (*Bolboschoenus caldwellii*), Coast Couch (*Zoysia macrantha*), Coastal Wattle (*Acacia sophorae*), Common Reed (*Phragmites australis*), Common Spike-rush (*Eleocharis acuta*), Couch Grass (*Cynodon dactylon*), Crassula (*Crassula peduncularis*), Creeping Monkey-flower (*Mimulus repens*), Duck Weed (*Spirodela punctata*), False Quilwort (*Lilaeopsis polyantha*), Flat Spurge (*Chamaesyce psammogeton*), Floating Club-rush (*Isolepis fluitans*), Goosefoot (*Chenopodium glaucum*), Guinea-flower (*Hibbertia scandens*), Inverted Sedge (*Carex inversa*), Jersy Cudweed (*Pseudognaphalium luteoalbum*), Kangaroo Grass (*Themeda triandra*), Knobby Club-rush (*Isolepis nodosa*), Lesser Joyweed (*Alternanthera denticulata*), Many-spiked Sedge (*Cyperus polystachyos*), Monier's Bacopa (*Bacopa monniera*), Nodding Club-rush (*Isolepis cernuus*), Ribbonweed (*Vallisneria gigantea*), River Buttercup (*Ranunculus inundatus*), River Club-rush (*Schoenoplectus validus*), Saltwater Couch (*Paspalum distichum*), Slender Knotweed (*Persicaria decipiens*), Spinifex (*Spinifex sericeus*), Streaked Arrowgrass (*Triglochin striatum*), Swamp Oak (*Casuarina glauca*), Tall Spike-rush (*Eleocharis sphacelata*), Velata Sedge (*Fimbristylus velata*), Water Primrose (Ludwigia peploides), and Water Ribbons (*Triglochin procerum*). Isolated clumps of Jointed Twig-rush (*Baumea articulata*) and Cumbungi (*Typha orientalis*) occur within the lagoon. Records exist of up to 300 Black Swans on the lagoon including many young cygnets. Other waterbird species present included Pied Cormorant (*Phalacrocorax varius*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Pelicans and Black Duck (*Anas superciliosa*). ***Significance*** Considered to be a good example of a freshwater coastal lagoon. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Killalea Lagoon - NSW079, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW079. Accessed 25 Jul 2017.*
Kooragang Nature Reserve	***Site description*** (No data) ***Physical features*** Kooragang Nature Reserve comprises two areas: Kooragang Island and Fullerton Cove. Kooragang Island originally consisted of several smaller islands or bars. Several attempts to control deposition and siltation of the Newcastle port area resulted in the agglomeration of these islands into a smaller number of larger units by the artificial filling of channels and the construction of training walls. Fullerton Cove is a large shallow embayment north of Kooragang Island. It has a maximum depth of two to three metres at its centre and at low tide large areas of mudflats are exposed. The lower Hunter River is a barrier estuary formed by the deposition of sediments in swamps and flats lying between the inner and outer coastal barrier sands. The sediments on Kooragang Island and adjacent estuarine areas comprise black silty and highly saturated soft clays to a depth of about 2 metres which are underlain by a light grey and silty sand. Depending on their elevation above sea level, drainage pattern and susceptibility to freshwater flooding, these sediments may be more or less saline. Salinities may vary from as high as 70% in evaporative salt marsh areas to as low as 8% behind levees where the soil is generally more fertile and regularly flooded by fresh water. Most soils of Kooragang Island are only slightly acidic, although small areas of sandy clays supporting brackish swamps can reach significantly low pH and create the potential for acid sulphates to occur, should they be permanently dried out or drained. ***Ecological features*** Extensive areas of mangrove (approximately 15 km^2), saltmarsh (approximately 5 km^2) and mudflats, occurring within the Hunter River estuary. Past filling has destroyed up to 10 km^2 of estuarine wetlands, but remaining wetlands remain in a healthy condition. Kooragang Nature Reserve contains numerous wetland types. The area is ecologically diverse and represents a significant genetic pool for wetland species in the region. Habitat types contained within Kooragang Nature Reserve include Mangrove forests dominated by Grey Mangrove with some River Mangrove; Saltmarsh dominated by *Samphire Sarcocornia* sp. and Saltwater Couch (the community of saltmarsh in the area to the west of Fullerton Cove was once the largest in the region). Saline and freshwater pastures are dominated by couch and other agricultural grasses, sedges and introduced weeds; Swamp forests consisting of Swamp Oak and Paperbarks. that are now limited (these forests once formed an

Wetland	Key Features
	intermediate stage in the succession of habitats from mangroves to forests in brackish water above the saline regime). Rainforest communities exist in remnants on Kooragang Island (isolated individual trees, for example figs *Ficus* spp. and Cabbage Tree Palms, still occur). A small area of seagrass *Ruppia spiralis* is located in a large tide pool adjacent to the railway line south of the Reserve; and Brackish swamps and standing open water containing sedges *Scirpus* spp. and other aquatic species. Other important habitats that exist include standing open water, mudflats, sandy beaches and rock training walls. The Nature Reserve is listed as a wetland of international importance under the Ramsar Convention because of its value as migratory wader habitat. ***Significance*** Considered to be a representative example of its type. ***Social and Cultural values*** Kooragang Nature Reserve and the surrounding areas have become known as one of the most important bird study areas in NSW. The Reserve is used for both research and recreational birdwatching. Limited recreational fishing is also undertaken within the Reserve. The Worimi and Awabakal Aboriginal tribes were the earliest inhabitants of the lower Hunter estuary. There are numerous middens and campsites scattered throughout the lower Hunter but they occur particularly along the river banks and within the dunes along Stockton Bight. The nearest Aboriginal sites outside the reserve come from the dunes and coastal forests between Fullerton Cove and Stockton Bight where many and varied sites are known to occur. There are a few European historic sites within Kooragang Nature Reserve. These include concrete footings of an old dairy on Sandy Island, a timber bridge, a mature Moreton Bay Fig associated with early farming and a half submerged timber drogher. The most significant structure on the island is the school teachers residence; however this lies outside the reserve. Reference *Department of the Environment and Energy. 2017. Kooragang Nature Reserve - NSW080, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW080. Accessed 25 Jul 2017.*
Lagoon Head	***Site description*** A small undisturbed hind-dunal wetland and draining creek on crown land, SEPP No. 14 168. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** A rare wetland type with a diversity of communities and plants, some significant. This small wetland contains a high diversity of plant communities of which Freshwater Herbland, Spike-rush Sedgeland, Freshwater Baumea Sedgeland and Melaleuca-Baumea Shrubland are poorly represented along the NSW south coast. ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. Lagoon Head - NSW173, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW173. Accessed 25 Jul 2017.*
Lake Hiawatha and Minnie Water	***Site description*** (No data) ***Physical features*** The geology of Lake Hiawatha and Minnie Water is primarily undifferentiated Palaeozoic greywacke, slate, sandstone, quartzite and chert with minor areas to the north and south of the lake consisting of Quaternary alluvium including alluvium, gravel, sand, silt and clay with dunes to the east of the lakes. The Palaeozoic geology supports soils such as red and yellow podzolics, and yellow and grey earths. ***Ecological features*** The sedge *Lepironia articulata* is the major emergent shoreline plant of both lakes. The bed of Minnie Water is covered by a dense mat of aquatic plants such as Musk Grass (*Chara fibrosa*) and Golden Bladderwort (*Utricularia aurea*). The Great Crested Grebe (*Podiceps cristatus*) and the Hoary-headed Grebe (*Poliocephalus poliocephalus*) occur on Lake Hiawatha and the Little Grassbird (*Megalurus gramineus*) if found in the reed beds at the waters edge. A variety of water beetles are common in both lakes. They are notable for their characteristic fauna such as the

Wetland	Key Features
	zooplankton including *Calamoecia tasmanica*, *Mesocyclops leuckarti* and *Bosmina meridionalis*. Twelve species of fish have been recorded within the lakes, the dominant ones being the Fire-tail Gudgeon (*Hypseleutris galii*) and the introduced Mosquito Fish (*Gambusia holbrooki*). ***Significance*** These wetlands are the largest dune contact lakes in this biogeographic region. Extensive research in the area suggested these sites were of regional significance with respect to freshwater invertebrates. ***Social and Cultural values*** Aboriginal sites within the park include pippie shell middens along the dune systems (possibly those near the lakes), mythological sites, campsites and stone tool workshops and quarries. The pippie shell middens are evidence of transitory day camps and together with campsites these demonstrate the marine-centred activity of the local Aborigines over the past 1,000 years. The lakes have significant value for scientific research for studying biological and physiochemical interactions. Reference *Department of the Environment and Energy. 2017. Lake Hiawatha and Minnie Water - NSW031, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW031. Accessed 25 Jul 2017.*
Lake Illawarra	***Site description*** (No data) ***Physical features*** Lake Illawarra is an early-intermediate barrier estuary with its entrance to the ocean being a weakly active fluvial delta system. The entrance channel is constantly changing by shifting aeolian sands and a high energy beachfront. ***Ecological features*** The shallow waters and saline conditions allow seagrasses such as *Zostera* sp. and *Ruppia* sp. to thrive. These seagrasses provide food for waterfowl. A total of 24 species of waterbirds was recorded on Lake Illawarra, including 97 Grey Teal (*Anas gibberifrons*), 74 Chestnut Teal (*Anas castanea*), 42 Black Swan (*Cygnus atratus*), and 40 Australasian Little Grebe (*Podiceps novaehollandiae*). Estuarine vegetation of Lake Illawarra was mapped and included saltmarsh communities and extensive seagrass beds. Four major structural units or complexes and 15 communities for the foreshore vegetation of Lake Illawarra, with a total of 126 species recorded. The peripheral and foreshore vegetation includes the saltmarsh of Samphire (*Sarcocornia quinqueflora*), Shore Rush (*Juncus kraussii*), Common Reed (*Phragmites australis*), Swamp Oak (*Casuarina glauca*), and Creeping Saltbush (*Atriplex australasica*). ***Significance*** (No data) ***Social and Cultural values*** Aboriginal sites of archaeological significance occur near the lake including a burial ground, quarry and open midden. Reference *Department of the Environment and Energy. 2017. Lake Illawarra - NSW081, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW081. Accessed 25 Jul 2017.*
Lake Termeil Wetland Complex	***Site description*** Termeil Lake is a large relatively undisturbed coastal lagoon with a catchment area of about 1400 ha. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** The complex of wetlands at Lake Termeil make this area significant and has been described as near pristine. The wetland supports a number of regionally rare plant species and uncommon wetland vegetation communities. The wetland is a rare example of freshwater vegetation communities. In addition the wetland supports a range of water birds and two threatened bat species and has been protected from anthropogenic disturbance. ***Social and Cultural values*** Does not appear to have a high level of recreational use. A number of aboriginal sites have been recorded around the lake. Reference

Wetland	Key Features
	Department of the Environment and Energy. 2017. Lake Termeil Wetland Complex - NSW174, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW174. Accessed 25 Jul 2017.
Limeburners Creek Nature Reserve	***Site description*** (No data) ***Physical features*** The geology of Limeburners Creek Nature Reserve is varied i.e. the headlands consist of Carboniferous sediments including sandstone, siltstone, tuff, shale and limestone and the western areas of the reserve consist of Quaternary sand dunes. Soils are sandy and are derived from clays, sands, silt mud and gravel. ***Ecological features*** Dunal wetland system, consisting of a mosaic of wet heath, sedgeland, dry heath, forested swamp and sclerophyll forest. The majority of the reserve contains Broad-leaved Tea Tree (*Melaleuca quinquenervia*) and Swamp Oak (*Casuarina glauca*) swamp sclerophyll forest and woodland, Heath Banksia (*Banksia ericifolia*) swamp shrubland, Grass Tree (*Xanthorrhoea fulva*), Tea Tree (*Leptospermum* sp.) and Banksia (*Banksia oblongifolia*) wet heath and sedgelands. Small pockets of littoral rainforest, mangroves, dune heathlands, and saltmarsh communities are also represented within the nature reserve. ***Significance*** Limeburners Creek Nature Reserve is a large complex of dunal wetlands remaining in a relatively natural condition, and is therefore considered to be a good example of coastal dunal wetlands. ***Social and Cultural values*** Aboriginal occupation of the area dates back to 5-6,000 years. A particularly high concentration of Aboriginal sites have been recorded within the Nature Reserve including burial sites, shell middens, campsites, axe-grinding grooves, and stone quarries. One of the three Aboriginal fish traps recorded along the north coast of NSW is located within the Nature Reserve. There is also evidence of European settlement in the area, for example, there is evidence of the gathering of shells which were burnt to produce lime for the penal colony at Port Macquarie. The Nature Reserve provides opportunities for scientific research of coastal processes, wetland systems and vegetation succession. Reference *Department of the Environment and Energy. 2017. Limeburners Creek Nature Reserve - NSW032, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW032. Accessed 25 Jul 2017.*
Merimbula Lake	***Site description*** (No data) ***Physical features*** The geology of Merrimbula Lake consists of Tertiary sediments including gravel, sand, sandstone, clay and lignite on the southern shores and Upper Devonian sediments of the Merrimbula Formation including conglomerate, red and brown shale, sandstone, quartzite, and arkose. ***Ecological features*** Supports relatively large area of seagrasses (2300 ha) and smaller areas of mangrove (40 ha) and saltmarsh (60 ha. Flora species which occur in the area include Dune Thistle (*Actites megalocarpa*), Knobby Club-rush (*Isolepis nodosa*), Rush *Lepidosperma gladiatum*, Coastal Bearded Heath (*Leucopogon parviflorus*), Coastal Wattle (*Acacia sophorae*), Spiny-headed Mat-rush (*Lomandra longifolia*), Wood Sorrel (*Oxalis chnoodes*), Beach Fescue (*Austrofestuca littoralis*), Hairy Spinifex (*Spinifex sericeus*), Prickly Couch (*Zoysia macrantha*), and the herb *Acaena novae-zelandiae*. Fauna species include the Hawksbill Turtle (*Eretmochelys imbricata*), Leopard Seal (*Hydrurga leptonyx*), Dugong (*Dugong dugon*), Little Penguin (*Eudyptula minor*), Little Pied Cormorant (*Phalacrocorax melanoleucos*), Little Black Cormorant (*Phalacrocorax sulcirostris*), Australian Pelican (*Pelecanus conspicillatus*), and Australian White Ibis (*Threskiornis molucca*). ***Significance*** (No data) ***Social and Cultural values*** Two large Aboriginal shell middens have been located at the site. Reference *Department of the Environment and Energy. 2017. Merimbula Lake - NSW061, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW061. Accessed 25 Jul 2017.*

Wetland	Key Features
Meroo Lake Wetland Complex	***Site description*** Meroo Lake is an extensive coastal lagoon with a catchment area of approximately 1950 ha. It comprises one large and one small estuarine wetland that are linked to the lake. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** Saltwater sedgeland is probably the largest stand of the river clubrush near its southern limit. This very large wetland contains some mosaic communities with mixes of dominant species not often seen elsewhere. In a study of the fauna of the wetlands of the lower Shoalhaven City, Lake Meroo stood out in terms of the diversity and abundance of mammals and frogs. The Lake supports the only population of Nationally Endangered Green and Golden Bell Frog found in the coastal lakes, and it is considered to be the third largest population in the Shoalhaven Region. The lake also provides habitat for three other threatened animal species. ***Social and Cultural values*** Does not appear to have a high level of recreational use. A number of aboriginal sites have been recorded around the lake. Reference *Department of the Environment and Energy. 2017. Meroo Lake Wetland Complex - NSW175, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW175. Accessed 25 Jul 2017.*
Minnamurra River Estuary - NSW084	***Site description*** (No data) ***Physical features*** (No data) ***Ecological features*** The riverine vegetation is dominated by thick stands of Grey Mangrove (*Avicennia marina*) and River Mangrove (*Aegiceras corniculatum*) with areas of saltmarsh, Casuarina forest and rushes in brackish areas subject to flooding or tidal movements. Rocklow Creek (SEPP 14 wetland 374) supports mangrove forest along the immediate banks of the creek. Adjacent to the creek is a brackish wetland dominated by Salt Rush (*Juncus kraussii*) and Samphire (*Sarcocornia quinqueflora*). Swamp She-oak (*Casuarina glauca*) and Common Reed (*Phragmites australis*) are found around the margins of the wetland. SEPP 14 wetland 373 consists of a crown reserve on the southern side of the river downstream of the road bridge. The reserve consists of mangrove and saltmarsh communities with considerable amounts of regenerating mangroves present. Saltmarsh species present include Samphire (*Sarcocornia quinqueflora*), Salt Couch (*Sporobolus virginicus*) and pigface. The mangroves appear to be regenerating after disturbance. SEPP 14 wetland 372 is at the upper reaches of the estuary and consists of a mixture of Swamp She-oak forest and saltmarsh which occurs on the floodplain of the river. This floodplain area is crossed by a number of saline-brackish creeks which support thin fringes of mangroves along their banks. Species present in the Swamp She-oak forest community include Swamp She-oak (*Casuarina glauca*), Northern Boobialla (*Myoporum acuminatum*), Salt Rush (*Juncus kraussii*), Club Rush (*Isolepis nodosa*), Seablite (*Suaeda australis*), Salt Couch (*Sporobolus virginicus*), and Samphire (*Sarcocornia quinqueflora*). In the saltmarsh areas records exis of Salt Rush (*Juncus kraussii*), Streaked Arrowgrass (*Triglochin striata*), Creeping Brookweed (*Samolus repens*), Salt Couch (*Sporobolus virginicus*), Samphire (*Sarcocornia quinqueflora*), and Seablite (*Suaeda australis*). SEPP 14 coastal wetland 372 is located on private property which is subject to grazing. A new residential development has been constructed around the south-eastern side of the wetland. ***Significance*** (No data) ***Social and Cultural values*** The Minnamurra Estuary is also an important area for commercial oyster farming. Reference *Department of the Environment and Energy. 2017. Minnamurra River Estuary - NSW084, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW084. Accessed 25 Jul 2017.*
Moruya River Estuary Saltmarshes	***Site description*** (No data)

Wetland	Key Features
	Physical features The saltmarsh is part of a mature estuarine system with a relatively extensive floodplain. The marsh is geographically defined by SEPP 14 coastal wetlands No. 177 and 178 and possibly SEPP 14 coastal wetlands in Malabar Lagoon. ***Ecological features*** A large Samphire (*Sarcocornia quinqueflora*) dominated herbfield, sparse Mangrove shrubland lining the channel banks, Juncus rushlands and Swamp Oak (*Casuarina glauca*) forest on the landward side of the marsh occurs at SEPP 14 coastal wetland No. 177. ***Significance*** Moruya River estuary contains a number of extensive, modified salt and brackish marshes. All are of conservation significance and due to their variability, of considerable floristic interest. ***Social and Cultural values*** Grazing area. Reference *Department of the Environment and Energy. 2017. Moruya River Estuary Saltmarshes - NSW119, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW119. Accessed 25 Jul 2017.*
Myall Lakes	***Site description*** (No data) ***Physical features*** On the mainland the dominant geological structure is the Myall Syncline within which the main rock types are Carboniferous sandstones, siltstones and mudstones, with some igneous intrusions of the Alum Mountain volcanics varying in composition from rhyolite to basalt. A belt of limestone outcrops on the eastern side of the Myall Lake. Broughton Island and Little Broughton Island have rock types associated with the Carboniferous Nerong Volcanics that are made up of toscanite, dacite, andesite, ignimbrite, agglomerate, conglomerate, sandstone and siltstone. The lakes are drowned river basins and the remnants of former hind dune drainage systems. The configuration of the lakes is largely determined by the irregular bedrock topography of the western shoreline. The eastern shores are mainly formed by the two distinct beach ridge systems of an inner and outer barrier. The coastal dune systems were laid down between 60,000 and 2,000 years ago. The inner barrier system is composed of highly podzolized sands overlying a sandrock hardpan. The sands of the outer barrier are only moderately podzolized. An intervening swamp or lagoon usually separates these two larger systems. Acid peat soils occur in these areas. ***Ecological features*** The low lying sands around the lagoons support a mosaic of wet heath, sedgeland, dry heath, forested swamp and sclerophyll forest. The dominant species in woodland communities in sheltered sites include Smooth-barked Apple (*Angophora costata*) and Banksia species. On deep stable sands, a forest of Blackbutt (*Eucalyptus pilularis*) often with Red Bloodwood (*Eucalyptus gummifera*) develops. A protected fringe forest of Swamp Mahogany (*Eucalyptus robusta*) occurs with an understorey including Paperbark (*Melaleuca sieberi*) and Saw-sedge (*Gahnia clarkei*). A small area of seagrasses (approximately 8 ha) occur within the lakes. The open water in the lake is fringed by a reed swamp, except where sand reaches the water's edge. The bottom of Boolambayte and Broadwater Lakes is covered with submerged vegetation including Prickly Water Nymph (*Najas marina*) (which extends towards the shore to depths of about 0.5 m), Floating Pondweed (*Potamogeton tricarinatus*), Ribbonweed (*Vallisneria gigantea*), and Sea Tassel (*Ruppia maritima*). Reeds extend from the waters edge up to a depth of 1.5 m. From the edge of the reed swamp to the junction with the stable sand or silt flats extends a characteristic Swamp Oak (*Casuarina glauca*), and Paperbark (*Melaleuca quinquenervia*) swamp forest with a dense undergrowth of sedges. An extensive heath, 6–8 km long and as much as 1 km wide, lies between the coastal dunes and the tuff hills south-east of Myall Lakes. In the wetter areas the heath gives way to peat-swamps. These areas are dominated by Tea Tree (*Leptospermum liversidgei*). The vegetation of the tuff hills differs markedly from the settled dunes and sand flats and consists of a mixed Eucalyptus forest and a sub-tropical rain-forest. ***Significance*** Largely because of their undeveloped condition, the Myall Lakes represent a large example of the coastal lagoons that occur along the central and lower north coasts of NSW. ***Social and Cultural values*** The park contains numerous Aboriginal middens, which are the major archaeological features of Aboriginal heritage. Some of these middens also contain Aboriginal burials. The Myall Lakes wetlands have high social and cultural value. The park also contains evidence of early European occupation including graves and early sawmill sites, the fishing village of Tamboy, old farm

Wetland	Key Features
	houses at Kataway Bay and Sunnyside, and the remains of droughers. There is a diverse range of recreational activities undertaken throughout the area that includes sailing, swimming, commercial and recreational fishing, camping, power boating, canoeing, four-wheel driving and bird watching. The University of New South Wales has established a Research Station in the park for the conduct of ecological studies. Reference *Department of the Environment and Energy. 2017. Myall Lakes - NSW033, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW033. Accessed 25 Jul 2017.*
Nadgee Lake and tributary wetlands	***Site description*** (No data) ***Physical features*** Nadgee Lake is an intermittently open/closed coastal lake. It has never been mechanically opened. It has a relatively large catchment of 15.5 km^2 and a surface water area of about 1 km^2. It has a broad unvegetated sand berm at the normal breakout entrance. The depth of the lake is unknown but likely to be less than 5 m. ***Ecological features*** The area is habitat for a range of wildlife including threatened species. The lake supports interesting waterbird assemblages including Musk Duck and Black Swan and may be an important drought refuge for waterbirds. Emergent rushes protect the western foreshore and merge into the adjoining swamp communities. Estuarine aquatic vegetation includes sea grass beds of *Ruppia* sp. Up to 1,000 Black Swans gather at Nadgee Lake between September and January to moult. During this time the birds are flightless and dependent on the lake to supply all their needs including food and shelter until the moult is finished. During winter as few as two swans have been recorded. ***Significance*** (No data) ***Social and Cultural values*** It is the only coastal lagoon of its type within a wilderness area in NSW and is the most undisturbed coastal lake in NSW. There is evidence of Aboriginal occupation of the area. Due to its pristine nature, the lake is an excellent reference site for scientific research regarding coastal lagoon ecology. Reference *Department of the Environment and Energy. 2017. Nadgee Lake and tributary wetlands - NSW187, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW187. Accessed 25 Jul 2017.*
Nargal Lake	***Site description*** (No data) ***Physical features*** Nargal Lake is one of few dune-swale freshwater lakes in the bioregion the other main one being Bondi Lake. The total catchment is about 60 ha. A relatively narrow frontal dune about 50 m basal width and about 10 m total height separates the lake from the ocean. This is much narrower and lower than the Bondi Lake foredune. ***Ecological features*** The eastern shoreline and fringe contains small areas of Swamp Oak (*Casuarina glauca*) forest. Sedgelands of Spike-rush (*Eleocharis* sp.) occur in the south-western and northern sectors of the lake providing shelter for waterbirds and waterfowl, eg. Musk Duck (*Biziura lobata*), and breeding grounds for Black Swan (*Cygnus atratus*). Possible drought refuge for waterfowl. A strandline herbfield of Selliera radicans and other species occurs on the eastern shoreline. ***Significance*** (No data) ***Social and Cultural values*** Of significance to Aboriginal people Reference *Department of the Environment and Energy. 2017. Nargal Lake - NSW120, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW120. Accessed 25 Jul 2017.*
Nelson Lagoon	***Site description*** (No data)

Wetland	Key Features
	Physical features Intermittently closed and open barrier lagoon with several small indented bays and with 20 km^2 catchment. Aerial photo interpretation suggest that this lagoon has undergone a high degree of in-filling. A delta has formed at mouth of Nelson Creek. ***Ecological features*** Areas of saltmarsh of conservation significance. ***Significance*** (No data) ***Social and Cultural values*** Natural recreation, swimming and fishing Reference *Department of the Environment and Energy. 2017. Nelson Lagoon - NSW121, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW121. Accessed 25 Jul 2017.*
Pambula Estuarine Wetlands	***Site description*** (No data) ***Physical features*** Estuarine system with a backwater extending as a closed tributary to the Yowaka River. They are located upstream of Pambula lake at the fluvo-estuarine interface on the southern edge of the Pambula River floodplain. The wetlands are located across a number of different land tenures including freehold, reserved and unreserved crown lands, and a small flora and fauna reserve. ***Ecological features*** The area is habitat for a number of fauna including threatened species. Areas of exposed sandflats and Mangroves (*Avicennia marina*), saltmarsh and brackish/freshwater assemblages. ***Significance*** (No data) ***Social and Cultural values*** The area is a landmark to the local community. It is a developing icon for the community with strong recognition developing for its environmental and historical values. The community and Bega Valley shire council are working together to define a balance for the area between protection and potential recreational use. The area has significant historical values linked to use of part of the area as a race course. Reference *Department of the Environment and Energy. 2017. Pambula Estuarine Wetlands - NSW122, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW122. Accessed 25 Jul 2017.*
Port Stephens Estuary	***Site description*** (No data) ***Physical features*** The geology of the Port Stephens estuary comprises primarily of Quaternary alluvium (gravel, sand, silt, clay, 'Waterloo Rock', marine and freshwater deposits) and Carboniferous Nerong Volcanics (Toscanite, dacite, andesite, ignimbrite, agglomerate, conglomerate, sandstone and siltstone). Smaller areas on the west of the estuary are comprised of Carboniferous undifferentiated volcanics and Permian sediments of the Dalwood Group (sandstone, siltstone, mudstone, shale, conglomerate, tuff, and basalt). The soils of the area are generally acidic. The soils of the beach fore dune are leached, well drained and sandy whereas the soils of the hind dunes are grey, well drained with a humic zone. Poorly drained peat and silty soils over sand occur in the swamp heaths and forests. The soils of the tidal zone comprise of silts and muds compacted with shell fragments. ***Ecological features*** Extensive estuarine system consisting of an area of 2,776 ha of mangroves, 1000 ha of seagrass, and 1433 ha of saltmarshes. This comprises approximately 21% of mangrove forests, 13% of saltmarsh, and 5% of seagrasses in NSW. Other aquatic plant communities present within the estuary include Seawracks *Halophila* spp. The flora of the beach fore dunes consists of species such as Many-flowered Mat-rush *Lomandra multiflora*, Prickly Couch *Zoysia macrantha*, Bearded Heath *Leucopogon lanceolatus*, Guinea Flower *Hibbertia scanden*s, Coast Tea Tree *Leptospermum laevigatum*, Paperbark *Melaleuca armillaris*, Coast Banksia *Banksia integrifolia*, Old Man Banksia *Banksia serrata*, and Black Sheoak *Allocasuarina littoralis*. In the hind dunes dense vegetation includes Smooth-barked Apple *Angophora costata*, Old Man Banksia *Banksia serrata*, *Monotoca elliptica* and Blackbutt *Eucalyptus pilularis* with an understorey of Blady Grass *Imperata cylindrica*, Bracken Fern Pteridium esculentum and Wattle *Acacia* sp. The vegetation of the inner barrier dunes support scrubland vegetation including Old Man Banksia *Banksia serrata*, Tea Trees

Wetland	Key Features
	Leptospermum trinervium, *L. polygalifolium*, Rice Flower *Pimelia linifolia*, Grass Tree *Xanthorrhoea australis*, Prickly Moses *Acacia ulicifolia*, Sydney Golden Wattle *Acacia longifolia*, Broad-leaved Scribbly Gum *Eucalyptus haemastoma*, and Parramatta Red Gum *Eucalyptus parramattensis*. Swamp heath and swamp forest occurs near Salamander Bay and includes dominant species such as Banksias *Banksia robur, B. oblongifolia*, Hakea *Hakea teretifolia*, Paperbarks *Melaleuca nodosa, M. quinquenervia*, Swamp Mahogany *Eucalyptus robusta*, Broad-leaved Scribbly Gum *Eucalyptus haemastoma*, Native Broom *Viminaria juncea*, Prickly-leaved Tea Tree *Melaleuca styphelioides*, and Christmas Bells *Blandfordia grandiflora*. Mangrove species growing in the tidal zone are the River Mangrove *Aegiceras corniculatum*, Grey Mangrove *Avicennia m*arina. Other species growing in this zone include Swamp Oak *Casuarina glauca*, Sea Rush *Juncus krausii*, Tuckeroo *Cupaniopsis anacardioides*, Brush Muttonwood *Rapanea howittiana*, Creeping Brookwood *Samolus repens*, Samphire *Sarcocornia quinqueflora*, the herb *Sueada australis*, Ruby Saltbush *Enchylaena tomentosa, Isolepis nodosa*, and Prickly Couch *Zoysia macrantha*. Freshwater swamps occur between the outer barrier dunes and terrestrial dunes and includes species such as Water Ribbons *Triglochin procerum*, Tall Spike-*rush Eleocharis sphacelata*, Tea *Tree Leptospermum liversidgei*, Christmas Bells *Blandfordia grandiflora*, Vanilla Plant *Sowerbaea juncea*, Milkmaids *Burchardia umbellata*, and Selaginella *Selaginella uliginosa*. Mammal species which have been recorded within the area include the Yellow-footed Antechinus *Antechinus flavipes*, Brown Antechinus *Antechinus stuartii*, New Holland Mouse *Pseudomys novaehollandiae*, Common Brushtail Possum *Trichosurus vulpecula*, Lesser Long-eared Bat *Nyctophilus geoffroyi*, Gould's Long-eared Bat *Nyctophilus gouldi*, and the Northern Brown Bandicoot *Isoodon macrourus*. Other species recorded within the area include the Eastern Banjo Frog *Limnodynastes dumerilii*. ***Significance*** The Port Stephens Estuary is considered to be a good example of estuarine wetland due to large areas of mangroves and saltmarsh in a healthy condition. ***Social and Cultural values*** The Port Stephens area was traditionally occupied by the Worimi people. Evidence of Aboriginal occupation of the area is not well documented, however, some middens and stone artefacts have been recorded within Tomaree National Park. James Cook named Port Stephens after he sailed past in 1770. In 1791, the Salamander was the first ship to enter the harbour while carrying out an informal investigation. Governor Macquarie arrived in Port Stephens in the Lady Nelson in 1811. John Oxley arrived in 1818 on returning from his trek seeking the source of the Macquarie River. Prior to permanent European settlement of the area, groups of Chinese fishermen were reputed to have lived along the shores of Port Macquarie. Reference *Department of the Environment and Energy. 2017. Port Stephens Estuary - NSW034, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW034. Accessed 25 Jul 2017.*
Shoalhaven / Crookhaven Estuary	***Site description*** (No data) ***Physical features*** Geographical area of listing includes Comerong Island, an extensive sand island in the Shoalhaven River estuary. The eastern side of Comerong Island consists of a marine sand barrier on which parallel dunes have formed. The northern part of this sand barrier is a sandspit across the Shoalhaven River entrance and is subject to flooding. The remainder of Comerong Island and the other islands within the estuary have built up on river silt behind the sand barrier. The islands are joined by mudflats at low tide. Additional habitats of sandspits (at Shoalhaven Heads) and sediments of various assortments occur as a result of riverine and marine deposition. ***Ecological features*** Supports relatively large area of mangrove (350 ha) and saltmarsh (150 ha), with smaller area of seagrasses (100 ha) and small patches of swamp oak forest. Common species include River Mangrove (*Avicennia marina*), Sea Rush (*Juncus kraussii*), Bracken Fern (*Pteridium esculentum*), *Juncus polyanthemus*, Common Reed (*Phragmites australis*), Swamp Oak (*Casuarina glauca*), Samphire (*Sarcocornia quinqueflora*), *Sporobolus virginicus*, Seablite (*Suaeda australis*), Goosefoot (*Chenopodium glaucum*), and New Zealand Spinach (*Tetragonia tetragonioides*). An area of littoral rainforest occurs on the south western side of the dunes on Comerong Island. Common species include

Wetland	Key Features
	Corkwood (*Guioa semiglauca*), Red Olive Plum (*Cassine australis*), Brown Beech (*Cryptocarya glaucescens*), Cabbage Tree Palm (*Livistona australis*), and Turnip Wood (*Rapanea howittiana*). ***Significance*** Due to relatively large areas of mangrove, saltmarsh and seagrasses, considered to be representative example of estuarine wetland on the south coast. ***Social and Cultural values*** One Aboriginal midden of significance has been recorded within the estuary and several other sites within the area are of significance to the Aboriginal community such as other open middens and axe grinding grooves. Also of scientific importance in the areas of wader conservation and research. Reference *Department of the Environment and Energy. 2017. Shoalhaven / Crookhaven Estuary - NSW088, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW088. Accessed 25 Jul 2017.*
Solitary Islands Marine Park	***Site description*** (No data) ***Physical features*** The Marine Park lies in the region where the warm tropical waters of the East Australian Current meet cool coastal waters of temperate origin creating a biogeographic overlap zone of unusually high diversity. The Solitary Islands are remnants of a north-south outcrop of marine rocks of Carboniferous age. The inner shelf, beaches and dunes consist of silica sands. ***Ecological features*** Habitats include open waters, continental shelf floor, coral reefs, rocky reefs and headlands, sandy beaches, estuaries, tidal mud flats, seagrass, mangroves, saltmarsh, low scrub lands, grass leans, shallow soils and bare rock. ***Significance*** (No data) ***Social and Cultural values*** The marine park is a focus for tourism activities, particularly whale watching, boating, snorkelling, scuba diving and recreational fishing. It is also of key importance to education and scientific research in a variety of universities and museums and The University Of Armidale operates a research station at Arrawarra Headland. Reference *Department of the Environment and Energy. 2017. Solitary Islands Marine Park - NSW109, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW109. Accessed 25 Jul 2017.*
St. Georges Basin	***Site description*** (No data) ***Physical features*** The geology of the northern shores of the St Georges Basin consists primarily of Permian sediments of the Wandrawandian Siltstone which includes siltstone, and silty sandstone. The eastern and western shores consists of Permian sediments of the Conjola formation including conglomerate, sandstone and silty sandstone, while the southern shore consists primarily of Quaternary sediments including alluvium gravel, swamp deposits and sand dunes. ***Ecological features*** Supports relatively large area of seagrasses (850 ha) and smaller areas of mangrove (25 ha) and saltmarsh (4 ha). Swamp Oak (*Casuarina glauca*) woodland fringes much of the basin with smaller areas of Swamp Paperbark (*Melaleuca ericifolia*) shrubland and Common Reed (*Phragmites australis*) reedland. The catchments on the southern and western sides of the basin are covered largely in native vegetation. ***Significance*** (No data) ***Social and Cultural values*** (No data) Reference *Department of the Environment and Energy. 2017. St. Georges Basin - NSW090, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW090. Accessed 25 Jul 2017.*
Swan Lagoon	***Site description*** (No data)

Wetland	Key Features
	Physical features The lagoon is characteristic of many south coastal lagoons separated from the sea by beach dunes. ***Ecological features*** A small lagoon with reed swamp catchment. The lagoon itself is surrounded by Grey Swamp She-oak (*Casuarina glauca*) which is considered to be 20 plus year old regeneration. Early reports from the area indicate a more open woodland probably of forest red gum (*Eucalyptus tereticornis*). *Juncus* sp. and Common Reed (*Phragmites australis*) fringe the water edge. ***Significance*** (No data) ***Social and Cultural values*** The significance is cultural both traditional and contemporary. The lagoon (in part) lies within the Murramarang Aboriginal Area and forms part of a complex of sites within a culturally significant landscape. The area is one of only three archaeological sites of Pleistocene age on the south coast. The area has high Aboriginal significance. Part of significance relates to the lagoon being home to the mythological serpent, a creature common in Aboriginal culture. The mythology of the lagoon makes connections as far as the far south coast and the Snowy mountains. The lagoon and swamp provide a range from freshwater to brackish conditions, with associated vegetation. This wetland complex would have provided several alternative sources of animal and plant food for Aboriginal people who were also exploiting marine resources around Murramarang Point. The area including the lagoon continues to be of significance for contemporary Aboriginal people of the south coast who regard the area as been indicative of their culture, signifying intertribal relationships through its use as a meeting place. Reference *Department of the Environment and Energy. 2017. Swan Lagoon - NSW140, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW140. Accessed 25 Jul 2017.*
Swan Pool / Belmore Swamp	***Site description*** (No data) ***Physical features*** The geology of the area consists of Quaternary sediments including sand, silt, mud and gravel. ***Ecological features*** Very extensive fresh meadows, seasonal fresh swamps, and reed swamps, characterised by a zonation from fresh meadow to seasonal fresh swamp and reed swamp with increasing depth and permanence of inundation. Common species include Marsh Clubrush (*Bolboschoenus fluviatilis*), Common Reed (*Phragmites australis*), Spike-rushes (*Eleocharis equisetina* and *Eleocharis dietrichiana*), Water Couch (*Paspalum distichum*), and Water Pepper (*Persicaria hydropiper*). Swamp forests of Broad-leaved Paperbark (*Melaleuca quinquenervia*), Snow-in-summer (*Melaleuca linariifolia*) and Swamp Oak (*Casuarina glauca*) fringe the wetlands. ***Significance*** A good example of a large area of coastal floodplain swamp. ***Social and Cultural values*** The Macleay coastal area is part of the area of the Thunghutti (Dhunghutti) group of Aboriginal people. Aboriginal sites recorded within the local area include bora rings, shell middens, campsites, and burial sites. Sites specifically recorded within Belmore Swamp include shell middens and burial grounds. Cedar cutters were the first Europeans to explore the rainforests of the north coast rivers during the 1820s. Farmers cleared the rainforests of the alluvial plains for agriculture and Kempsy was then established in 1836. Reference *Department of the Environment and Energy. 2017. Swan Pool / Belmore Swamp - NSW035, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW035. Accessed 25 Jul 2017.*
Tabourie Lake	***Site description*** Extensive estuarine lake comprising 5 SEPP 14 wetlands. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** Saltmarsh is a community type declining in area in NSW, which may provide important nursery habitat for fish. Nearly all of the region's saltmarsh occurs in two small bays at Lake Tabourie, and in Tabourie Creek. It supports a number of rare plant species and two threatened animal species.

Wetland	Key Features
	Social and Cultural values A number of aboriginal sites have been recorded around the lake; recreational use. Reference *Department of the Environment and Energy. 2017. Tabourie Lake - NSW171, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW171. Accessed 25 Jul 2017.*
Terrigal Lagoon	***Site description*** A shallow, brackish lagoon with *Phragmites australis* reedlands at the extremities of the western arm. A wide border of *Juncus kraussii* is found there on the landward edge and *Casuarina glauca* is spreading into the reedlands. Spoonbills and Black ducks were observed on this arm of the lagoon. The northern arm has been significantly altered by development on the shores and filling of the wetlands. The bottom is very silty and the water becomes very turbid when mixed by wind waves. There are no obvious algal areas or seagrasses. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** Condition is poor. Septic pollution is being reduced as the sewer is connected but urban run-off, fertilisers and the like, continue to add nutrients. Landfill, erosion in the catchment and frequent opening, all result in accelerated sedimentation. Some of the wetlands are recommended for conservation in SEPP No. 14 numbers 908 and 910. ***Social and Cultural values*** The lagoon is an important tourist attraction and recreation area. Water birds and animals still use the western arm of the lagoon where the shore vegetation is less disturbed. Reference *Department of the Environment and Energy. 2017. Terrigal Lagoon - NSW180, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW180. Accessed 25 Jul 2017.*
Towra Point Estuarine Wetlands	***Site description*** (No data) ***Physical features*** Towra Point is located on the northern side of Kurnell Peninsula which forms the southern shore of Botany Bay. It is an estuarine complex bounded by Woolooware, Quibray and Weeney Bays. Towra Point and Taren Point are low lying promontorys of Holocene sandy sediments. The muddy sand flats at the eastern end of Towra Point and at the western end of Towra Spit are being damaged by coastal erosion. Towra Spit is actively extending in a southwesterly direction and the beaches on the eastern and western faces of Towra Point are eroding and contributing sand to the growth of the spit. Recent erosion has been partly attributed to dredging and port works within Botany Bay. In 1991, erosion caused the western portion of Towra Spit to separate from the mainland and to form a highly mobile island west of the spit. However, during 1997 the island rejoined the mainland at the eastern end after a large local storm. ***Ecological features*** The terrestrial parts of the land are fringed by extensive tidal wetlands, including approximately 600 ha of seagrasses including Strapweed (*Posidonia australis*), Eelgrass (*Zostera capricorni*), and the Paddleweeds *Halophila ovalis* and *Halophila decipiens*; 400 ha of mangroves including the Grey Mangrove (*Avicennia marina*) and River Mangrove (*Aegiceras corniculatum*); and 161 ha of saltmarshes, representing one of the few large remnant systems near Sydney. Towra Point is an important bird feeding, roosting and nesting site for migratory waders and waterfowl. Towra Point Nature Reserve is listed under the Ramsar Convention because of its value as migratory wader habitat. The terrestrial plant communities comprise a number of recognised associations such as Swamp She-oak (*Casuarina glauca*) forest, littoral rainforest, littoral strandline and a complex mosaic of dune sclerophyll scrub/forest. ***Significance*** Large areas of mangroves and saltmarsh in a healthy condition provide a representative example of estuarine wetlands. The site contains 50% of mangrove communities remaining in the Sydney region. It is an important habitat for many species of migratory waders, and is considered an important area for wading birds in NSW, and is especially significant for wading and wetland birds in the Sydney region. As with other areas of estuarine wetlands, also an important habitat for many

Wetland	Key Features
	commercial fish species. Because of the presence of migratory waders, the area is often used for wader research, including banding. Located close to Kurnell Field Studies Centre, and is used for environmental education. ***Social and Cultural values*** Because of the presence of migratory waders, the area is often used for wader research, including banding. Located close to Kurnell Field Studies Centre, and is used for environmental education. The Towra Point area offers a readily accessible variety of wetland plants and animals in close proximity to Sydney for research and teaching. The Reserve has some historic structures and three known Aboriginal sites. The shorebird community occurring on the relict tidal delta sands at Taren Point has been listed as an endangered ecological community under the NSW Threatened Species Conservation Act, 1996. Reference *Department of the Environment and Energy. 2017. Towra Point Estuarine Wetlands - NSW092, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW092. Accessed 25 Jul 2017.*
Tuggerah Lake	***Site description*** (No data) ***Physical features*** (No data) ***Ecological features*** Three main features of the wetlands are Teatree Swamps dominated by Broad-leafed Paperbarks *Melaleuca quinquenervia*; Casuarina swamps containing major forests of Swamp Oak *Casuarina glauca*; and Shallow Estuarine Waters, the main aquatic vegetation being the seagrasses *Zostera capricorni*, *Halophila ovalis* and Sea Wrack *Ruppia megacarpa*. The areas of saltmarsh surround the lake. Saltmarsh of Rushes *Juncus* sp., Samphire *Sarcocornia quinqueflora* and Saltwater Couch *Paspalum vaginatum* occur around the lakes in addition to the fringing paperbarks and swamp oaks. Seagrass beds are very extensive and drop their leaves twice a year so that large areas of wrack occur around the lake. At times extensive beds of algaes occur which die and mix with the wrack of the seaweed. ***Significance*** (No data) ***Social and Cultural values*** About 50,000 people live around Tuggerah Lakes in the suburbs of The Entrance, Long Jetty, Killarney Vale, Berkeley Vale, Chittaway, North and South Tacoma, Wyongah, Gorokan, Toukley and Norahville. Fourteen professional fishermen operate all year round; the area is important for recreational fishing, sailing and water skiing and The Entrance is a major holiday resort, c.25 caravan parks front onto the lake. Coal mining will shortly take place under the lake. Reference *Department of the Environment and Energy. 2017. Tuggerah Lake - NSW141, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW141. Accessed 25 Jul 2017.*
Tuross River Estuary	***Site description*** (No data) ***Physical features*** A complex delta estuary at intermediate stage of infilling with many low islands and islets (>20), draining a major SEC bioregion river system and enters the sea adjoining a relatively long beach barrier. ***Ecological features*** A diverse area of land and waters with high shoreline length due to the delta system. Islands contain a variety of plant and animal communities including mangroves, saltmarsh, Casuarina swamp forest, mapped littoral rainforest (SEPP 26), sand and mud flats. ***Significance*** (No data) ***Social and Cultural values*** Oyster farming, recreational boating and fishing, productive (cattle, dairy) grazing land on & adjoining delta. Aboriginal middens and sites of Aboriginal sacred significance are known in the area. Reference *Department of the Environment and Energy. 2017. Tuross River Estuary - NSW123, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from:*

Wetland	Key Features
	http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW123. Accessed 25 Jul 2017.
Twofold Bay	***Site description*** (No data) ***Physical features*** The area of the Bay shoreline and seabed up to 6 m depth. Includes the rocky and sandy shorelines of Twofold Bay, the Towamba River and Nullica River estuaries, Curalo Lagoon and the seabed of four separate embayments including Calle Calle Bay in the north, Quarantine Bay and Nullica Bay in the west and East Boyd Bay in the south. Excludes wharf area and harbour facilities at Snug Cove; and breakwall and boat ramp near Quarantine Bay. ***Ecological features*** The area is habitat for a number of marine mammals and birds including threatened species. Areas of exposed sandflats in the Towamba River estuary are potential habitat for waders. Flora species present within the bay include Pigface (*Carpobrotus glaucescens*), New Zealand Spinach (*Tetragonia tetragonioides*), Fireweed Groundsel (*Senecio linearifolius*), Coastal Saltbush (*Rhagodia candoleana* ssp. *candolleana*), Calystegia soldanella, Sedge (*Carex pumila*), Knobby Club-rush (*Isolepis nodosa*), Bracken Fern (*Pteridium esculentum*), Coast Beard-heath (*Leucopogon parviflorus*), Coastal Wattle (*Acacia sophorae*), Geranium (*Geranium homeanum*), Native Storksbill (*Pelargonium australe*), Spiny-headed Mat-rush (*Lomandra longifolia*), Paperbark (*Melaleuca armillaris*), Wood Sorrel (*Oxalis chnoodes*), Coast Blowngrass (*Agrostis billardieri*), Long-hair Plume Grass (Dichelachne crinita), Blady Grass (*Imperata cylindrica*), Hairy Spinifex (*Spinifex sericeus*), Speargrass (*Stipa flavescens*), Prickly Couch (*Zoysia macrantha*), Climbing Lignum (*Muehlenbeckia adpressa*), Coast Banksia (*Banksia integrifolia*), Small-leaved Clematis (*Clematis microphylla* var. *leptophylla*), and Bidgee Widgee (*Acaena novae-zelandiae*). ***Significance*** (No data) ***Social and Cultural values*** Twofold Bay has a legendary maritime history of whaling and fishing. It is a safe harbour for shipping. The Bay is a focus for marine ecotourism such as whale watching and produces oysters, mussels, abalone and other fin-fish. It is the largest and deepest embayment in the South-East Corner bioregion. <u>Reference</u> *Department of the Environment and Energy. 2017. Twofold Bay - NSW124, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW124. Accessed 25 Jul 2017.*
Ukerebagh Nature Reserve	***Site description*** (No data) ***Physical features*** Ukerebagh Nature Reserve consists of Ukerebagh Island and a mainland portion within and adjacent to the Tweed River estuary. It occurs on the Tweed floodplain which is formed from Quaternary alluvial and ocean beach deposits of gravel, sand, silt, clay and peat. ***Ecological features*** Vegetation communities found within Ukerebagh Nature Reserve include littoral rainforest, swamp forest, mangrove forest, open forest and saltmarsh associations. Seagrass is common in Ukerebagh Passage and together with Ukerebagh Nature Reserve forms one of the larger saline wetland systems in the Tweed estuary. ***Significance*** (No data) ***Social and Cultural values*** Association from pre-European times to the present day is evident in identified values of both traditional and contemporary historical significance. Several Aboriginal sites and 28 species of bush foods and medicinal plants traditionally utilised by local Aboriginal people have been recorded within Ukerebagh Nature Reserve. Many Aboriginal families lived on Ukerebagh Island during the 1920s and 1930s. Ukerebagh Nature Reserve is instrumental in the maintenance of the cultural identity of local Aboriginal people. <u>Reference</u> *Department of the Environment and Energy. 2017. Ukerebagh Nature Reserve - NSW111, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW111. Accessed 25 Jul 2017.*

Wetland	Key Features
Waldrons Swamp	***Site description*** (No data) ***Physical features*** Draining forested creeks from Pollwombra Mountain, Waldrons Swamp superimposes amorphously upon the northern part of the Broulee (Bengello) relict dunefield that extends to the Moruya River. The dunal features are very significant geomorphologically and of great scientific interest. The main body of the swamp is 2 km inland (at the ancient beachline) with a narrow outflow channel of some 1.5 km length meandering and cutting through the dunefield to connect very intermittently to the ocean at Bengello Beach between Broulee and Moruya Heads. ***Ecological features*** A variable mosaic of closed Swamp Paperbark (*Melaleuca ericifolia*) shrublands, Gahnia, Carex and Cladium sedgelands, rushlands and periodically open water providing breeding, refuge, roost and forage habitat for protected and threatened terrestrial species. ***Significance*** (No data) ***Social and Cultural values*** Locally important for grazing , eel fishing, water conservation and environmental protection. The relict dunal system adjacent to and south of the swamp is a great scientific interest. Reference *Department of the Environment and Energy. 2017. Waldrons Swamp - NSW125, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW125. Accessed 25 Jul 2017.*
Wallaga Lake	***Site description*** (No data) ***Physical features*** A permanently open estuary with considerable area (100 ha.) of sandflat exposed at low tide near the entrance. The lake backs up into convoluted shallow reaches of inflowing tributaries flanked by Eucalyptus open forest including Red Gum (*Eucalyptus tereticornis*), Southern Mahogany (*Eucalyptus botryoides*), Black Apple (*Planchonella australis*), Water Gum (*Tristania laurina*), Lilly Pilly (*Acmena smithii*), Grey Myrtle (*Backhousia myrtifolia*), Sweet Pittosporum (*Pittosporum undulatum*), Rough Tree Fern (*Cyathea australis*), and Late Black Wattle (*Acacia mearnsii*). Swamp Paperbark (*Melaleuca ericifolia*) occurs along much of the shoreline of the lake. Forested islands occur within the lake. The lake is drained by a relatively large catchment of mostly forested and some rural lands. ***Ecological features*** Upper reaches of tributaries contain saltmarsh habitats. The lake is mostly fringed by a Swamp Oak (*Casuarina glauca*) stand. Extensive eelgrasses indicate potential fish nursery habitat. Occasional mangrove specimens only. Waterbird and seabird habitat for resting and forage provided by sandflats. ***Significance*** (No data) ***Social and Cultural values*** Islands within the lake and the lake itself are of strong spiritual significance to local Aboriginal people. Dreamtime songlines link tribal kings such as King Merriman to the Lake. Approximately 60 middens have been recorded on the shore of Wallaga Lake. Spectacular scenic vistas from coastal vantage points near lake entrance; the presence of Gulaga (Mt. Dromedary) to the north-west and the seascape to the east and north-east (including Montague Island) combine to evoke a classic south coast scenescape of ‘estuary-mountain-ocean’. Reference *Department of the Environment and Energy. 2017. Wallaga Lake - NSW126, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW126. Accessed 25 Jul 2017.*
Wallagoot Lagoon (Wallagoot Lake)	***Site description*** (No data) ***Physical features*** Wallagoot Lagoon is an example of a Simple Embayment Lake. Embayment lakes are formed in the same formative process as in drowned valley lakes, except that in this case a bay is cut off. Such lakes were formed in the Holocene marine transgression. Extensive sand spits and sandy islets occur at the eastern end of the Lagoon, total area of these features dependent on water level. ***Ecological features*** The Lagoon has extensive areas of seagrass beds (area unknown), and a variety of rushes and sedges occur and include Saltmarsh (*Sarcocornia quinqueflora*), Streaked Arrow-grass

Wetland	Key Features
	(*Triglochin striata*), Saw-sedge (*Gahnia* sp.), Common Reed (*Phragmites australis*) and Sedges (*Juncus* spp.) A total of 480 faunal records have been recorded in the Wallagoot Lagoon area to date. ***Significance*** (No data) ***Social and Cultural values*** Tourism, recreation, education, commercial and recreational fishing. Extensive evidence of Aboriginal occupation (recorded sites) surrounding the lagoon. Reference *Department of the Environment and Energy. 2017. Wallagoot Lagoon (Wallagoot Lake) - NSW127, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW127. Accessed 25 Jul 2017.*
Wallis Lake and adjacent estuarine islands	***Site description*** (No data) ***Physical features*** The geology of Wallis Lake consists predominantly of Quaternary sediments of gravel, sand, silt, clay and marine and freshwater deposits. The geology of the western and southern area of the lake consists of Carboniferous sediments of the Wooton Beds and includes sandstone, siltstone, claystone, shale, and limestone. The lake is largely underlain by Pleistocene barrier, dune and back barrier deposits and underlying these estuarine sediments. ***Ecological features*** Coastal lagoon with extensive seagrass beds [including Eelgrasses (*Zostera capricorni*) and the Seagrass *Posidonia australis*] (3,079 ha), areas of saltmarsh (405 ha), mangroves (79 ha) [including Grey Mangrove (*Avicennia marina*), and River Mangrove (*Aegiceras corniculatum*)], *Ruppia* sp. and algal (*Hormisira banksii*) beds. The extensive seagrass beds in this estuary comprise approximately 20% of total seagrasses in NSW. Saltmarsh communities are dominated by *Sarcocornia quinqueflora*. The saltmarsh communities grade into swamp woodland with dominant species including Swamp Oak (*Casuarina glauca*) and Paperbark (*Melaleuca quinquenervia*. Sea Rushes (*Juncus kraussii*) dominate the area behind the saltmarsh with patches of sedge (*Baumea juncea*), rush (*Schoenoplectus* sp.) and Common Reed (*Phragmites australis*). Yahoo Island also supports a low closed forest (rainforest) community and an extensive tract of open Cabbage Palm (*Livistona australis*) community. Wallis Island includes communities of Paperbarks and Cabbage Palms and Swamp Mahogany (*Eucalyptus robusta*), Spotted Gum (*Eucalyptus maculata*), Grey Ironbark (*Eucalyptus paniculata*) and Forest Red Gum (*Eucalyptus tereticornis*) forests. ***Significance*** (No data) ***Social and Cultural values*** Aboriginal middens have been recorded within Yahoo Island Nature Reserve. Reference *Department of the Environment and Energy. 2017. Wallis Lake and adjacent estuarine islands - NSW038, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW038. Accessed 25 Jul 2017.*
Wamberal Lagoon	***Site description*** A shallow, brackish lagoon that is normally closed by a sandbar. Extensive flooded Baumea juncea, Juncus kraussii and Phragmites australis reedlands at the northern end support large frog populations. Parts of the dense Melaleuca ericifolia and Melaleuca nodosa scrub near Forresters Ck are normally inundated. The foredune is relatively well preserved and shows a vegetation succession from Spinifex hirsutus near the ocean to Banksia integrifolia and Melaleuca quinquenervia forest. Eleocharis species and Phragmites sp. occur on the lagoon shore. ***Physical features*** (No data) ***Ecological features*** (No data) ***Significance*** It is in good condition. Some of the catchment is still protected by dense vegetation. The dense vegetation acts as a nutrient sink and sediment trap. Septic pollution, urban runoff, rubbish dumping and sedimentation are major problems for the continued well being on the lagoon. The effects of frequent artificial opening are unknown. Some of the wetlands are recommended for conservation in SEPP No. 14 site numbers 907 and 909. The lagoon and foredune are in the Wamberal Lagoon Nature Reserve, and parts of the catchment have conservation zonings.

Wetland	Key Features
	Social and Cultural values The area is an important wildlife habitat, especially as so few coastal lagoons remain in good condition. It has great educational value and guided tours are given to schools and other groups. The area is also used for recreation and is a valuable tourist attraction. Reference *Department of the Environment and Energy. 2017. Wamberal Lagoon - NSW179, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW179. Accessed 25 Jul 2017.*
Wollumboola Lake	***Site description*** (No data) ***Physical features*** Soils consists primarily of grey sandy loam underlain by heavy red clay derived from the Permian Wandrawandian siltstone common to the area. ***Ecological features*** The lake supports surrounding wetland areas of Casuarina forest, teatree scrub, saltmarsh and sedgelands. The bed of the lake supports seagrasses. Reports that wetland 365 consists of a narrow herbfield on the shores of the lake dominated by coastal saline tolerant species. Behind this is an area of rushes and sedges consisting of a mix of Common Reed (*Phragmites australis*), Salt Rush (*Juncus kraussii*) and the Sedge, *Baumea juncea*. It is only one of three sites containing *Wilsonia rotundifolia* in coastal NSW. Wetland 364 consists of a small bay in the northwest corner of the lake which support extensive sandflats and saltmarsh communities. The dominant species in the saltmarsh is Samphire (*Sarcocornia quinqueflora*). Shoreward from the saltmarsh is an area of mixed sedgeland consisting of sedge species and salt rush (*Juncus kraussii*). The bay is surrounded by a dense closed forest of Paperbark (*Melaleuca* sp.) and Swamp She-oak (Casuarina glauca). ***Significance*** (No data) ***Social and Cultural values*** Around 200 Aboriginal sites have been recorded in the area including symbolic / sacred sites, art sites, habitation sites and axe grinding grooves. Reference *Department of the Environment and Energy. 2017. Wollumboola Lake - NSW094, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW094. Accessed 25 Jul 2017.*
Wooloweyah Lagoon	***Site description*** (No data) ***Physical features*** The geology of Wooloweyah Lagoon is comprised predominantly of Quaternary sediments including alluvium. gravel, sand, silt, clay, beach sand and dune sand overlying Triassic-Jurassic sandstone, shale, and conglomerate. ***Ecological features*** Estuarine lagoon, and associated seagrass, mangrove and saltmarsh areas. Dominant plant species include the aquatic herb *Bacopa monniera*, Swamp Oak (*Casuarina glauca*), Spike-rush (*Eleocharis equisetina*), Rushes (*Juncus* spp.), Paperbark (*Melaleuca quinquenervia*), Water Couch (*Paspalum distichum*), Common Reed (*Phragmites australis*). ***Significance*** (No data) ***Social and Cultural values*** The Clarence Estuary was utilised by Aborigines for fishing and evidence of this includes oyster shell middens that have been recorded on Micalo Island. In the early 1800s Richard Craig pioneered the harvesting of extensive Red Cedar stands of the Clarence (Clancy, 1992). Cropping began with sugar cane farms in 1864 on the Clarence River floodplain. Reference *Department of the Environment and Energy. 2017. Wooloweyah Lagoon - NSW039, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=NSW039. Accessed 25 Jul 2017.*
Queensland	
Bribie Island	***Site description*** Bribie is a low sand island, with an elevation less than 10 m. The island has formed the narrow Pumicestone Passage to the west. The wetlands occur as creeks, lagoons, swamps and tidal flats. The majority of the island's interior is flat with closed depressions. Creeklines are short or

Wetland	Key Features
	interrupted. Large swamps (hundreds to thousands of hectares in size) occur in the sand plain and supra-tidal zone. The most extensive geology is a formation of Holocene tidal flats and meadows of sand and mud found in central and western parts of the island along with Pleistocene estuarine deposits. Pleistocene sand ridges, and Holocene beach ridges occur along southern and eastern beaches. Soils are podzols (bleached sands) on the eastern dunes and gleyed podzolic soils with a higher clay content in the west. This is broken by more than 200 ha of peat swamp. Groundwater podzols are found in some of the wet areas. Recent soil samples have found the presence of acid sulfate soil deposits in south-western parts of the island. ***Physical features*** (No data) ***Ecological features*** The freshwater wetlands are primarily composed from six community types. Swamp paperbark (*Melaleuca quinquenervia*), swamp box (Lophostemon suaveolens), *Eucalyptus tereticornis*, flooded gum (*Eucalyptus grandis*), scribbly gum (*E. racemosa*), swamp mahogany (*E. robusta*), pink bloodwood (*Corymbia intermedia*), cabbage tree palm (*Livistona australis*) open forest on beach ridges and old estuarine deposits, open forest or woodland dominated by *M. quinquenervia* with *E. robusta* and no understorey except swamp water fern (*Blechnum indicum*), *Baumea*, *Restio* and *Villarsia* spp. ground cover. Heathland or sedgeland with Hakea actites, broad-leaved banksia (Banksia robur), *Leptospermum* spp. and swamp grasstree (*Xanthorrhoea fulva*), *Ghania*, *Epacris* and *Restio* species, with emergents such as *E. robusta*, brush box (*Lophostemon confertus*), *L. suaveolens*. Wallum banksia (*Banksia aemula*) low open forest and woodland with black sheoak (*Allocasuarina littoralis*) and open heath. *M. quinquenervia*, and heathland or sedgeland on beach ridges. Open heath with *Caustis recurata*, *Xanthorrhoea fulva*, *Coleocarya gracilis*, *Sowerbea juncea* and *Leptospermum*, *Banksia* and *Bauera* species on beach ridge systems. Eight hundred and fifty hectares of intertidal and low coastal shrubland and forests occur in the south, west and north. These areas have communities with grey mangrove (*Avicennia marina*), river mangrove (*Aegiceras corniculatum*), yellow mangrove (*Ceriops tagal*), spotted mangrove (*Rhizophora stylosa*), large-fruited orange mangrove (*Bruguiera gymnorhiza*), milky mangrove (*Excoecaria agallocha*) and black mangrove (*Lumnitzera racemosa*), swamp she-oak (*Casuarina glauca*), Salicorna quinqueflora, Triglochin striata and sand couch (*Sporobolus virginicus*). ***Significance*** At least 850 ha of gazetted intertidal and estuarine shrubland and forests occur in the south, west and northern shorelines of the island. On the island, most wetland and vegetation mosaics are hundreds to thousands of hectares. These communities are considered highly significant representatives of their type in south-east Queensland because of their size and naturalness. A survey of intertidal vegetation by the Queensland Herbarium has delineated 26 communities that intersect the Bribie wetland. These include 21 communities of State significance, three communities with regional significance, and two communities with local or major significance. Significant areas of sub-tidal sea grass occur in Pumicestone Passage. These areas are protected by a wetland reserve and fish habitat area in an area of more than 7000ha on the western side of the island. The shorelines and tidal wetlands of the island are listed in the Moreton Bay Ramsar area. The area provides refuge for threatened wildlife and is species rich. ***Social and Cultural values*** Bribie Island has two listings in the Register of the National Estate: Pumicestone Passage and Bribie Island, and for the World War II fortifications in the northern ocean-side of the island. The area is recognised for its value to migratory waders, and local naturalist groups visit the island for annual bird surveys. The island has been used by Brisbane universities for research into oceanography, coastal geomorphology, and for coastal heath studies. QPWS provides educational facilities. The Department of Primary Industries Fisheries Branch has an aquaculture research facility on the south-eastern part of the island. The beaches attract tourists from the greater Brisbane area and picnic facilities and parks are provided for this purpose. The intersecting Pumicestone Passage is very high natural and scenic amenity, and the natural quality of its habitats attract naturalists and fishermen. The value to commercial fisheries is very high due to the spawning, recruitment, refugia and feeding values for aquatic fauna in the passage. No commercial fishing is allowed within the passage. More than 50 cultural heritage sites have been identified on the island. Numerous middens, artefact scatters, scarred and carved trees have been identified. Highly significant evidence from campsites and villages indicates that Indigenous peoples have lived on the island for more than 2,000 years. European settler

Wetland	Key Features
	heritage (additional to the war fortifications) includes historic wooden lighthouses (built in 1896) and a fish cannery site built in the early 1900s. Reference *Department of the Environment and Energy. 2017. Bribie Island. - QLD189, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD189. Accessed 25 Jul 2017.*
Burrum Coast	***Site description*** The site comprises the coastline and estuaries between, and including, Beelbi and Theodolite creeks. It is made up of extensive intertidal flats associated with the mouth of the Burrum River and adjacent coastline; mangrove and saltflat systems along estuaries and coastline; freshwater wetlands dominated by wallum heaths, and lesser areas of sedgeland and swamp forests. ***Physical features*** Landforms: shallow, protected marine waters; broad intertidal sand flats and tidal deltas; fringing mangrove/saltflat; beaches backed by frontal dunes; and beach ridges with swampy swales. Geology: dominated by relatively recent (Holocene) deposits - sandy beach ridges, muddy estuarine sediments and sandy tidal deltas; much larger areas of Pleistocene sandy beach ridge deposits occur behind the more recent ones; undifferentiated Quaternary freshwater swamp deposits of mud and peat occur in the lower parts of the beach ridge systems. Soils: calcareous sands on the beaches, siliceous sands in the Holocene beach ridges, siliceous podosols in the Pleistocene beach ridges, sands/loams/muds in mangrove and saltmarsh, and acid peats and peaty sands in the low lying swampy areas between the beach ridges. ***Ecological features*** Major habitat types include seagrass beds, mangrove low closed forest to open shrubland, saltmarsh, bare claypan, and extensive bare sandflats (exposed at low tide); sedgelands, open forest/woodland and closed heath occur in swampy areas of the beach ridge systems; fringing woodlands and open forests, dominated variously by *Casuarina*, *Melaleuca* and *Eucalyptus* spp., occur adjacent to the beaches and wetland communities. The mangrove communities vary in structure and composition - low closed forest of grey mangrove (Avicennia marina) and/or club mangrove (*Aegialitis annulata*) shrubs fringes the larger estuaries; large-fruited orange mangrove (*Bruguiera gymnorhiza*) and/or yellow mangrove (*Ceriops tagal*) and/or river mangrove (*Aegiceras corniculatum*) and/or spotted mangrove (*Rhizophora stylosa*) low forest to open shrubland fringes smaller estuaries; less frequently inundated areas support yellow mangrove and/or river mangrove open shrubland; while milky mangrove (*Excoecaria agallocha*), myrtle mangrove (*Osbornia octodonta*) and cotton tree (*Hibiscus tiliaceus*) are confined to the landward fringes of the mangrove forest and shrubland. Saltmarsh areas behind the mangroves are variously dominated by sand couch (*Sporobolus virginicus*) grassland and samphire herbland (e.g. samphire (*Halosarcia indica*), seablite (*Suaeda australis*) and *Tetragonia tetragonoides*). These areas may also be fringed by woodlands of *Melaleuca* spp. and swamp she-oak (*Casuarina glauca*). The swampy areas on peaty soils comprise three community types - open forest/woodland dominated by *Melaleuca* spp. but including cabbage tree palm (*Livistona australis*), *Tristania suaveolens* and *Eucalyptus tereticornis*; closed heath with species including *Boronia falcifolis*, wallum bottlebrush (*Callistemon pachyphyllus*), wallum tea-tree (*Leptospermum semibaccatum*), *Restio fastigiatus* and common heath (*Epacris obtusifolia*); and sedgeland, common species including *Schoenoplectus litoralis*, sea rush (*Juncus kraussii*) and sword grass (*Gahnia sieberiana*). ***Significance*** (No data) ***Social and Cultural values*** Several high value Aboriginal cultural sites occur, mainly along the Burrum and Gregory rivers and behind the beach at Woodgate. Important and increasingly popular for tourism and recreation, particularly for fishing and boating. Valuable area for research into both natural and cultural features of the Hervey Bay coastline. Reference *Department of the Environment and Energy. 2017. Burrum Coast - QLD126, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD126. Accessed 25 Jul 2017.*

Wetland	Key Features
Bustard Bay Wetlands	***Site description*** The site includes the embayment and estuaries between Rodds Peninsula and Round Hill. It is comprised of three interconnected, mangrove dominated, estuarine wetlands on and around Middle Island (Pancake, Middle and Jenny Lind creeks), plus two similar small estuaries at the southern end of Bustard Bay (Eurimbula and Round Hill creeks); an extensive non tidal, seasonal, freshwater wetland exists between the two southern estuaries, in Eurimbula National Park. ***Physical features*** The coastline of Bustard Bay consists largely of Holocene beach ridge deposits (including a large exposed sandmass on Middle Island); Holocene estuarine deposits dominate the western side of Middle Island and the major estuaries; on the north of Middle Island, Bustard Head and Clews Point are formed on unnamed granites of Triassic origin. A small area of the same granite occurs on the west side of Middle Island, near the centre of the Pancake Estuary; the estuarine deposits are bounded variously by Quaternary alluvium and Agnes Water volcanics (Triassic), an outcrop of which also forms Round Hill Head. There is considerable variation in the sediment of the estuaries - Round Hill Creek is predominantly sandy with a small fraction of fine mud, Eurimbula and Middle creeks are largely fine mud with small amount of sand at their mouths, Jenny Lind and Pancake creeks are sandy. ***Ecological features*** The dominant plant community in the site is mangrove forest and shrubland, with relatively small areas of saltflats behind; mangroves exhibit distinct banding from seaward to land : - Avicennia and/or Aegialitis fringe on seaward margin; - Rhizophora and/or Avicennia and/or Ceriops zone (main zone); - Ceriops and/or Avicennia and/or Rhizophora zone; - coastal saltflat (sand couch (*Sporobolus virginicus*) and/or chenopods); - Ceriops fringe (between saltflat and terrestrial vegetation); several intertidal seagrass beds are situated in Pancake Inlet and in the small bay formed between Bustard Head and Clews Point. Of significance is the somewhat unusual occurrence of a fringing coral reef in an estuary (Pancake); the site supports a variety of marine fauna (e.g. 25 crab species and 29 mollusc species in Eurimbula and Round Hill creeks), as well as numerous shore, sea and land birds. ***Significance*** The Round Hill Head area is one of only three places where James Cook went ashore on his journey up the east coast of Australia in 1770. The site provides popular anchorages for recreational boats travelling up and down the coast, as well as unique natural features (landscape, flora and fauna, estuarine coral reef) in a relatively undisturbed condition. ***Social and Cultural values*** James Cook came ashore at Round Hill Head during his voyage up the east coast of Australia in 1770, and the Bustard Head Lighthouse was the second to be built in Queensland in 1868. Bustard Head also has a cemetery associated with early exploration of the area. Aboriginal shell middens occur throughout the area and there is considerable intrinsic value to fisheries as habitat and crab fishery. Bustard Bay supports a trawl fishery, while the estuaries support crab fisheries. Middle Island supports a small grazing enterprise, and several shipwrecks are located in Bustard Bay. Scientific interest and research values: Especially in the coral reef. The area is becoming increasingly popular as a tourist destination, especially as an access point to the Great Barrier Reef. Reference *Department of the Environment and Energy. 2017. Bustard Bay Wetlands - QLD127, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD127. Accessed 25 Jul 2017.*
Colosseum Inlet - Rodds Bay	***Site description*** The site is comprised of the area of the Curtis Coast between Wild Cattle Island and Rodds Peninsula. It contains three large estuaries/embayments with extensive mangroves and lesser areas of coastal saltflat and seagrass beds, supporting fauna of state and national significance. ***Physical features*** Geology/geomorphology: marine lowlands surrounded by flat to undulating terrain; geology is predominantly Quaternary estuarine (Holocene) and alluvial (Pleistocene) deposits fringed by Agnes Water granites (Triassic) and Miriam Vale granodiorites (Permian); Hummock Hill Island has an area of the latter granites surrounded by estuarine deposits and Quaternary beach ridge deposits on the north and south ends; a small area of Quaternary tidal delta sands occurs at the mouth of Colosseum Inlet. Soils: the lowlands are mainly saline clays (Olsen et al., 1980).

Wetland	Key Features
	Ecological features Extensive mangrove forests and shrublands; restricted seagrass beds; coastal saltflats (claypan and saltmarsh) and a small coral reef. Mangroves exhibit distinct banding from seaward to land : - Avicennia fringe on seaward margin - Rhizophora zone (main zone) - Ceriops zone - Coastal saltflat - Ceriops fringe (between saltflat and terrestrial vegetation). Seagrasses are generally intertidal due to the natural turbidity of the waters - most abundant species are *Zostera capricornia*, *Halophila ovalis* and *Halodule uninervis*. Coastal saltflats range from bare claypan, through low/dwarf open halophytic shrubland (e.g. *Sarcocornia* spp. and *Suaeda* spp.), to open and closed grasslands dominated by sand couch (*Sporobolus virginicus*). ***Significance*** (No data) ***Social and Cultural values*** Several sites of archaeological importance occur in Colosseum Inlet and around Rodds Bay. These waterways are popular for boating, providing an extensive sheltered passage along the coast, as well as mooring sites inside Colosseum Inlet and Rodds Harbour. It is an important recreational fishing/crabbing area, and also an important source of commercial fisheries species. Hummock Hill Island supports a small grazing operation. Tourism is gaining momentum with several resort proposals in this area. There are also mineral reserves under exploration. Reference *Department of the Environment and Energy. 2017. Colosseum Inlet - Rodds Bay - QLD129, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD129. Accessed 25 Jul 2017.*
Deepwater Creek	***Site description*** (No data) ***Physical features*** The Deepwater landscape is characterised by a gently sloping alluvial plain that is closed by a coastal dunefield in the north and east. The catchment includes extensive Quaternary alluvium and Tertiary sandstone formations. The sandstones occur in elevated western areas and alluvium occurs in the north, east and south-eastern plains. Outcrops of the Triassic volcanics are found in the north and east. A small highland area in the south west of the catchment is Triassic granite. Minor formations of Jurassic and Triassic sandstone and mudstone occur in southern areas. Dune formations contain Holocene sands, and the estuary contains Holocene deposits. Gradational yellow massive earths (Gn2.3) predominate in elevated and western sections of the catchment. Soloths (Dy 3.41) have formed in the low eastern areas and deeply leached siliceous sands (Uc 1.21) have formed on the coastal dunes. Most discharge is produced from northern watersheds and shallow sandy aquifers. Other significant creeks include Reedy, Fullers, Bullock, Five mile, Pearson, Blackwater and Pig creeks. The drainage network is organised, convergent and unidirectional. Waterholes are found in the main channel and swamp formations occur near the coastal dunes. The climate is 'temperate humid' but a close proximity to the sub-tropics in the north is associated with thunderstorms and high rainfall intensity. ***Ecological features*** The inland alluvial and palustrine environments and ecosystems (together with the Eurimbula and Bustard Bay area) provide the largest and least disturbed northern representatives of their type. The estuary is flanked by more than 100 ha of littoral forest, grass meadow and reed beds. Closed Ceriops mangrove forests dominate with *Avicennia* forest and *Sporobolous* grassland. *Aegiceras* and *Rhizophera* forests occur in smaller communities. Sporobolous meadows are associated with *Juncus*, *Casuarina* and *Melaleuca* communities. Coastal rocky headlands support *Themeda triandra* and heath communities while adjacent foredunes support *Themeda, Allocasuarina, Banksia* and *Accacia* species. Further inland, the Quaternary sand plain and dune swales support microphyll and notophyll rainforest and open forest including *Eucalyptus, Corymbia, Melaleuca, Callitris* and *Livistonia* species. The swamps and ponded areas inland of the dunes support fringing sedge *Leperonia articulata*, meadows with *Blechnum indicum* and areas of *Urtricularia, Lepidosperma*, and *Philydrum* species. These areas merge with the prevalent alluvial ecosystems of wet heaths with *Melaleuca, Banksia, Hakea, Leptospermum* and *Baekia species* (typical wallum), open riparian forests of *Melaleuca*

Wetland	Key Features
	quinquenervia, Eucalyptus robusta, E. tereticornis, E. racemosa, Corymbia intermedia and *Lophostemon suaveolons*. On slopes of seasonally waterlogged Tertiary sediment or volcanic rock, open forests and grassy woodlands with *Eucalyptus, Corymbia, Melaleuca* and *Banksia* species are prevalent. ***Significance*** The Deepwater catchment and lowlands provide a large and relatively intact wetland system at the northern limit of the coastal lowland 'wallum' ecosystem of south-east Queensland. The area is one of the least disturbed mainland representatives for coastal acid freshwater wetlands in Queensland. The area is part of the Macpherson-Macleay zone of biogeographical transition, an area with enhanced species diversity. The sandy beaches support the second largest aggregation of mainland breeding sea turtles in Queensland, and provide the only mainland nesting site used repeatedly by the nationally endangered leatherback turtle. ***Social and Cultural values*** This is an important area for nature based recreation (camping, boating and fishing), and it provides a destination for regional communities. Shell middens are found on the foredunes. The Gooreng Gooreng Aboriginal people have a tradition with the land. Captain Cook visited the area in 1770, which may have been his first landing place in Queensland. Captain Cook's landing just to the north of the mapped area (Town of 1770) attracts tourists to the Deepwater beaches and headlands. The 1770 area has high social value in south-east Queensland. The mineral-rich Deepwater Beach ridge dunes are of high economic and natural value. The dune field is listed in the Register of the National Estate. Reference *Department of the Environment and Energy. 2017. Deepwater Creek - QLD182, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD182. Accessed 25 Jul 2017.*
Fraser Island	***Site description*** Fraser Island is the largest sand island in the world. It has huge reserves of fresh groundwater and characteristic window and barrage dune lakes. The topography of the island is characterised by rough dunes reaching an elevation of more than 220 m. Steep cliffs are common on the east coast and extensive flats are common on the west. The catchment is that of the permeable Fraser Island sandmass and there is relatively little direct runoff. ***Physical features*** Landform: intertidal flat, beach, floodout, supratidal flat, drainage depression, stream channel, stream bed, tidal creek, estuary, swamp, swale and lake; uplands are rough dunes with high relief. General geology: Fraser Island is dominated by a series of overlapping parabolic dunes which have been deposited as a result of inland migration of sands from coastal blowouts. These Quaternary and older siliceous sands overlie Cretaceous sediments of the Maryborough and Burrum sediments. Igneous intrusives at Indian Head and Waddy Point are the only true rocks on the island. The sand dunes were derived from the erosion of sandstones from coastal river valleys in northern NSW and southern Queensland. These late Pleistocene deposits were transported up the coast to their present position with successive rises and falls in sea level due to eustatic oscillations. The Pleistocene units are characterised by pure white sand while the Holocene dunes of pale yellow-brown sand overlap and, in some cases, form a veneer over the Pleistocene units. Soils: the soils are mostly quartzipsamments. They are deep sands with an A horizon of variable development and some deeper organic staining. Giant podosols occur with thick, richly coloured B horizons. There are also some groundwater podosols and peats. ***Ecological features*** The following wetland and related environments occur on the island: (i) permanent creeks fed by springs draining the major sand aquifers, on the east and west of the island. Rainforest communities are found along Eli and Wanggoolba creeks and comprise notophyll vine forests, notophyll palm forests and microphyll vine forests. Six species of rare or vulnerable plants have been recorded from the rainforests. Isolated dense palm forests of piccabeen palm (*Archontophoenix cunninghamiana*) are found in sheltered areas along the streams. Little information is available on aquatic macrophytes within the creeks. Some waterways support different morphs of the Fraser Island sunfish (*Rhadinocentrus ornatus*); (ii) dry sclerophyll forests or paperbark woodland (swamp paperbark (*Melaleuca quinquenervia*)) grading into paperbark swamp at the margins of the lakes. Forests are structurally variable and can include forest red gum (*Eucalyptus tereticornis*), red bloodwood (*Corymbia*

Wetland	Key Features
	spp.) and swamp box (*Lophostemon suaveolens*) as well as swamp mahogany (*Eucalyptus robusta*) and weeping cabbage palm (*Livistona decipiens*) in moister sites; (iii) open shrublands and low woodlands dominated by the wallum banksia (*Banksia aemula*). Other associated flora includes black sheoak (*Leptospermum trinervum*), monotoca white banksia and mallee forms of brush box. A notable species is Wide Bay boronia (*Boronia rivularis*) which occurs near lakes to the north end of the island, and which is recorded as a rare species with a restricted habitat. The acidic waters within this "wallum" environment are inhabited by a specialist frog fauna which has evolved in response to apparent constraints imposed on most other frogs by the acid waters. These "acid" frogs are represented by wallum rocketfrog (*Litoria freycineti*), Cooloola sedgefrog (*L. cooloolensis*), wallum sedgefrog (*L. olongburensis*) and wallum froglet (*Crinia tinnula*). The Fraser Island sunfish (*Rhadinocentrus ornatus*) is confined to wallum waters; (iv) freshwater perched water table window lakes and barrage dune lakes with marginal bands of sedges, dominated by *Lepironia articulata*. The sedge *Schoenus scabripes* is notable as a rare species restricted to highly specific habitats. Exposed areas of moist sand on lake margins area colonised by sundews (*Drosera spatulata*), dwarf yellow-eye (*Xyris juncea*) and fairy aprons (*Utricularia dichotoma*). A short-necked tortoise *Emydur*a sp. is confined to island lakes and may be subspecifically different to current forms. The lakes are filled with either clear "white" or discoloured "black" water. Most lakes are oligotrophic and have depauperate fauna and flora. The lake catchments are closed and the organisms that inhabit them are isolated with the potential to diverge morphologically and genetically. Water birds occur in low numbers. Lake Wabby has a diverse fish fauna of 11 species, including the rare honey blue-eye (*Pseudomugil mellis*). The ancient chironomid midge *Anaphrotenia lacustris* is endemic to Lake Boernigin; (v) saline soil communities including mangroves, salt marshes and salt flats occur in the intertidal zones. The mangrove communities are dominant in terms of area and comprise 12 species. The dominant species of mangroves are grey mangrove (*Avicennia marina*), river mangrove (*Aegiceras corniculatum*), yellow mangrove (*Ceriops tagal*) and spotted mangrove (*Rhizophora stylosa*). Some of the mangrove species are at the southern limit of their distributions and some are of disjunct occurrence. Salt marshes and supratidal flats are dominated by samphires such as *Arthrocnemum* spp., *Suaeda* spp. and beadweed (*Salicornia quinqueflora*). sand couch (*Sporobolus virginicus*) is common; (vi) intertidal habitats including surf, sheltered beach and estuaries also occur. ***Significance*** The Fraser Island wetlands are significant because of their distinctness and because they are the best Australian example of a complex of wetlands characteristic of the South Eastern Queensland bioregion. Fraser Island possess the most numerous, most diverse, largest and highest perched lakes in the world. The lakes are notable for their palynology, climatology, ecology and, particularly, their hydrology. The hydrology and physicochemical properties of the groundwater are of notable scientific significance due to the relatively long residence time of water in the sandmass (70-100 years) and the characteristics of waters passing through the soil profiles. This island is also significant as a habitat for a diverse range of endemic, rare, and threatened fauna and flora. Fraser Island is also a World Heritage site. ***Social and Cultural values*** Fraser Island has a very long history of Aboriginal occupation. Only a small proportion of Aboriginal sites have been identified to non Aboriginal people. Details of cultural landscapes with symbolic, ceremonial, and/or mythological significance to Aboriginal people are therefore not widely known. In addition to the above a large number of prehistoric sites have been identified. Fraser Island is also significant because of the number of sites relating to European occupation e.g. Bool Creek as the site of the first European landing, by Flinders from the Investigator. Currently Fraser Island is one of the most important tourism and recreational destinations in southeast Queensland. Reference *Department of the Environment and Energy. 2017. Fraser Island - QLD131, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD131. Accessed 25 Jul 2017.*
Great Barrier Reef Marine Park	***Site description*** (No data) ***Physical features*** The Great Barrier Reef is not a continuous barrier but a broken maze of coral reefs, some with coral islands (or cays). The reef comprises some 2,500 reefs which range in size from less

Wetland	Key Features
	than one hectare to more than 10,000 ha, and in shape from flat platform reefs to elongate ribbon reefs. There are 71 cays on the reef. The reefs are composed of the accumulated remains of animal calcium carbonate skeletal material and plant material, supporting a veneer of living plants and animals. The reef can be divided into three distinct sectors. The northern sector (north of latitude 16°S) contains many patch reefs with cays. Of particular interest are the low wooded islands which are coral cays carrying mangrove communities. The central sector (from 16°S to 21°S) is characterised by scattered platform reefs which are separated from fringing reefs of the mainland coast and coastal islands by a channel 15 km wide in the north and 50 km wide in the south. The southern sector (from 21°S to 24°S) is characterised in the north by a tightly packed maze of wall-like reefs separated by channels which carry strong tidal currents. To the south the reefs are tightly packed patch reefs with large patch reefs at the very southern end having well developed vegetated coral cays. ***Ecological features*** The Great Barrier Reef Marine Park contains a variety of habitats in a number of ecosystems. The area is recognised for its seagrass beds, estuarine wetlands, mangrove woodlands, island cays and coral atolls. The reef formations owe themselves to the ability of corals to produce substantial skeletons of calcium carbonate. Many of the corals have a variety of growth forms (branching corals, massive brain corals, plate-like corals, encrusting corals and mushroom corals) which relate not only to the genetic makeup of the corals but also, in part, to the hydrological regime and exposure of the location in which they develop. ***Significance*** (No data) ***Social and Cultural values*** The great diversity of life forms, especially in the endemic species, makes it an area of enormous scientific importance. It is an area that is recognised as being of great natural beauty and wonder and as such is one of Australias most recognisable natural features. The area is extensively used for tourism and recreation. The area contains many archaeological sites of Aboriginal and Torres Strait Islander origin. There are over 30 historic shipwrecks in the area, and on the islands there are ruins and operating lighthouses. <u>Reference</u> *Department of the Environment and Energy. 2017. Great Barrier Reef Marine Park - QLD100, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD100. Accessed 25 Jul 2017.*
Great Sandy Strait	***Site description*** A very large and complex wetland system, consisting of intertidal sand and mud flats, extensive seagrass beds, mangrove forests, salt flats and saltmarshes. A number of individual wetlands have been described for the Great Sandy Strait. These wetlands cover some 46,000 ha. Kauri Creek, Tin Can Bay and Tin Can Inlet are significant wetlands (10,000 ha) at the southern end of the Great Sandy Strait. ***Physical features*** Soils are mostly modern fluvial (Mary River) sediments - fine to medium grained felspathic sands, with a 3-6% mud content. Most of the area lies on or close to the 1200 mm isohyet. ***Ecological features*** Major habitat types include mangrove forests, intertidal and subtidal seagrass beds, saltmarshes, unvegetated mud, sand and salt flats, and estuarine and channel waters of varying depth and width. As well as the extensive seagrass beds and ten species of mangrove occurring in the wetland, large and important communities of migratory waders, mangrove invertebrates and fish are present throughout the wetland. The wetland is also home to dugong (*Dugong dugon*) and marine turtles. ***Significance*** The Great Sandy Strait is one of few passage landscapes in Australia where an offshore barrier island has formed sufficiently close to the mainland to block the outflow of a substantial river system, creating a double-ended estuary with a shifting pattern of mangroves, sand banks and mud islands. ***Social and Cultural values*** Aboriginal and non Aboriginal historical significance is attached to much of the Great Sandy Region; evidence of Aboriginal presence in the region dates back 5,500 years. The Great Sandy Strait is highly valued by commercial and recreational fishermen and boating enthusiasts. The unique natural features of the area provide almost unequalled opportunities for research into the species, communities and processes at work in this large wetland system.

Wetland	Key Features
	<u>Reference</u> *Department of the Environment and Energy. 2017. Great Sandy Strait - QLD132, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD132. Accessed 25 Jul 2017.*
Lake Coombabah	***Site description*** Lake Coombabah is a tidal lake at the mouth of Coombabah Creek. The lake and swamps have formed in the tidal delta and coastal plain of southern Moreton Bay. ***Physical features*** The majority of the wetland has formed on marine plain and alluvium. The upper alluvial and colluvial slopes occur on sub-coastal hills and rises. Tidal reaches and Melaleuca swamps in low lying and supra-tidal areas occur on Holocene muds and sands. Small beach ridge dunes to the east formed during the Holocene. The coastal flats are surrounded by Quaternary alluvial flats. The sub-coastal hills have developed from Devonian-Carboniferous geology of mudstone, shale and conglomerate. The beach ridge dunes have formed deep siliceous sands. Dune swales and swamps contain acid peat soils that are frequently waterlogged (eg. humic podzols). Some supratidal freshwater swamp zones have developed peat profiles. Humic gley soils typically occur in old tidal channels and depressions, and they have permanently wet subsoils. More saline soils include solonchaks. Gleyed podzolics occur upslope of the tidal soils. Yellow podzolics are prevalent on alluvium and colluvium. Erodible sandy duplex soils with impermeable subsoil occur on elevated slopes, whilst seasonally waterlogged podzolics (some support perched water tables) occur on lower slopes. More than half of the lowland alluvial and coastal plain area is affected by acid sulfate soil deposits. ***Ecological features*** The upper watershed forms a mosaic of tall forests and woodlands with *Corymbia citriodora*, *Eucalyptus siderophloia*, *E. major*, *E. seeana* and *E. racemosa* with *Angophora*, and *Lophostemon* species. The lowland communities include Mangroves with Avicennia marina and Casuarina glauca, saltmarsh communities with *Sporobolus virginicus*, *Suaeda* and *Salicornia* species, *Casuarina glauca* forests with *Melaleuca quinquenervia*, forests with *M. quinquenervia*, *Eucalyptus robusta*, and *Blechnum indicum* with heath representatives such as *Restio* species, wet heath with *Restio pallens*, *R. tetraphyllus*, *Leptocarpus tenax*, *Epacris obtusifolia*, *Leptospermum juniperinum* and *Melaleuca nodosa*, tall heaths with *Banksia aemula*, *Leptospermum trinervium*, *Acrotriche aggregata* and *Leucopogon lanceolatus*, low heaths with *Bauera captitata*, *Hibbertia salicifolia*, *Epacris pulchella*, *Leucopogon species*, and Boronia species, lowland forests and woodlands with *Corymbia tessellaris*, *E. intermedia, Lophostemon confertus*, and *M. quinquenervia*, woodlands with *E. pilularis, E. crebra, E. tereticornis, E. intermedia, Lophostemon confertus*, *Acacia* species and *Callitris columellaris*, and open woodlands and grasslands with *E. pilularis, E. tereticornis, Xanthorrhoea* species, *Haemodorum tenuifolium, Tricoryne elatior, Xyris complanata*, and *Dianella caerulea*. ***Significance*** The Coombabah wetlands are significant because they are the most southerly lake and coastal swampland representatives in the bioregion, and because the area provides significant wildlife value and refuge habitat. Remnant vegetation mosaics are 10s to 100s of hectares in size. Remnant connectivity is poor and mosaics occur primarily as isolated fragments. Remnants have low to modest integrity, primarily due to numerous edge effects, illegal waste disposal and weed growth, clearing and fire. Weeds in the lowland areas include groundsel (*Baccharis halimifolia*), ragweed (*Ambrosia species*), introduced pine wildings and various pasture and annual species. Saline or brackish lowland wetlands are included in the Moreton Bay Ramsar area. Coombabah Lake and confluent tidal creeks intersect 41 mosaics of significant intertidal vegetation and tidal beds. The mosaics incorporate an area of about 500 ha. The Queensland Herbarium surveyed the tidal and near-tidal coastal vegetation and found 22 significant mosaics. Eleven mosaics have State significance and 11 have regional significance. Two Gazetted fish habitat areas extend through the tidal lake. The habitat areas include about 560 ha of the tidal wetland. The majority of the tidal lake and surrounding swamp area is used by waders for feeding and roosting. ***Social and Cultural values*** The Lake Coombabah area includes Ramsar and fish habitat areas because of its high value to bird and fish life. This wildlife activity attracts naturalist groups and bird watchers who survey the movement of migratory waders. The area is also popular with boat users. The Gold Coast City Council and QPWS supports the use of the area for natural history education, and local schools use the facilities for their studies. This is the last remaining representative of its type and size in

Wetland	Key Features
	the mainland area of the Gold Coast. The wetland area has high heritage value to the Kombumerri people. The area contains sites and relics such as shell middens and artifacts that indicate the use of natural resources by indigenous people for more than 5,000 years. These people harvested fish, crayfish, shellfish and dugong, as well as macropods, invertebrates and reptiles. The lowlands also provided vegetables and fruit, yams, nuts, berries, seeds etc. The area was used as a meeting and feasting place, and a place for ceremonies. The area also holds evidence of the development of the area by white settlers. The white settlers grazed cattle, cut and milled the timber, and fished the fisheries. From the 1950s to the present, the area has been marketed as a recreational, tourist and urban destination. Reference *Department of the Environment and Energy. 2017. Lake Coombabah - QLD194, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD194. Accessed 25 Jul 2017.*
Lake Weyba	***Site description*** The site comprises the area which covers that part of Noosa National Park south of the original headland park and the adjacent Lake Weyba. ***Physical features*** General geology: two geological units are represented. The majority of the area is of Pleistocene origins as old tidal delta sand deposits. The landform is level sand plain with humus podosols and peaty podosols on poorly drained plains and depressions. These low lying areas are seasonally waterlogged and the water table can be permanently close to the surface. Depression areas are permanently waterlogged. The western part of the block is on Myrtle Creek sandstones of Triassic/Jurassic origins. The landform here is gently undulating rises of coarse grained quartzose sandstones. Soils are yellow podosolics or yellow earths, low in nutrients and with little or no structure. ***Ecological features*** (No data) ***Significance*** (No data) ***Social and Cultural values*** Increasingly used for recreation. Reference *Department of the Environment and Energy. 2017. Lake Weyba - QLD133, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD133. Accessed 25 Jul 2017.*
Lower Mooloolah River	***Site description*** The Mooloolah River runs through a long reach of sandy coastal plain to become a delta with small islands, bars and meander channels. ***Physical features*** The Mooloolah River is pinned to the north by a beach ridge plain, alluvium, rocky headland, and urban infrastructure such as canals. The landscape is very gently to gently inclined with occasional very low rises. Most of the lower Mooloolah River is derived from Quaternary alluvium deposits. Some low rises and ridgelines are formed on sandstone, siltstone, shale, and ferruginous material formed during the Triassic-Jurassic period. The majority of coastal sands and silts in the lowest areas have formed from deposits of Holocene tidal sandy mud or peat-mud. Humic gley soils occur on Quaternary alluvium, while bleached sandy soils with pans (humic podzols, ground water podzols) are found in northern areas. The soils are generally nutrient poor and poorly drained. Hummock microrelief is found in areas of frequent waterlogging. Acid sulfate soil deposits with Jarosite occurs in the majority of low-lying areas. ***Ecological features*** Eight vegetation associations occur in the lower floodplain. These are *Eucalyptus tereticornis*, swamp paperbark (*Melaleuca quinquenervia*), scribbly gum (*E. racemosa*), and pink bloodwood (*Corymbia intermedia*) open forest on old estuarine deposits, *M. quinquenervia*, swamp box (*Lophostemon suaveolens*), *E. tereticornis*, flooded gum (*E. grandis*), *E. racemosa*, swamp mahogany (*E. robusta*), *C. intermedia*, cabbage tree palm (*Livistona australis*) and piccabeen palm (*Archontophoenix cunninghamiana*) open forest on old estuarine deposits, *E. robusta*, *L. suaveolens* with *M. quinquenervia* open forest on old estuarine deposits, E. *robusta, E. racemosa*, red bloodwood (*C. gummifera*), *M. quinquenervia* open woodland, *L. suaveolens* on old estuarine deposits, *E. racemosa*, red mahogany (*E. resinifera*), *C. gummifera* woodland on old estuarine deposits, swamp

Wetland	Key Features
	stringybark (*E. conglomerata*), Queensland white stringybark (*E. tindaliae*), *E. robusta*, *C. gummifera* and *Syncarpia glomulifera* in woodland or open forest on old estuarine deposits, closed heathland and sedgeland commonly with Hakea actites, broad-leaved banksia (*Banksia robur*), *Leptospermum* spp. and swamp grasstree (*Xanthorrhoea fulva*) on old estuarine deposits with emergents such as *E. robusta*, *E. racemosa*, *E.conglomerata*, *M. quinquenervia*, and black sheoak (*Allocasuarina littoralis*), and open to closed heathland/sedgeland with *M. quinquenervia* on old estuarine deposits. Aquatic emergents include *Phragmites*, *Lepironia*, *Ghania* and *Baumea* species. Estuarine species include river mangrove (*Aegiceras corniculatum*), grey mangrove (*Avicennia marina*), spotted mangrove (*Rhizophora stylosa*), large-fruited orange mangrove (*Bruguiera gymnorhiza*). ***Significance*** The Mooloolah River wetlands are significant because of they are a good representative of a number of wetland types and coastal environments, and because of the diversity of habitats, wildlife and provision of wildlife refuge. ***Social and Cultural values*** Two sites are listed in the Register of the National Estate; these are the Mooloolah River National Park and the Currimundi Lake Envirionmental Park. These areas are recognised and celebrated by local naturalist and conservation groups for their annual flower displays. The Mooloolah River and much of the mapped area is culturally significant to Indigenous peoples. Oyster middens have been found on the river banks and bora rings have been found in the area. Swards of Blechnum indicum within the Melaleuca forests provided a food source for Indigenous people. Evidence of Indigenous artefacts and tools is found in scatters in eastern coastal areas of the Mooloolah floodplain along with scarred trees. Reference *Department of the Environment and Energy. 2017. Lower Mooloolah River - QLD187, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD187. Accessed 25 Jul 2017.*
Moreton Bay Aggregation	***Site description*** The Moreton Bay Aggregation site is a basin forming one of the largest semi enclosed estuarine bays in Australia, and is bounded by two of the largest sand dune islands in the world. The mainland catchment is that of a large number of streams draining eastwards into Moreton Bay and Pumicestone Passage, principally the Coomera, Logan, Brisbane, Pine and Caboolture rivers. Bribie, Moreton, North and South Stradbroke sand islands have local catchments and trap considerable reserves of groundwater in the permeable sand masses. There is relatively little direct runoff from these. ***Physical features*** Landform: reef, tidal flat, intertidal flat, supratidal flat, beach, tidal creek, estuary, drainage depression, stream channel, swamp and lake; uplands are mostly flats and dunes with high relief. General geology: the dune island barriers, barrier islands, strand plains, coastal plains, tidal deltas and back barrier lagoons of the bay are all depositional features and consist mainly of Quaternary sediments. These sediments were derived by stream erosion of Mesozoic and Permian sedimentary rocks and granites of the eastern Australian highlands. Strong longshore currents transported these predominantly quartz grains north throughout the Quaternary Period where they were trapped between the older rocky outcrops of the bay. Between these outcrops the average depth of the bedrock is 45 m. The rocky outcrops, coastal headlands and underlying bedrock of the islands and the bay itself are formed of Tertiary basalts and freshwater shales, Mesozoic sandstone and Palaeozoic metamorphic rocks with some laterite soil development at the surface. The bay is enclosed by the sand islands of South Stradbroke, North Stradbroke, Moreton and Bribie. Except for South Stradbroke, these islands are sand dune-island barriers. They were formed by wave and wind action during several cycles of sea level changes and date back 215,000 years. Unlike the dune-island barriers, South Stradbroke Island is a Holocene feature described as a true barrier island. Oceanic entrances into the bay incorporate a delta generated by tidal currents and consist of a network of sand shoals and channels on both sides of the inlet. Soils: undescribed saline soils and sediments on the tidal flats. Sandy soils and sediments in the eastern bay. A range of soils on the islands. ***Ecological features*** Moreton Bay is situated in an area transitional between tropical and temperate zones, and a number of species and associations are at the southern limit of their range. Diurnal circulation of oceanic water through the various entrances maintains high salinity throughout the bay. Moreton Bay consists of a deeper eastern section subject to strong north- south tidal circulation, and a

Wetland	Key Features
	shallower western section with much weaker east-west mixing. Consequently, fine particles settle in the less turbulent western areas of the bay, while the eastern bay is characterised by sandy sediments associated with higher tidal velocities. The following wetland and related habitats occur in the site: (i) marine and wetland environs of Moreton Bay: small areas of rocky shore and a total of approximately 23,000 ha of tidal flats with substrates of mud, sand or coral are exposed at low tide. These flats provide a variety of habitats and are of particular relevance to the migratory species of birds that are covered by JAMBA and CAMBA. Within the bay, mangroves colonise the muddy intertidal zone associated with the estuaries and sheltered embayments around the islands and mainland. Moreton Bay, including Pumicestone Passage, contains approximately 13,720 ha of mangroves. Seven species of mangroves have been recorded. Within Moreton Bay densely vegetated seagrass meadows cover approximately 4,261 ha and a further 2,596 ha is covered by sparser patches. Of the total apprximately 6,857 ha, 67% is in the Kooringal, Dunwich and Amity Banks area. The saltpans and saltmarshes generally are located adjacent to mangroves. Moreton Bay has approximately 6,328 ha of salt flats including unvegetated marine clay pans, dense mats of sand couch (*Sporobolus virginicus*), and samphire communities containing species of *Sarcocornia*, *Halosarcia* and *Suaeda*. In addition, *Juncus maritimus* is present in areas of low salinity; (ii) fringing coral reefs have formed around islands in the centre of the bay; (iii) dune-island barriers: North Stradbroke, Moreton and Bribie islands have the same genesis and have similar topography. Narrow coastal plains and long straight beaches border the high sand dunes of the interior. The western margins are mostly low energy environments characterised by tidal flats and mangrove swamps. The southern half of Bribie Island consists of lines of stranded beach ridges mainly of Pleistocene origin. The uniform sand, high infiltration rate and low runoff rate provide ideal conditions for a substantial store of ground water. Perched water tables form above the regional water table where buried organic soils or peats of old lagoons impede the vertical infiltration of water to the regional water table. Both perched lakes and window table lakes occur on the sand islands of the bay, although the former are much more common. Perched dune lakes form in depressions in a perched water table and may occur 100 m above sea level. The perched dune lakes have a distinctive water chemistry which strongly influences their biological communities. Species such as the 'acid' frogs have evolved adaptations to conditions of low pH and are restricted to a narrow coastal strip of 'wallum'. The biological communities of acid dune lakes are distinctive. Dense swards of sedges grow in the littoral zone. The dominant species is typically Lepironia articulata. Phytoplankton biomass is low and desmids dominate. Characteristic of dune lakes, the zooplankton consist almost entirely of the calanoid copepod Calamoceia tasmanica; (iv) swamps: acid peats consisting of decomposing vegetation have accumulated to depths of more than 1 m in the freshwater swamps. Sedges, Restiads and ferns, sword grass (*Gahnia sieberiana*) and Blechnum, and the twining climber snake fern (*Lygodium microphyllum*) dominate the majority of the island swamps; (v) frontal dune communities: the dominant species consist of Spinifex sericeus in association with the creepers *Ipomoea pes-caprae, Oenothera drummondii*, *Senecio lautus*, sea rocket (*Cakile edentula*), coastal jack bean (*Canavalia rosea*), pigface (*Carpobrotus glaucescens*) and climbing guinea flower (*Hibbertia scandens*). ***Significance*** The Moreton Bay Aggregation wetlands are nationally significant as one of the largest estuarine bays in Australia, enclosed by barrier islands of vegetated dunes, which together with the permanent lakes of the sand island components provide a diverse and rich suite of wetland habitats. The wetlands are particularly significant as habitat for migratory waders and dugongs (*Dugong dugon*). More than 50,000 wintering and staging waders depend on Moreton Bay during the non breeding season. The Bay is internationally significant for wintering Eastern Curlew (*Numenius madagascarensis*) (3,000-5,000 birds) and Grey-tailed Tattler (*Tringa breviceps*) (>10,000 birds). ***Social and Cultural values*** Moreton Island contains some of the best remaining evidence of Aboriginal adaptation to a marine based society. Sites of Aboriginal significance are on many islands in the bay and consist of middens, fish traps, artefact scatters, quarries and sacred trees. The shoreline was the first to be settled by Europeans in the Brisbane region. There has been a long history of scientific research and use by various schools, universities and government agencies. Queensland University, CSIRO, and the Queensland Department of Primary Industries have research stations in the Moreton Bay area. St. Helena Island was the first national park in Queensland to be reserved solely because of its historical significance, and is the only national park in Queensland containing substantial historic

Wetland	Key Features
	ruins. An estimated 300,000 recreational fishermen spend 1.5 million man days per year in the Bay. Approximately 2,000 people visit Brisbane annually to watch waders in Moreton Bay. The values of fish and related products from the Moreton Bay area is more than $40 million annually to commercial operators, with a retail value of $80 million. Reference *Department of the Environment and Energy. 2017. Moreton Bay Aggregation - QLD134, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD134. Accessed 25 Jul 2017.*
Noosa River Wetlands	***Site description*** Spectacular and extensive system of freshwater, brackish and saline lakes, marshes, heathlands and estuarine wetlands associated with the Noosa River; it has unique landforms, vegetation and fauna. ***Physical features*** The Noosa River flows across a low lying, low gradient coastal plain, between the Cooloola sandmass on the coast and a series of sandstone hills (Benham Range) a short distance to the west; this plain extends to the coast, east of Lakes Cootharaba and Cooroibah. The entire plain is generally sandy (Quaternary beach, estuarine and lacustrine deposits). Lakes Cootharaba and Cooroibah are open ended; Como, Weyba and Doonella are culs-de-sac; and Cooloola is isolated. Lakes Cooloola and Como are delta lakes, formed by deposition of sediment from the Noosa River where it enters Lake Cootharaba (which was formerly much more extensive). South of Lake Cooroibah, the river becomes more typically estuarine, with numerous low sand/mud islands, adjacent saline flats, and tidal delta and bars near the river mouth. Lake Weyba is located south of the Noosa estuary and, while not strictly a part of the Noosa River Lakes system, is tidally connected to the estuary. ***Ecological features*** Major habitat types include permanent open water bodies, estuarine waters, intertidal sand/mud flats, mangrove forest/shrubland, saltmarsh, open forest, woodland, sedgelands and heathland. Mangroves, intertidal flats and saltmarsh are the dominant communities in the Noosa River estuary, including islands and adjacent lakes. Fringing communities of mangrove forest/shrubland and/or swamp she-oak (*Casuarina glauca*) forest occur along the river and lake edges, to the limit of tidal influence. Mixed high to tall open forest/woodland communities occur along creek/river banks throughout the site (pink bloodwood (*Corymbia intermedia*), broad-leaved white mahogany (*Eucalyptus umbra*), *E. tereticornis*, black sheoak (*Allocasuarina littoralis*), coastal cypress (*Callitris columellaris*), swamp paperbark (*Melaleuca quinquenervia*) and swamp box (*Lophostemon suaveolens*). Seasonally and permanently waterlogged areas generally support tall woodlands dominated by swamp paperbark, with *Eucalyptus* spp., swamp box and swamp she-oak, and with or without shrub and ground layers of heath, grasses, sedges and restiads. Permanently saturated areas (e.g. freshwater lake margins) also support sedgelands. Common species including *Lepironia articulata*, soft twigrush (*Baumea rubiginosa*), *Baloskion pallens*, pithy swordsedge (*Lepidosperma longitudinale*) and sword grass (*Gahnia sieberiana*). Areas of low closed heathland occur on sand lenses within the drainage lines. ***Significance*** The Noosa River lakes and adjacent wetlands are one of few such wetland complexes on the Australian east coast; ***Social and Cultural values*** This site is a highly valued area for tourism and recreation; education is also a significant use (e.g. many school groups use facilities at Lake Cootharaba for geography and science field trips); rapidly increasing urban and tourism development due to the natural values of the area; invaluable area for research into unique flora, fauna and landscape processes; and highly significant to Aboriginal people with numerous archaeological sites. Reference *Department of the Environment and Energy. 2017. Noosa River Wetlands - QLD135, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD135. Accessed 25 Jul 2017.*
North Stradbroke Island	***Site description*** North Stradbroke Island is a sand island anchored by sedimentary and volcanic rocky headlands developed in the Mesozoic and Palaeozoic period

Wetland	Key Features
	Physical features The island has been built by periodic ocean rise during the Quaternary. These transgressions move sand to the island and initiate dune formation. Most dune building occurred in the Pleistocene, with different periods of formation producing mosaics of dunes of different sizes and shapes. Dune patterns, elevation, and the distribution of peat and estuarine clay control wetland formation. The western marine flats form a tidal delta for southern Moreton Bay. In the Holocene, beach ridge formations have developed a large freshwater lagoon at the foothills of the eastern parabolic dunes. The lagoon (18 Mile Lagoon) includes approximately 3,000 ha of swamp and creekline. Acid peats and humic podzols (with organic pans) have developed in this type of environment. The wetlands are surrounded by fast draining siliceous sands. Marine flats have developed gleyed duplex soils. ***Ecological features*** Evapotranspiration accounts for 750–1,000 mm of water loss each year. Runoff quantities are less than 500 mm per annum, because soil-water and groundwater recharge captures most surface water. Recharge occurs through direct infiltration to an 'unconfined' aquifer. Surface water is retained in perched or groundwater swamps and lakes. Stream flow is mostly lateral discharge from the island's sand aquifers. The mapped area that is near-permanently waterlogged or inundated exceeds 5,300 ha including tidal flats and estuaries. During seasonally wet periods, the wetland area expands to at least 6,300 ha. Water depth in swamps is usually less than 1.5 m, but depths greater than 6 m occur in lakes (eg. Blue and Brown Lake). Water quality is very good. Water is often tannin stained but turbidity is low, nitrogen levels are low, salinity is low and chlrophyll-a levels are low. Water pH is generally between 4 and 5. The primary function of the wetlands is for recharge, flood detention, discharge (lateral seepage holds saline water from groundwater), and supply of clean water to lagoons, swamps and lakes. ***Significance*** North Stradbroke Island wetlands are significant because they provide some of the best and largest representatives of southern sandy island wetlands, they include a diversity of wildlife in natural conditions, and provide refuge habitat to wildlife including migratory species. The wetlands provide substantial cultural and historical value to indigenous people, for European settlers and because of the significant role they have provided for research and education. Remnant ecosystems are large and well connected. Mosaics of remnants vary from 10s to 1000s of hectares in extent and have a high level of integrity. The Queensland Herbarium has identified 23 low-lying coastal wetland habitats in the mapped area. All of the mosaics are considered to have State significance. Some of the southern and north western open tidal and estuarine areas are included in designated fish habitat area. These areas contain more than 200 ha of designated fish habitat area within the mapped wetland. Migratory waders use numerous small bays and flats for feeding and roosting (about 120 ha in the mapped wetland area), and these sites connect with extensive Moreton Bay general wader habitat. The majority of fresh and saline wetlands are included in the Moreton Bay Ramsar area. Contemporary disturbance to remnant patches includes fire and weeds (*Lantana camara* and *Baccharis halimifolia*), clearing and water use for sand mining. ***Social and Cultural values*** A number of historical and indigenous sites are listed by the Register of the National Estate. These include natural values of the central and southern sections of the island, Blue Lake National Park, the Dunwich Cemetery, Southern and Eastern Moreton Bay, and places of indigenous value at Point Lookout and Dunwich. The sea caves and cliffs of the island have regional geohistorical value. The area is visited by birdwatchers and naturalist groups, to survey birds, especially migratory waders, and to observe dugong and whales. Universities from Brisbane have an established history and tradition of zoological, ecological, coastal geomorphology and oceanographic research from the island. The island's estuaries and harbours provide frequently used recreational boating and fishing facilities and resources. The North Stradbroke Island wetlands were a critical part of the traditional indigenous hunter-gather economy. The significance of wetlands to the traditional Aboriginal lifestyle of the North Stradbroke Island people is substantial. The *Blechnum indicum* fern was the predominant vegetable staple food, while swamp yam species such as *Ipomea* and *Typha* species, and wild fruits and berries appear to have also played a food role. The swamps, swamp margins and their ecotones harboured the majority of plant species used in, and essential to, the traditional economy. These include blueberry ash (fish poison); foods such as midgim and pig face; paperbark for housing, shelter, packaging and fish storage; cottonbush and native hibiscus for cordage, twine and hunting and fishing nets; bark and trees for canoes and housing; timber and wood for spears, boomerangs and tools; and

Wetland	Key Features
	reeds and boronia for basketry.The Eighteen Mile Swamp provided no constraints to movement of resources and the western margin was also used for traditional rights of passage initiation ceremony associated with a large bora ring associated located on the southern end of the island near Swan Bay. The west coast sites contain little evidence of the cross-island transport of food and other resources. Traditional occupation to the south of Dunwich appears to have been more low-key with family-sized occupation sites, often targeting premium local resources such as hairy mussel, oyster and quampie. European historic values include the use of Dunwich and Amity Point (areas with close access to Flinders and Myora swamps and springs) for early penal settlements until 1839. An initial survey of the island and contact with Aboriginals occurred in 1803 with an expedition led by Matthew Flinders. At that stage more than 300 indigenous people inhabitaed the island in permanent camps. Amity Point in the 1820s was used as a harbour and transfer point for goods dispatched to Brisbane. This activity was soon shifted to Dunwich. A Catholic mission for Aborigines was established at Dunwich in 1843. From 1850 to 1947 Dunwich played a Quarantine and 'Benevolent Asylum' role. Six large shipwrecks have occurred around the island. The historic cement and timber Point Lookout Light House was built in 1932 to reduce the number of shipping accidents. The island has an established history in the fishery industry, particularly from the 1940s. The most recent profitable and heavy industry to commence on the island is mineral sand mining (for ilmenite, rutile and zircon), which began in 1950. Much of the island's infrastructure was built with the initiation of mining activities. The area is now better known for its tourism and urban lifestyle. Reference *Department of the Environment and Energy. 2017. North Stradbroke Island - QLD191, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD191. Accessed 25 Jul 2017.*
Northeast Curtis Island	***Site description*** The site is the northeastern side of Curtis Island, between Cape Keppel and Cape Capricorn, incorporating the extensive marine plain south of Yellow Patch inlet, and also Rundle Island. It is a shallow embayment some 20 km long, with small rocky headlands at each end; bay and estuary fringed largely by mangroves, behind which there is a 4,000 ha marine plain, which is tending to the southern limit of such habitat. ***Physical features*** Shallow embayment and small estuaries; offshore islands and sand bars; small rocky headlands; coastal lowlands; parabolic dune system and exposed sandmass. Geology dominated by estuarine deposits of the Holocene epoch; tidal delta sands of the same age at the mouth of Yellow Patch Inlet and in the sandbar offshore from it; Holocene high dune system occur along the southeastern boundary of the site (coastline running up to Cape Capricorn); Capes Capricorn and Keppel are formed on the Shoalwater and Wandilla formations respectively (Devonian); minor areas of Eocene colluvium occurs between the estuarine deposits and the Ramsay Range (Wandilla Formation). ***Ecological features*** Mangrove forest and shrubland forms an extensive fringing community along the estuaries and protected coastline of the bay; distinct banding occurs from seaward to land - Avicennia fringe on the seaward margin through a Rhizophora zone (main zone) a Ceriops zone on coastal saltflat to Ceriops fringe (between a saltflat and terrestrial vegetation). The most prominent feature of this wetland site is the vast (4,000 ha) marine plain, which represents the southern limit of this habitat type; the marine plain supports swampy or mixed grassland, dominated by green couch (*Cynodon dactylon*), *Paspalum* sp. and *Digitaria* sp., often in pure swards. The area supports a variety of flora and fauna, both terrestrial and marine, some of which are threatened species. ***Significance*** The extent of the marine plain, at the southern limit of the habitat type, the presence of threatened fauna, migratory waders, notable landscape features and the overall near natural condition of the area in general combine to make this site a highly significant wetland at the regional, state and national levels. ***Social and Cultural values*** A number of Aboriginal shell middens occur in the area. There is an historic lighthouse at Cape Capricorn which is listed on the Queensland Heritage Register. The site comprises an important grazing resource for leaseholders, and has significant tourism/recreation values (e.g. estuarine boating and fishing, sight seeing). There is a popular and spectacular mooring site in Yellow Patch Inlet, and Yellow Patch sand blow is a significant landscape feature.

Wetland	Key Features
	Reference *Department of the Environment and Energy. 2017. Northeast Curtis Island - QLD017, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD017. Accessed 25 Jul 2017.*
Pine River and Hays Inlet	***Site description*** (No data) ***Physical features*** The Lower Pine River and Hays Inlet area is an estuarine delta at the northern limit of Brisbane City. Pine River, Fresh Water and Hays creeks discharge into the delta. Hays Creek forms Hays Inlet, a shallow linear inlet with extensive tidal flats. The genesis of the inlet and lower Pine River has defined the delta. The inlet is bounded by Tertiary ferricrete with outcrops of Tertiary basalt on Redcliffe Peninsula in the east, and Triassic-Jurassic sandstones and shales in Mango Hill to the west. The majority of the delta and inlet is formed from Holocene and Pleistocene sand and mud. Northern and western areas on sandstone, colluvium and palaeosol have formed clayey humic gley soils with poor drainage and ironstone nodules. Eastern parts of the delta include krasnozem soils. The majority of supratidal flats and meadows have gleyed podzolic or soloth duplex soils with poor drainage and frequent waterlogging. Soils in southern and south-western reaches include humic gleys formed in depressions and old tidal channels with high water tables. Acid sulfate soil deposits are known or expected to occur in almost all wetland areas. ***Ecological features*** Vegetation in the wetland is dominated by mangrove shrublands and forests, saltmarshes and claypans, mixed Eucalyptus forest, Melaleuca forest, Casuarina open forest and sedge swamps on old pasture. Mangrove communities include grey mangrove (*Avicennia marina*) closed forests and shrublands, with river mangrove (*Aegiceras corniculatum*), large-fruited orange mangrove (*Bruguiera gymnorhiza*), yellow mangrove (*Ceriops tagal*), spotted mangrove (*Rhizophora stylosa*), milky mangrove (*Exoecaria agallocha*) and black mangrove (*Lumnitzera racemosa*). Low open Ceriops shrubland are a common feature in the high tidal zone. Intertidal saltmarshes include sand couch (*Sporobolus virginicus*) grassland, samphire communities, claypans and algal mats. Mixed Eucalyptus forests and woodland include *E. tereticornis*, Moreton Bay ash (*E. tessellaris*), grey ironbark (*E. drepanophylla*), swamp she-oak (*Casuarina glauca*), white bottlebrush (*Callistemon salignus*), swamp paperbark (*M. quinquenervia*), *Cupaniopsis anarcardioides*, *Ficus platypoda*, *Brachychiton populneus*, broad-leaved leopard tree (*Flindersia collina*) and cotton tree (*Hibiscus tiliaceus*). Forests of *M. quinquenervia* occur as small remnants in the south but more extensive forests occur around Hays Inlet. *Casuarina glauca* with *S. virginicus* occur on estuarine verges. Sedge swamps include broad-leaved cumbungi (*Typha orientalis*), common reed (*Phragmites australis*), *Eleocharis species*, *Lepironia articulata*, and frogsmouth (*Philydrum lanuginosum*). Minor scrub remnants occur with epiphytes (*Asplenium australiasicum*), glossy acronychia (*Acronychia laevis*), and crow's ash (*Flindersia australis*). ***Significance*** The Pine River and Hays Inlet wetland is significant because of its value to wildlife, especially migratory waders, and because of the facilities provided for wildlife education and research. The Queensland Herbarium has classified the extensive tidal wetlands and low-lying freshwater wetland vegetation into 46 vegetation mosaics of tens of hectares. Twenty-three mosaics have been identified with State significance, seven mosaics have regional significance and 16 mosaics have local significance. A large area of the tidal zone, about 1,350 ha, is conserved for fish habitat, because of its value to fish and crustacean spawning and feeding. The area is critical to migratory waders. Seven areas of approximately 110 ha, as well as habitat mapped with the greater Moreton Bay area, provide essential wader roosting and feeding areas. The majority of the mapped wetland is included in the Moreton Bay Ramsar area because of its wader and fisheries significance. Significant weeds occur in the wetland, including *Cyperus papyrus*, *Eichhornia crassipes*, *Protasparagus species*, *Chloris gayana*, *Baccharis halimifolia*, and *Lantana camara*. These threats combined with pollution, littering and fire reduce the integrity and value of many habitats. ***Social and Cultural values*** The area is recognized regionally and nationally for its value to migratory waders. Thousands of visitors visit the wetland reserves (e.g. the Tinchi Tamba environmental park) to survey and observe the birds. Bird observer groups monitor the site annually and periodically to survey bird numbers. Bird hides and educational materials are provided in the Tinchi Tamba reserve. The area is recognized as a significant fishery, attracting tourists, boat and fishing enthusiasts from the Brisbane

Wetland	Key Features
	area. Indigenous values include middens, scarred trees and the use of the area for a burial area. Evidence of historic corduroy tracks and soldier settlements have been identified. One of these soldier settlement blocks was one of only two given to returned indigenous WW1soldiers. The formal use of the area for recreation dates back to 1929 when a caretaker's cottage and kiosk was built. Public parks and picnic areas are regularly used. Swimming, photography and nature appreciation are activities encouraged within the reserves and conservation areas. The Tinchi Tamba reserve is used by local school and TAFE colleges for educational purposes. Reference *Department of the Environment and Energy. 2017. Pine River and Hays Inlet - QLD190, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD190. Accessed 25 Jul 2017.*
Port Curtis	***Site description*** The site includes all tidal areas in the vicinity of Gladstone, from a line between Laird Point and Friend Point (southern end of The Narrows), to a line between Gatcombe Head and Canoe Point, including the seaward side of Facing Island and Sable Chief Rocks, and southern Curtis Island west of a line between North Point and Connor Bluff. ***Physical features*** Partially enclosed embayment and shallow estuaries, including small, continental rocky islands, intertidal flats and estuarine islands. The geology consists of two main groups - Holocene estuarine deposits (lowlands), and Wandilla and Shoalwater Formations; both Devonian (islands and coastal hills), plus relatively smaller areas of Holocene tidal delta sands and beach ridges near the mouth of the Boyne River, and Pleistocene alluvium, associated with the Boyne and Calliope rivers. ***Ecological features*** There are extensive mangrove forests and shrublands (3,300 ha), seagrass beds (2,430 ha) and saltflats (2,800 ha). Mangroves exhibit distinct banding from seaward to land - Avicennia fringe on seaward margin through a Rhizophora zone (main zone) a Ceriops zone on coastal saltflat to a Ceriops fringe (between saltflat and terrestrial vegetation). Seagrasses are generally intertidal due to the natural turbidity of the waters - most abundant species is *Zostera capricornia*, with *Halophila ovalis* and *Halodule uninervis* also common. Coastal saltflats are mostly bare claypan, with lesser areas ranging from low/dwarf open halophytic shrubland (e.g. *Sarcocornia* sp. and *Suaeda* spp.), to open and closed grasslands dominated by sand couch (*Sporobolus virginicus*). ***Significance*** (No data) ***Social and Cultural values*** Several sites of high archaeological significance occur on Facing Island, and a number of shipwrecks are also found along the coast. Gladstone Harbour is the major port of central Queensland - 20% of Queenslands and 5% of Australias export revenue is earned through this port. The area provides an important access to the Great Barrier Reef and has a developing tourism industry; the harbour facilities and other infrastructure in Gladstone continue to provide initiative for major ongoing industrial development. Reference *Department of the Environment and Energy. 2017. Port Curtis - QLD019, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD019. Accessed 25 Jul 2017.*
Pumicestone Passage	***Site description*** Several creek systems drain into Pumicestone Passage at the northern extent of Moreton Bay. The direct access of these creeks to the sea is blocked by the barrier island, Bribie Island. This gives rise to a narrow, shallow passage which has limited water exchange with the ocean. The build up of silt carried down by these creeks has formed vast tidal flats, providing feeding areas for waders. Seagrass meadows occur throughout the site. The adjacent national park on Bribie Island is fringed by mangroves backed by melaleuca swamps. ***Physical features*** General geology: the regional geology of the catchment area of Pumicestone Passage consists of a variety of volcanic and sedimentary rocks and associated unconsolidated sediments. The western boundary of the catchment is defined by the coastal ranges, consisting of sandstone, siltstone, shale, conglomerate, ironstone and coal of the Landsborough Sandstone. Along the coastal plain, the Landsborough Sandstone is the main sedimentary formation while Quaternary

Wetland	Key Features
	alluvium and coastal deposits are associated with streams issuing into Pumicestone Passage and along the western shores of that feature. Acid volcanic plugs, forming the Glasshouse Mountains, intrude into the sandstone unit. Bribie Island, which forms the eastern side of Pumicestone Passage, is built of Holocene dunes, tidal deltas, flats overlying Pleistocene sand ridges and estuarine deposits. It has no comparable major aeolian landforms such as those exhibited by the other barrier islands (Moreton, North Stradbroke and South Stradbroke) which form the eastern edge of Moreton Bay. ***Ecological features*** Four wetland habitats occur within the site, or adjacent to it: (i) shallow estuarine water systems including seagrass beds; (ii) lower intertidal mudflats; (iii) mangrove communities; and (iv) supratidal flats. ***Significance*** (No data): ***Social and Cultural values*** The site is important as a recreational area (e.g. swimming, fishing). <u>Reference</u> *Department of the Environment and Energy. 2017. Pumicestone Passage - QLD136, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD136. Accessed 25 Jul 2017.*
The Narrows	***Site description*** The site is the passage between Curtis Island and the mainland, including the tidal wetlands on northwestern Curtis Island, and Graham Creek east of Deception Creek. ***Physical features*** Passage landform between mainland and continental island; supra and intertidal flats and estuary landforms; predominantly recent and Quaternary alluvial and marine deposits of silt, clay and sand. Significant oil shale deposits are found below the more recent sediments. ***Ecological features*** Habitat types include: (i) saline coastal flats; (ii) mangrove forests; (iii) intertidal sand and mud flats; (iv) seagrass beds and (v) open marine and estuarine waters. ***Significance*** The Narrows is a unusual landform feature, being one of only four tidal passages in Australia. ***Social and Cultural values*** Several registered sites of Aboriginal significance occur along The Narrows; a major commercial and recreational fishing and crabbing area; important waterway (at high tide) for boats moving up and down the coast. <u>Reference</u> *Department of the Environment and Energy. 2017. The Narrows - QLD021, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD021. Accessed 25 Jul 2017.*
Upper Pumicestone Coastal Plain	***Site description*** The upper Pumicestone coastal and subcoastal plain includes the subcatchments of Bells, Lamerough, Halls, Bluegum, Mellum, Coochin, Coonorwin and Hussey creeks. ***Physical features*** The creeks are interrupted by depressions and swamps with hummock microrelief. Most water is shed from very low ridges of sandstone and lateritic residue. The creeks drain through tidal deltas to Pumicestone Passage. The creeks have low flow capacities and floodplain development is minimal. The geology is dominated by shale and sandstone from the Triassic-Jurassic period. The lowest plains are derived from tidal sands and muds. Soils include lateritic podzols, gleyed podzolics, humic gleys and groundwater podzols. The groundwater podzols are humus rich and have an organic pan. The podzolic gleyed soils are silt and clay rich, and are found in depressions subject to frequent inundation and anoxia. The humic gleys also occur in frequently inundated areas but are sandier and include perched water tables. Large areas with peat and peaty sands occur. The wetlands include hundreds of hectares of acid sulfate deposits. ***Ecological features*** Feature wetland communities include Melaleuca forested wetlands with swamp water fern (*Blechnum indicum*) and broad-leaved banksia (*Banksia robur*), fringing riparian swamp paperbark (*M. quinquenervia*) and black sheoak (*Allocasuarina littoralis*) with *Hypolepis, Lepironia, Lygodium, Rhynchospora* and *Cyperus* species, *M. quinquenervia* wet heaths with *Banksia, Leptospermum, Callistemon* and *Ghani*a species, sedgelands with *Lepironia articulata, Cyperus, Ghania, Baumea, Schoenus, Leersia* and *Philydrum* species, gallery myrtaceous forests in the supratidal zone (scribbly gum (*Eucalyptus racemosa*) and *M. quinquenervia*), notophyll vine forest, open

Wetland	Key Features
	and closed proteaceous wet heath with swamp stringybark (*E. conglomerata*), Bancroft's red gum (*Eucalyptus bancroftii*), swamp box (*Lophostemon suaveolens*), Syncarpia glomulifera, tinywattle (*Acacia attenuata*), broad-leaved tea-tree (*M. leucadendra*), *Epacris, Lomandra, Baeckia* and *Banksi*a species, scribbly gum (*E. racemosa*) and blackbutt (*E. pilularis*) forest, intertidal meadows and pans with sand couch (*Sporobolus virginicus*) and swamp she-oak (*Casuarina glauca*), and mangrove shrublands and forests with *Avicennia, Aegiceris, Ceriops, Rhizophora*, and *Bruguiera* species. ***Significance*** The Upper Pumicestone Coastal Plain wetlands are significant because they contain some of the last remnants of wallum and intertidal wetland from the once extensive wetlands of the northern Caboolture plain. These remnants are good representatives because they have been conserved from development and for research. The area hosts a very large number of wildlife species, including migratory species, and provides refuge habitat for wildlife. The area has high cultural significance to Indigenous peoples and for research and education purposes. ***Social and Cultural values*** Several features in the area are listed in the Register of the National Estate. These include Pumicestone Passage and places of Indigenous value (e.g. bora and kippa rings, and fish traps occur in the area). The Pumicestone plain contains numerous sites of artefact scatters, scarred trees, middens and camps. The wetlands in this area provided an abundance of food (e.g. fish, crayfish, shellfish and vegetable matter) for Indigenous peoples. The area has an historic timber harvesting record, and a collection of Jinker logs and stumps cut using springboards are located in the area. The mapped area includes four scientific areas with a combined area of 800 ha. These areas were conserved from logging and wildfires to provide ecological reference sites to illustrate coastal wallum conditions prior to logging, and to enable the evaluation of soil types and the evolution of habitats. Habitat evolution research included analysis of fire frequency effects on wallum community diversity and viability. Local conservation and naturalist groups and QPWS survey these areas periodically and encourage community involvement. Universities also contribute to research. These areas are managed with risk management plans. The scientific areas have been established for 26 to 75 years, and their biological and ecological characteristics and dynamics have been extensively researched during that period of time. Large numbers of naturalists visit Pumicestone Passage for bird surveys because the area hosts large numbers of migratory waders. The passage is popular for boating activities, particularly recreational fishermen, and attracts tourists from across the region for this purpose. <u>Reference</u> *Department of the Environment and Energy. 2017. Upper Pumicestone Coastal Plain - QLD188, in Australian Wetlands Database. Department of the Environment and Energy, Canberra. Available from: http://www.environment.gov.au/cgi-bin/wetlands/report.pl?smode=DOIW;doiw_refcodelist=QLD188. Accessed 25 Jul 2017.*

Appendix 3 - EPBC Protected Matters Search Reports

Environment Sectors:

- Otway
- Bass Strait
- Gippsland
- Sorell
- SE Tasmania
- Central NSW
- SE Queensland
- Lord Howe
- Norfolk Island

Report

RPS

Appendix 5: Oil Spill Trajectory Modelling

21 MAY 2019

Annie-1

Oil Spill Modelling

Document status

Version	Purpose of document	Authored by	Reviewed by	Review date
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Approval for issue

Name	Signature	Date
Nathan Benfer	Natt Z	21/05/2019

Prepared by: **RPS AUSTRALIA WEST PTY LTD**
Suite E1, Level 4
140 Bundall Road
Bundall, QLD, 4217
Australia

T: +61 7 5574 1112+61 7 5574 1112
E: Nathan.Benfer@rpsgroup.com.au

Prepared for: **COOPER ENERGY**
Level 8, 70 Franklin Street
Adelaide SA 5000 Australia

T: 0487 888 091 +61 (0)8 8100 4900
E: ollieg@cooperenergy.com.au
W: www.cooperenergy.com.au

Author: Fernando Alvarez
Reviewed: Ryan Dunn
Approved: Nathan Benfer
No.: MAQ0748J
Version: 5
Date: 21 May 2019

RPS

Contents

Tables

RPS

Figures

RPS

RPS

Executive Summary

Background

Cooper Energy commissioned RPS to conduct quantitative oil spill trajectory modelling (OSTM) for the Otway Basin Exploration Drilling Program to estimate the potential exposure to surrounding waters and shorelines. This OSTM study considered two possible, yet hypothetical, scenarios:

- a 151,671 bbl (variable release rate from 2,375 bbl/day to 1,419 bbl/day) subsea release of condensate over 84 days in the event of a loss of well control scenario from the Annie-1 well location.
- a 250 m^3 surface release of diesel over 6 hours in the event of containment loss from a vessel.

Each scenario was independently assessed for two independent seasons; summer (October to March) and winter (April to September). This allows for appropriately assessing potential impacts to migratory species in the region.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model, SIMAP (Spill Impact Mapping Analysis Program). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 “Standard Practice for Development and Use of Oil Spill Models”.

Note that the modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.

Methodology

The modelling study was carried out in several stages. Firstly, a five-year current dataset (2008–2012) that includes the combined influence of ocean currents from the HYCOM model and tidal currents from the HYDROMAP model was developed. Secondly, high-resolution local winds from the CFSR model and detailed hydrocarbon characteristics were used as inputs in the three-dimensional oil spill model (SIMAP) to simulate the drift, spread, weathering and fate of the spilled oils.

As spills can occur during any set of wind and current conditions, modelling was conducted using a stochastic (random or non-deterministic) approach, which involved running 100 spill simulations per season for each scenario initiated at random start times, using the same release information (spill volume, duration and composition of the oil). This ensured that each simulation was subject to different wind and current conditions and, in turn, movement and weathering of the oil.

Oil properties

A proxy condensate provided by Cooper Energy was used for the loss of well control scenario from the Annie-1 well. The condensate has an API of 48.23, density of 728.6 kg/m^3 at 15ºC) with low viscosity (1.063 cP), classifying it as a Group I oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%). This means that the condensate will evaporate readily when on the water surface, with limited persistent components to remain on the water surface over time.

Marine Diesel Oil (MDO) was used for the event of containment loss from a vessel. The MDO is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6) and a low pour point (-14 ºC). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. Approximately, 5% (by mass) of the oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Key findings

Scenario: Loss of well control

- The predicted maximum distance of surface exposure from the well location at the low threshold (0.1 g/m^2) was 174 km and 275 km for the summer and winter seasons respectively. For the moderate threshold (10 g/m^2) the exposure was limited to the vicinity of the release location (<1 km) for both seasons. No exposure at the high threshold (25 g/m^2) were predicted.
- The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 100% for both seasons.
- The predicted maximum volume of hydrocarbons ashore was 151 m^3 and 199 m^3 for the summer and winter seasons respectively.
- The predicted minimum time before contact to any shoreline at, or above, the minimum shoreline contact threshold (1g/m^2) was 21 h and 17 h, for the summer and winter seasons respectively.

Scenario: Containment loss from a vessel

- For the summer conditions, the predicted maximum distances of surface exposure from the well location at the low (0.1 g/m^2), moderate (10 g/m^2) and high (25 g/m^2) thresholds were 145 km, 10 km and 7 km respectively.
- For the winter conditions, the predicted maximum distances of surface exposure from the well location at the low (0.1 g/m^2), moderate (10 g/m^2) and high (25 g/m^2) thresholds were 193 km, 16 km and 6 km respectively.
- The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 58% and 54% for the summer and winter seasons respectively.
- The predicted maximum volume of hydrocarbons ashore was 35 m^3 and 42 m^3 for the summer and winter seasons respectively.
- The predicted minimum time before contact to any shoreline at, or above, the minimum shoreline contact threshold was 19 h and 16 h, for the summer and winter seasons respectively.

1 INTRODUCTION

Cooper Energy has commissioned RPS to conduct quantitative oil spill trajectory modelling (OSTM) for their Otway Basin Exploration drilling program to estimate the potential exposure to surrounding waters and shorelines. The Otway Basin operations are situated approximately 15 km southwest of Port Campbell. The water depth surrounding the well is 70 m (see Table 1 and Figure 1).

This OSTM study considered two possible, yet hypothetical, scenarios:

- a 151,671 bbl (variable release rate from 2,375 bbl/day to 1,419 bbl/day) subsea release of condensate over 84 days in the event of a loss of well control scenario from the Annie-1 location.
- a 250 m^3 surface release of diesel over 6 hours in the event of containment loss from a vessel.

Each scenario was independently assessed for two independent seasons; summer (October to March) and winter (April to September). This allows for appropriately assessing potential impacts to migratory species in the region.

The spill modelling was performed using an advanced three-dimensional trajectory and fates model, SIMAP (Spill Impact Mapping Analysis Program). The SIMAP model calculates the transport, spreading, entrainment and evaporation of spilled hydrocarbons over time, based on the prevailing wind and current conditions and the physical and chemical properties.

The SIMAP system, the methods and analysis presented herein, use modelling algorithms which have been anonymously peer reviewed and published in international journals. Further, RPS warrants that this work meets and exceeds the ASTM Standard F2067-13 “Standard Practice for Development and Use of Oil Spill Models”.

Note that the modelling makes no allowance for intervention following a spill to reduce volumes and/or prevent hydrocarbons from reaching sensitive areas.

Table 1 Location of the release site.

Release site	Latitude	Longitude	Water Depth (m)
Annie-1	-38.681236	142.8259598	70

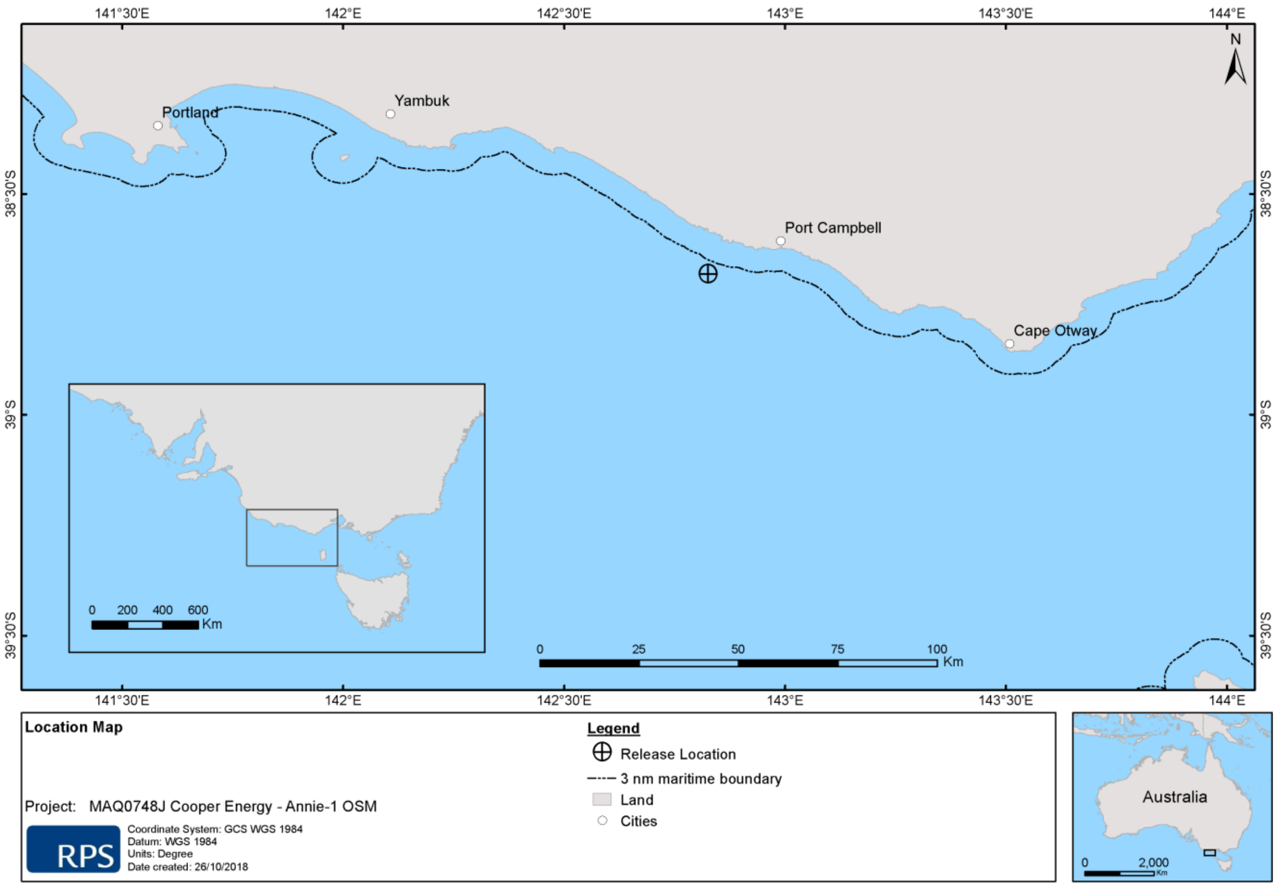

Figure 1 Location of the Annie-1 well as used in the oil spill modelling.

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2 SCOPE OF WORK

The scope of work will include the following components:

- Generate tidal current patterns of the region using a validated ocean/coastal model, HYDROMAP;
- Use existing 2008 to 2012 (inclusive) dataset that describes the large-scale flow of ocean waters in the region (as predicted by the US Navy ocean model, HYCOM (Hybrid Coordinate Ocean Model) and combine with tidal currents;
- Use 5 years of high-resolution wind data, current data and hydrocarbon characteristics as input into the 3-dimensional oil spill model, SIMAP to model the movement, spreading, entrainment, weathering and potential shoreline contact by the hydrocarbon over time.
- Use SIMAP's stochastic model (also known as a probability model) to calculate exposure to surround waters and shorelines. This involved running 100 randomly selected single trajectory simulations for each season, with each simulation having the same spill information (spill volume, duration and composition of hydrocarbons) but varying start times. This approach ensures that each spill trajectory is subjected to unique wind and current conditions.
- Review the results and carry out detailed assessment on the individual spill trajectories that resulted in the worst-case scenario based on a combination of greatest volume of oil ashore and longest length of shoreline contacted at, or above, the shoreline actionable threshold (>100 g/m^2).

3 REGIONAL CURRENTS

Bass Strait is a body of water separating Tasmania from the southern Australian mainland, specifically the state of Victoria. The strait is a relatively shallow area of the continental shelf, connecting the southeast Indian Ocean with the Tasman Sea. Currents within the strait are primarily driven by tides, winds, incident continental shelf waves and density driven flows; high winds and strong tidal currents are frequent within the area (Jones, 1980).

The Otway Basin is part of the western field of the Bass Strait and lies along a north-west to south-east axis. It is approximately 500 km long and extends from Cape Jaffa in South Australia to north-west Tasmania and forms part of the Australian Southern Rift System.

The varied geography and bathymetry of the region, in addition to the forcing of the south-eastern Indian Ocean and local meteorology lead to complex shelf and slope circulation patterns (Middleton & Bye, 2007). Figure 2 displays seasonal current trends within the Bass Strait. During winter there is a strong eastward water flow due to the strengthening of the South Australian Current (fed by the Leeuwin Current in the Northwest Shelf), which bifurcates with one extension moving though the Bass Strait, and another forming the Zeehan Current off western Tasmania (Sandery & Kampf 2007). During summer, water flow reverses off Tasmania, King Island and the Otway Basin travelling eastward, as the coastal current develops due to south-easterly winds. To accurately describe the variability in currents between the inshore and offshore region, a hybrid regional dataset was developed by combining deep ocean predictions obtained from HYCOM (Hybrid Coordinate Ocean Model) with surface tidal currents developed by RPS. The following sections provide a summary of the hybrid regional data set.

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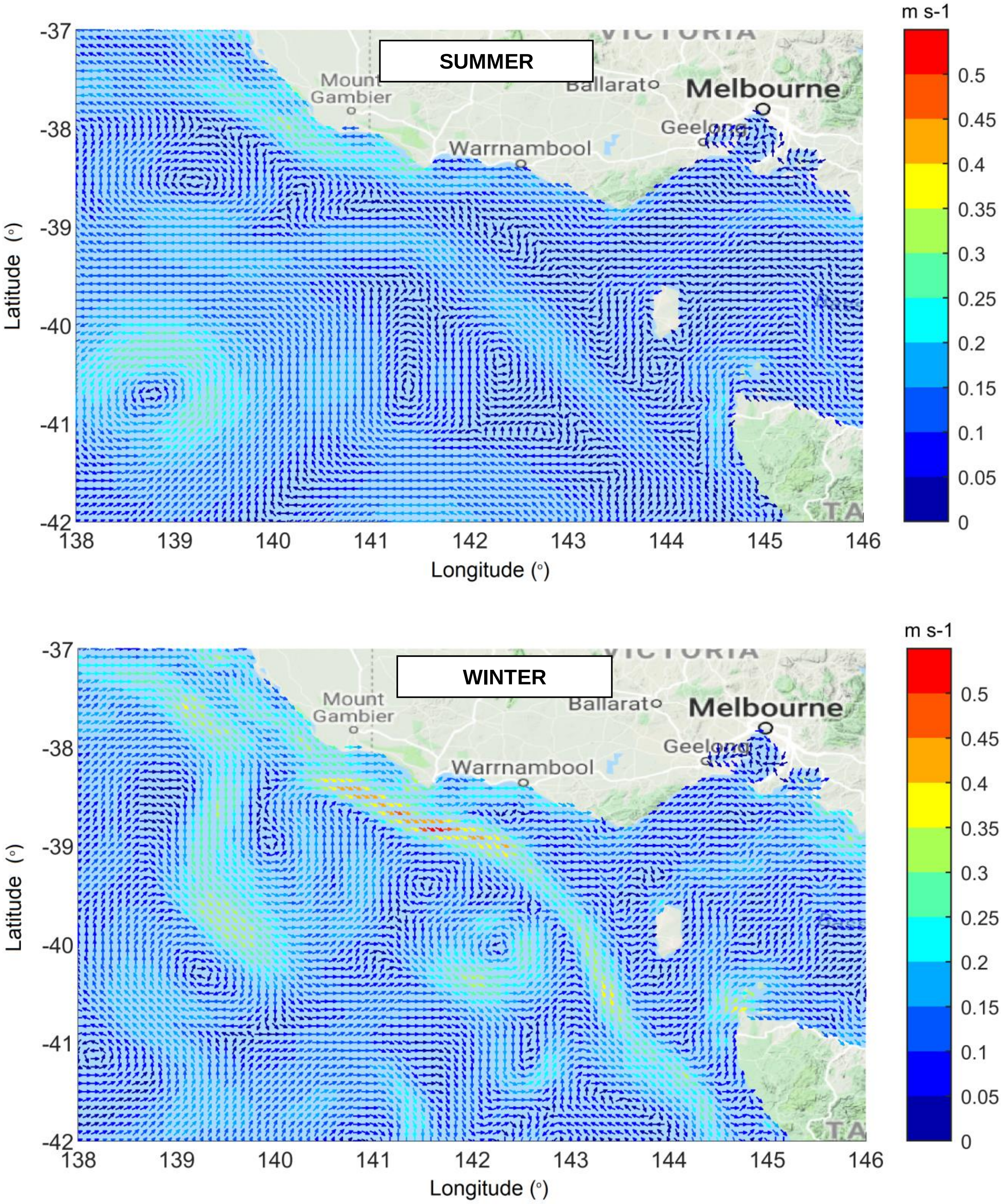

Figure 2 HYCOM averaged seasonal surface drift currents during summer (top) and winter (bottom).

3.1 Tidal Currents

Tidal current data was generated using RPS's advanced ocean/coastal model, HYDROMAP. The HYDROMAP model has been thoroughly tested and verified through field measurements throughout the world over the past 32 years (Isaji & Spaulding, 1984; Isaji, et al., 2001; Zigic, et al., 2003). HYDROMAP tidal current data has been used as input to forecast (in the future) and hindcast (in the past) pollutant spills in Australian waters and forms part of the Australian National Oil Spill Emergency Response System operated by AMSA (Australian Maritime Safety Authority).

HYDROMAP employs a sophisticated sub-gridding strategy, which supports up to six levels of spatial resolution, halving the grid cell size as each level of resolution is employed. The sub-gridding allows for higher resolution of currents within areas of greater bathymetric and coastline complexity, and/or of particular interest to a study.

The numerical solution methodology follows that of Davies (1977a and 1977b) with further developments for model efficiency by Owen (1980) and Gordon (1982). A more detailed presentation of the model can be found in Isaji and Spaulding (1984) and Isaji et al. (2001).

3.1.1 Grid Setup

RPS has a seamless and validated global tidal model. The tidal domains are sub-gridded to a resolution of 500 m for shallow and coastal regions, starting from an offshore (or deep water) resolution of 8 km. The finer grids were allocated in a step-wise fashion to more accurately resolve flows along the coastline, around islands and over regions with more complex bathymetry. Figure 3 shows the tidal model grid covering the study domain.

A combination of datasets was used and merged to describe the shape of the seabed within the grid domain (Figure 4). These included spot depths and contours which were digitised from nautical charts released by the hydrographic offices as well as Geoscience Australia database and depths extracted from the Shuttle Radar Topography Mission (SRTM30_PLUS) Plus dataset (see Becker et al., 2009).

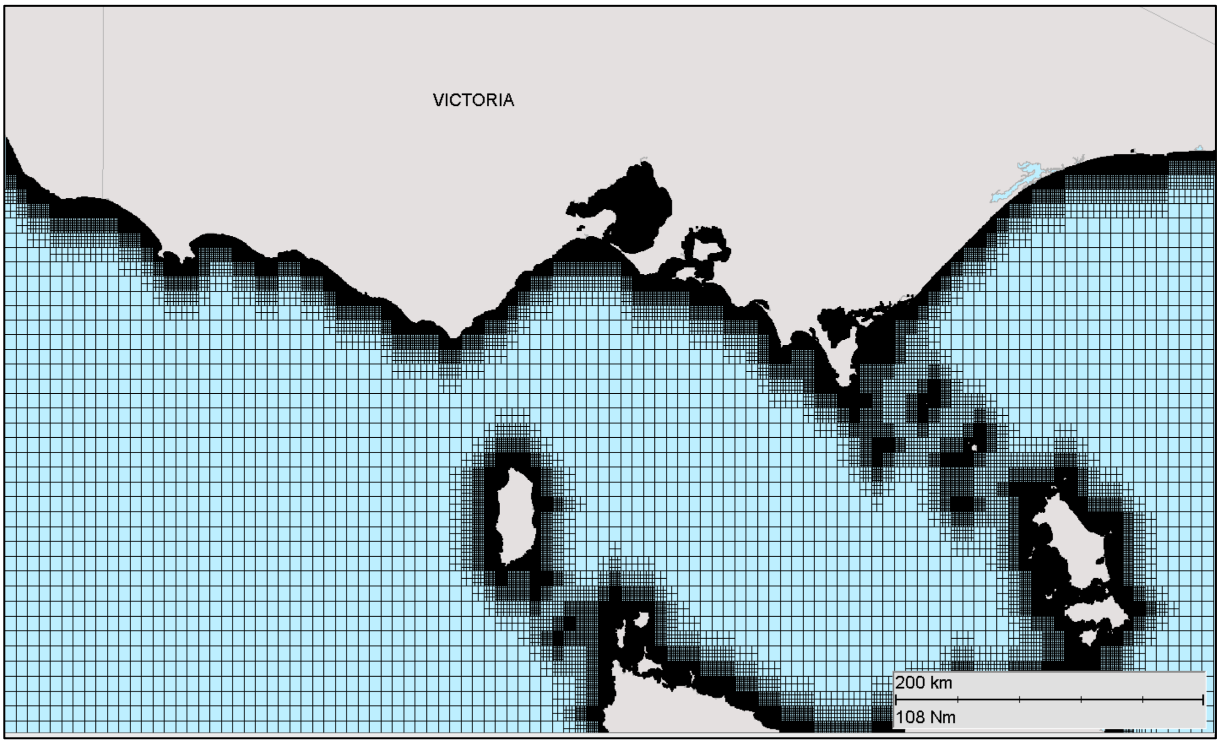

Figure 3 Sample of the model grid used to generate the tidal currents for the study region. Higher resolution areas are shown by the denser mesh.

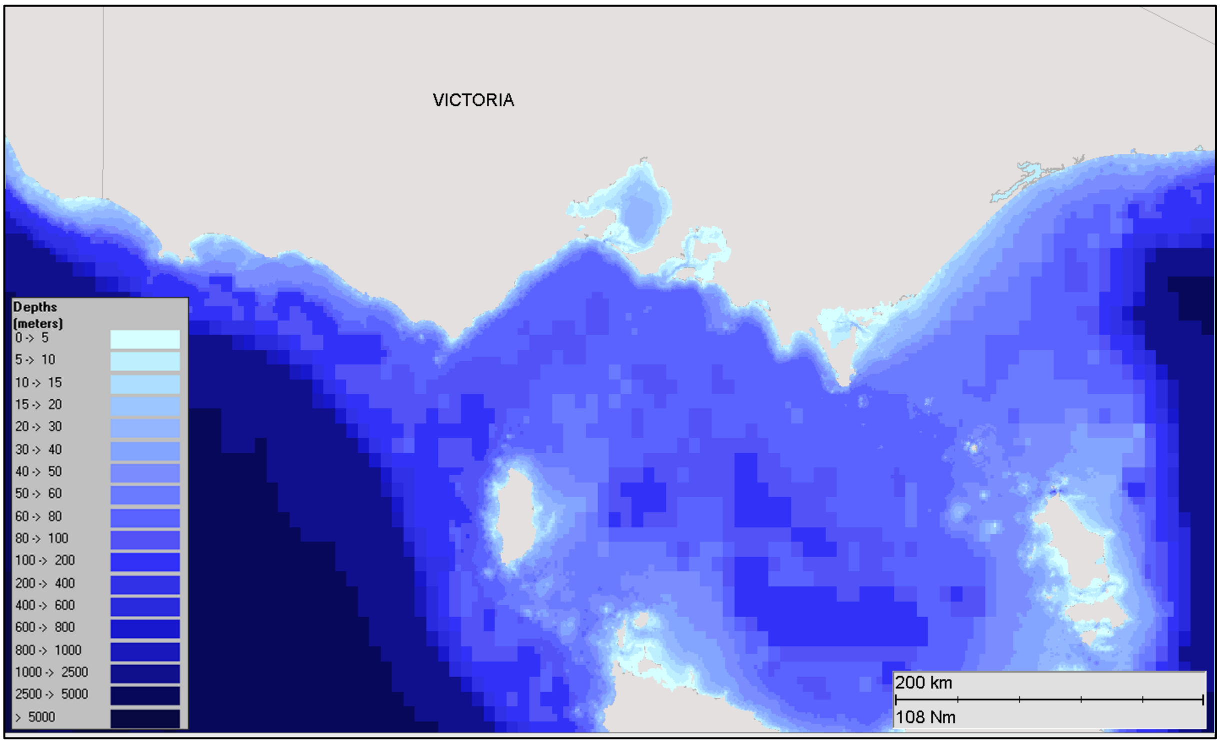

Figure 4 Bathymetry defined throughout the tidal model domain.

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3.1.2 Tidal Conditions

The tidal harmonic data to force the tidal model was obtained from satellite measured altimetry data (TOPEX/Poseidon 7.2) which provided estimates of the eight dominant tidal constituents at a horizontal scale of approximately 0.25 degrees. The eight major tidal constituents used were K_2, S_2, M_2, N_2, K_1, P_1, O_1 and Q_1.

The Topex-Poseidon satellite data has a resolution of 0.25 degrees globally and is produced and quality controlled by NASA (National Aeronautics and Space Administration). The data capturing satellites, equipped with two altimeters capable of taking sea level measurements accurate to less than ± 5 cm, measured oceanic surface elevations (and the resultant tides) for the period 1992–2005. In total these satellites carried out 62,000 orbits of the planet. The Topex-Poseidon tidal data has been widely used amongst the oceanographic community, being included in more than 2,100 research publications (e.g. Andersen, 1995; Ludicone et al., 1998; Matsumoto et al., 2000; Kostianoy et al., 2003; Yaremchuk & Tangdong, 2004; Qiu & Chen 2010). The Topex/Poseidon tidal data is considered suitably accurate for this study.

3.1.3 Surface Elevation Validation

To ensure that tidal predictions were accurate, predicted surface elevations were compared to data observed at five locations (see Figure 5).

To provide a statistical measure of the model performance, the Index of Agreement (IOA - Willmott (1981)) and the Mean Absolute Error (MAE - Willmott (1982) and Willmott & Matsuura (2005)) were used.

The MAE (Eq.1) is simply the average of the absolute values of the difference between the model-predicted (P) and observed (O) variables. It is a more natural measure of the average error (Willmott & Matsuura, 2005) and more readily understood. The MAE is determined by:

$$MAE = N^{-1} \sum_{i=1}^{N} |P_i - O_i| \qquad \text{Eq.1}$$

Where: N = Number of observations

P_i = Model predicted surface elevation

O_i = Observed surface elevation

The Index of Agreement (IOA; Eq. 2) in contrast, gives a non-dimensional measure of model accuracy or performance. A perfect agreement between the model predicted and observed surface elevations exists if the index gives an agreement value of 1, and complete disagreement between model and observed surface elevations will produce an index measure of 0 (Wilmott, 1981). Willmott et al (1985) also suggests that values larger than 0.5 may represent good model performance. The IOA is determined by:

$$IOA = 1 - \frac{\sum |X_{model} - X_{obs}|^2}{\sum (|X_{model} - \overline{X_{obs}}| + |X_{obs} - \overline{X_{obs}}|)^2} \qquad \text{Eq.2}$$

Where: X_{model} = Model predicted surface elevation

X_{obs} = Observed surface elevation

Clearly, a greater IOA and lower MAE represent a better model performance.

Figure 6 and Figure 7 illustrate a comparison of the predicted and observed surface elevations for each location for January 2014. As shown on the graph, the model accurately reproduced the phase and amplitudes throughout the spring and neap tidal cycles.

Figure 8 presents an example snapshot of the tidal current speeds within the project region.

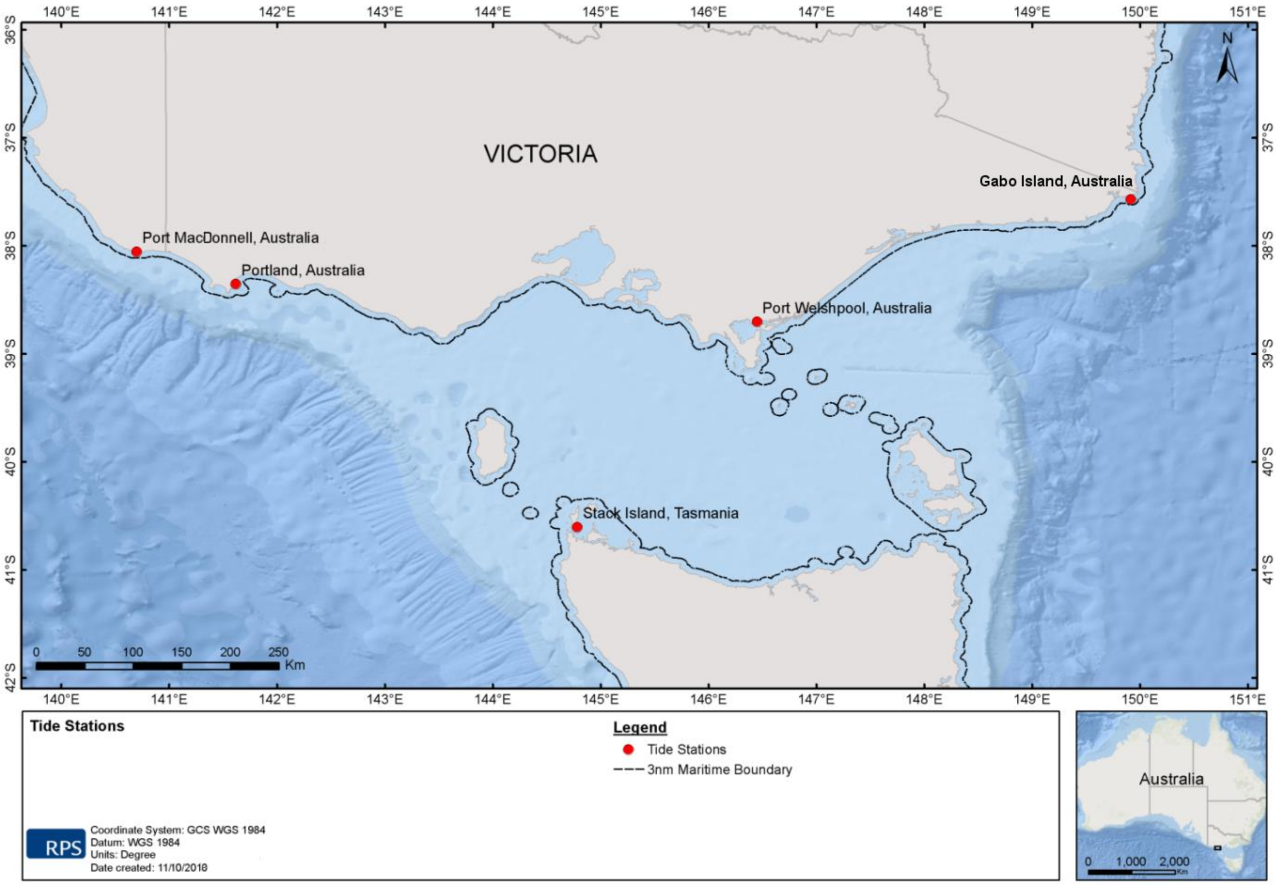

Figure 5 Tide stations used to validate surface elevation within the model.

Table 2 Statistical comparison between the observed and predicted surface elevations.

Tide Station	IOA	MAE (m)
Gabo Island	0.98	0.08
Port MacDonnell	0.98	0.05
Port Welshpool	0.92	0.30
Portland	0.97	0.07
Stack Island	0.96	0.22

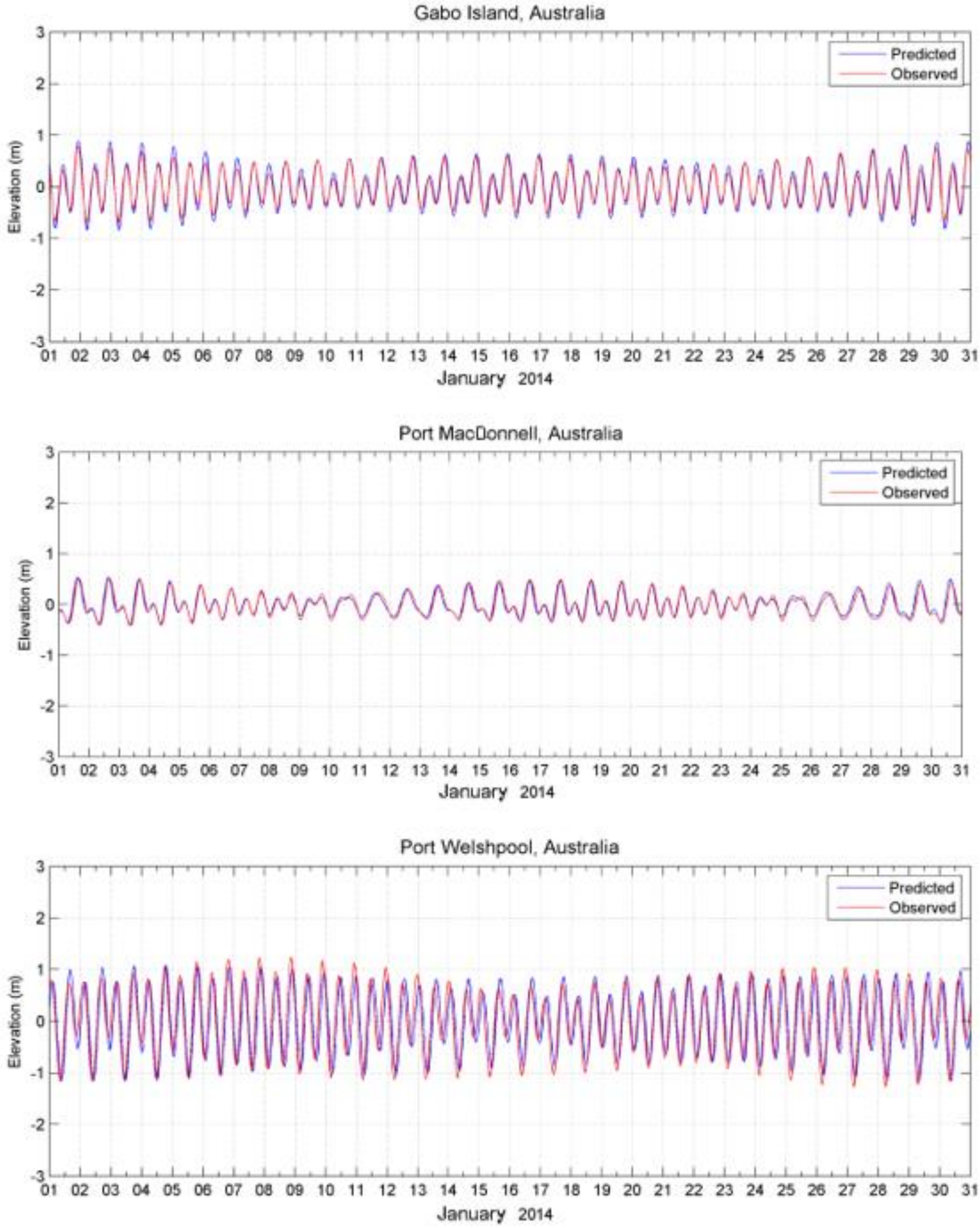

Figure 6 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

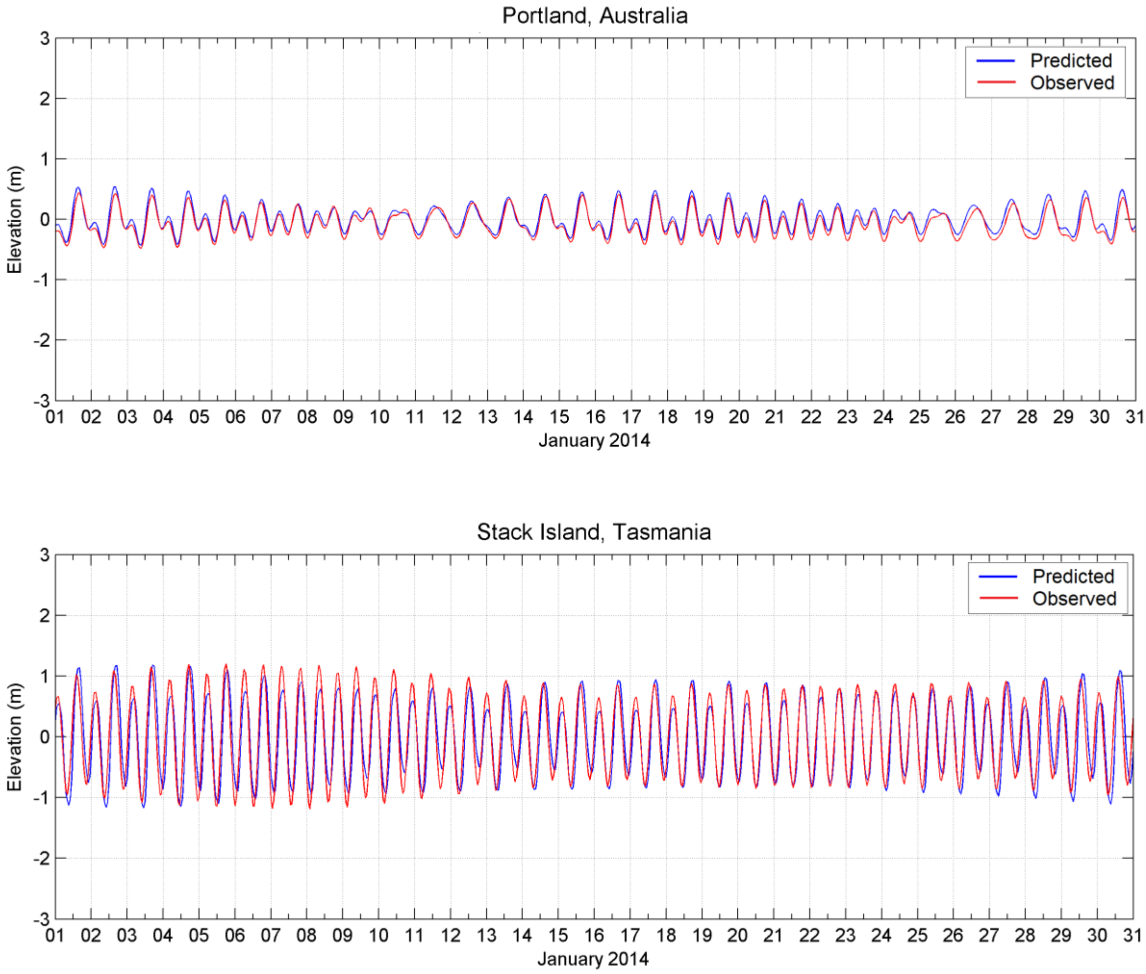

Figure 7 Comparison between HYDROMAP predicted (blue line) and observed (red line) surface elevation.

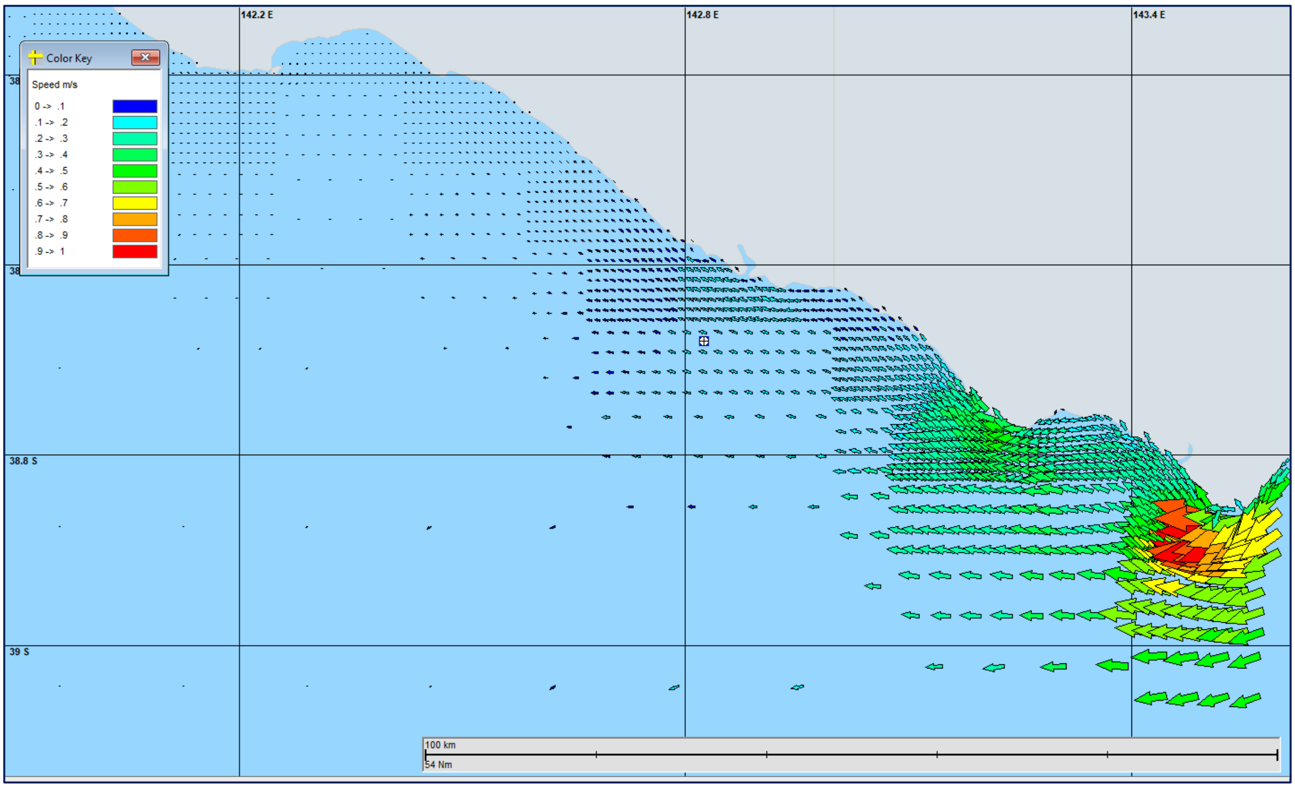

Figure 8 **Snapshot of the predicted tidal current vectors. Note the density of the tidal vectors vary with the grid resolution, particularly along the coastline and around the islands and sholas. Colourations of individual vectors indicate current speed. Only vectors every 2 grid cells are shown for simplicity.**

3.2 Ocean Currents

Data describing the flow of ocean currents was obtained from HYCOM (Hybrid Coordinate Ocean Model, (Chassignet et al., 2007), which is operated by the HYCOM Consortium, sponsored by the Global Ocean Data Assimilation Experiment (GODAE). HYCOM is a data-assimilative, three-dimensional ocean model that is run as a hindcast (for a past period), assimilating time-varying observations of sea surface height, sea surface temperature and in-situ temperature and salinity measurements (Chassignet et al., 2009). The HYCOM predictions for drift currents are produced at a horizontal spatial resolution of approximately 8.25 km (1/12th of a degree) over the region, at a frequency of once per day. HYCOM uses isopycnal layers in the open, stratified ocean, but uses the layered continuity equation to make a dynamically smooth transition to a terrain following coordinate in shallow coastal regions, and to z-level coordinates in the mixed layer and/or unstratified seas.

For this study, the HYCOM hindcast currents were obtained for the years 2008 to 2012 (inclusive). This dataset is the most recent dataset available including data assimilation (i.e. using newly available measured data to calibrate the model) and therefore providing higher precision on the currents description. Figure 9 shows example modelled surface ocean currents (HYCOM) during the model period.

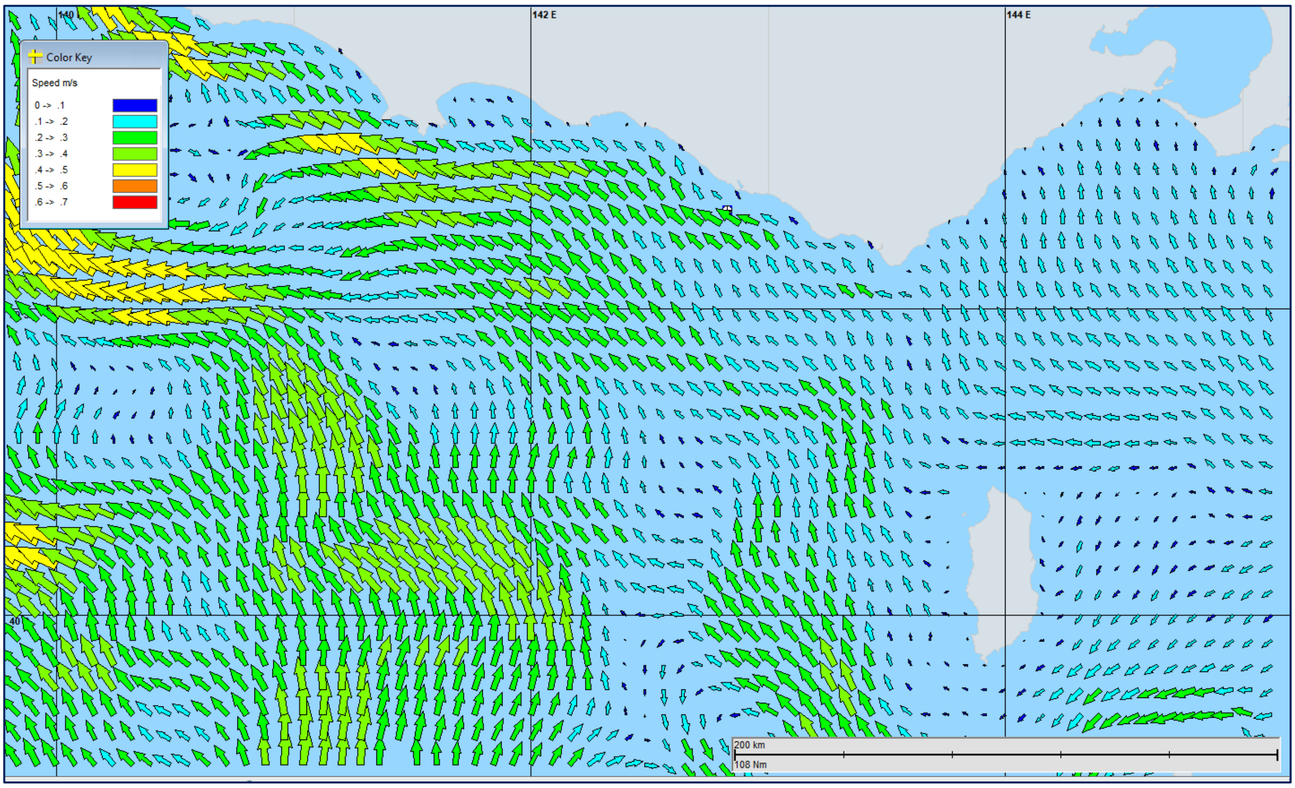

Figure 9 Modelled surface ocean currents on 4th February 2008. Derived from the HYCOM ocean hindcast model. The colours of the vectors indicate current speed in m/s.

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3.3 Surface Currents at the release site

Table 3 displays the predicted average and maximum surface current adjacent to the release site. Figure 10 to Figure 12 show the monthly, annual and seasonal current rose distributions (2008-2012 inclusive) derived from HYCOM ocean current data and HYDROMAP tidal data adjacent to the release site, respectively.

Note the convention for defining current direction is the direction the current flows towards, which is used to reference current direction throughout this report. Each branch of the rose represents the currents flowing to that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent the current speed ranges for each direction. Speed intervals of 0.2 m/s are predominantly used in these current roses. The length of each coloured segment is relative to the proportion of currents flowing within the corresponding speed and direction.

The combined current data (ocean plus tides) showed that waters at the release site flowed along a predominant northwest to southeast axis, running parallel to the coastline. Monthly average surface current speed ranged between 0.15 m/s (May) and 0.25 m/s (August). In addition, the monthly maximum surface current speeds ranged between 0.61 m/s (January) and 1.22 m/s (April).

Table 3 Predicted monthly average and maximum surface current speeds adjacent to the release location. Data derived by combining the HYCOM ocean data and HYDROMAP high resolution tidal data from 2008-2012 (inclusive).

Month	Average current speed (m/s)	Maximum current speed (m/s)	General Direction
January	0.16	0.61	East-West
February	0.20	0.71	West
March	0.16	0.93	East-West
April	0.16	1.22	East-South-East
May	0.15	0.76	East-South-East
June	0.20	0.98	East-South-East
July	0.20	1.13	East-South-East
August	0.25	0.98	East-South-East
September	0.22	0.94	East-South-East
October	0.17	0.63	East-South-East
November	0.17	0.69	East
December	0.18	0.67	East
Minimum	**0.15**	**0.61**	
Maximum	**0.25**	**1.22**	

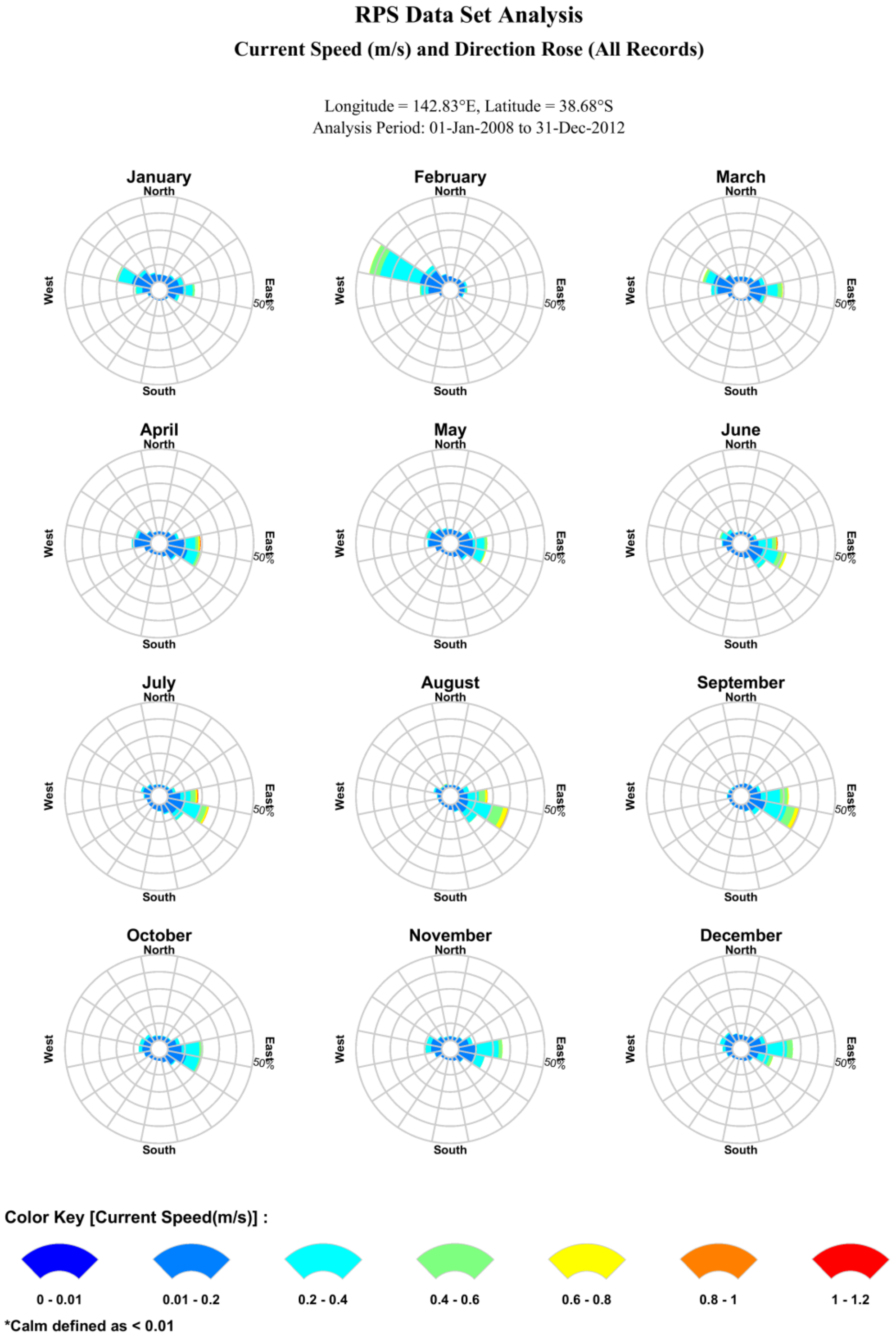

Figure 10 Monthly surface current rose plots adjacent to the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

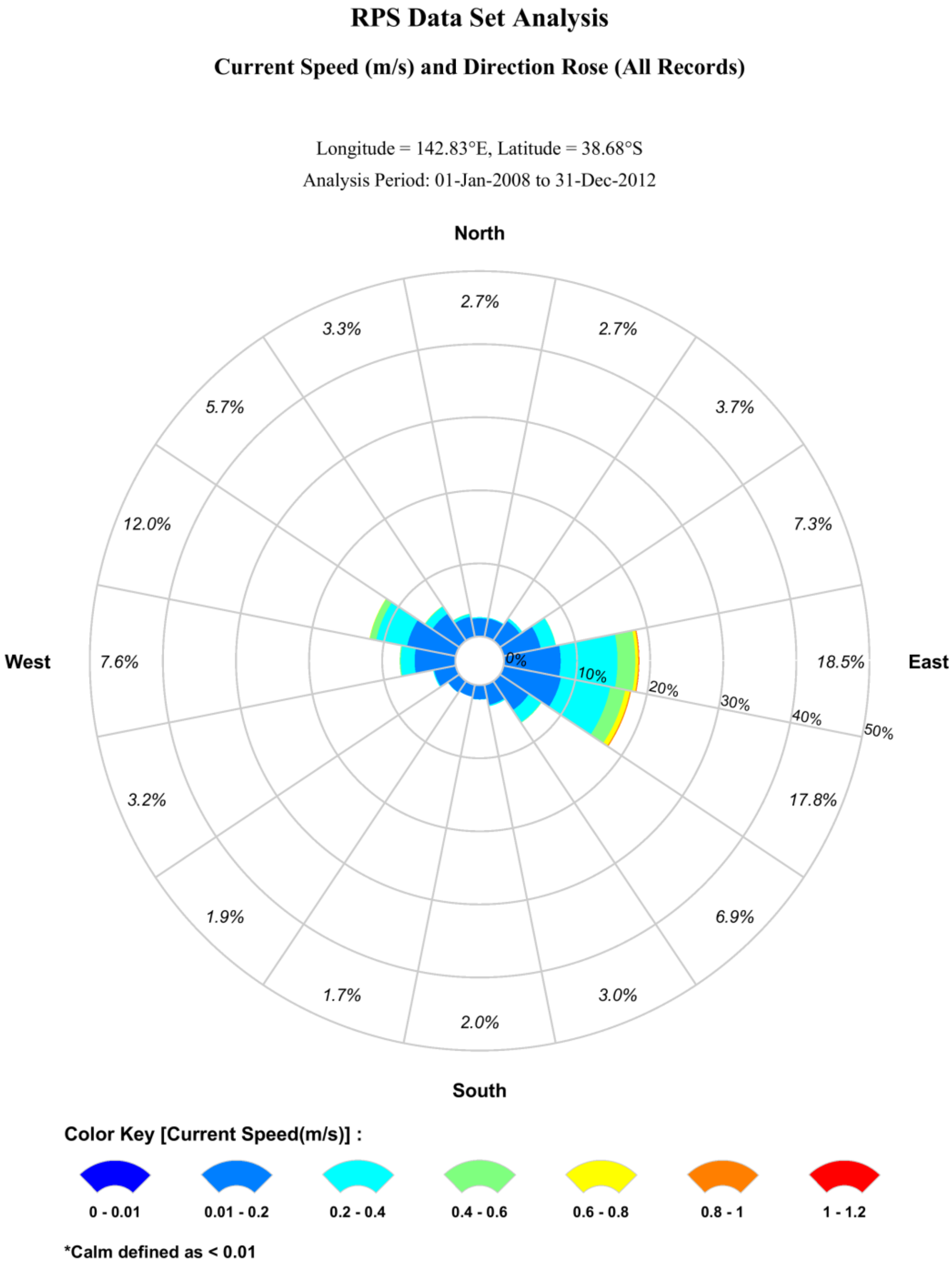

Figure 11 **Annual combined current rose plot adjacent to the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.**

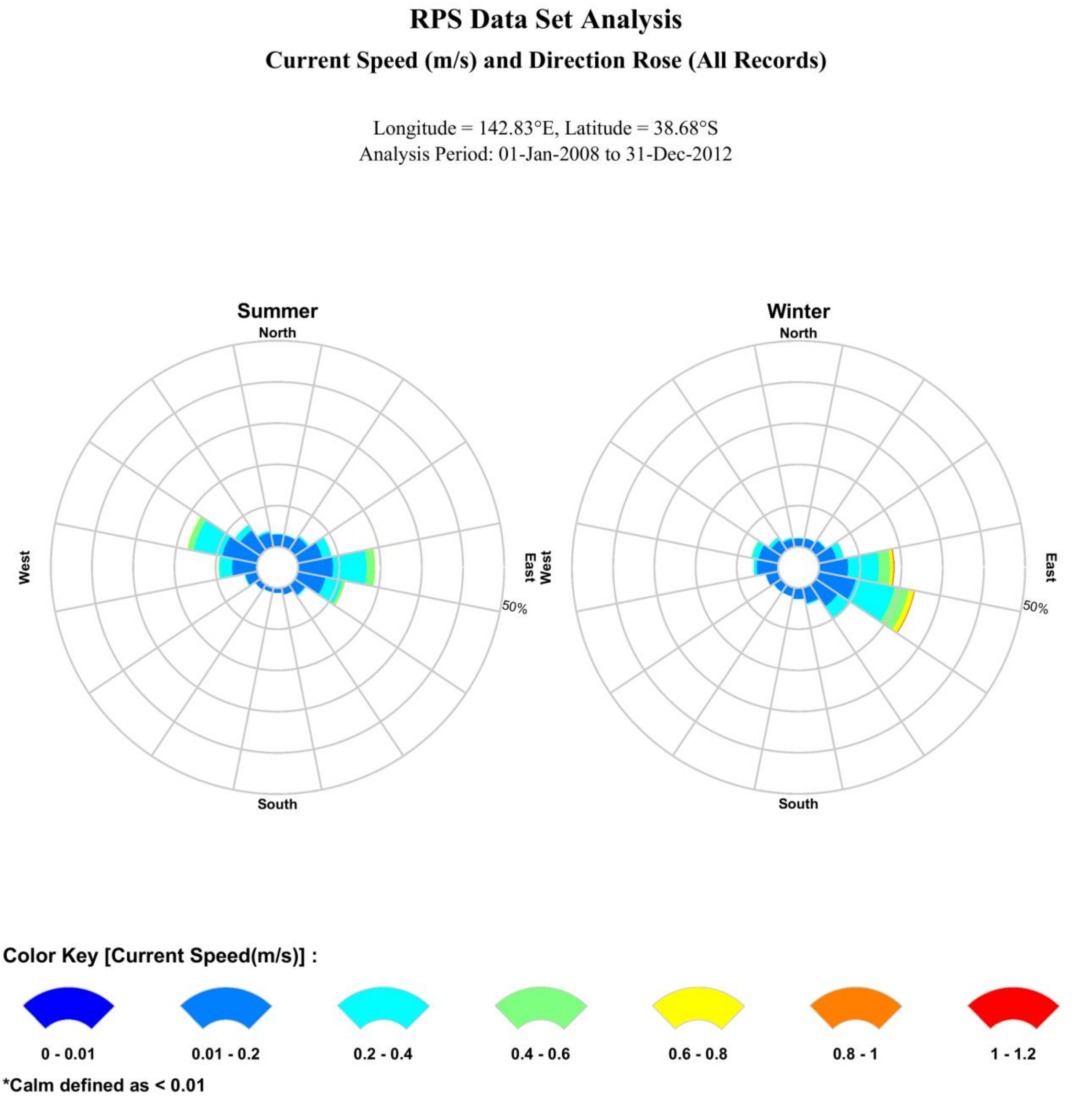

Figure 12 **Seasonal combined current rose plot adjacent to the release location (derived by combining the HYDROMAP tidal currents and HYCOM ocean currents for 2008 – 2012 inclusive). The colour key shows the current magnitude (m/s), the compass direction provides the current direction flowing TOWARDS and the length of the wedge gives the percentage of the record for a particular speed and direction combination.**

4 WIND DATA

High resolution wind data from 2008 to 2012 (inclusive) was sourced from the National Centre for Environmental Prediction (NCEP) Climate Forecast System Reanalysis (CFSR; see Saha et al., 2010). The CFSR wind model includes observations from many data sources; surface observations, upper-atmosphere air balloon observations, aircraft observations and satellite observations. The model is capable of accurately representing the interaction between the earth's oceans, land and atmosphere. The gridded wind data output is available at ¼ of a degree resolution (~33 km) and 1-hourly time intervals. Figure 13 shows the spatial resolution of the wind field used as input into the oil spill model and the station used to create the wind roses. Table 4 shows the monthly average and maximum winds derived from the CFSR station located adjacent to the release site. Figure 14 and Figure 15 show the monthly and annual wind rose distributions, respectively.

Note that the atmospheric convention for defining wind direction, that is, the direction the wind blows from, is used to reference wind direction throughout this report. Each branch of the rose represents wind coming from that direction, with north to the top of the diagram. Sixteen directions are used. The branches are divided into segments of different colour, which represent wind speed ranges from that direction. Speed ranges of 5 knot intervals, excluding the calm and near calm conditions are used in these wind roses. The length of each segment within a branch is proportional to the frequency of winds blowing within the corresponding range of speeds from that direction.

The data indicated that the winds across the region are relatively moderate with monthly average wind speeds varying from 9.8 knots (March) to 14.2 knots (August), whilst monthly maximum wind speeds ranged from 27.1 knots (February) to 41.0 knots (September).

Table 4 Predicted monthly average and maximum winds for the wind station adjacent to the release location. Data derived from CFSR hindcast model from 2008-2012 (inclusive).

Month	Average wind (knots)	Maximum wind (knots)	General Direction (From)
January	10.2	32.8	South-East
February	10.3	27.1	South-East
March	9.8	34.4	Variable
April	10.1	37.6	Variable
May	10.1	28.8	Variable
June	12.3	39.8	North
July	12.6	35.3	North-West
August	14.2	39.4	North-West
September	12.7	41.0	West
October	10.6	28.2	West
November	10.2	31.2	Variable
December	10.9	30.7	Variable
Minimum	**9.8**	**27.1**	
Maximum	**14.2**	**41.0**	

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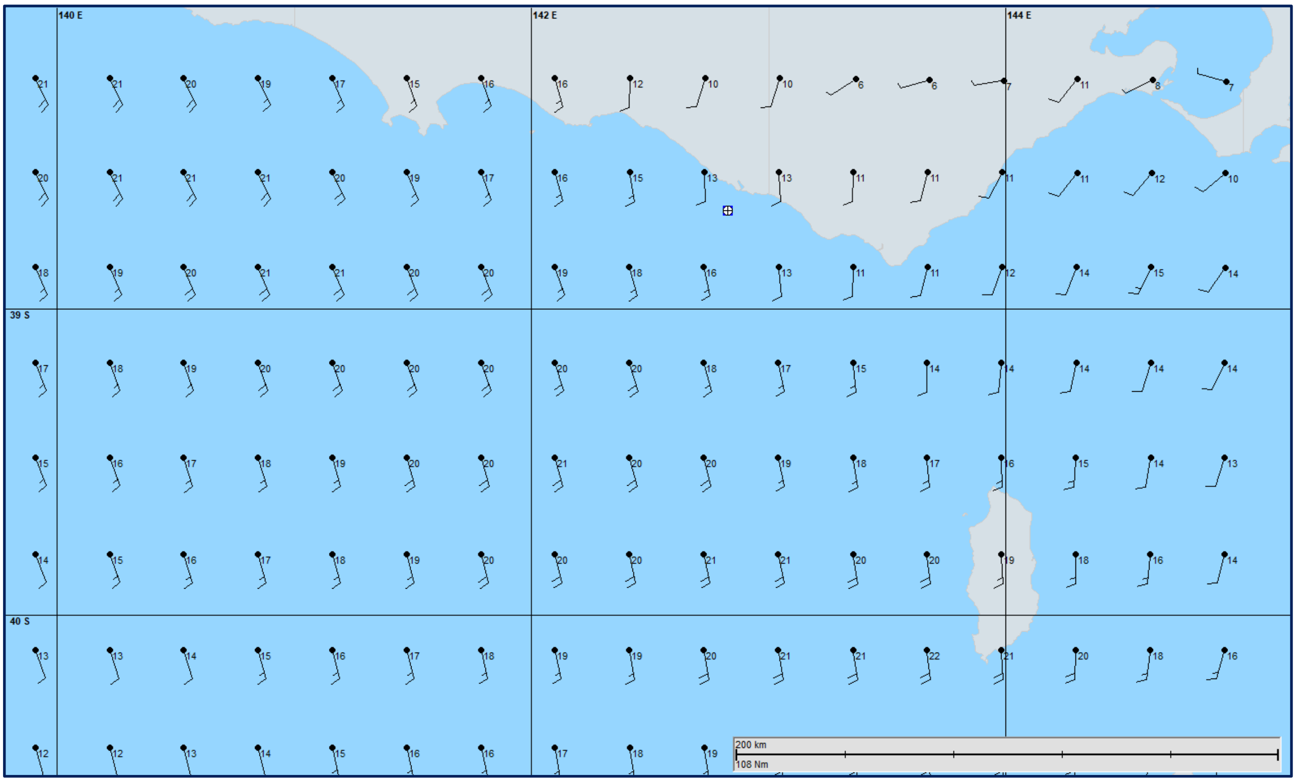

Figure 13 **Spatial resolution of the CFSR modelled wind data used as input into the oil spill model. The cross-hair icon represents the release location.**

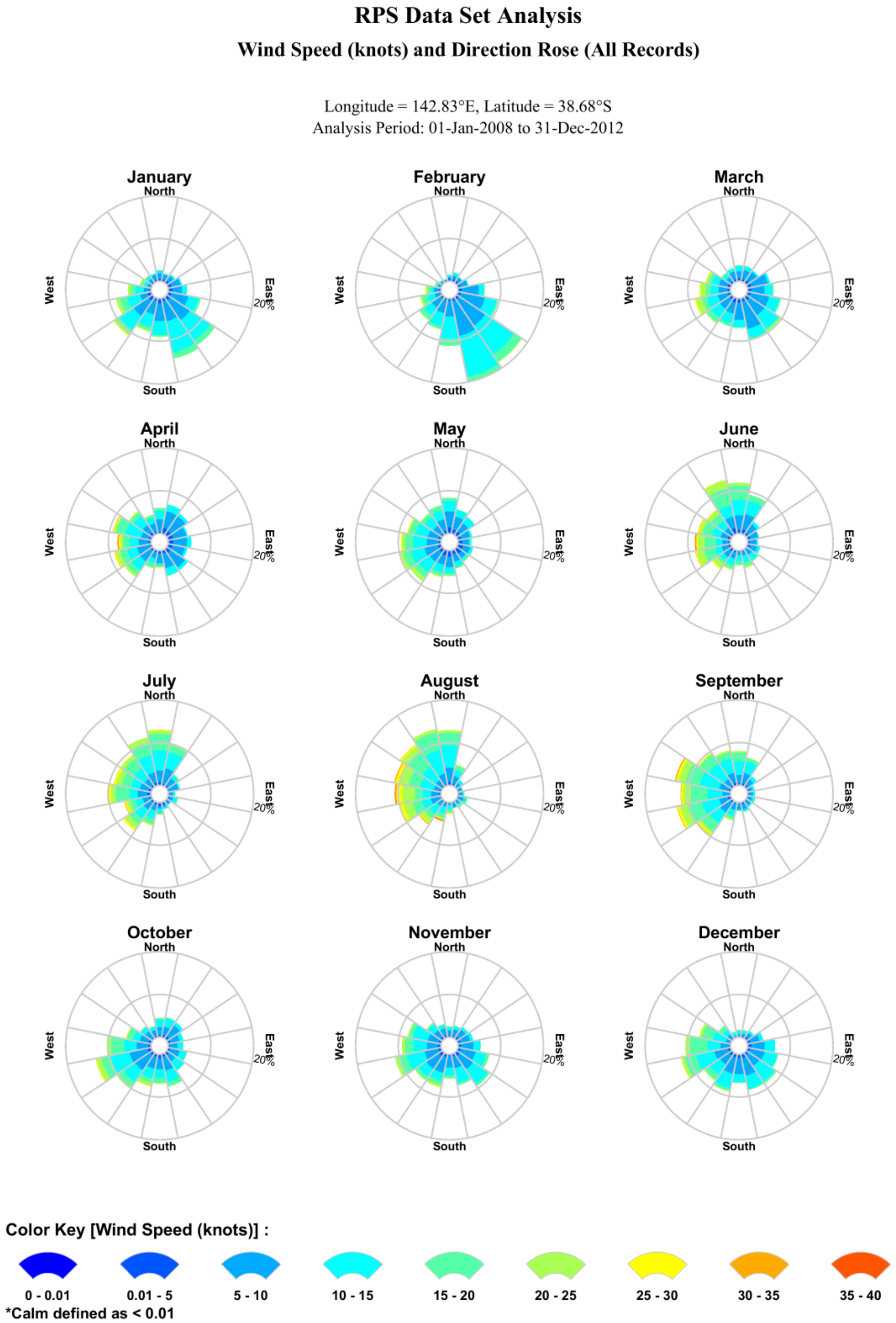

Figure 14 Modelled monthly wind rose distributions from 2008–2012 (inclusive), for the wind station adjacent to the release location. The colour key shows the wind magnitude, the compass direction provides the direction FROM and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

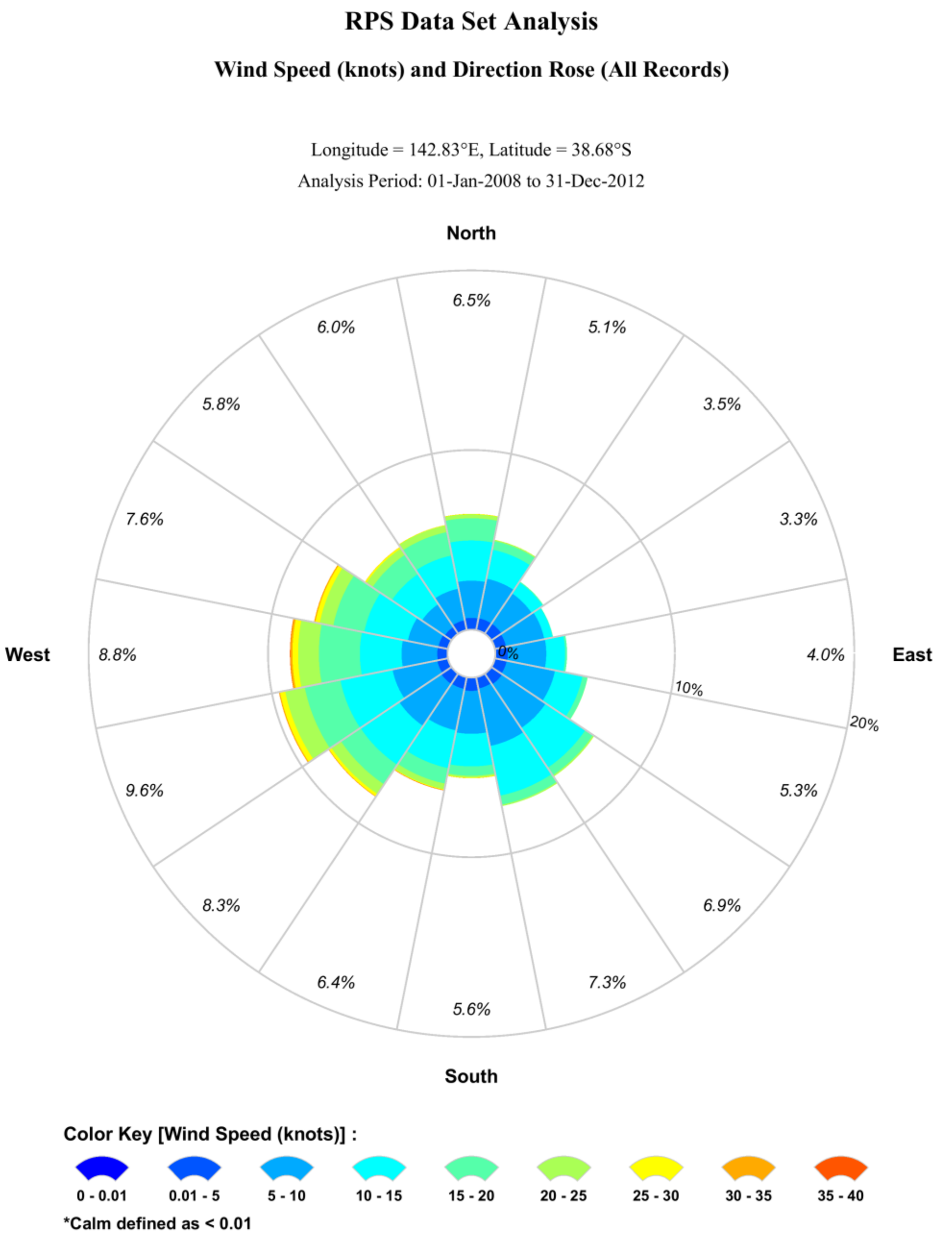

Figure 15 Modelled annual wind rose distributions from 2008–2012 (inclusive), for the wind station closest adjacent to the release location. The colour key shows the wind magnitude, the compass direction provides the direction FROM and the length of the wedge gives the percentage of the record for a particular speed and direction combination.

5 WATER TEMPERATURE AND SALINITY

The monthly sea temperature and salinity profiles of the water column adjacent to the release site was obtained from the World Ocean Atlas 2013 database produced by the National Oceanographic Data Centre (National Oceanic and Atmospheric Administration) and its co-located World Data Service (WDS) for Oceanography (formerly The World Data Center for Oceanography) (see Levitus et al., 2013).

To account for depth-varying sea temperature and salinity the modelling used monthly average sea temperature and salinity profiles at 5 m intervals through the water column (refer to Figure 16).

Table 5 details the monthly average sea surface temperatures and salinity (0-5 m depth layer). Monthly average sea surface temperatures were shown to range from 16.1°C (Summer) and 14.5°C (Winter). Salinity remained consistent throughout the year ranging from 35.2 to 35.6 psu.

Table 5 Monthly average sea surface temperature and salinity in the Otway Basin in the 0–5 m depth layer.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature (°C)	17.6	17.2	17.6	16.2	15.9	15.7	14.9	13.6	13.7	14.0	14.3	16.0
Salinity (psu)	35.3	35.2	35.4	35.3	35.3	35.4	35.6	35.3	35.3	35.3	35.4	35.4

RPS

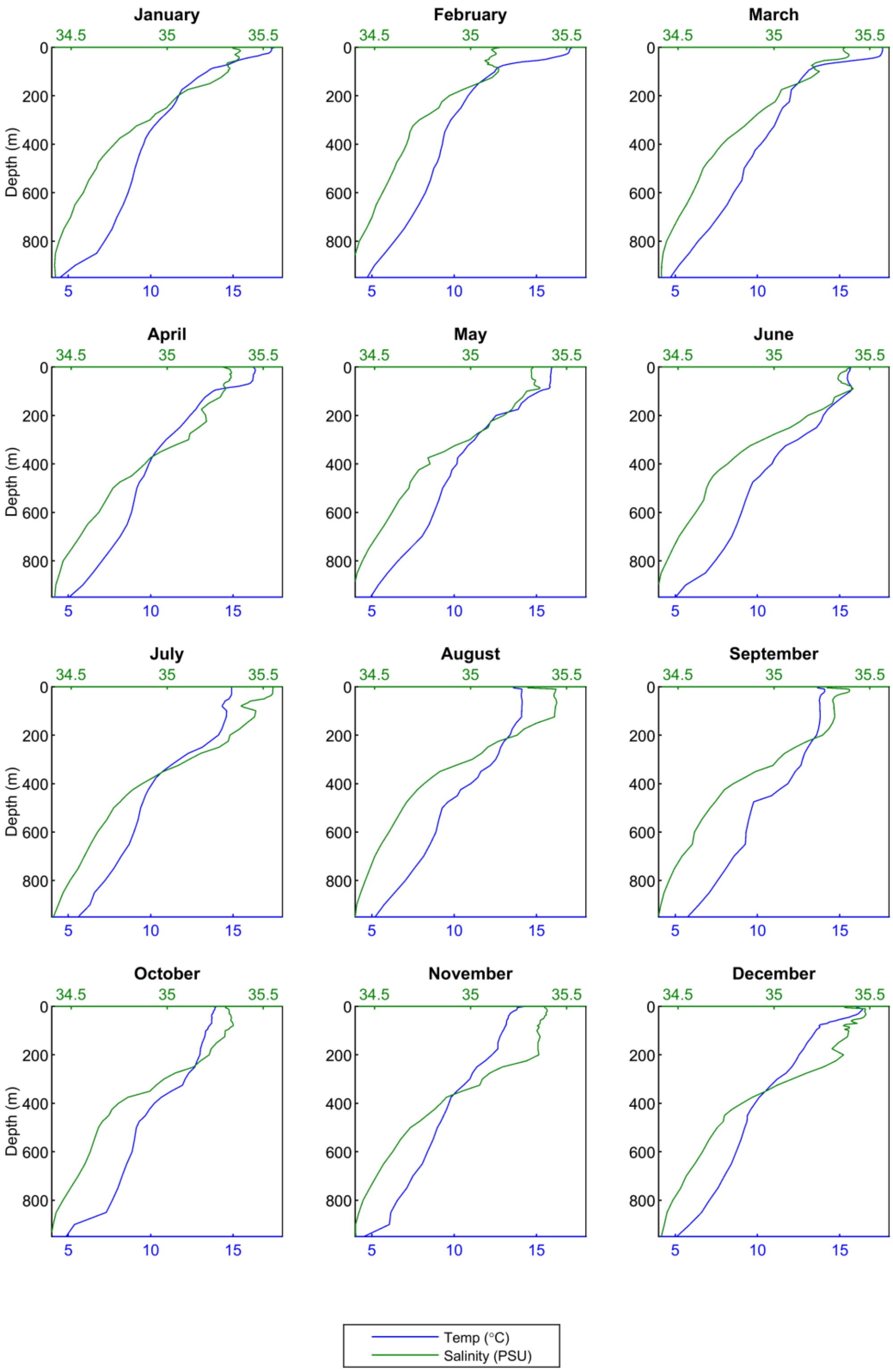

Figure 16 Monthly water temperature and salinity depth profiles adjacent to the release location.

6 OIL SPILL MODEL – SIMAP

The oil spill modelling was performed using SIMAP. SIMAP is designed to simulate the fate and effects of spilled hydrocarbons for both the surface and subsurface releases (Spaulding et al., 1994; French et al., 1999; French-McCay, 2003; French-McCay, 2004; French-McCay et al., 2004; Spaulding, et al., 2015).

The SIMAP trajectory model separately calculates the movement of the material that: (i) is on the water surface (as surface slicks), (ii) in the water column (as either entrained whole oil droplets or dissolved hydrocarbon), (iii) has stranded on shorelines, or (iv) that has precipitated out of the water column onto the seabed. The model calculates the transport of surface slicks from the combined forces exerted by surface currents and wind acting on the oil. Transport of entrained oil (oil that is below the water surface) is calculated using the currents only.

6.1 Stochastic Modelling

As spills can occur during any set of wind and current conditions, SIMAP's stochastic model was used to quantify the probability of exposure to the sea surface, water column and contact to shorelines for the hypothetical spill scenario. Stochastic modelling involves running numerous individual oil spill simulations using a range of prevailing wind and current conditions. For this assessment, a total of 100 single spill trajectories for each season and for each scenario were run from the release site location, using a range of prevailing wind and current conditions from a 5-year period (2008–2012).

Each simulation had the same spill information (i.e. spill volume, duration and oil type) but with varying start times, and in turn, prevailing wind and current conditions. This approach ensures that the predicted transport and weathering of an oil slick is subject to a wide range of current and wind conditions.

During each spill trajectory, the model records the grid cells exposed to hydrocarbons, as well as the time elapsed. Once all the spill trajectories have been run, the model then combines the results from the individual simulations to determine the following:

- Maximum exposure (or load) observed on the sea surface;
- Minimum time before sea surface exposure;
- Probability of contact to any shorelines;
- Probability of contact to individual sections of shorelines;
- Maximum volume of oil that may contact shorelines from a single simulation;
- Maximum length of shoreline contacted above each shoreline threshold;
- Maximum load that an individual shoreline may experience;
- Maximum exposure from entrained hydrocarbons observed in the water column; and
- Maximum exposure from dissolved hydrocarbons observed in the water column.

The stochastic model output does not represent the extent of any one spill trajectory (which would be significantly smaller) but rather provides a summary of all trajectories run for the scenario.

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6.2 Sea surface, Shoreline and In-Water Thresholds

The SIMAP model can track the spill trajectories to levels that are lower than biologically significant or visible to the naked eye. Therefore, thresholds have been specified (based on scientific literature) to account for “exposure” on the sea surface and “contact” to shorelines at meaningful levels.

6.2.1 Sea surface Exposure Thresholds

To better assess the potential for sea surface exposure, each of the 100 spill trajectories was tracked to a minimum reporting threshold thickness of 0.1 g/m^2 (~0.1 µm). Oil of this thickness is described as having a sheen appearance on the water surface according to the Bonn Agreement (2009) Oil Appearance Code (BAOAC) (see Table 6) and is below levels that have been found to cause environmental harm. Figure 17 illustrates the appearance of rainbow sheen in the marine environment.

Interestingly, Peakall et al. (1985) stated the oil thicknesses less than 1 µm was not harmful to seabirds. Literature reviews by Engelhardt (1983), Clark (1984), Geraci and St. Aubin (1988), Jenssen (1994), and Scholten et al. (1996) regarding the effects of oil on aquatic birds and marine mammals indicate that the threshold layer thickness at which wildlife can be affected ranges between 10 µm (~10 g/m^2) and 25 µm (~25 g/m^2). Hence, 10 µm was selected to define the moderate exposure zone and 25 µm the high exposure zone.

The sea surface exposure threshold of 10 g/m^2 (or 10 µm) also represents the practical limit for surface response options (i.e. sea surface actionable threshold). Below this thickness containment and recovery and chemical treatment (dispersant) become ineffective (AMSA 2015a). Table 7 defines the thresholds used to classify the zones of sea surface exposure reported herein.

Table 6 The Bonn Agreement Oil Appearance Code.

Code	Description Appearance	Layer Thickness Interval (g/m^2 or µm)	Litres per km^2
1	*Sheen (silvery/grey)*	0.04 – 0.30	40 – 300
2	*Rainbow*	0.30 – 5.0	300 – 5,000
3	*Metallic*	5.0 – 50	5,000 – 50,000
4	*Discontinuous True Oil Colour*	50 – 200	50,000 – 200,000
5	*Continuous True Oil Colour*	200 –>	200,000 –>

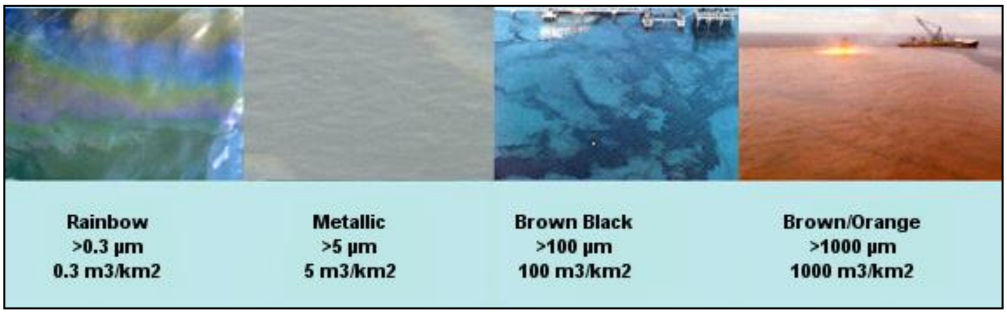

Figure 17 Photographs showing the difference between oil colour and thickness on the sea surface (source: adapted from Oil SpillSolutions.org 2015).

Table 7 Thresholds used to classify the zones of sea surface exposure.

Oil concentration (g/m^2)	Zone description
0.1 – 10	Low
10 – 25	Moderate
>25	High

6.2.2 Shoreline Contact Thresholds

There are many different types of shorelines, ranging from cliffs, rocky beaches, sandy beaches, mud flats and mangroves, and each of these influences the volume of oil that can remain stranded ashore and its thickness before the shoreline saturation point occurs. For instance, a sandy beach may allow oil to percolate through the sand, thus increasing its ability to hold more oil ashore over tidal cycles and various wave actions than an equivalent area of water; hence oil can increase in thickness onshore over time. A sandy beach shoreline was assumed as the default shoreline type for the modelling herein, as it allows for the highest carrying capacity of oil (of the available open/exposed shoreline types). Hence the results contained herein would be indicative of a worst-case scenario, where the highest volume of oil may be stranded on the shoreline (when compared to other shoreline types, such as exposed rocky shores).

In previous risk assessment studies, French-McCay et al. (2005a; 2005b) used a threshold of 10 g/m^2 to assess the potential for shoreline contact. This threshold used to define regions of socio-economic impact, such as triggering temporary closures of adjoining fisheries. This threshold value equates to approximately two teaspoons of hydrocarbon per square meter of shoreline contacted. The appearance is described as a stain/film. In this study, a more conservative threshold of 1 g/m^2 was selected to define the zone of potential "low shoreline contact".

French et al. (1996) and French-McCay (2009) have defined a hydrocarbon exposure threshold for shorebirds and wildlife (furbearing aquatic mammals and marine reptiles) on or along the shore at 100 g/m^2, which is based on studies for sub-lethal and lethal impacts. This threshold has been used in previous environmental risk assessment studies (see French-McCay, 2003; French-McCay et al., 2004, French-McCay et al., 2011; NOAA, 2013). The 100 g/m^2 shoreline contact threshold is also recommended in the

Australian Maritime Safety Authority's (AMSA) foreshore assessment guide[1] as the acceptable minimum thickness that does not inhibit the potential for recovery and is best remediated by natural coastal processes alone (AMSA, 2015b). It equates to approximately ½ a cup of hydrocarbon per square meter of shoreline contacted. The appearance is described as a hydrocarbon coat. Therefore, 100 g/m^2 has been selected to define the zone of potential "moderate shoreline contact". In addition, the shoreline contact threshold of 100 g/m^2 also represents the practical limit for shoreline response options (i.e. shoreline actionable threshold).

Observations by Lin and Mendelssohn (1996), demonstrated that loadings of more than 1,000 g/m^2 of hydrocarbon during the growing season would be required to impact marsh plants significantly. Similar thresholds have been found in studies assessing hydrocarbon impacts on mangroves (Grant et al., 1993; Suprayogi & Murray 1999). Hence, 1,000 g/m^2 has been selected to define the zone of potential "high shoreline contact". This threshold equates to approximately 1 litre of hydrocarbon per square meter of shoreline contacted.

The following thresholds outlined in Table 8 have therefore been specified to classify the zones of shoreline contact based on socio-economic and ecological effects.

Table 8 Thresholds used to assess shoreline contact.

Shoreline Concentration (g/m^2)	Zone Description
1 – 100	Low
100 – 1,000	Moderate
>1,000	High

6.2.3 Water Column Exposure Thresholds

The most toxic components of oil to water-column and benthic organisms are lower-molecular-weight compounds, which are both volatile and soluble in water. The polynuclear aromatic hydrocarbons (PAHs) exert the most toxic effects because they are semi-soluble and not highly volatile, so they persist in the environment long enough for significant exposure to occur (Anderson et al., 1974, 1987; Neff & Anderson, 1981; Malins & Hodgins, 1981; McAuliffe, 1987; NRC 2003, 2005).

Entrained hydrocarbons are oil droplets suspended in the water column. These may come into contact with and adhere to filter feeding organisms and the gills of fish. The toxic PAH component of the oil is accounted for by the dissolved aromatic exposure thresholds, and the PAH component of entrained droplets will change over time as PAHs are removed through dissolution and degradation in the water column. Therefore, the environmental effects of undissolved droplets require different exposure thresholds that consider the total hydrocarbon content.

A recent review of aquatic toxicity was carried out by French McCay (2018). In this review the author has identified the shortcomings of previously adopted thresholds for entrained hydrocarbons, e.g. ANZECC (2000) and Smit et al. (2009) and the author points out that THC/TPH thresholds derived from Water Accommodated Fraction (WAF) solutions prepared in the lab are inappropriate to apply to whole oil droplets resulting from a spill of hydrocarbons in the marine environment.

[1] Recommended for shoreline types including sandy beach, boulder shorelines, pebble shorelines, rock platforms and industry facility structures.

The author goes on to identify more appropriate thresholds from more recent and more relevant literature. The thresholds described in French McCay (2018) cover a range of potential effects on the environment that have been broken down into 3 protection levels; 1) sublethal effects (or Predicted No Effect Concentration) for all life stages; 2) lethal effects for sensitive species and/or early life stages; and 3) lethal effects for less sensitive species and/or older life stages (Table 9).

Each of the thresholds provided in French McCay (2018) are relevant to time-based exposure (or dose), that is, they need to be applied across a several-or-more day exposure, such as a 96-hour interval, to be appropriate. A simple approach to account for the time-based nature of the thresholds is to use time-based averaging in the model to calculate the potential exposure. The LC_{50} values quoted in French McCay (2018) are typically for 48 to 96 hours of exposure, thus the conservative averaging over 48 hours is used in this study.

To apply these thresholds for shorter durations of exposure, or to apply them instantaneously, to estimate potential impacts to the environment, would be extremely conservative and overly protective. However, the instantaneous concentrations could be used as screening values to demonstrate areas where hydrocarbons may be detected if a spill were to occur, without the assumption of an impact to the environment, such is the case for this study.

Table 9 Summary of in-water time-averaged exposure thresholds.

Potential Effect	Dissolved Hydrocarbons	Entrained Hydrocarbons
Sublethal Effect	1 ppb	100 ppb
Lethal Effect for Sensitive Species	10 ppb	1,000 ppb
Lethal Effect for Less Sensitive Species	300 ppb	30,000 ppb

6.3 Oil Properties

6.3.1 Condensate

A proxy condensate selected by Cooper Energy was used for the loss of well control scenario from the Annie-1 well. The condensate has an API of 48.23, density of 728.6 kg/m^3 at 15ºC) with low viscosity (1.063 cP) (refer to Table 10), classifying it as a Group I oil according to the International Tankers Owners Pollution Federation (ITOPF, 2014) and USEPA/USCG classifications. The condensate comprises a significant portion of volatiles and semi to low volatiles (99% total) with very little residual components (<1%) (refer to Table 11). This means that the condensate will evaporate readily when on the water surface, with limited persistent components to remain on the water surface over time.

Figure 18 displays the weathering of the condensate during three static wind conditions. Rapid evaporation occurs during the first 24 hours of the simulation (while the condensate is still spilling) under all static wind conditions the condensate is predicted to readily entrain into the water column under all wind speeds (in particular the higher wind speeds). Due to the high volatility of the condensate, little is predicted to remain on the water surface after the spill ceases.

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6.3.2 Marine Diesel Oil

A Marine Diesel Oil (MDO) was used for the containment loss from a vessel scenario. The MDO is a light-persistent fuel oil used in the maritime industry. It has a density of 829.1 kg/m^3 (API of 37.6) and a low pour point (-14 ºC). The low viscosity (4 cP) indicates that this oil will spread quickly when released and will form a thin to low thickness film on the sea surface, increasing the rate of evaporation. Approximately, 5% (by mass) of the oil is categorised as a group II oil (light-persistent) based on categorisation and classification derived from AMSA (2015a) guidelines. The classification is based on the specific gravity of hydrocarbons in combination with relevant boiling point ranges.

Table 10 details the physical properties of MDO, while Table 11 presents the boiling point ranges of the MDO used in this study.

Figure 19 shows weathering graphs for 5, 10 and 15 knots spill trajectories, each spill trajectory represents the release of 250 m^3 of MDO over 6 hours tracked for 30 days.

The prevailing weather conditions will influence the weathering and fate of the MDO. Under lower wind-speeds (5 knots), the MDO will remain on the surface longer, spread quicker, and in turn increase the evaporative process. Conversely, sustained stronger winds (>15 knots) will generate breaking waves at the surface, causing a higher amount of MDO to be entrained into the water column and reducing the amount available to evaporate.

Table 10 Physical properties of Marine Diesel Oil.

Characteristic	Proxy Condensate	Marine Diesel Oil
Density (kg/m^3)	782.6	829.1
API	48.23	37.6
Dynamic viscosity (cP)	1.063	4
Pour Point (ºC)	-30	-14
Wax content (%)	0.1	1
Hydrocarbon property category	Group-I	Group II
Hydrocarbon property classification	Non-persistent oil	Light - Persistent

Table 11 Boiling point ranges.

	Not Persistent			Persistent
Characteristic	**Volatile**	**Semi-volatile**	**Low volatility**	**Residual**
Boiling point (ºC)	**< 180**	**180 - 265**	**265 - 380**	**>380**
Proxy Condensate	54.7	32.6	11.7	0
Marine Diesel Oil	6	34.6	54.4	5

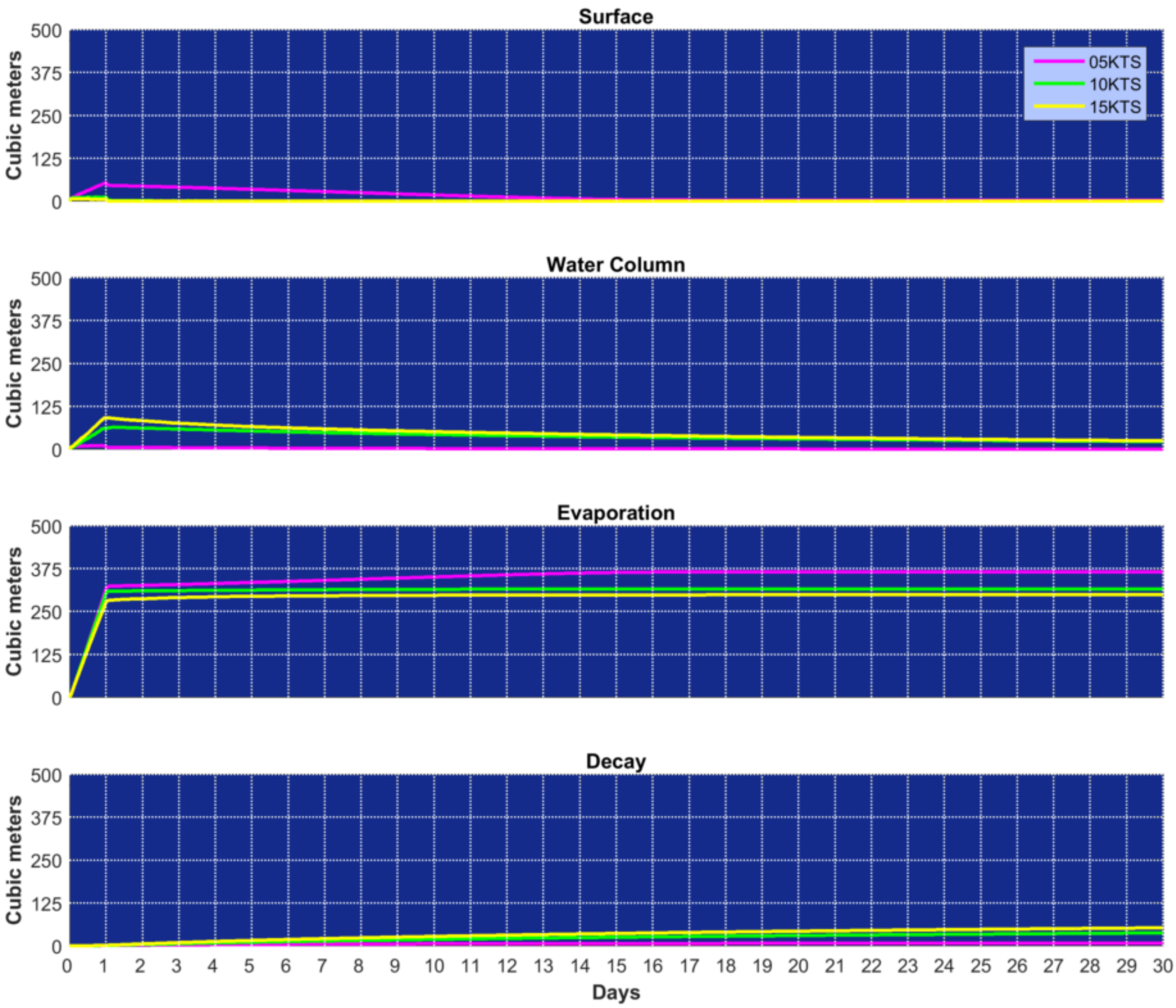

Figure 18 **Weathering of the proxy condensate under three static wind conditions. The results are based on a 24,113 m^3 spill of condensate released over 24 hours track for 30 days.**

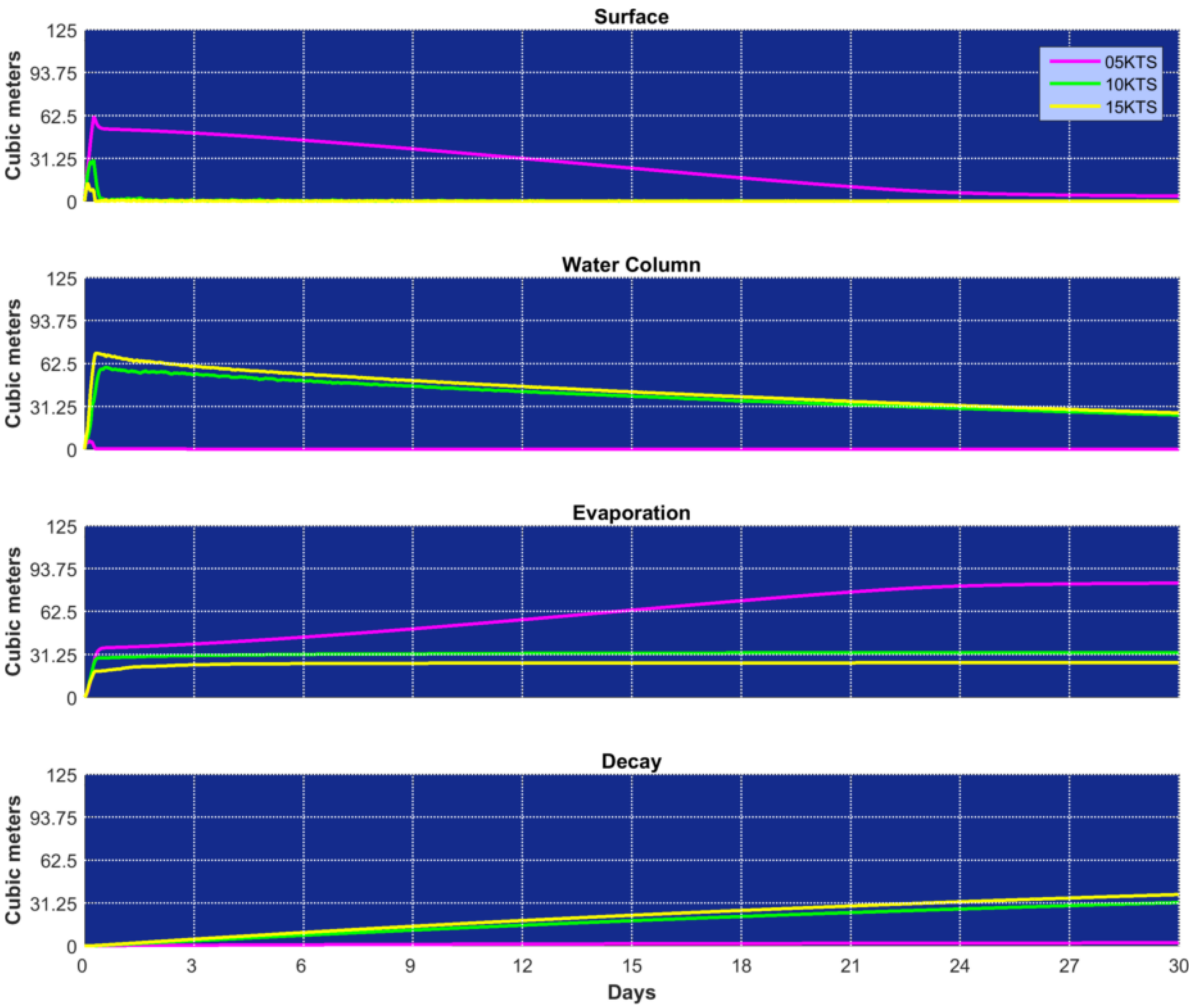

Figure 19 Weathering of MDO under three static winds conditions (5, 10 and 15 knots). The results are based on a 250 m^3 surface release of MDO over 6 hours and tracked for 30 days.

6.4 Model Settings

This oil spill modelling study quantified the seasonal risk and potential exposure to the surrounding waters and shorelines for two plausible, yet hypothetical, scenarios:

- a 151,671 bbl (variable release rate from 2,375 bbl/day to 1,419 bbl/day, see Figure 20) subsea release of condensate over 84 days in the event of a loss of well control scenario from the Annie-1 location (;
- a 250 m³ surface release of diesel over 6 hours in the event of containment loss from a vessel.

Each scenario was independently assessed for two independent seasons; summer (October to March) and winter (April to September). This allows for appropriately assessing potential impacts to migratory species in the region. Table 12 provides a summary of the oil spill model settings and assumptions.

Table 12 Summary of the oil spill model settings used in this assessment.

Parameter	Oil Spill Scenario	
Scenario description	**Well blowout**	**MDO release**
Model period	Summer (October to March) Winter (April to September)	Summer (October to March) Winter (April to September)
Number of randomly selected spill start times and locations per season	100	
Oil type	Condensate	Marine Diesel Oil
Spill volume (m^3)	24,113	250
Release type	Sub-surface	Surface
Release duration	84 days	6 hr
Release Rate	Variable (2,375 bbl/day to 1,419 bbl/day)	250 m^3/6 hrs
Simulation length (days)	120	30
Surface oil concentration thresholds	0.1 g/m^2, 10 g/m^2, >25 g/m^2	
Shoreline load threshold	1 g/m^2, 100 g/m^2, >1,000 g/m^2	
Dissolved hydrocarbon time-averaged exposure (ppb)	1 ppb, potential low exposure 10 ppb, potential moderate exposure 300 ppb, potential high exposure	
Entrained hydrocarbon time-averaged exposure (ppb)	100 ppb, potential low exposure 1,000 ppb, potential moderate exposure 30,000 ppb, potential high exposure	

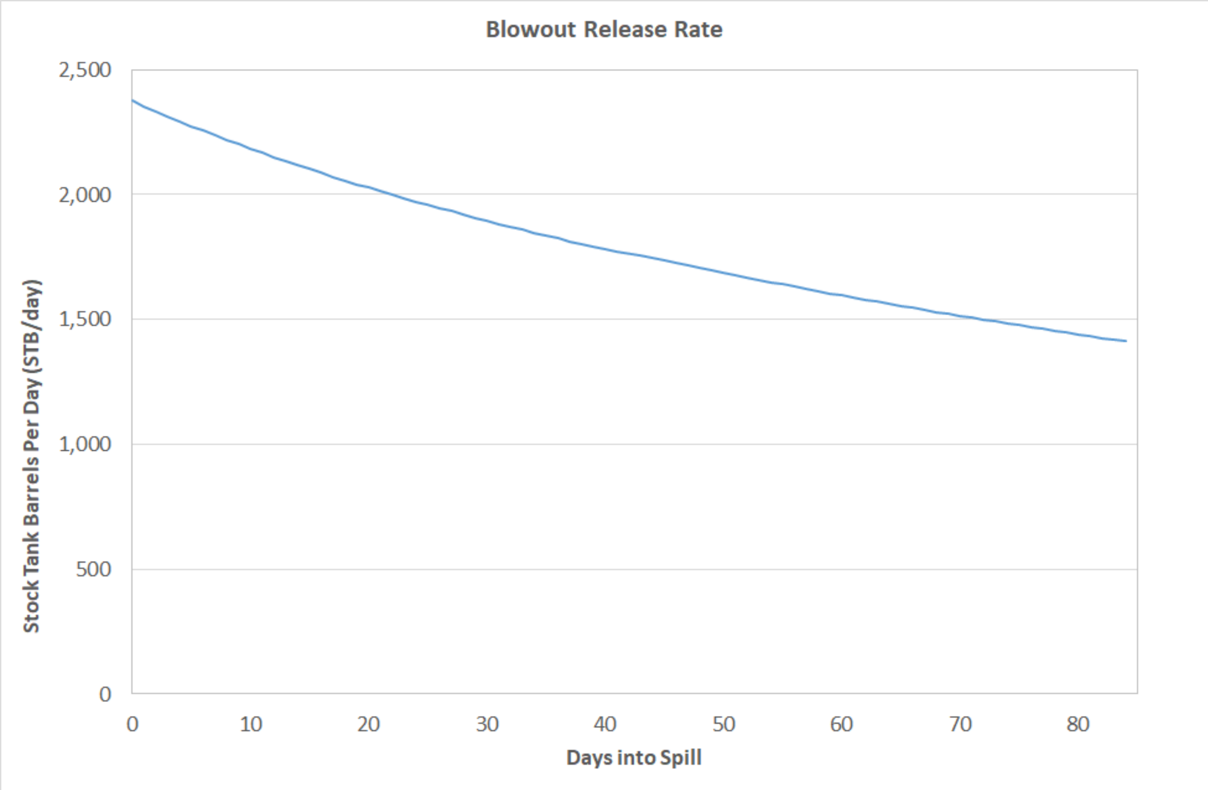

Figure 20 **Variable release rate used in the model.**

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7 PRESENTATION AND INTERPRETATION OF MODEL RESULTS

The results from the modelling study are presented in a number of tables and figures, which aim to provide an understanding of the predicted sea surface and sub-surface exposure and shoreline contact.

7.1 Stochastic Analysis

The figures are based on the following principles:

- ***The potential zones of exposure (surface oil, entrained hydrocarbons and dissolved hydrocarbons)*** – is determined by identifying the maximum loading (surface) or dosage (subsea) within a grid cell and is then classified according to identified surface or subsea thresholds.
- The ***minimum time before oil exposure on the sea surface*** **–** is determined by recording the elapsed time before sea surface exposure to a grid cell, at a specified threshold.
- The ***probability of exposure/contact (surface oil, shoreline oil, entrained hydrocarbon or dissolved hydrocarbon)*** **–** is calculated by dividing the number of spill trajectories passing over that given cell (surface, shoreline or subsea) by the total number of spill trajectories, above the specified threshold value.
- **Maximum potential shoreline loading –** is determined by identifying the maximum loading within a shoreline cell and is then classified according to the identified thresholds (i.e. 1 g/m^2, 100 g/m^2 and 1,000 g/m^2).

The statistics are based on the following principles:

- The ***greatest distance travelled by a spill trajectory*** **–** is determined by: a) recording the maximum distance travelled by a single trajectory, within a scenario, from the release site to the identified exposure thresholds.
- The ***probability of shoreline contact*** – is determined by recording the number of spill trajectories to contact the shoreline, at a specific threshold, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before oil exposure*** – is determined by recording the minimum time for a grid cell to record exposure, at a specific threshold.
- The ***average volume of oil ashore for a single spill*** – is determined by calculating the average volume of the all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum volume of oil ashore from a single spill trajectory*** – is determined by identifying the single spill trajectory within a scenario/season, that recorded the maximum volume of oil to come ashore and presenting that value.
- The ***average length of shoreline contacted by oil*** - is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- The ***maximum length of shoreline contacted by oil*** - is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil above a specified threshold.
- The ***probability of oil exposure to a receptor*** **–** is determined by recording the number of spill trajectories to reach a specified sea surface or subsea threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.

- The ***minimum time before oil exposure to a receptor*** **–** is determined by ranking the elapsed time before sea surface exposure, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The ***probability of oil contact to a receptor*** **–** is determined by recording the number of spill trajectories to reach a specified shoreline contact threshold within a receptor polygon, divided by the total number of spill trajectories within that scenario.
- The ***minimum time before shoreline contact to a receptor*** **–** is determined by ranking the elapsed time before shoreline contact, at a specified threshold, to grid cells within a receptor polygon and recording the minimum value.
- The ***average potential oil loading within a receptor*** – is determined taking the average of the maximum loading to any grid cell within a polygon, for all simulations within a scenario/season, that recorded shoreline.
- The ***maximum potential oil loading within a receptor*** – is determined by identifying the maximum loading to any grid cell within a receptor polygon, for a scenario.
- The ***average volume of oil ashore within a receptor*** – is determined by calculating the average volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum volume of oil ashore within a receptor*** – is determined by recording the maximum volume of oil to come ashore within a receptor polygon, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***average length of shoreline contacted within a receptor*** is determined by calculating the average of the length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***maximum length of shoreline contacted by oil*** is determined by recording the maximum length of shoreline (measured as grid cells) contacted by oil within a receptor polygon, at a specified threshold, from all the single spill trajectories which were predicted to make shoreline contact within a scenario.
- The ***zones of entrained and dissolved hydrocarbon exposure*** **–** are calculated from the results of the 100 spill trajectories, for each given grid cell by applying equivalent time-based averaging (e.g. 48 or 96 hour) in the model to calculate the potential exposure

7.2 Deterministic Analysis

Single deterministic trajectories are also presented in the results section to display the potential weathering, movement and extent of surface oil from a single run, as opposed to the cumulative effect of all 100 individual trajectories. This run was chosen as the worst-case scenario based on the following combined criterion;

- Greatest volume ashore;
- Longest length of shoreline contacted by the condensate at, or above, the shoreline actionable threshold ($\geq$ 100 g/m^2).

7.3 Receptors Assessed

Figure 21 to Figure 28 show range of shoreline, environmental and biological receptors were considered as part of the oil spill modelling assessment, including the receptors assessed in this study, including:

- Local Government Areas (LGAs)
- Sub-local Government Areas (sub-LGAs)
- Integrated Marine and Coastal Regionalisation of Australia (IMCRA)
- Key Ecological Features (KEF)
- Interim Biogeographic Regions of Australia (IBRA)
- Marine National Parks
- State waters
- Australia Marine Parks (AMP)

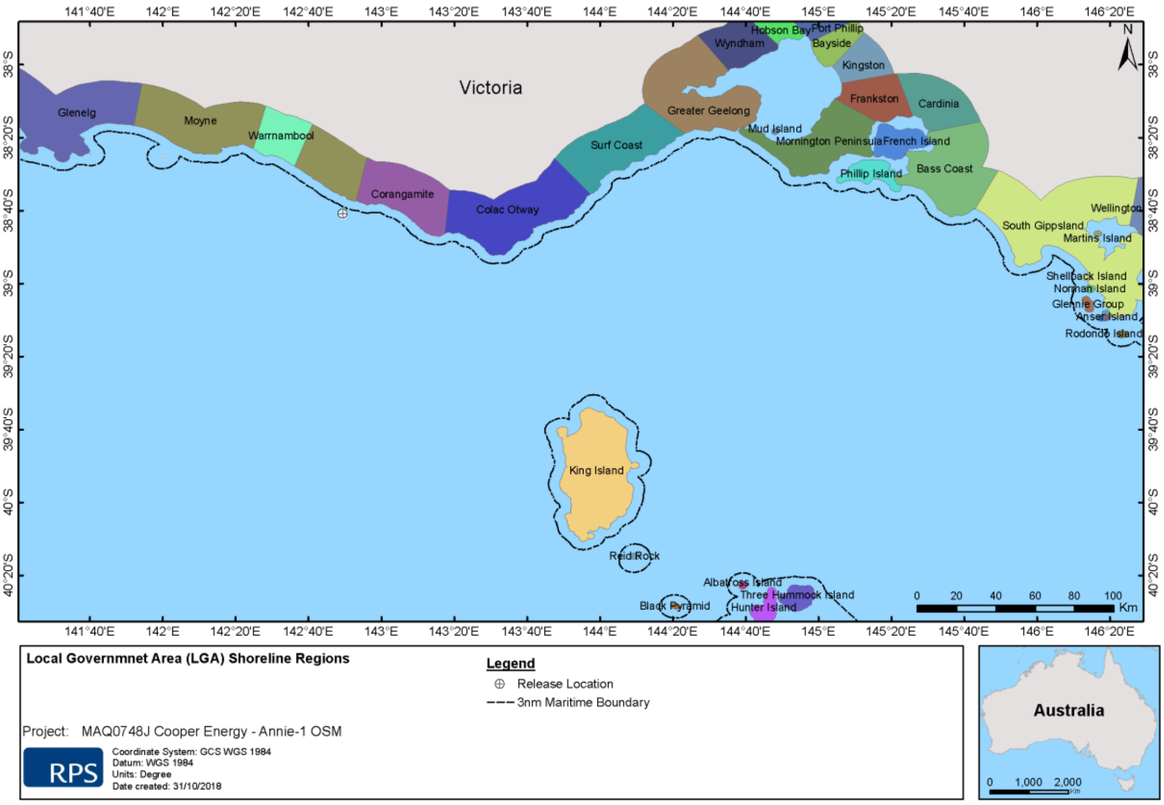

Figure 21 Local Government Areas (LGA) assessed for oil contact.

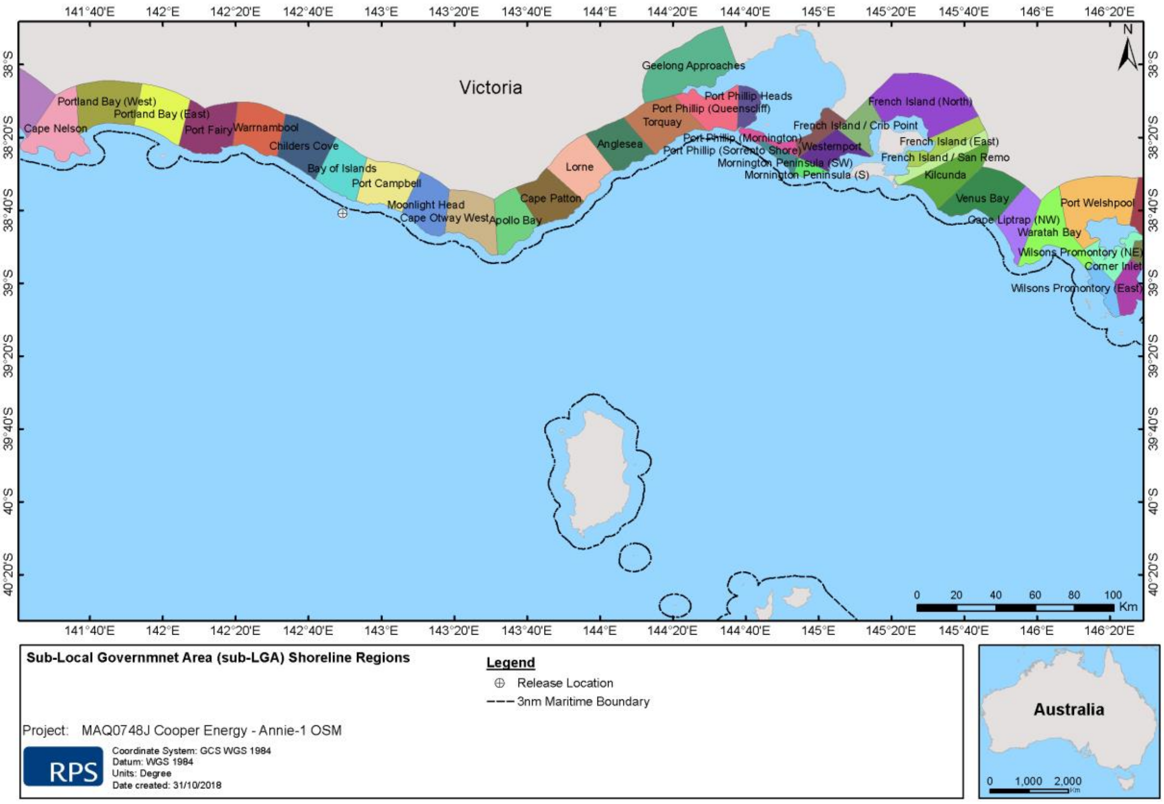

Figure 22 Sub-local Government Areas (sub-LGA) assessed for oil contact.

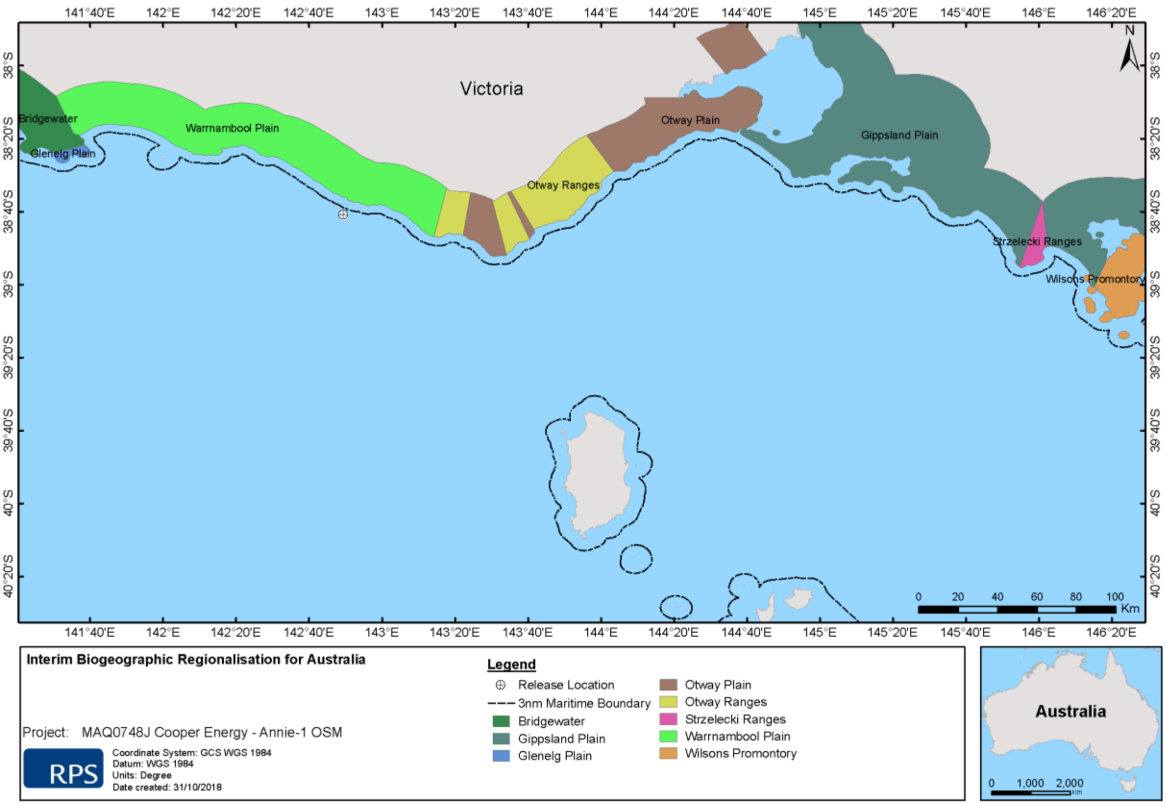

Figure 23 Interim Biogeographic Regionalisation for Australia (IBRA) regions assessed for oil contact.

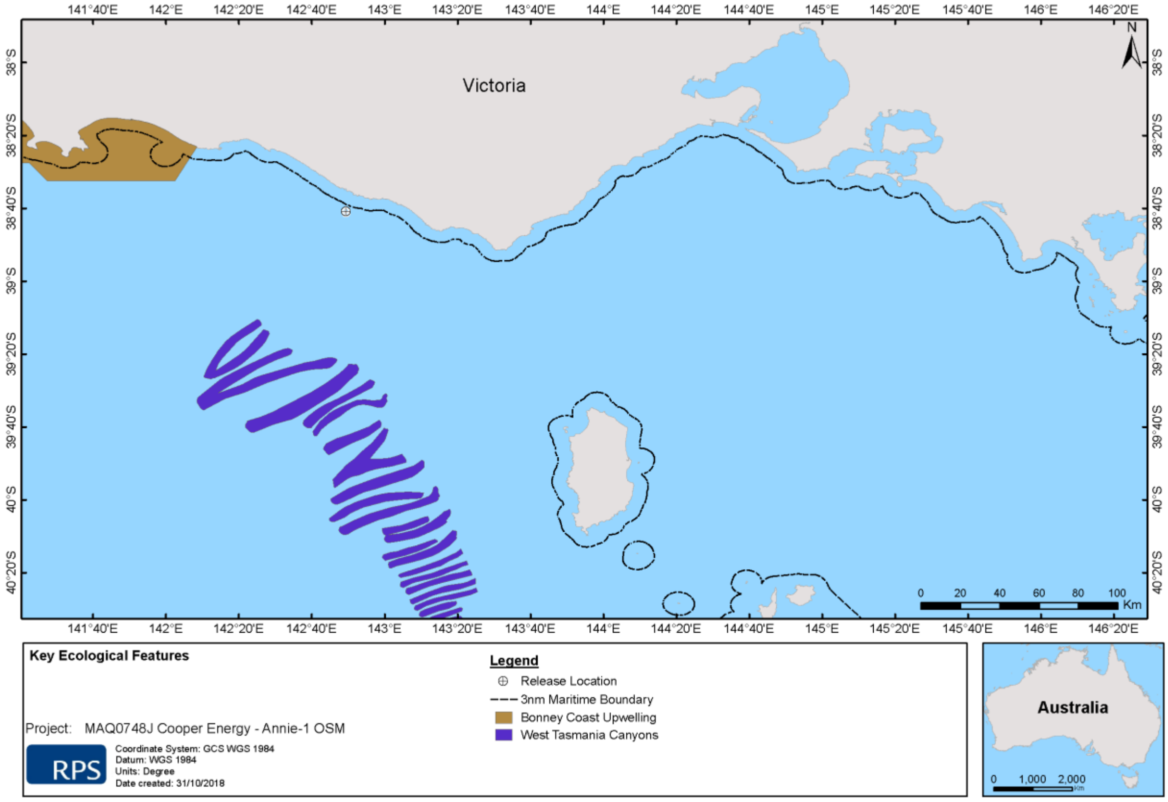

Figure 24 Key ecological features assessed for oil contact.

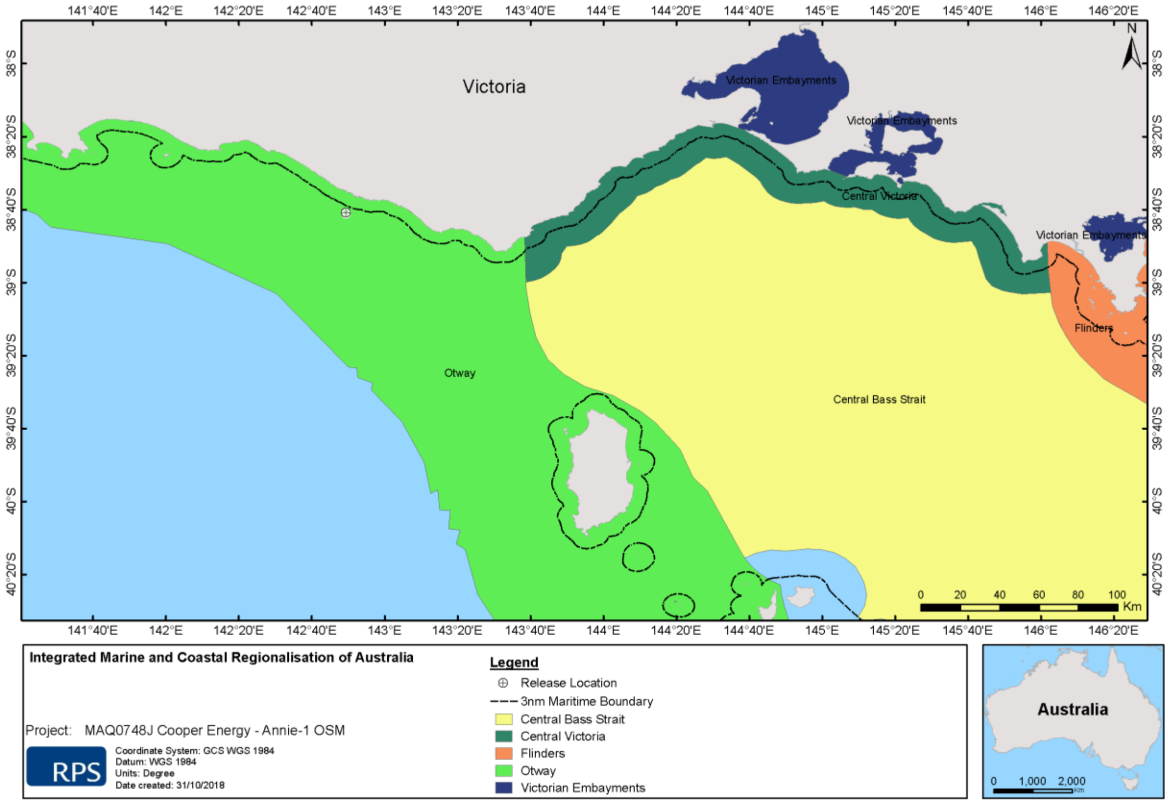

Figure 25 Integrated Marine and Coastal Regionalisation of Australia (IMCRA) areas assessed for oil contact.

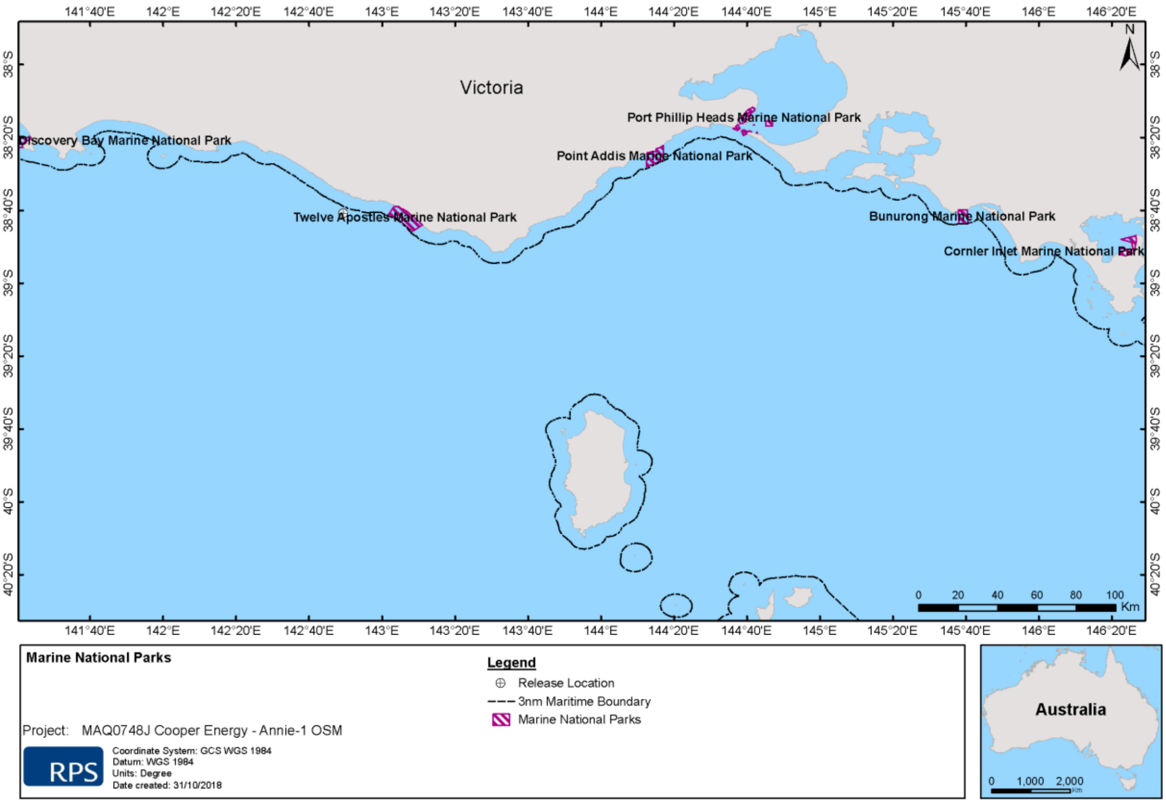

Figure 26 Marine National Parks assessed for oil contact.

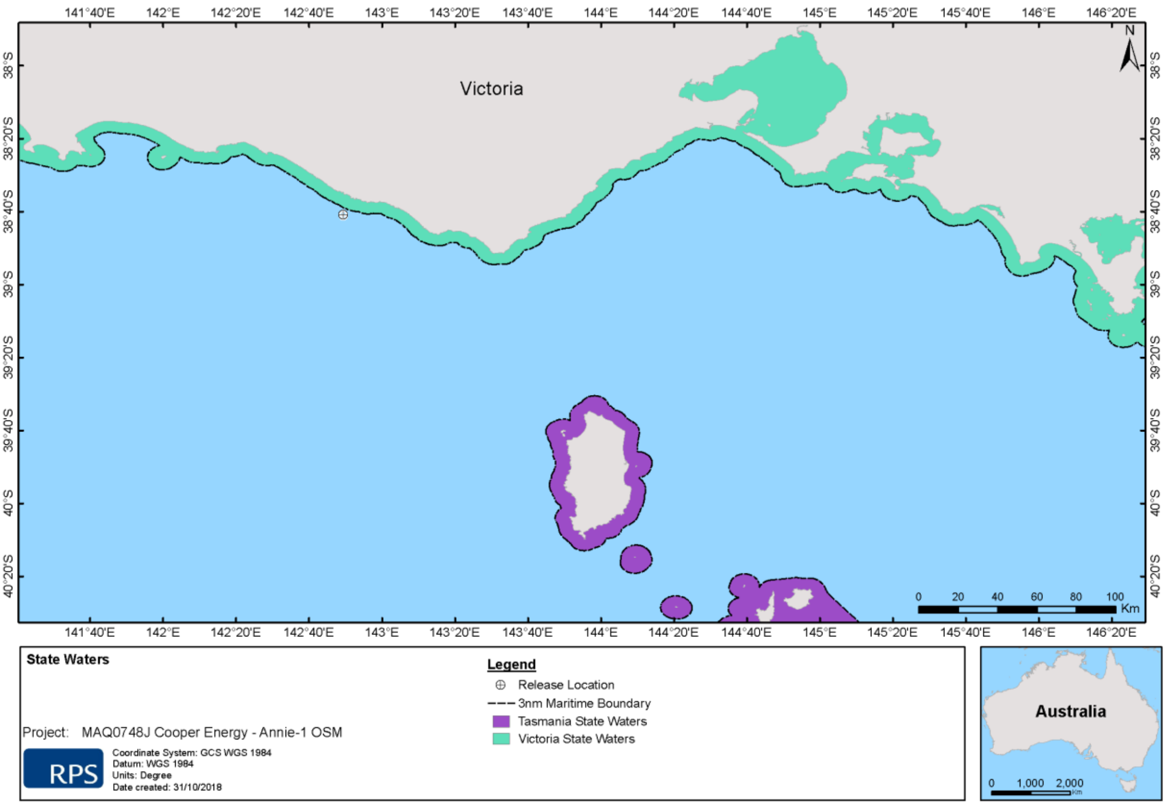

Figure 27 State waters assessed for oil contact.

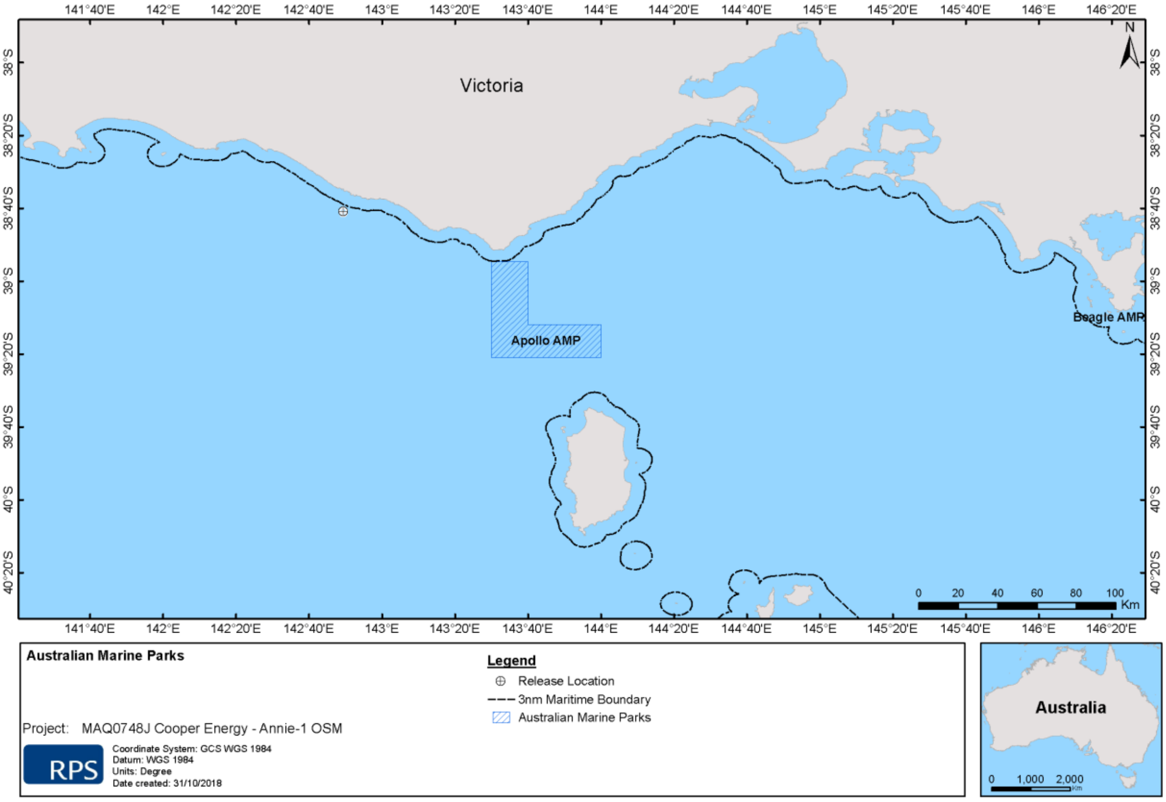

Figure 28 Australian Marine Parks (AMP) assessed for oil contact.

8 STOCHASTIC ANALYSIS

For the modelling study each spill trajectory was tracked to the following minimum thresholds:

- Sea surface exposure – 0.1 g/m^2
- Shoreline contact – 1 g/m^2
- Dissolved hydrocarbons exposure – 1 ppb
- Entrained hydrocarbons exposure – 100 ppb

8.1 RESULTS: 1,805 BBL/D RELEASE OF CONDENSATE FROM ANNIE-1 WELL BLOWOUT OVER 84 DAYS UNDER SUMMER CONDITIONS

The scenario examined an 84-day subsea release of condensate following a well blowout incident at the Annie-1 release site, tracked for a period of 120 days. A total of 100 spill trajectories were simulated over the summer period (October to March).

8.1.1 Sea Surface Exposure and Shoreline Contact

Table 13 presents a summary of the maximum distance and direction travelled by oil on the sea surface at the low (0.1–10 g/m^2), moderate (10–25 g/m^2) and high (>25 g/m^2) exposure thresholds. The maximum distance predicted for low, moderate and high sea surface exposure was 174 km (east) and 1 km (west-north-west) respectively while no exposure at the high threshold was observed.

Table 14 presents the potential sea surface exposure to individual receptors. The results demonstrate that no receptors are exposed at the high threshold (>25 g/m^2) and only the IMCRA - Otway area is exposed to the moderate threshold (10-25 g/m^2). This is due to the location of the release location being within the IMCRA – Otway receptor polygon. Several receptors are predicted to be exposed at the low threshold (0.1-10 g/m^2).

Zones of sea surface exposure over the modelled period are presented in Figure 29 and were predicted to extend predominantly north-west and south-east of the release site, following the shoreline alignment. Figure 30 and Figure 31 present the probability of oil exposure on the sea surface at the low (0.1 ppb) and moderate (10 ppb) thresholds, while Figure 32 and Figure 33 present the minimum time before oil exposure on the sea surface reported at low and moderate thresholds, respectively.

Table 15 presents a summary of the predicted shoreline contact. The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 100% (i.e. all the trajectories simulated were predicted to make shoreline contact at the low contact threshold). The minimum time before oil contact was approximately 21 hours and the maximum volume of oil ashore was 151 m^3. The maximum potential shoreline loading above low, moderate and high shoreline thresholds are presented in Figure 34.

Table 16 summarises the shoreline contact to individual receptors. Three IBRA regions were predicted to be contacted by oil at the low (>1 g/m^2) and moderate (>100 g/m^2) thresholds, with Warrnambool Plain also predicted to be contacted by oil at the high threshold (>1,000 g/m^2). Multiple LGAs (and sub-LGAs) were predicted to be contacted by oil at different thresholds (see Table 16). Otway Ranges, Otway Plain (IBRAs) and Colac Otway (LGA) were predicted to be the first shoreline receptors to be exposed to visible sea surface exposure, at 1 hour.

RPS

Table 13 Maximum distance and direction travelled on the sea surface by a single trajectory from the release location to oil exposure thresholds.

Modelling Period	Distance and direction	Zones of potential sea surface exposure: Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
Summer	Max. distance from release site (km)	174	1	NA
	Max distance from release site (km) (99th percentile)	126	1	NA
	Direction	E	WNW	NA

Table 14 Summary of the potential sea surface exposure to receptors.

Receptor		Probability of oil exposure on the sea surface (%): Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)	Minimum time before oil exposure on the sea surface (hours): Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
SUB-LGA	Apollo Bay	5	0	0	146	-	-
SUB-LGA	Cape Otway West	78	0	0	111	-	-
SUB-LGA	Moonlight Head	99	0	0	26	-	-
SUB-LGA	Port Campbell	100	0	0	24	-	-
SUB-LGA	Bay of Islands	100	0	0	18	-	-
SUB-LGA	Childers Cove	47	0	0	78	-	-
SUB-LGA	Warrnambool	6	0	0	154	-	-
SUB-LGA	Port Fairy	9	0	0	200	-	-
IBRA	Warrnambool Plain	100	0	0	18	-	-
IBRA	Otway Ranges	76	0	0	62	-	-
IBRA	Otway Plain	74	0	0	11	-	-
IMCRA	Otway	100	93	0	1	-	-
IMCRA	Central Victoria	17	0	0	118	-	-
IMCRA	Central Bass Strait	12	0	0	393	-	-
IMCRA	Flinders	3	0	0	2,064	-	-
State Waters	Victoria State Waters	100	0	0	5	-	-

RPS

		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
AMP	Apollo AMP	4	0	0	1,735	-	-
Receptor		**Low (0.1-10 g/m²)**	**Moderate (10-25 g/m²)**	**High (>25 g/m²)**	**Low (0.1-10 g/m²)**	**Moderate (10-25 g/m²)**	**High (>25 g/m²)**
NP	Twelve Apostles Marine National Park	100	0	0	17	-	-
KEF	Bonney Coast Upwelling	32	0	0	90	-	-

Table 15 Summary of oil contact across all shorelines.

Shoreline statistics	
Probability of contact to any shoreline (%)	100
Minimum time for visible oil to shore (hours)	21
Maximum volume of hydrocarbons ashore (m^3)	151
Average volume of hydrocarbons ashore (m^3)	73
Maximum length of the shoreline at **low** (km)	91
Average shoreline length (km) at **low** threshold (km)	64
Maximum length of the shoreline at **moderate** threshold (km)	35
Average shoreline length (km) at **moderate** threshold (km)	21
Maximum length of the shoreline at **high** threshold (km)	4
Average shoreline length (km) at **high** threshold (km)	2

RPS

Table 16 Summary of oil contact to individual shoreline receptors.

Shoreline Receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	
Interim Biogeographic Regionalisation for Australia (IBRA)																	
Warrnambool Plain	100	100	23	21	39	800	110	1,596	73	151	91	35	4	64	21	2	18
Otway Ranges	75	49	0	42	179	-	66	469	2	7	12	1	0	5	1	0	1
Otway Plain	77	50	0	78	150	-	52	289	5	19	21	6	0	9	3	0	1
Local Government Area (LGA)																	
Warrnambool	17	0	0	86	-	-	24	92	<1	3	10	0	0	4	0	0	154
Moyne	100	92	1	21	41	1,710	86	1,132	21	50	37	16	1	21	6	1	18
Corangamite	100	100	22	25	39	800	119	1,596	58	134	53	23	4	44	16	2	24
Colac Otway	78	50	0	64	150	0	48	289	5	19	25	6	0	10	3	0	1
Sub-Local Government Area (Sub-LGA)																	
Apollo Bay	4	0	0	138	-	-	3	6	<1	<1	2	0	0	2	0	0	146
Cape Otway West	78	50	0	64	150	-	48	289	5	19	25	6	0	10	3	0	1
Moonlight Head	99	94	22	27	54	800	133	1,596	34	103	27	14	4	20	9	2	26
Port Campbell	100	100	0	25	39	-	101	821	27	58	26	13	0	24	8	0	24
Bay of Islands	100	92	1	21	41	1,710	91	1,132	20	49	27	13	1	19	6	1	18
Childers Cove	46	12	0	44	139	-	26	233	1	10	17	3	0	5	2	0	78
Warrnambool	9	0	0	125	-	-	18	92	<1	2	2	0	0	1	0	0	154
Port Fairy	10	0	0	152	-	-	26	89	<1	4	12	0	0	6	0	0	200

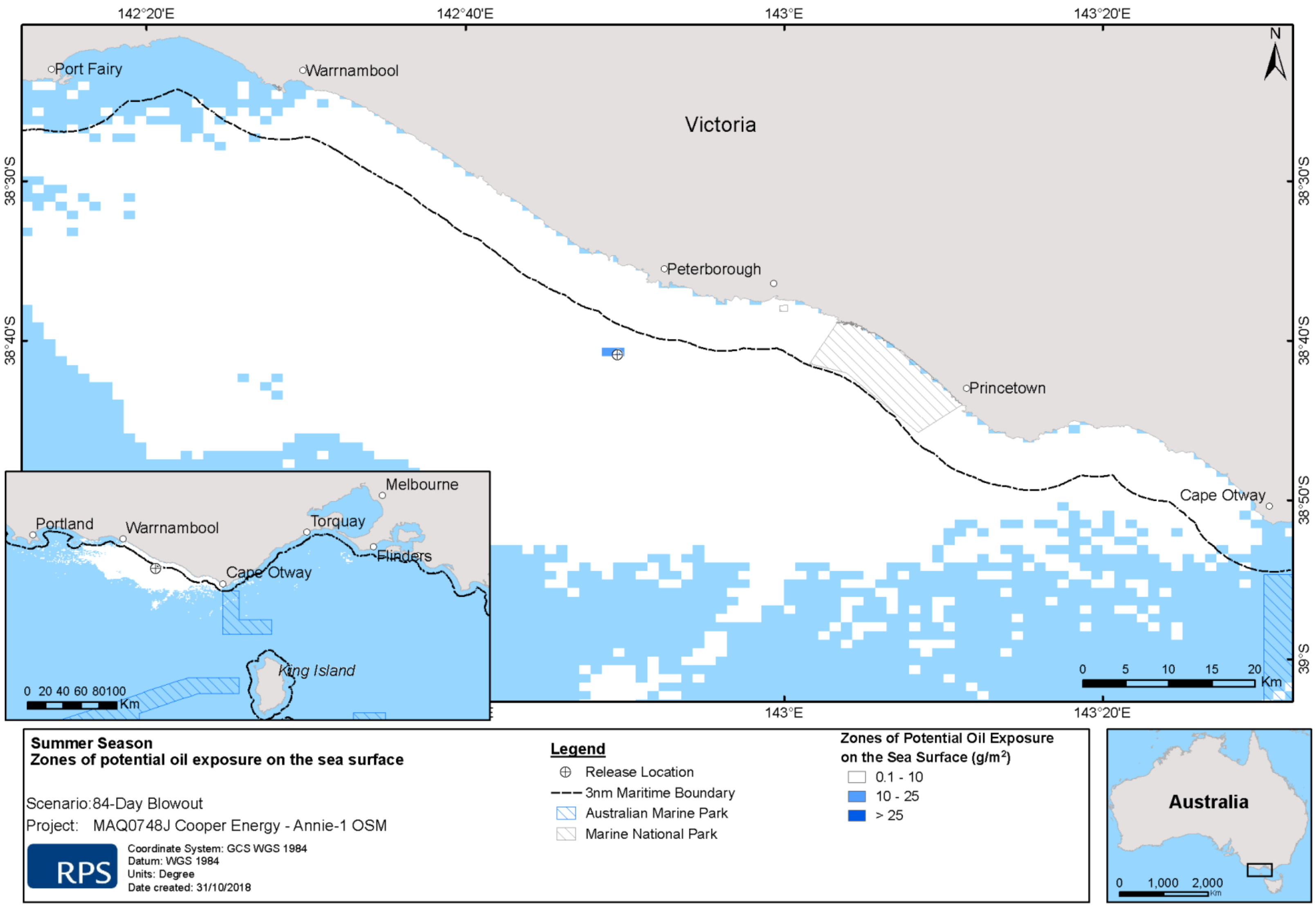

Figure 29 Zones of potential oil exposure on the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

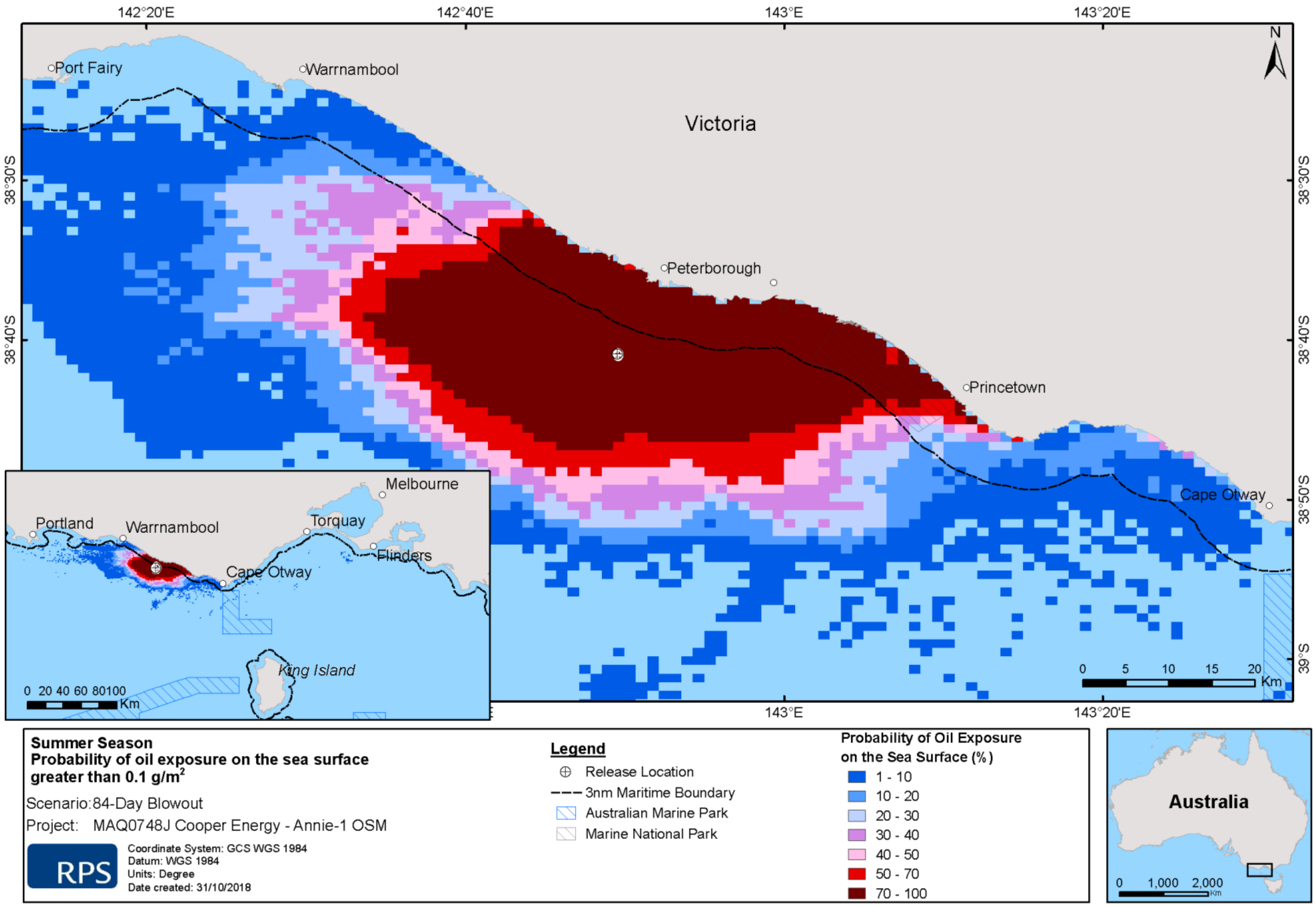

Figure 30 Probability of oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

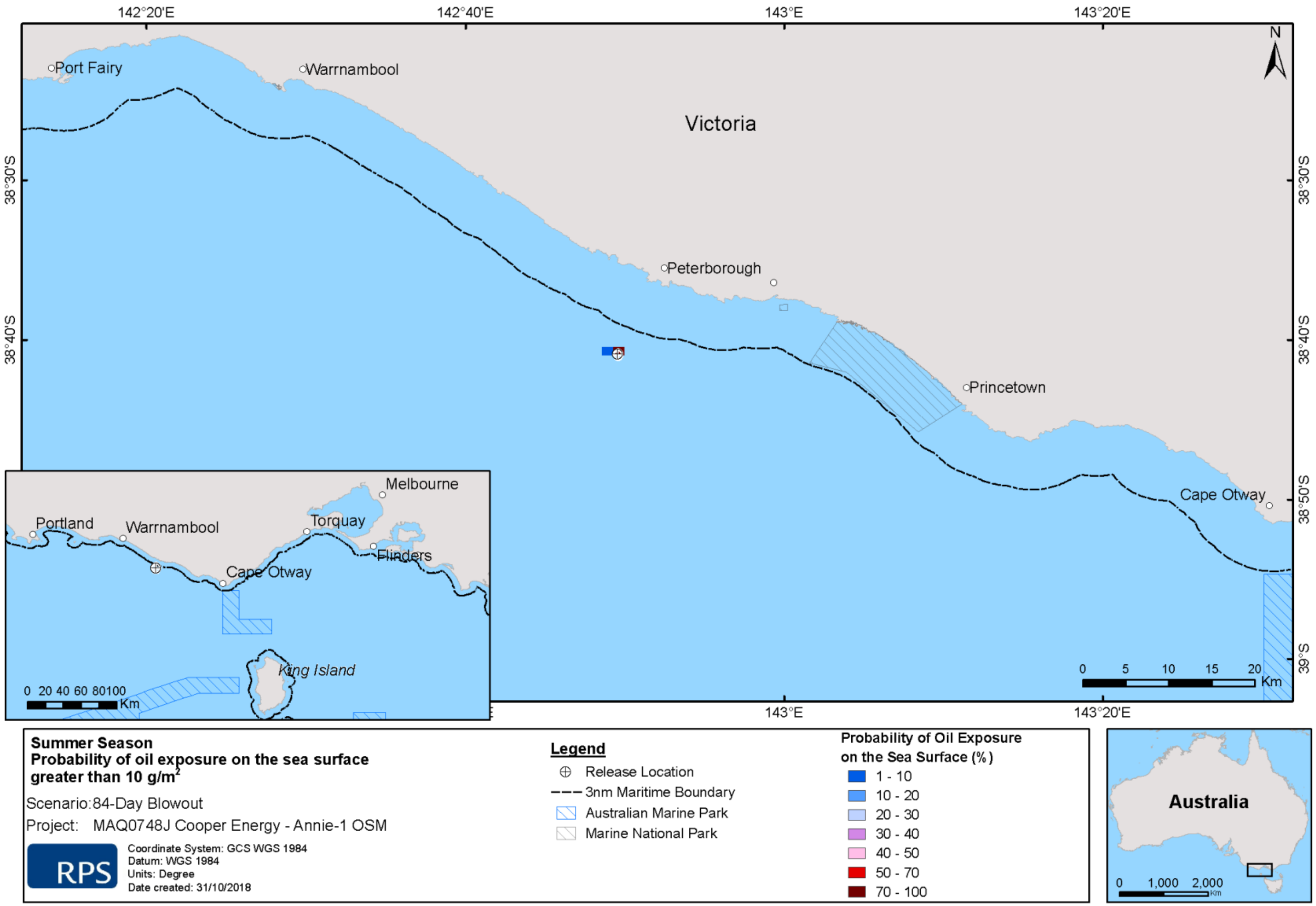

Figure 31 **Probability of oil exposure on the sea surface for the moderate threshold (10 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.**

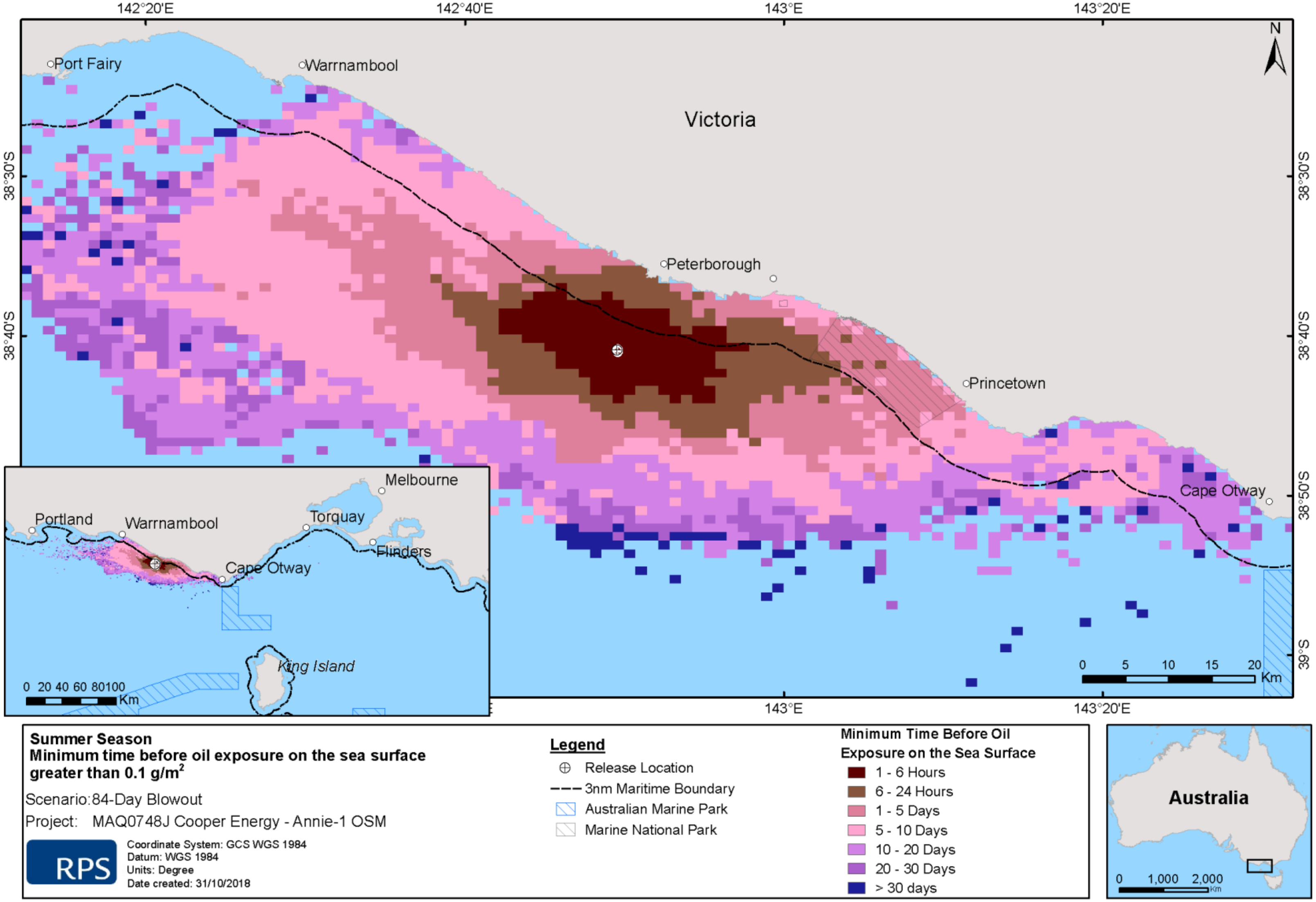

Figure 32 Minimum time before oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

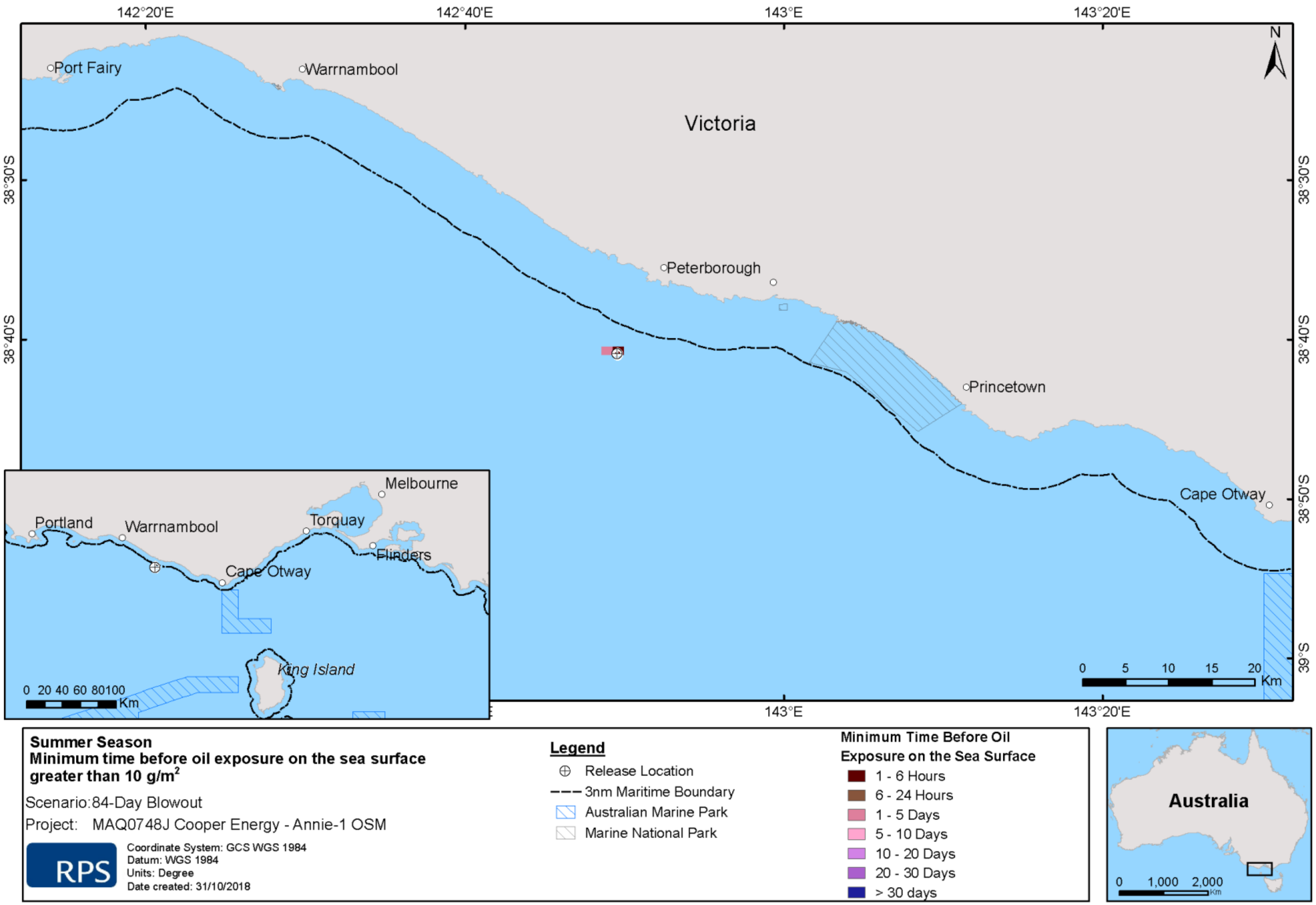

Figure 33 Minimum time before oil exposure on the sea surface for the low threshold (10 g/m²), in the event of a 24,113 m³ subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

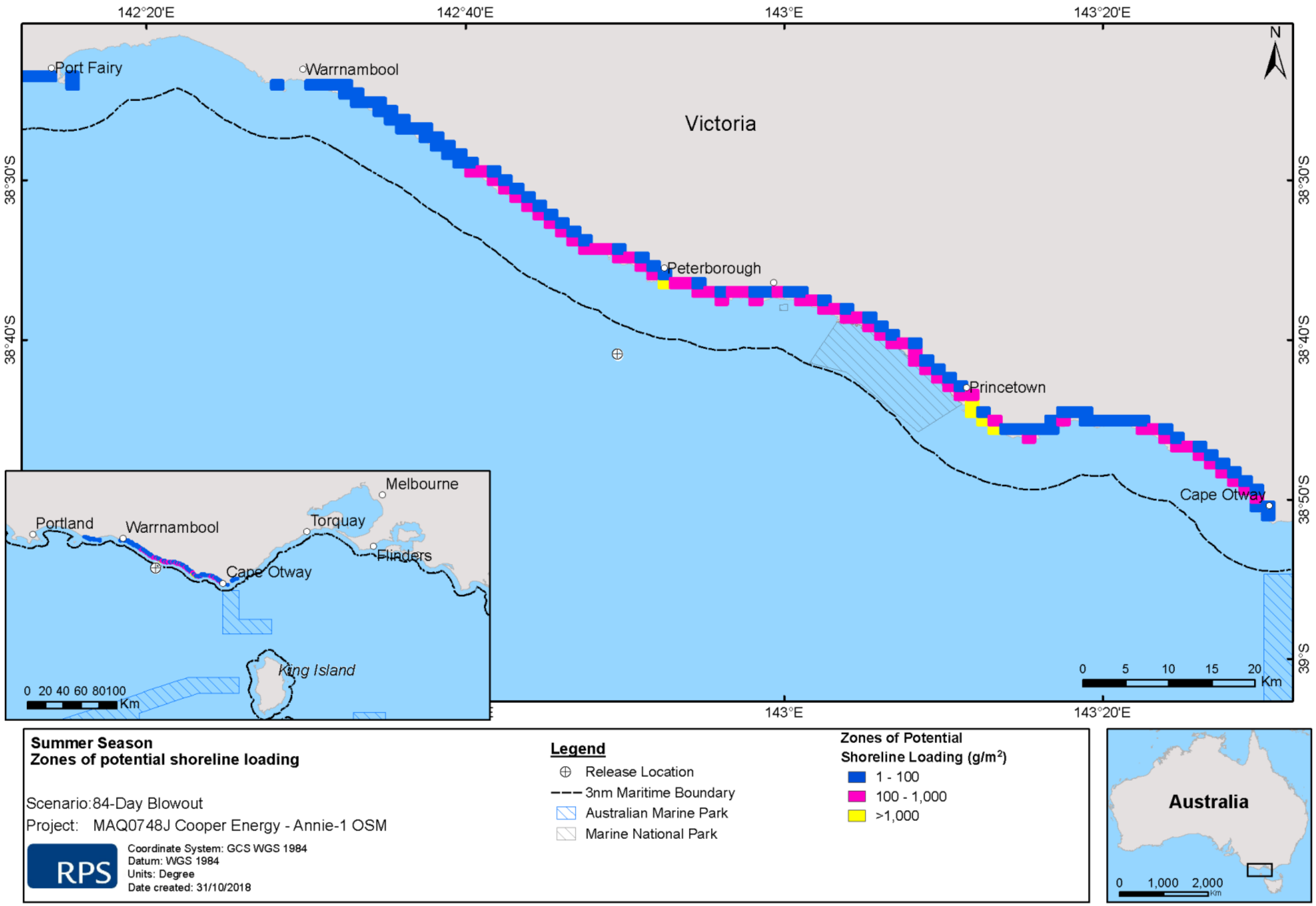

Figure 34 Maximum potential shoreline loading for the low (1 g/m^2) moderate (100 g/m^2) and high (>1,000 g/m^2) thresholds. Results were based on a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days.

8.1.2 Water Column Exposure

8.1.2.1 Dissolved Hydrocarbons

Table 17 to Table 20 summarise the predicted probability (at each threshold) and maximum exposures (instantaneous and time-averaged) to dissolved hydrocarbons to shoreline, environmental and biological receptors for the summer period at the depths of 0-10 m, 10-20 m, 20-40 m and 40-60 m, respectively.

Figure 35 to Figure 37 show the potential zones of low (1 ppb), moderate (10 ppb) and high (300 ppb) time-averaged exposure to dissolved hydrocarbons for the summer period. The largest extent was in the surface layer of the water column (0-10 m). At this depth low dissolved hydrocarbon exposure was shown to extend 130 km west towards Portland and 124 km east from the release location towards Torquay. Moderate dissolved hydrocarbon exposure was observed up to 52 km east from the release site towards Cape Otway.

RPS

Table 17 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 0–10 m below the sea surface during Summer. Results are based on a 1850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Wilsons Promontory (West)	1	<1	0	0	0
SUB-LGA	Waratah Bay	1	<1	0	0	0
SUB-LGA	Cape Liptrap (NW)	1	<1	0	0	0
SUB-LGA	Venus Bay	1	<1	0	0	0
SUB-LGA	Kilcunda	1	<1	0	0	0
SUB-LGA	French Island / San Remo	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (S)	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (SW)	1	<1	0	0	0
SUB-LGA	Port Phillip (Sorrento Shore)	1	<1	0	0	0
SUB-LGA	Port Phillip (Queenscliff)	1	<1	0	0	0
SUB-LGA	Torquay	1	<1	0	0	0
SUB-LGA	Anglesea	1	<1	0	0	0
SUB-LGA	Lorne	2	<1	0	0	0
SUB-LGA	Cape Patton	3	<1	0	0	0
SUB-LGA	Apollo Bay	13	2	8	0	0
SUB-LGA	Cape Otway West	43	12	88	5	0
SUB-LGA	Moonlight Head	92	35	100	61	0
SUB-LGA	Port Campbell	70	22	100	43	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Bay of Islands	48	19	100	24	0
SUB-LGA	Childers Cove	40	14	37	5	0
SUB-LGA	Warrnambool	14	3	20	0	0
SUB-LGA	Port Fairy	10	4	11	0	0
SUB-LGA	Portland Bay (East)	3	1	3	0	0
SUB-LGA	Portland Bay (West)	2	<1	0	0	0
SUB-LGA	Cape Nelson	11	3	6	0	0
SUB-LGA	Discovery Bay (East)	1	<1	0	0	0
SUB-LGA	Discovery Bay (West)	1	<1	0	0	0
IBRA	Glenelg Plain	11	3	6	0	0
IBRA	Bridgewater	4	<1	0	0	0
IBRA	Warrnambool Plain	92	35	100	61	0
IBRA	Otway Ranges	64	16	94	14	0
IBRA	Otway Plain	43	12	88	5	0
IBRA	Gippsland Plain	1	<1	0	0	0
IBRA	Strzelecki Ranges	1	<1	0	0	0
IBRA	Wilsons Promontory	3	<1	0	0	0
IMCRA	Otway	92	39	100	100	0
IMCRA	Victorian Embayments	1	<1	0	0	0
IMCRA	Central Victoria	15	1	2	0	0

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
IMCRA	Central Bass Strait	10	1	1	0	0
IMCRA	Flinders	3	<1	0	0	0
State Waters	Victoria State Waters	92	35	100	98	0
AMP	Apollo AMP	13	2	6	0	0
NP	Point Addis Marine National Park	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	75	26	100	60	0
NP	Discovery Bay Marine National Park	4	<1	0	0	0
NP	Bunurong Marine National Park	1	<1	0	0	0
RSB	Cody Bank	1	<1	0	0	0
KEF	West Tasmania Canyons	1	<1	0	0	0
KEF	Bonney Coast Upwelling	18	4	21	0	0

RPS

Table 18 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 10–20 m below the sea surface during Summer. Results are based on a 1850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Clonmel Island	1	<1	0	0	0
SUB-LGA	French Island / San Remo	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (SW)	1	<1	0	0	0
SUB-LGA	Torquay	1	<1	0	0	0
SUB-LGA	Anglesea	1	<1	0	0	0
SUB-LGA	Lorne	2	<1	0	0	0
SUB-LGA	Cape Patton	3	<1	0	0	0
SUB-LGA	Apollo Bay	8	<1	0	0	0
SUB-LGA	Cape Otway West	23	4	52	0	0
SUB-LGA	Moonlight Head	44	5	83	0	0
SUB-LGA	Port Campbell	56	8	88	0	0
SUB-LGA	Bay of Islands	20	3	55	0	0
SUB-LGA	Childers Cove	14	2	6	0	0
SUB-LGA	Warrnambool	10	1	2	0	0
SUB-LGA	Port Fairy	9	<1	0	0	0
SUB-LGA	Portland Bay (East)	2	<1	0	0	0
SUB-LGA	Portland Bay (West)	1	<1	0	0	0
SUB-LGA	Cape Nelson	6	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Discovery Bay (East)	1	<1	0	0	0
IBRA	Glenelg Plain	6	<1	0	0	0
IBRA	Bridgewater	3	<1	0	0	0
IBRA	Warrnambool Plain	56	8	88	0	0
IBRA	Otway Ranges	20	4	44	0	0
IBRA	Otway Plain	23	3	52	0	0
IBRA	Gippsland Plain	1	<1	0	0	0
IBRA	Wilsons Promontory	2	<1	0	0	0
IMCRA	Otway	58	10	97	1	0
IMCRA	Victorian Embayments	1	<1	0	0	0
IMCRA	Central Victoria	12	2	1	0	0
IMCRA	Central Bass Strait	11	<1	0	0	0
IMCRA	Flinders	2	<1	0	0	0
State Waters	Victoria State Waters	58	10	97	1	0
AMP	Apollo AMP	11	<1	0	0	0
NP	Point Addis Marine National Park	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	41	7	93	0	0
NP	Discovery Bay Marine National Park	2	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
NP	Bunurong Marine National Park	1	<1	0	0	0
RAMSAR	Western Port	1	<1	0	0	0
KEF	West Tasmania Canyons	1	<1	0	0	0
KEF	Bonney Coast Upwelling	14	2	2	0	0

RPS

Table 19 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 20–40 m below the sea surface during Summer. Results are based on a 1850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Lorne	1	<1	0	0	0
SUB-LGA	Cape Patton	1	<1	0	0	0
SUB-LGA	Apollo Bay	3	<1	0	0	0
SUB-LGA	Cape Otway West	4	<1	0	0	0
SUB-LGA	Moonlight Head	12	1	1	0	0
SUB-LGA	Port Campbell	9	2	2	0	0
SUB-LGA	Bay of Islands	6	<1	0	0	0
SUB-LGA	Childers Cove	4	<1	0	0	0
SUB-LGA	Warrnambool	2	<1	0	0	0
SUB-LGA	Port Fairy	2	<1	0	0	0
SUB-LGA	Portland Bay (East)	1	<1	0	0	0
SUB-LGA	Cape Nelson	1	<1	0	0	0
IBRA	Glenelg Plain	1	<1	0	0	0
IBRA	Bridgewater	1	<1	0	0	0
IBRA	Warrnambool Plain	12	2	2	0	0
IBRA	Otway Ranges	6	<1	0	0	0
IBRA	Otway Plain	3	<1	0	0	0
IBRA	Wilsons Promontory	1	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
IMCRA	Otway	15	2	2	0	0
IMCRA	Central Victoria	5	<1	0	0	0
IMCRA	Central Bass Strait	3	<1	0	0	0
IMCRA	Flinders	1	<1	0	0	0
State Waters	Victoria State Waters	15	2	2	0	0
AMP	Apollo AMP	2	<1	0	0	0
NP	Point Addis Marine National Park	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	12	2	2	0	0
NP	Discovery Bay Marine National Park	1	<1	0	0	0
KEF	Bonney Coast Upwelling	3	<1	0	0	0

RPS

Table 20 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 40–60 m below the sea surface during Summer. Results are based on a 1850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Otway West	1	<1	0	0	0
SUB-LGA	Moonlight Head	1	<1	0	0	0
IBRA	Warrnambool Plain	1	<1	0	0	0
IBRA	Otway Ranges	1	<1	0	0	0
IBRA	Otway Plain	1	<1	0	0	0
IMCRA	Otway	1	<1	0	0	0
State Waters	Victoria State Waters	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	1	<1	0	0	0

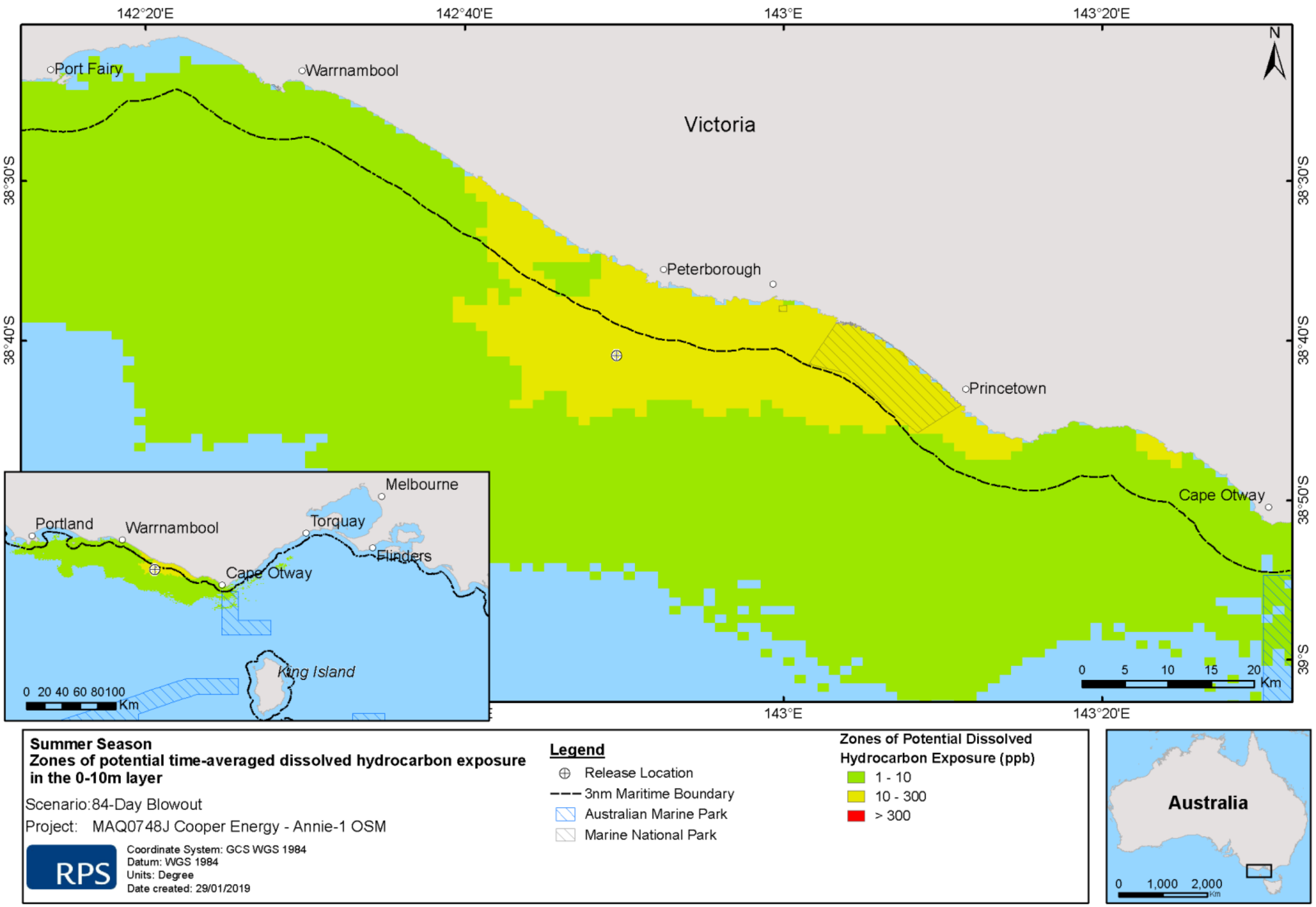

Figure 35 Zones of potential time-averaged dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during summer conditions.

RPS

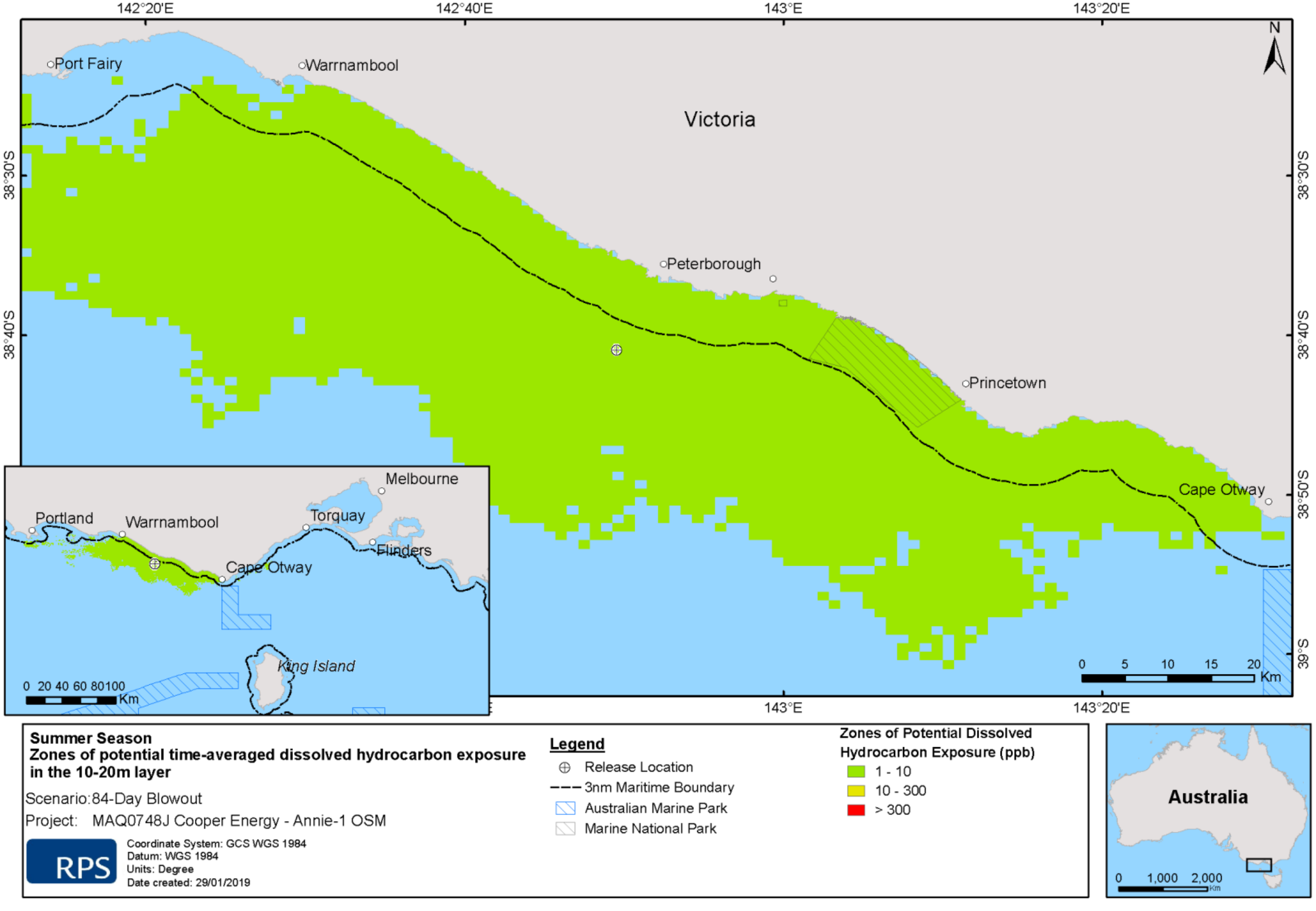

Figure 36 Zones of potential time-averaged dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during summer conditions.

RPS

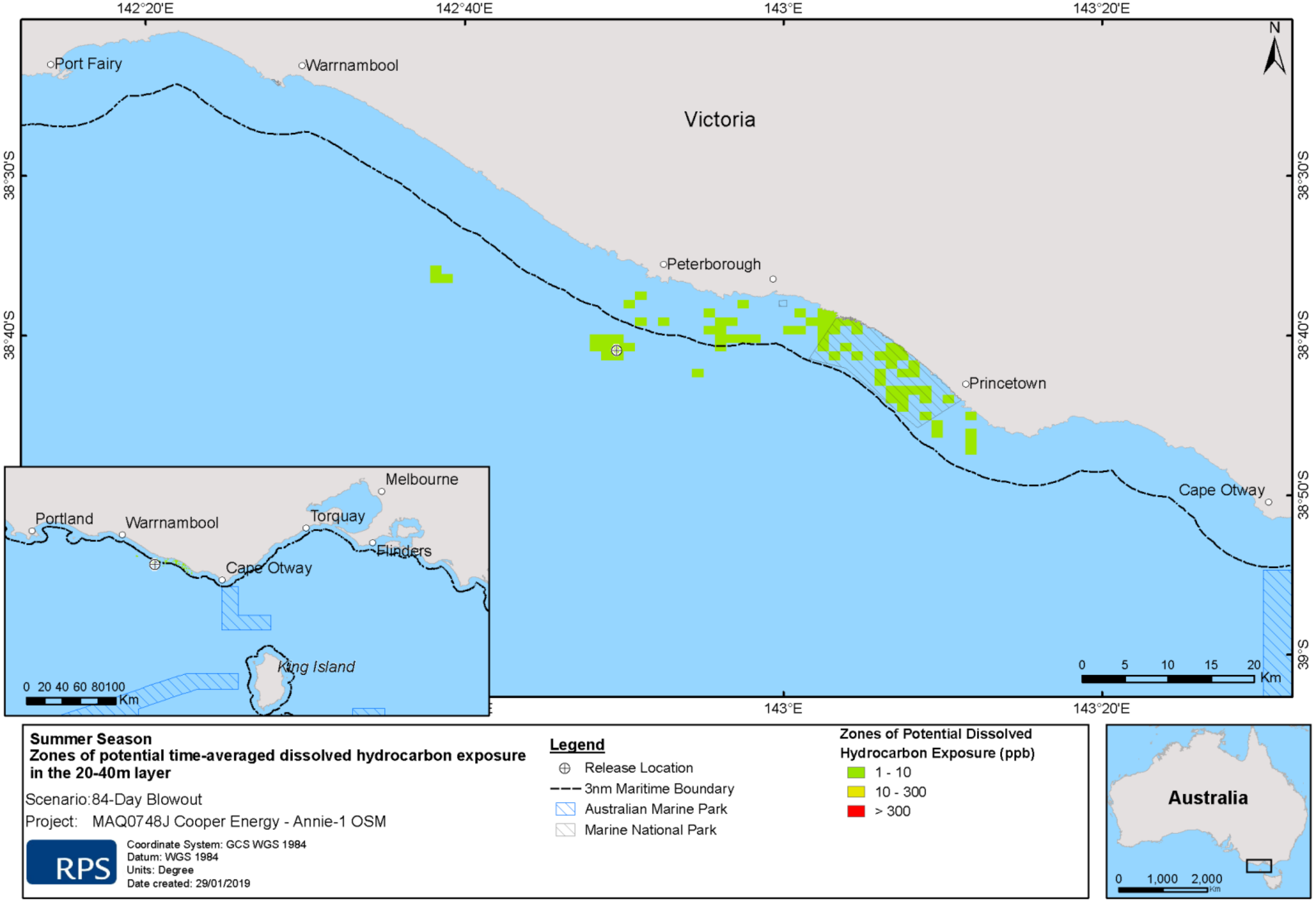

Figure 37 Zones of potential time-averaged dissolved hydrocarbon exposure at 20-40 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during summer conditions.

8.1.2.2 Entrained Hydrocarbons

Table 21 summarises the predicted probability (at each threshold) and maximum exposures (instantaneous and time averaged) to entrained hydrocarbons to shorelines, state waters and KEFs for the summer period at the depths of 0-10 m. The IMCRA Otway was predicted to have the highest probability of exposure at the low threshold (100%). This is due to the location of the release location being within the IMCRA – Otway receptor polygon. No entrained hydrocarbons were observed at levels of concern at deeper layers.

Figure 38 show the potential zones of low (100 ppb), moderate (1,000 ppb) and high (30,000 ppb) time-averaged exposure to entrained hydrocarbons for the summer period. In the 0-10 m depth layer, low entrained hydrocarbon exposure was predicted up to 31 km north-west of the release location, between Warrnambool and Peterborough and nearly 67km south-east just beyond Cape Otway. There was no exposure at the moderate threshold.

RPS

Table 21 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons, at 0–10 m below the sea surface Results are based on a 1850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
SUB-LGA	Apollo Bay	147	107	2	0	0
SUB-LGA	Cape Otway West	337	301	74	0	0
SUB-LGA	Moonlight Head	602	507	95	0	0
SUB-LGA	Port Campbell	488	393	91	0	0
SUB-LGA	Bay of Islands	407	284	61	0	0
SUB-LGA	Childers Cove	207	163	15	0	0
SUB-LGA	Warrnambool	107	95	0	0	0
SUB-LGA	Port Fairy	130	75	0	0	0
SUB-LGA	Cape Nelson	104	96	0	0	0
IBRA	Glenelg Plain	104	96	0	0	0
IBRA	Bridgewater	103	96	0	0	0
IBRA	Warrnambool Plain	602	507	95	0	0
IBRA	Otway Ranges	317	214	63	0	0
IBRA	Otway Plain	337	301	74	0	0
IMCRA	Otway	829	507	100	0	0
IMCRA	Central Victoria	115	91	0	0	0
IMCRA	Central Bass Strait	113	62	0	0	0
State Waters	Victoria State Waters	602	507	100	0	0

RPS

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
AMP	Apollo AMP	131	72	0	0	0
NP	Twelve Apostles Marine National Park	502	462	96	0	0
KEF	Bonney Coast Upwelling	112	96	0	0	0

RPS

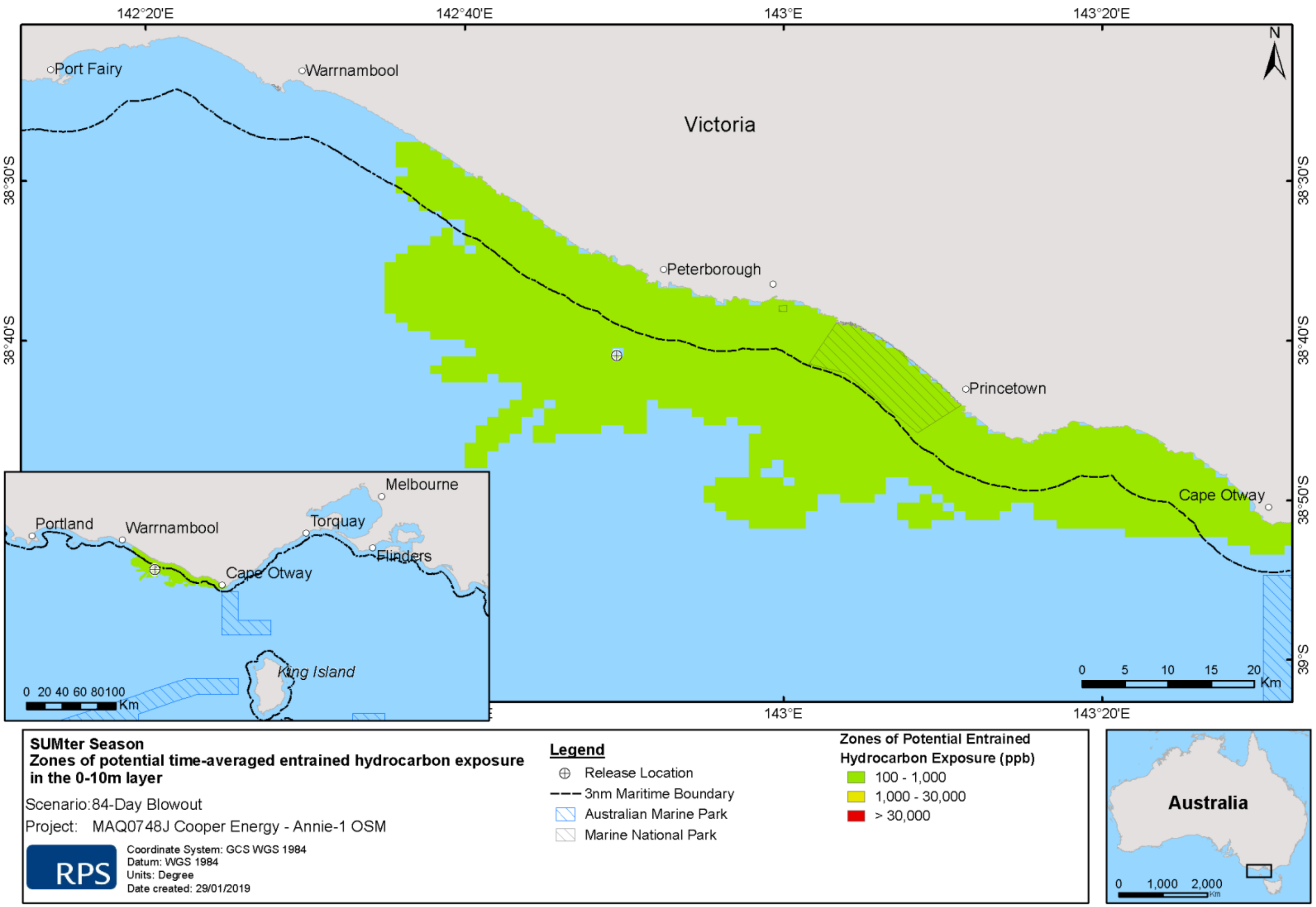

Figure 38 Zones of potential time-averaged entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during summer conditions.

RPS

8.2 RESULTS: 1,805 BBL/D RELEASE OF CONDENSATE FROM ANNIE-1 WELL BLOWOUT OVER 84 DAYS UNDER WINTER CONDITIONS

The scenario examined an 84-day subsea release of condensate following a well blowout incident at the Annie-1 release site, tracked for a period of 120 days. A total of 100 spill trajectories were simulated the winter period (April to September).

8.2.1 Sea Surface Exposure and Shoreline Contact

Table 22 presents a summary of the maximum distance and direction travelled by oil on the sea surface at the low (0.1–10 g/m^2), moderate (10–25 g/m^2) and high (>25 g/m^2) exposure thresholds. The maximum distance predicted for low, moderate and high sea surface exposure was 272 km (east) and 1 km (west-north-west) respectively while no exposure at the high threshold was observed.

Table 23 presents the potential sea surface exposure to individual receptors. The results demonstrate that no receptors are exposed at the high threshold (>25 g/m^2). The only receptors exposed to surface oil contact at the moderate threshold (10-25 g/m^2) are the IMCRA – Otway, and the three sub-LGAs closer to the release location, Bay of Islands, Port Campbell and Moonlight Head. Several receptors are exposed at the low threshold (0.1-10 g/m^2).

Zones of sea surface exposure over the modelled period are presented in Figure 39 and were predicted to extend predominantly southeast of the release site, in line with the current characteristics during the winter season. Figure 40 and Figure 41 present the probability of oil exposure on the sea surface at the low and moderate thresholds, while Figure 42 and Figure 43 present the minimum time before oil exposure on the sea surface reported at low and moderate thresholds, respectively.

Table 24 presents a summary of the predicted shoreline contact. The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 100% (i.e. all the trajectories simulated were predicted to make shoreline contact at the low contact threshold). The minimum time before oil contact was approximately 17 hours and the maximum volume of oil was 199 m^3. The maximum potential shoreline loading above low, moderate and high shoreline thresholds are presented in Figure 44.

Table 25 summarises the shoreline contact to individual receptors. Three IBRA regions were predicted to be contacted by oil at the low (>1 g/m^2) and moderate (>100 g/m^2) thresholds, with Warrnambool Plain predicted to be contacted by oil at the high threshold (>1,000 g/m^2). Multiple LGAs (including sub-LGAs) were predicted to be contacted by oil at different thresholds (see Table 25). Otway Ranges, Otway Plain (IBRAs) and Colac Otway (LGA) were predicted to be the first shoreline receptors to be exposed to visible sea surface exposure, at 1 hour.

RPS

Table 22 Maximum distance and direction travelled on the sea surface by a single trajectory from the release location to oil exposure thresholds.

Modelling Period	Distance and direction	Zones of potential sea surface exposure		
		Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
Winter	Max. distance from release site (km)	275	1	-
	Max distance from release site (km) (99th percentile)	183	1	-
	Direction	E	WNW	-

Table 23 Summary of the potential sea surface exposure to receptors.

Receptor		Probability of oil exposure on the sea surface (%)			Minimum time before oil exposure on the sea surface (hours)		
		Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)	Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
SUB-LGA	Kilcunda	2	0	0	999	-	-
SUB-LGA	Lorne	2	0	0	260	-	-
SUB-LGA	Cape Patton	9	0	0	206	-	-
SUB-LGA	Apollo Bay	31	0	0	83	-	-
SUB-LGA	Cape Otway West	95	0	0	51	-	-
SUB-LGA	Moonlight Head	100	34	0	19	-	-
SUB-LGA	Port Campbell	100	66	0	25	-	-
SUB-LGA	Bay of Islands	100	64	0	19	-	-
SUB-LGA	Childers Cove	31	0	0	146	-	-
SUB-LGA	Warrnambool	9	0	0	157	-	-
SUB-LGA	Port Fairy	1	0	0	684	-	-
IBRA	Warrnambool Plain	100	0	0	19	-	-
IBRA	Otway Ranges	95	0	0	57	-	-
IBRA	Otway Plain	95	0	0	51	-	-
IBRA	Gippsland Plain	2	0	0	999	-	-
IMCRA	Otway	100	92	0	1	3	-
IMCRA	Central Victoria	62	0	0	62	-	-

RPS

Receptor		Probability of oil exposure on the sea surface (%) Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)	Minimum time before oil exposure on the sea surface (hours) Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
IMCRA	Central Bass Strait	68	0	0	64	-	-
IMCRA	Flinders	11	0	0	354	-	-
State Waters	Victoria State Waters	100	0	0	6	-	-
AMP	Apollo AMP	54	0	0	45	-	-
NP	Point Addis Marine National Park	1	0	0	398	-	-
NP	Twelve Apostles Marine National Park	100	0	0	19	-	-
KEF	Bonney Coast Upwelling	4	0	0	172	-	-

Table 24 Summary of oil contact across all shorelines.

Shoreline statistics	
Probability of contact to any shoreline (%)	100
Minimum time for visible oil to shore (hours)	17
Maximum volume of hydrocarbons ashore (m^3)	199
Average volume of hydrocarbons ashore (m^3)	98
Maximum length of the shoreline at **low** (km)	100
Average shoreline length (km) at **low** threshold (km)	65
Maximum length of the shoreline at **moderate** threshold (km)	42
Average shoreline length (km) at **moderate** threshold (km)	24
Maximum length of the shoreline at **high** threshold (km)	3
Average shoreline length (km) at **high** threshold (km)	1

RPS

Table 25 Summary of oil contact to individual shoreline receptors.

Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	
Interim Biogeographic Regionalisation for Australia (IBRA)																	
Warrnambool Plain	100	100	40	17	44	198	139	2,103	98	199	100	42	2	65	24	1	19
Otway Ranges	93	80	1	27	110	1,986	85	1,042	5	16	26	2	1	6	1	1	1
Otway Plain	95	72	0	47	113	-	54	353	9	24	26	10	0	16	4	0	1
Local Government Area (LGA)																	
Warrnambool	20	12	0	147	187	-	39	218	1	9	13	3	0	8	2	0	157
Moyne	100	96	0	17	48	-	95	804	20	44	40	13	0	19	6	0	19
Corangamite	100	100	40	17	44	198	155	2,103	85	167	55	30	3	48	19	1	19
Colac Otway	95	72	0	47	113	-	50	353	10	24	44	11	0	18	4	0	1
Surf Coast	2	0	0	234	-	-	5	6	<1	<1	1	0	0	1	0	0	-
Sub-Local Government Area (Sub-LGA)																	
Lorne	2	0	0	224	-	-	16	40	<1	1	6	0	0	5	0	0	260
Cape Patton	8	0	0	140	-	-	12	33	<1	2	10	0	0	3	0	0	206
Apollo Bay	21	0	0	92	-	-	8	31	<1	1	7	0	0	2	0	0	83
Cape Otway West	95	72	0	47	113	-	52	353	10	24	30	11	0	17	4	0	1
Moonlight Head	100	100	38	17	44	290	204	2,103	60	113	29	15	3	24	12	1	19
Port Campbell	100	100	3	19	44	198	104	1,248	29	68	26	17	2	24	7	1	25
Bay of Islands	100	96	0	17	48	-	99	804	19	44	27	13	0	17	6	0	19
Childers Cove	30	13	0	97	499	-	39	228	2	20	27	7	0	10	3	0	146

RPS

Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	
Warrnambool	11	5	0	150	187	-	30	218	<1	5	6	1	0	3	1	0	157
Port Fairy	1	0	0	670	-	-	29	94	<1	3	9	0	0	9	0	0	684

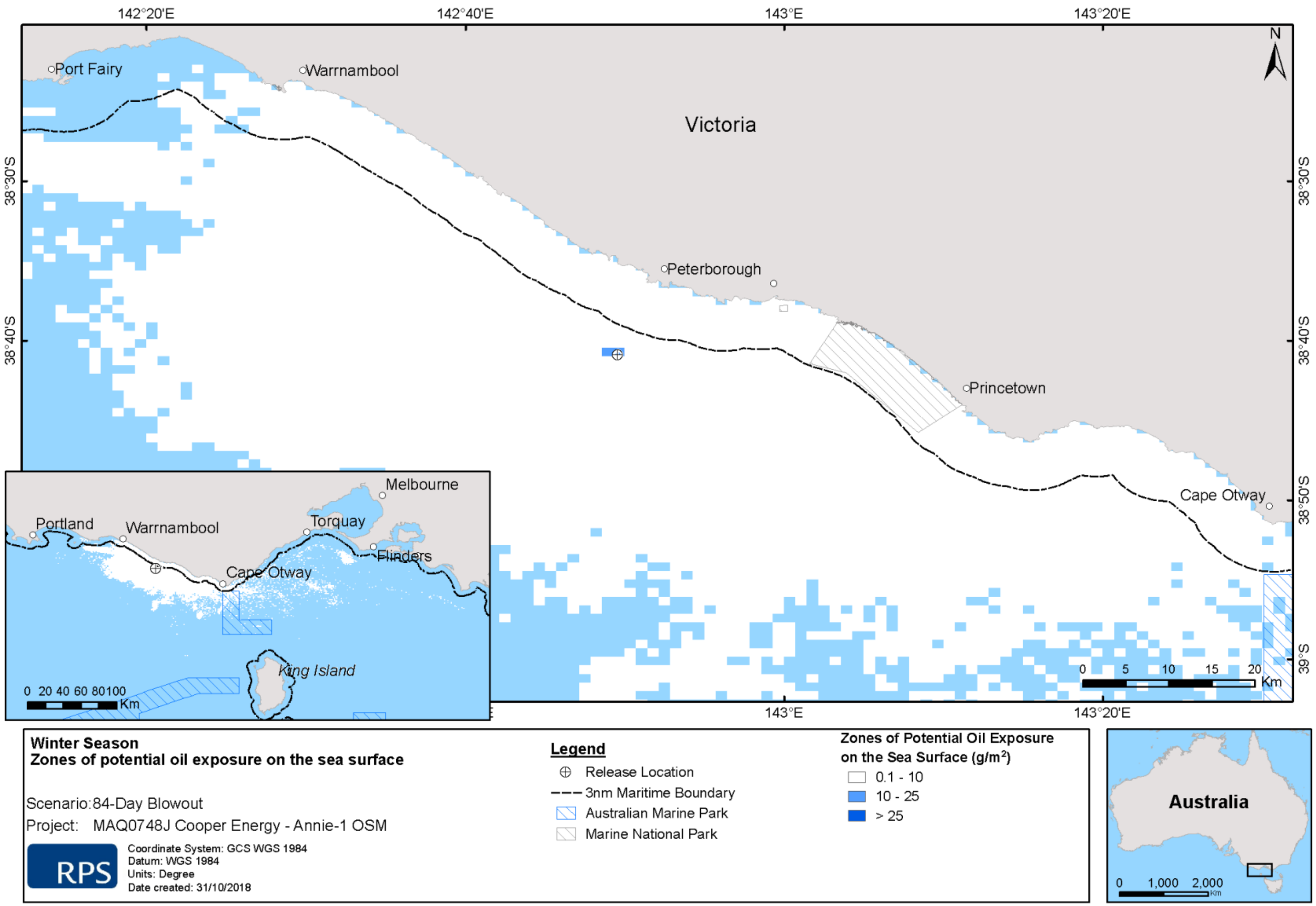

Figure 39 Zones of potential oil exposure on the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

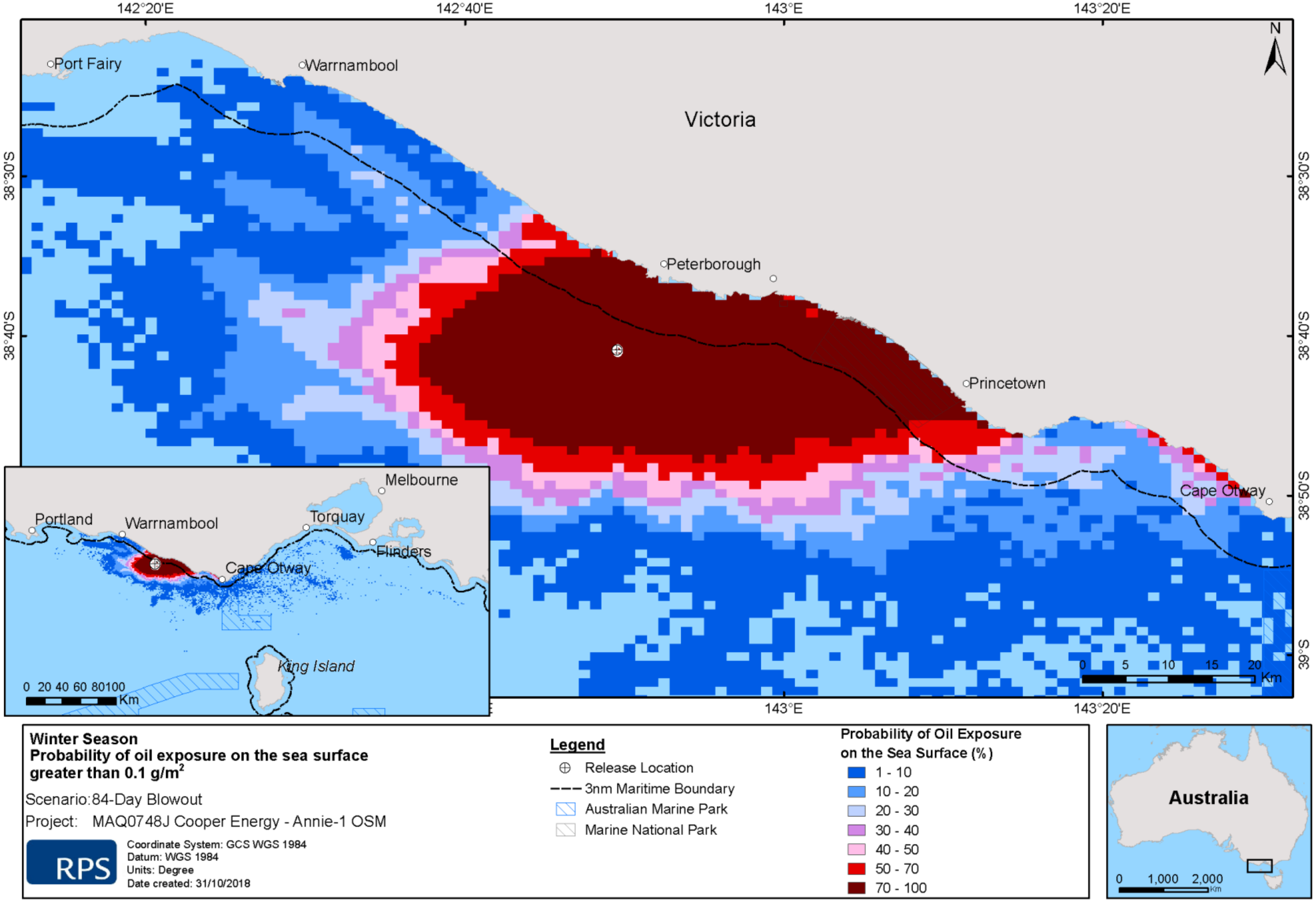

Figure 40 Probability of oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.

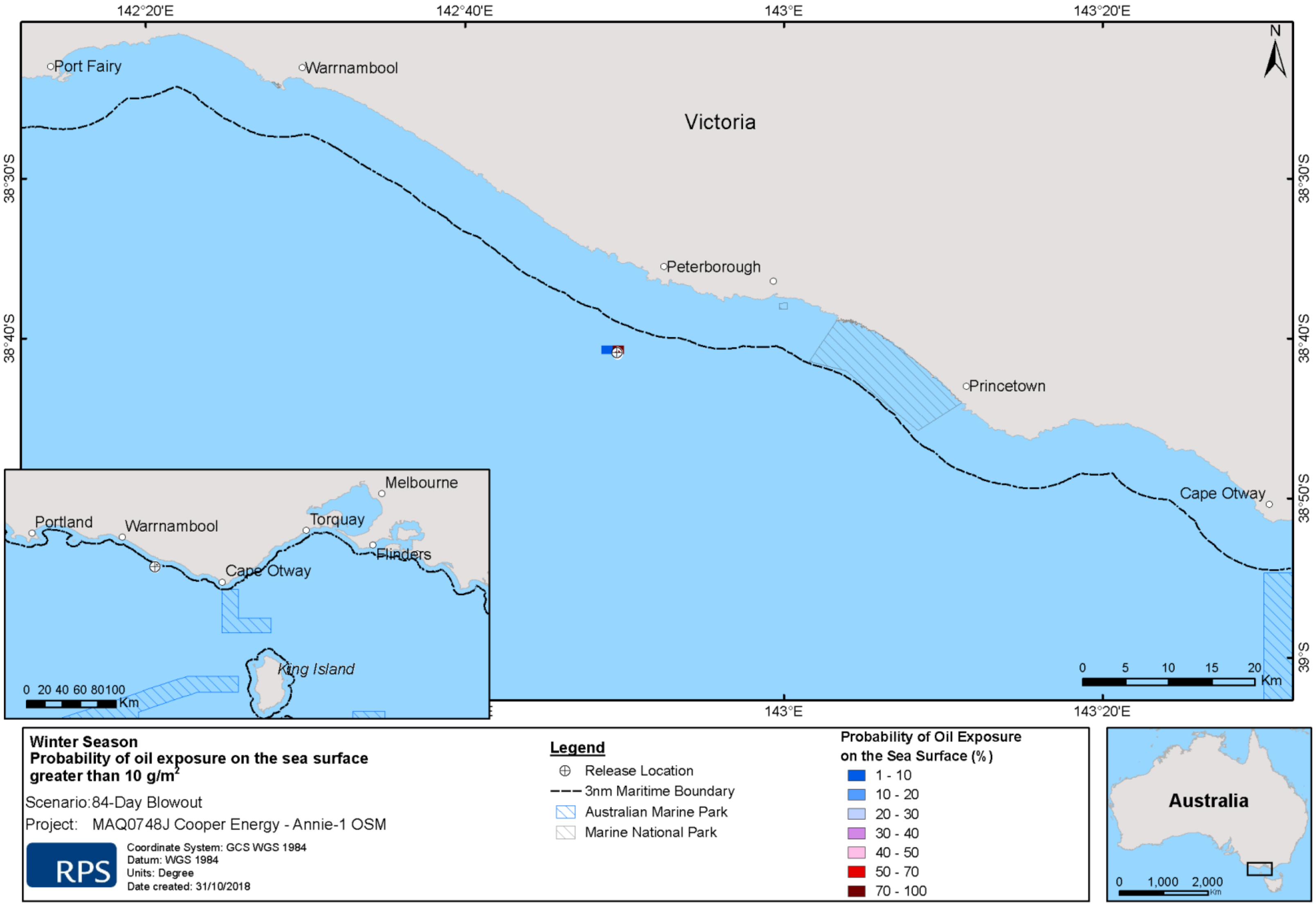

Figure 41 **Probability of oil exposure on the sea surface for the low threshold (10 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.**

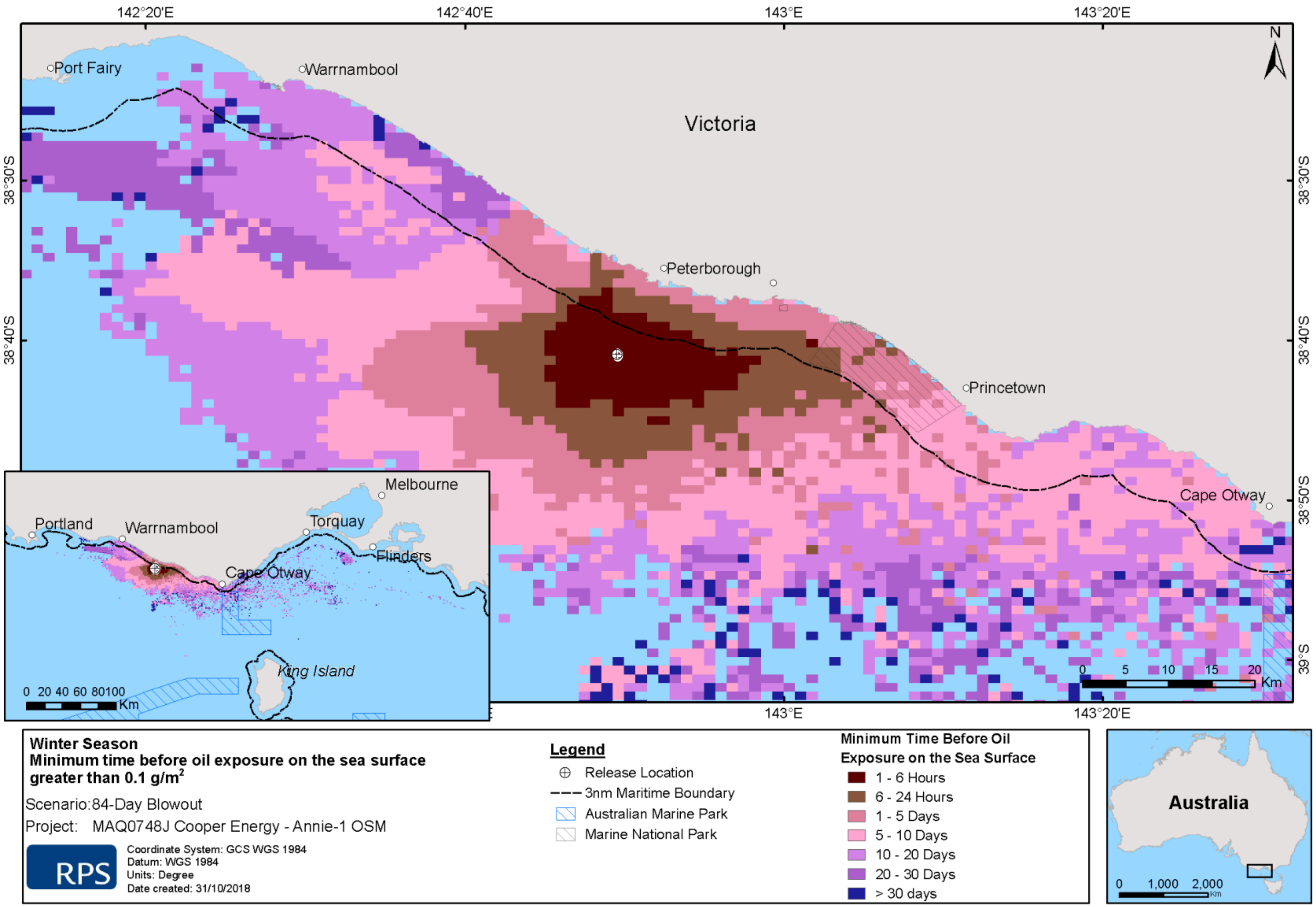

Figure 42 **Minimum time before oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.**

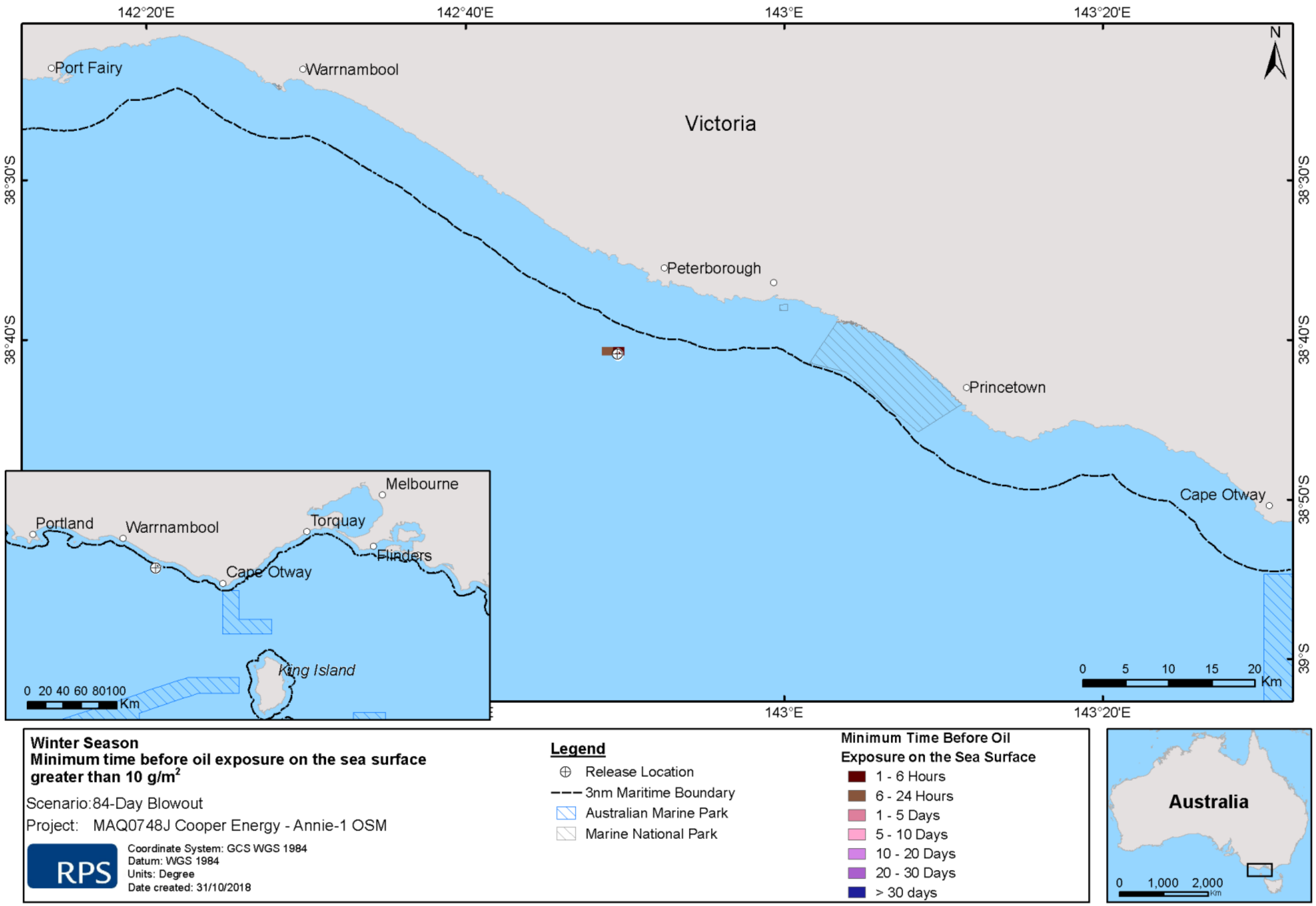

Figure 43 **Minimum time before oil exposure on the sea surface for the low threshold (10 g/m^2), in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories.**

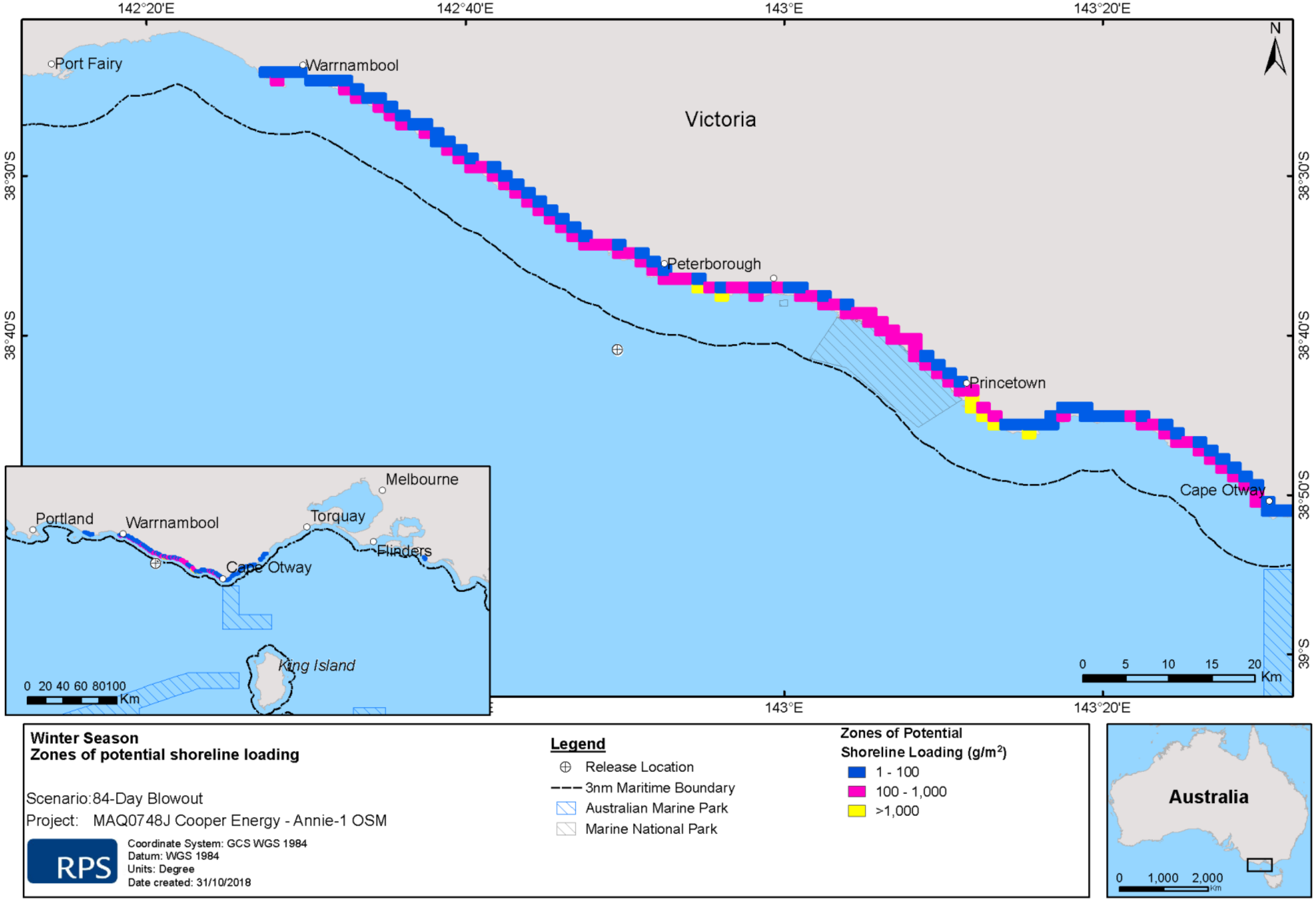

Figure 44 **Maximum potential shoreline loading for the low (1 g/m^2) moderate (100 g/m^2) and high (>1,000 g/m^2) thresholds. Results were based on a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days.**

8.2.2 Water Column Exposure

8.2.2.1 Dissolved Hydrocarbons

Table 26 and Table 29 summarise the predicted probability (at each threshold) and maximum exposures (instantaneous and time-averaged) to dissolved hydrocarbons to shoreline, environmental and biological receptors for the winter period at the depths of 0-10 m, 10-20 m, 20-40 m and 40-60 m, respectively.

Figure 45 and Figure 47 shows the potential zones of low (1 ppb), moderate (10 ppb) and high (300 ppb) time-averaged exposure to dissolved hydrocarbons for the winter period. In the 0-10 m depth layer, low dissolved hydrocarbon exposure was predicted up to 82 km north-west just past Yambuk and 156 km east beyond Torquay. Moderate dissolved hydrocarbon exposure was observed up to 36 km northwest from the release site towards Warrnambool and up to 56 km south-east from the release site towards Cape Otway.

RPS

Table 26 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 0–10 m below the sea surface during winter. Results are based on a 1,850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Clonmel Island	1	<1	0	0	0
SUB-LGA	Snake Island	1	<1	0	0	0
SUB-LGA	Corner Inlet	1	<1	0	0	0
SUB-LGA	Wilsons Promontory (NE)	1	<1	0	0	0
SUB-LGA	Wilsons Promontory (East)	1	<1	0	0	0
SUB-LGA	Wilsons Promontory (West)	2	<1	0	0	0
SUB-LGA	Waratah Bay	2	<1	0	0	0
SUB-LGA	Cape Liptrap (NW)	2	<1	0	0	0
SUB-LGA	Venus Bay	1	<1	0	0	0
SUB-LGA	Kilcunda	2	<1	0	0	0
SUB-LGA	French Island / San Remo	1	<1	0	0	0
SUB-LGA	Westernport	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (S)	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (SW)	1	<1	0	0	0
SUB-LGA	Port Phillip (Sorrento Shore)	1	<1	0	0	0
SUB-LGA	Port Phillip Heads	1	<1	0	0	0
SUB-LGA	Port Phillip (Queenscliff)	1	<1	0	0	0
SUB-LGA	Torquay	1	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Anglesea	2	<1	0	0	0
SUB-LGA	Lorne	10	<1	0	0	0
SUB-LGA	Cape Patton	10	1	2	0	0
SUB-LGA	Apollo Bay	21	3	36	0	0
SUB-LGA	Cape Otway West	52	11	99	3	0
SUB-LGA	Moonlight Head	106	37	100	79	0
SUB-LGA	Port Campbell	79	26	100	70	0
SUB-LGA	Bay of Islands	56	23	100	58	0
SUB-LGA	Childers Cove	33	13	30	3	0
SUB-LGA	Warrnambool	16	6	19	0	0
SUB-LGA	Port Fairy	11	3	1	0	0
SUB-LGA	Portland Bay (East)	4	1	1	0	0
IBRA	Warrnambool Plain	106	37	100	79	0
IBRA	Otway Ranges	54	18	100	20	0
IBRA	Otway Plain	52	11	98	3	0
IBRA	Gippsland Plain	2	<1	0	0	0
IBRA	Strzelecki Ranges	2	<1	0	0	0
IBRA	Wilsons Promontory	4	<1	0	0	0
IMCRA	Twofold Shelf	2	<1	0	0	0
IMCRA	Otway	106	38	100	100	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
IMCRA	Victorian Embayments	2	<1	0	0	0
IMCRA	Central Victoria	25	3	35	0	0
IMCRA	Central Bass Strait	20	2	9	0	0
IMCRA	Flinders	5	<1	0	0	0
State Waters	Tasmania State Waters	1	<1	0	0	0
State Waters	Victoria State Waters	106	37	100	90	0
AMP	Apollo AMP	22	3	52	0	0
AMP	Beagle AMP	2	<1	0	0	0
NP	Port Phillip Heads Marine National Park	1	<1	0	0	0
NP	Point Addis Marine National Park	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	87	31	100	83	0
NP	Discovery Bay Marine National Park	1	<1	0	0	0
NP	Bunurong Marine National Park	2	<1	0	0	0
RSB	Cody Bank	1	<1	0	0	0
RAMSAR	Corner Inlet	1	<1	0	0	0
RAMSAR	Western Port	1	<1	0	0	0
KEF	West Tasmania Canyons	3	<1	0	0	0
KEF	Bonney Coast Upwelling	18	4	1	0	0

RPS

Table 27 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 10–20 m below the sea surface during winter. Results are based on a 1,850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Clonmel Island	1	<1	0	0	0
SUB-LGA	Snake Island	1	<1	0	0	0
SUB-LGA	Wilsons Promontory (East)	1	<1	0	0	0
SUB-LGA	Wilsons Promontory (West)	2	<1	0	0	0
SUB-LGA	Waratah Bay	2	<1	0	0	0
SUB-LGA	Cape Liptrap (NW)	3	<1	0	0	0
SUB-LGA	Venus Bay	1	<1	0	0	0
SUB-LGA	Kilcunda	1	<1	0	0	0
SUB-LGA	Westernport	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (S)	1	<1	0	0	0
SUB-LGA	Mornington Peninsula (SW)	1	<1	0	0	0
SUB-LGA	Port Phillip (Sorrento Shore)	1	<1	0	0	0
SUB-LGA	Port Phillip Heads	1	<1	0	0	0
SUB-LGA	Port Phillip (Queenscliff)	1	<1	0	0	0
SUB-LGA	Torquay	1	<1	0	0	0
SUB-LGA	Anglesea	1	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Lorne	3	<1	0	0	0
SUB-LGA	Cape Patton	7	<1	0	0	0
SUB-LGA	Apollo Bay	14	2	3	0	0
SUB-LGA	Cape Otway West	24	3	57	0	0
SUB-LGA	Moonlight Head	47	6	93	0	0
SUB-LGA	Port Campbell	37	6	90	0	0
SUB-LGA	Bay of Islands	40	4	74	0	0
SUB-LGA	Childers Cove	19	3	2	0	0
SUB-LGA	Warrnambool	8	2	2	0	0
SUB-LGA	Port Fairy	6	<1	0	0	0
SUB-LGA	Portland Bay (East)	2	<1	0	0	0
IBRA	Warrnambool Plain	47	6	93	0	0
IBRA	Otway Ranges	34	4	74	0	0
IBRA	Otway Plain	20	3	57	0	0
IBRA	Gippsland Plain	3	<1	0	0	0
IBRA	Strzelecki Ranges	2	<1	0	0	0
IBRA	Wilsons Promontory	3	<1	0	0	0
IMCRA	Twofold Shelf	2	<1	0	0	0
IMCRA	Otway	60	8	98	0	0
IMCRA	Victorian Embayments	1	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
IMCRA	Central Victoria	21	3	3	0	0
IMCRA	Central Bass Strait	16	2	2	0	0
IMCRA	Flinders	3	<1	0	0	0
State Waters	Victoria State Waters	52	7	98	0	0
AMP	Apollo AMP	15	2	7	0	0
AMP	Beagle AMP	1	<1	0	0	0
NP	Port Phillip Heads Marine National Park	1	<1	0	0	0
NP	Point Addis Marine National Park	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	52	6	98	0	0
NP	Bunurong Marine National Park	1	<1	0	0	0
RSB	Cody Bank	2	<1	0	0	0
RAMSAR	Corner Inlet	1	<1	0	0	0
KEF	West Tasmania Canyons	1	<1	0	0	0
KEF	Bonney Coast Upwelling	7	<1	0	0	0

RPS

Table 28 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 20–40 m below the sea surface during winter. Results are based on a 1,850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Lorne	1	<1	0	0	0
SUB-LGA	Cape Patton	3	<1	0	0	0
SUB-LGA	Apollo Bay	3	<1	0	0	0
SUB-LGA	Cape Otway West	6	<1	0	0	0
SUB-LGA	Moonlight Head	9	<1	0	0	0
SUB-LGA	Port Campbell	10	<1	0	0	0
SUB-LGA	Bay of Islands	5	1	1	0	0
SUB-LGA	Childers Cove	2	<1	0	0	0
SUB-LGA	Warrnambool	3	<1	0	0	0
SUB-LGA	Port Fairy	2	<1	0	0	0
SUB-LGA	Portland Bay (East)	1	<1	0	0	0
IBRA	Warrnambool Plain	10	1	1	0	0
IBRA	Otway Ranges	6	<1	0	0	0
IBRA	Otway Plain	6	<1	0	0	0
IBRA	Gippsland Plain	1	<1	0	0	0
IBRA	Wilsons Promontory	1	<1	0	0	0
IMCRA	Twofold Shelf	1	<1	0	0	0
IMCRA	Otway	13	1	2	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
IMCRA	Central Victoria	7	<1	0	0	0
IMCRA	Central Bass Strait	4	<1	0	0	0
IMCRA	Flinders	1	<1	0	0	0
State Waters	Victoria State Waters	12	1	1	0	0
AMP	Apollo AMP	7	<1	0	0	0
NP	Twelve Apostles Marine National Park	9	1	1	0	0
KEF	Bonney Coast Upwelling	2	<1	0	0	0

RPS

Table 29 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 40–60 m below the sea surface during winter. Results are based on a 1,850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Port Campbell	1	<1	0	0	0
IBRA	Warrnambool Plain	1	<1	0	0	0
IMCRA	Otway	1	<1	0	0	0
IMCRA	Central Victoria	1	<1	0	0	0
State Waters	Victoria State Waters	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	1	<1	0	0	0

RPS

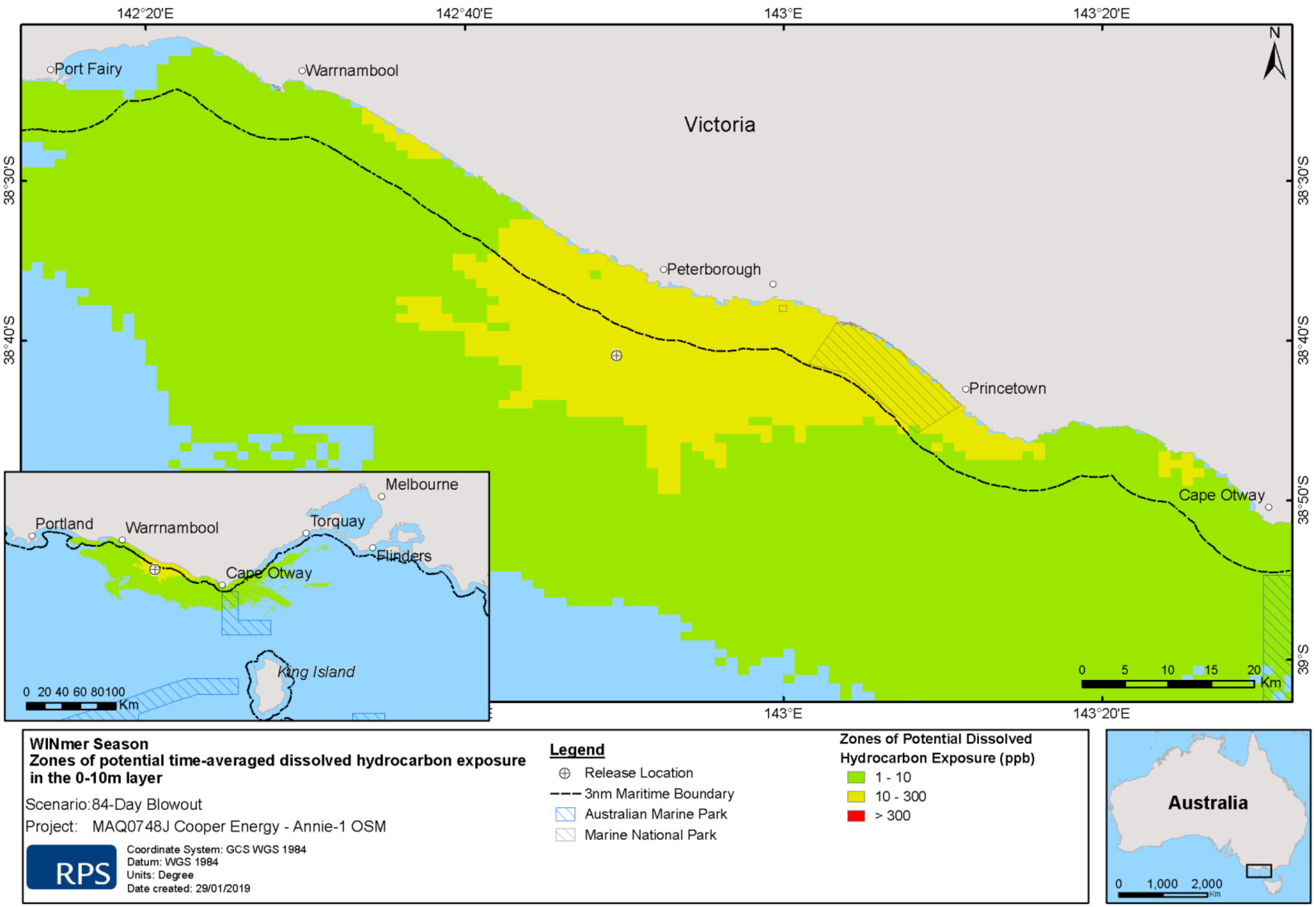

Figure 45 Zones of potential time-averaged dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during winter conditions.

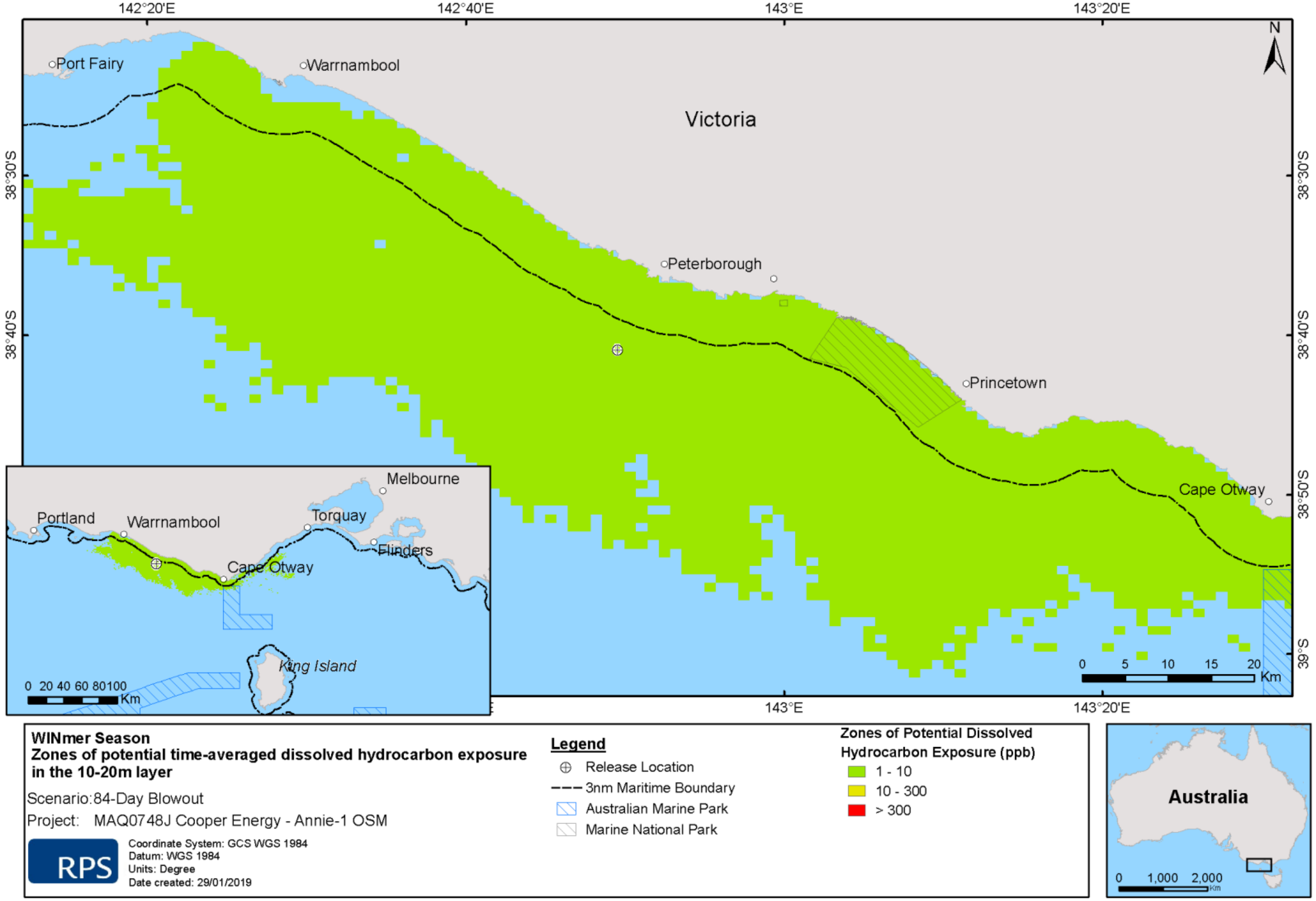

Figure 46 **Zones of potential time-averaged dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during winter conditions.**

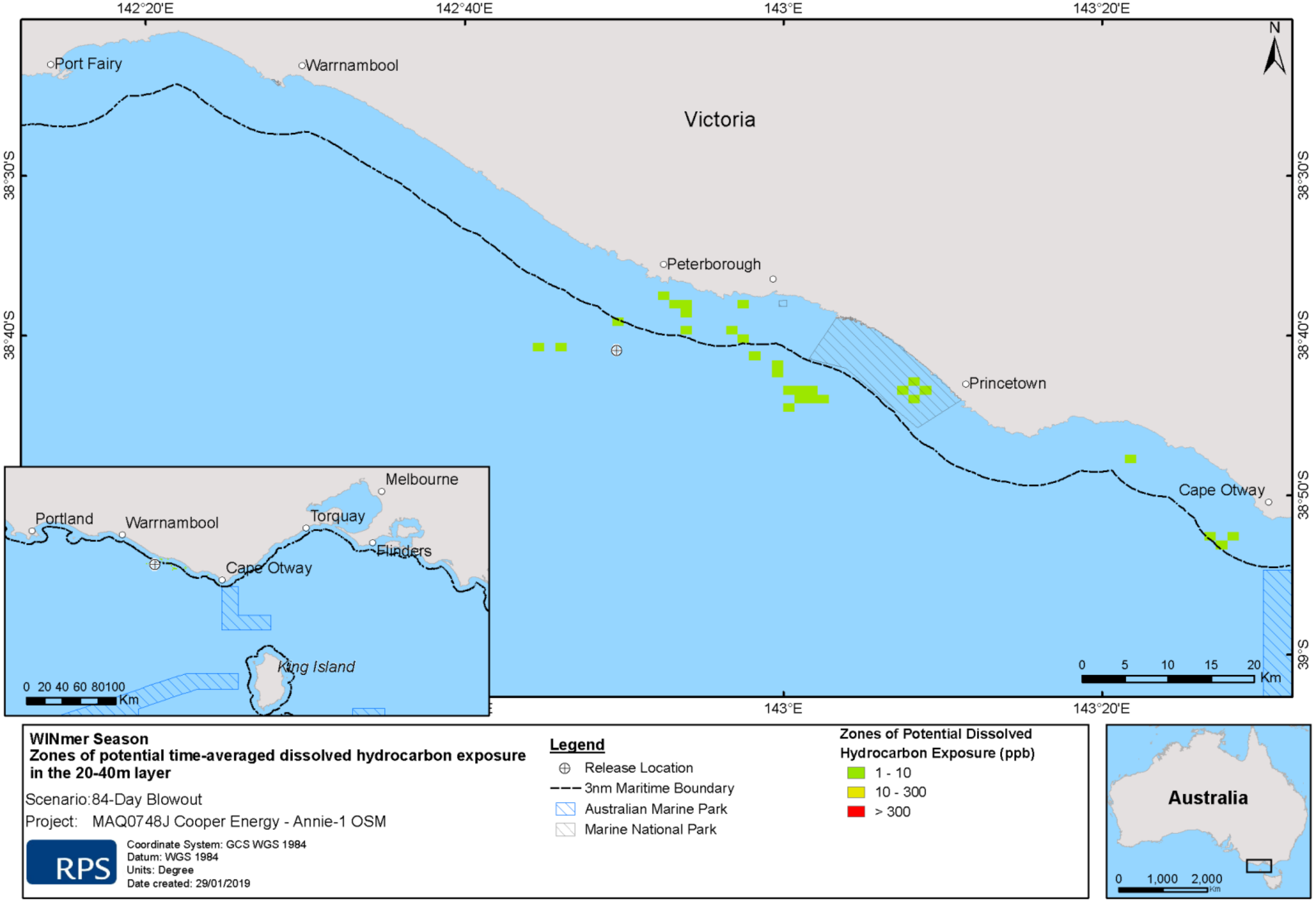

Figure 47 Zones of potential time-averaged dissolved hydrocarbon exposure at 20-40 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during winter conditions.

8.2.2.2 Entrained Hydrocarbons

Table 30 summarises the predicted probability (at each threshold) and maximum exposures (instantaneous and time averaged) to entrained hydrocarbons to shorelines, state waters and KEFs for the winter period at the depths of 0-10 m. The IMCRA Otway, the IBRA Warrnambool Plain and the Victoria State Waters were predicted to have the highest probability of exposure at the low threshold (100%). No exposure to entrained hydrocarbons were predicted at deeper layers.

Figure 48 show the potential zones of low (100 ppb), moderate (1,000 ppb) and high (30,000 ppb) time-averaged exposure to entrained hydrocarbons for the winter period. In the 0-10 m depth layer, low entrained hydrocarbon exposure was predicted up to 49 km to the northwest from the release location and 76 km towards the southeast just beyond Cape Otway. There was no exposure at the moderate threshold.

RPS

Table 30 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons, at 0–10 m below the sea surface. Results are based on a 1,850 bbl/d subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
SUB-LGA	Apollo Bay	131	62	0	0	0
SUB-LGA	Cape Otway West	332	297	73	0	0
SUB-LGA	Moonlight Head	620	541	100	0	0
SUB-LGA	Port Campbell	452	337	89	0	0
SUB-LGA	Bay of Islands	388	263	80	0	0
SUB-LGA	Childers Cove	225	187	8	0	0
SUB-LGA	Warrnambool	123	75	0	0	0
SUB-LGA	Port Fairy	167	95	0	0	0
IBRA	Warrnambool Plain	620	541	100	0	0
IBRA	Otway Ranges	271	207	86	0	0
IBRA	Otway Plain	332	297	73	0	0
IMCRA	Otway	912	541	100	0	0
IMCRA	Central Victoria	148	99	0	0	0
IMCRA	Central Bass Strait	120	81	0	0	0
State Waters	Victoria State Waters	620	541	100	0	0
AMP	Apollo AMP	171	104	2	0	0
NP	Twelve Apostles Marine National Park	557	431	100	0	0

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
KEF	Bonney Coast Upwelling	144	91	0	0	0

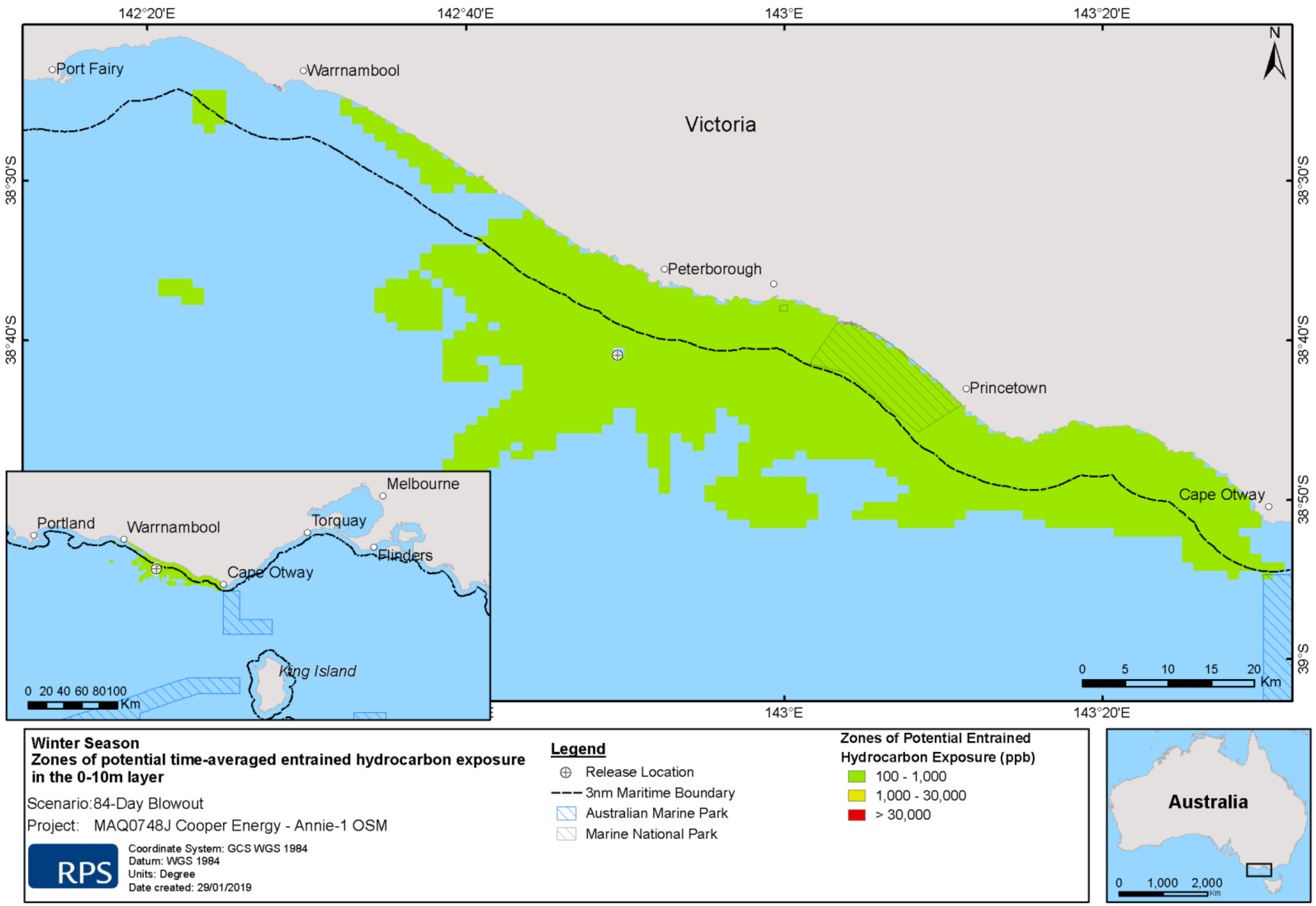

Figure 48 Zones of potential time-averaged entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days. The results were calculated from 100 spill trajectories during winter conditions.

RPS

8.3 RESULTS: 250 m^3 SURFACE RELEASE OF DIESEL FROM A LOSS OF VESSEL CONTAINMENT INCIDENT OVER 6HRS UNDER SUMMER CONDITIONS

The scenario examined a 250 m^3 release of MDO over 6 hours as a result of support vessels colliding with each other, resulting in the loss of one or more tanks of fuel, track for 30 days. A total of 100 spill trajectories were simulated for the summer period (October to March).

8.3.1 Sea Surface Exposure and Shoreline Contact

Table 31 presents a summary of the maximum distance and direction travelled by oil on the sea surface at the low (0.1–10 g/m^2), moderate (10–25 g/m^2) and high (>25 g/m^2) exposure thresholds. The maximum distance predicted for low, moderate and high sea surface exposure was 145 km (west), 10 km (west) and 7 km (west-north-west).

Table 32 presents the potential sea surface exposure to individual receptors. The results demonstrate that only the IMCRA – Otway receptor was exposed at the high threshold (>25 g/m^2). This is due the location of the release, within the IMCRA – Otway receptor polygon. Additionally, the Victoria State waters are also exposed at the moderate threshold (10-25 g/m^2). Several receptors are exposed at the low threshold (0.1-10 g/m^2). Zones of sea surface exposure over the modelled period are presented in Figure 49 and were predicted to extend predominantly northwest and southeast of the release site, following the shoreline alignment. Figure 50 to Figure 52 present the probability of oil exposure on the sea surface, while Figure 53 to Figure 55 present the minimum time before oil exposure on the sea surface reported at low, moderate and high thresholds, respectively

Table 33 presents a summary of the predicted shoreline contact. The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 58% (i.e. 58 of the 100 trajectories simulated were predicted to make shoreline contact at the low contact threshold). The minimum time before oil contact was approximately 19 hours and the maximum volume of oil ashore was 35 m^3. The maximum potential shoreline loading above low, moderate and high shoreline thresholds are presented in Figure 56.

Table 34 summarises the shoreline contact to individual receptors. Three IBRA regions were predicted to be contacted by oil at the low (>1 g/m^2)) and moderate (>100 g/m^2) thresholds, with Warrnambool Plain predicted to be contacted by oil at the high threshold (>1,000 g/m^2). Multiple LGAs (and sub-LGAs) were predicted to be contacted by oil at different thresholds (see Table 34). Otway Ranges, Otway Plain (IBRAs) and Colac Otway (LGA) were predicted to be the first shoreline receptors to be exposed to visible sea surface exposure, at 1 hour.

Table 31 Maximum distance and direction travelled on the sea surface by a single trajectory from the release location to oil exposure thresholds.

Modelling Period	Distance and direction	Zones of potential sea surface exposure		
		Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
Winter	Max. distance from release site (km)	145	10	7
	Max distance from release site (km) (99th percentile)	112	9	7
	Direction	W	W	WNW

RPS

Table 32 Summary of the potential sea surface exposure to receptors.

Receptor		Probability of oil exposure on the sea surface (%) Low (0.1-10 g/m²)	Moderate (10-25 g/m²)	High (>25 g/m²)	Minimum time before oil exposure on the sea surface (hours) Low (0.1-10 g/m²)	Moderate (10-25 g/m²)	High (>25 g/m²)
SUB-LGA	Cape Otway West	5	0	0	47	-	-
SUB-LGA	Moonlight Head	18	0	0	27	-	-
SUB-LGA	Port Campbell	37	0	0	18	-	-
SUB-LGA	Bay of Islands	21	0	0	15	-	-
SUB-LGA	Childers Cove	3	0	0	38	-	-
SUB-LGA	Warrnambool	1	0	0	77	-	-
IBRA	Warrnambool Plain	52	0	0	15	-	-
IBRA	Otway Ranges	2	0	0	47	-	-
IBRA	Otway Plain	5	0	0	51	-	-
IMCRA	Otway	100	99	62	1	1	1
State Waters	Victoria State Waters	82	7	0	3	7	-
NP	Twelve Apostles Marine National Park	27	0	0	14	-	-
KEF	Bonney Coast Upwelling	8	0	0	65	-	-

Table 33 Summary of oil contact across all shorelines.

Shoreline statistics	
Probability of contact to any shoreline (%)	58
Minimum time for visible oil to shore (hours)	19
Maximum volume of hydrocarbons ashore (m^3)	35
Average volume of hydrocarbons ashore (m^3)	5
Maximum length of the shoreline at **low** (km)	20
Average shoreline length (km) at **low** threshold (km)	10
Maximum length of the shoreline at **moderate** threshold (km)	6
Average shoreline length (km) at **moderate** threshold (km)	4
Maximum length of the shoreline at **high** threshold (km)	1
Average shoreline length (km) at **high** threshold (km)	1

RPS

Table 34 Summary of oil contact to individual shoreline receptors.

Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	
Interim Biogeographic Regionalisation for Australia (IBRA)																	
Warrnambool Plain	52	31	4	19	21	25	69	1,522	5	35	20	6	1	10	3	1	15
Otway Ranges	2	0	0	50	-	-	15	32	<1	<1	3	0	0	3	0	0	1
Otway Plain	5	3	0	50	59	-	31	209	<1	7	13	2	0	8	1	0	1
Local Government Area (LGA)																	
Warrnambool	2	0	0	68	-	-	6	6	<1	<1	1	0	0	1	0	0	77
Moyne	22	6	1	19	21	25	62	1,522	1	34	12	6	1	5	4	1	15
Corangamite	46	27	3	20	30	54	69	1,358	4	28	18	6	1	8	3	1	18
Colac Otway	5	3	0	50	59	0	29	209	<1	8	16	2	0	9	1	0	1
Sub-Local Government Area (sub-LGA)																	
Cape Otway West	5	3	0	50	59	-	29	209	<12	8	16	2	0	9	1	0	1
Moonlight Head	18	9	1	27	37	58	68	1,195	1	28	12	6	1	7	3	1	27
Port Campbell	37	21	2	20	30	54	61	1,358	2	24	14	5	1	7	2	1	18
Bay of Islands	21	6	1	19	21	25	65	1,522	1	34	12	6	1	5	4	1	15
Childers Cove	2	0	0	59	-	-	19	76	<1	2	5	0	0	5	0	0	38
Warrnambool	1	0	0	68	-	-	6	6	<1	<1	1	0	0	1	0	0	77

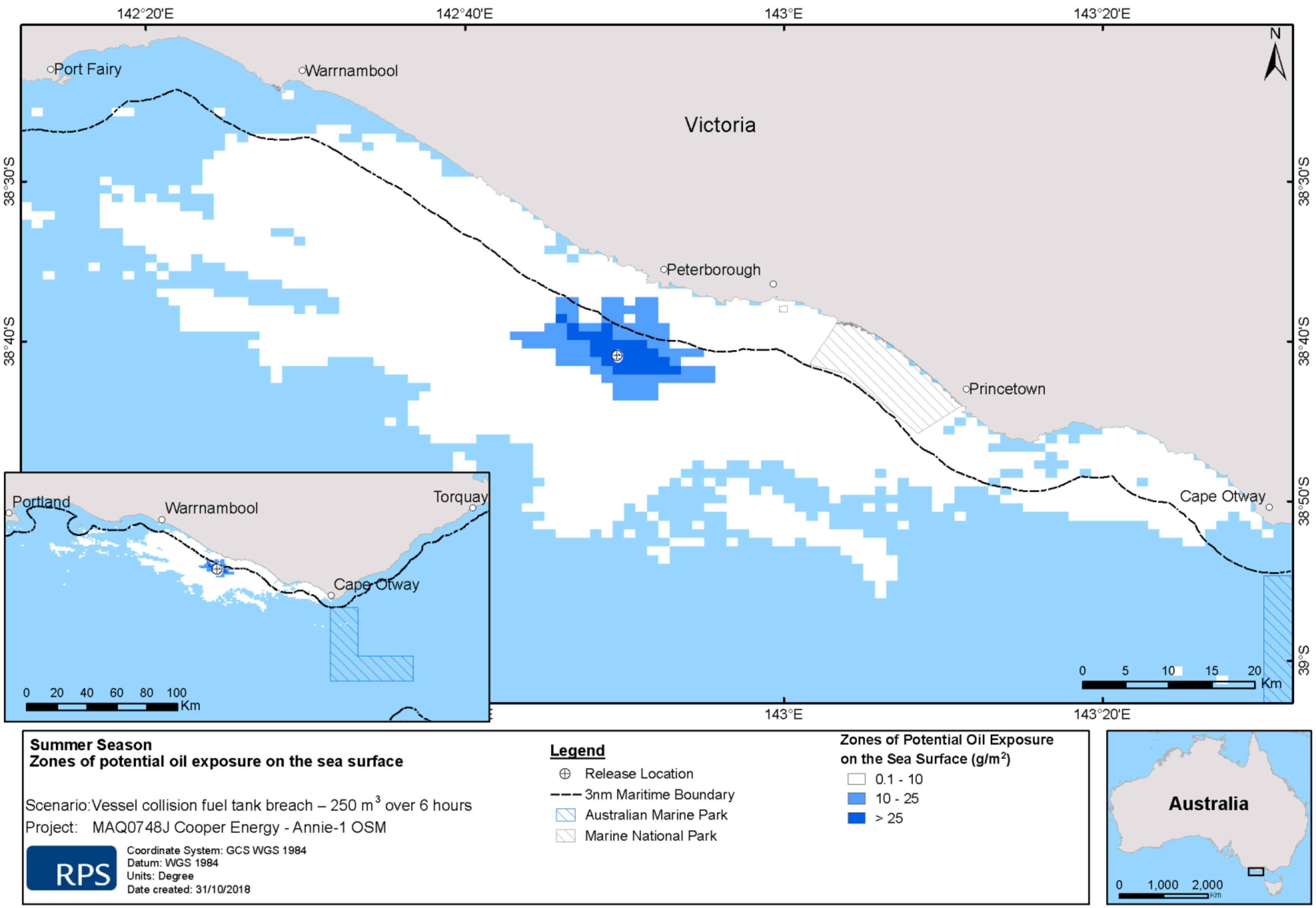

Figure 49 Zones of potential oil exposure on the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

RPS

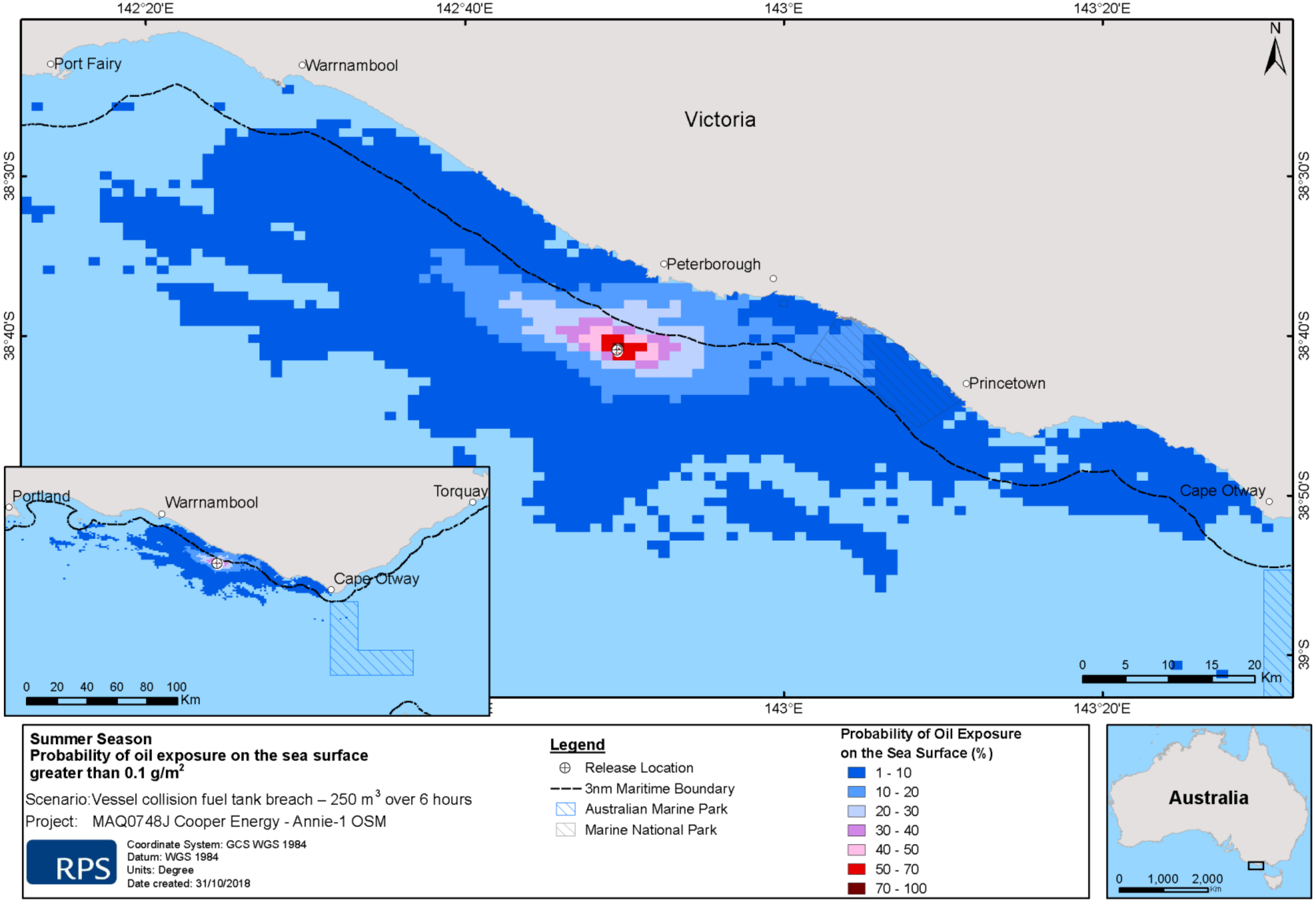

Figure 50 Probability of oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

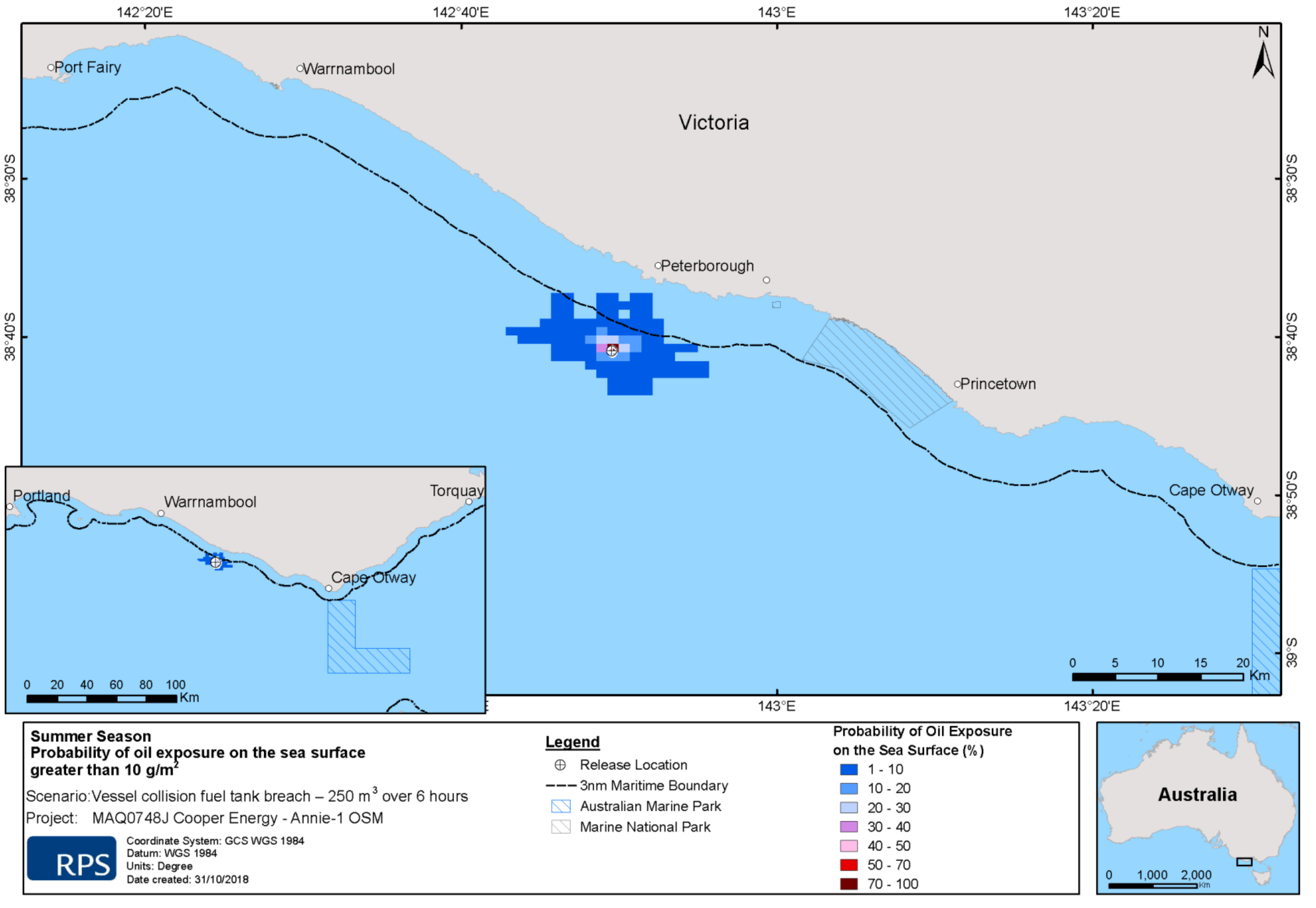

Figure 51 Probability of oil exposure on the sea surface for the moderate threshold (10 g/m²), in the event of a 250 m³ surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

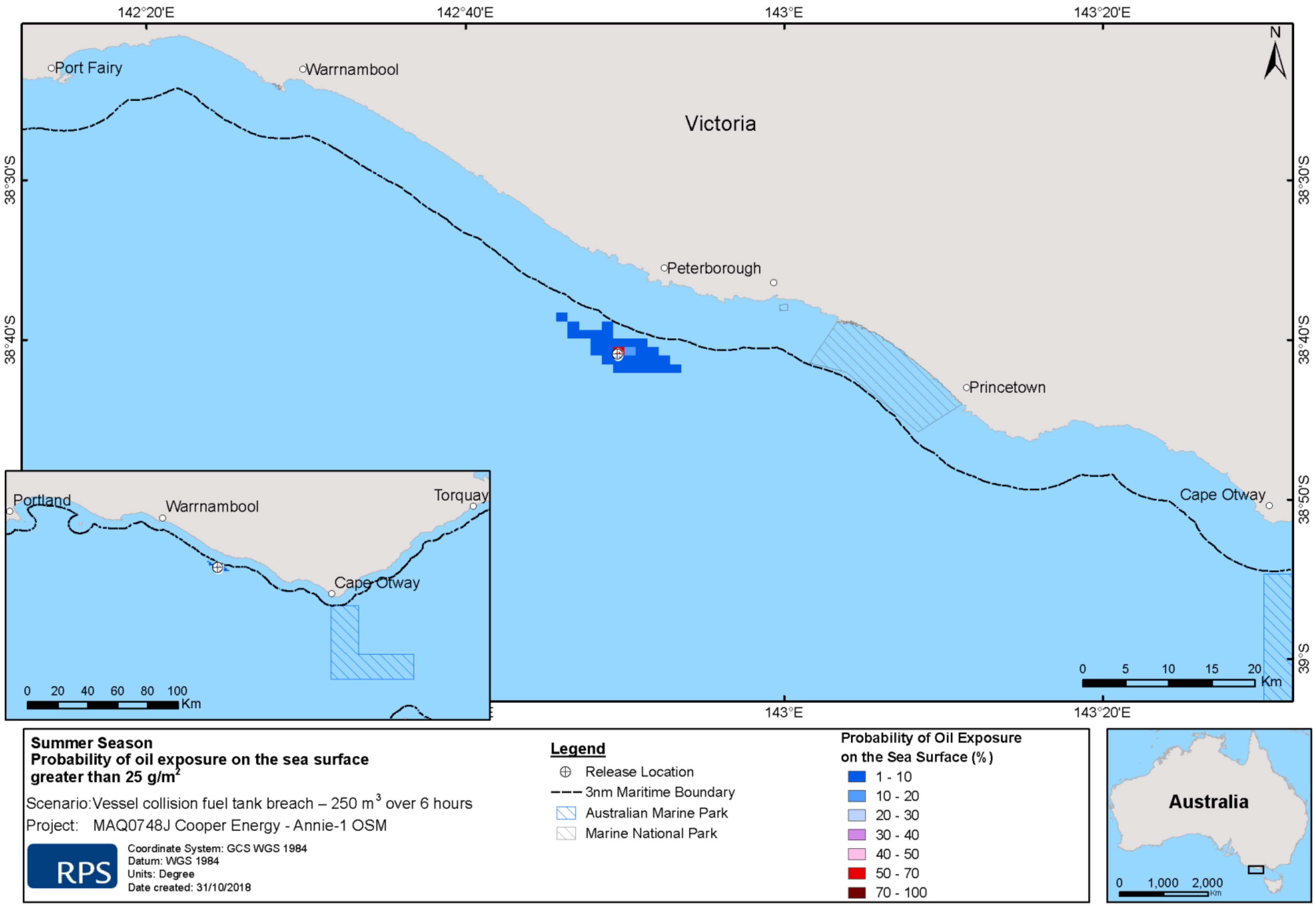

Figure 52 Probability of oil exposure on the sea surface for the high threshold (25 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

RPS

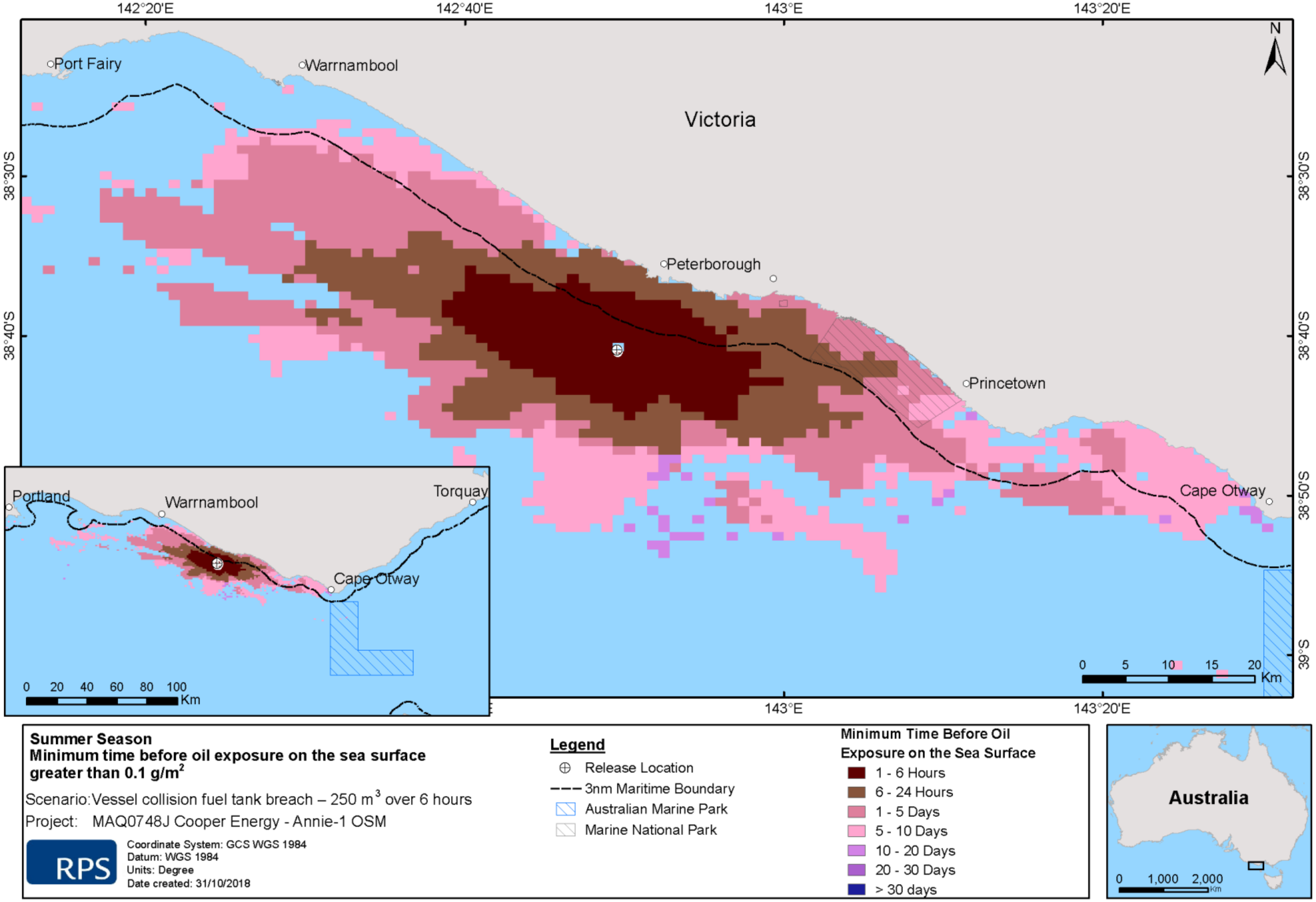

Figure 53 Minimum time before oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

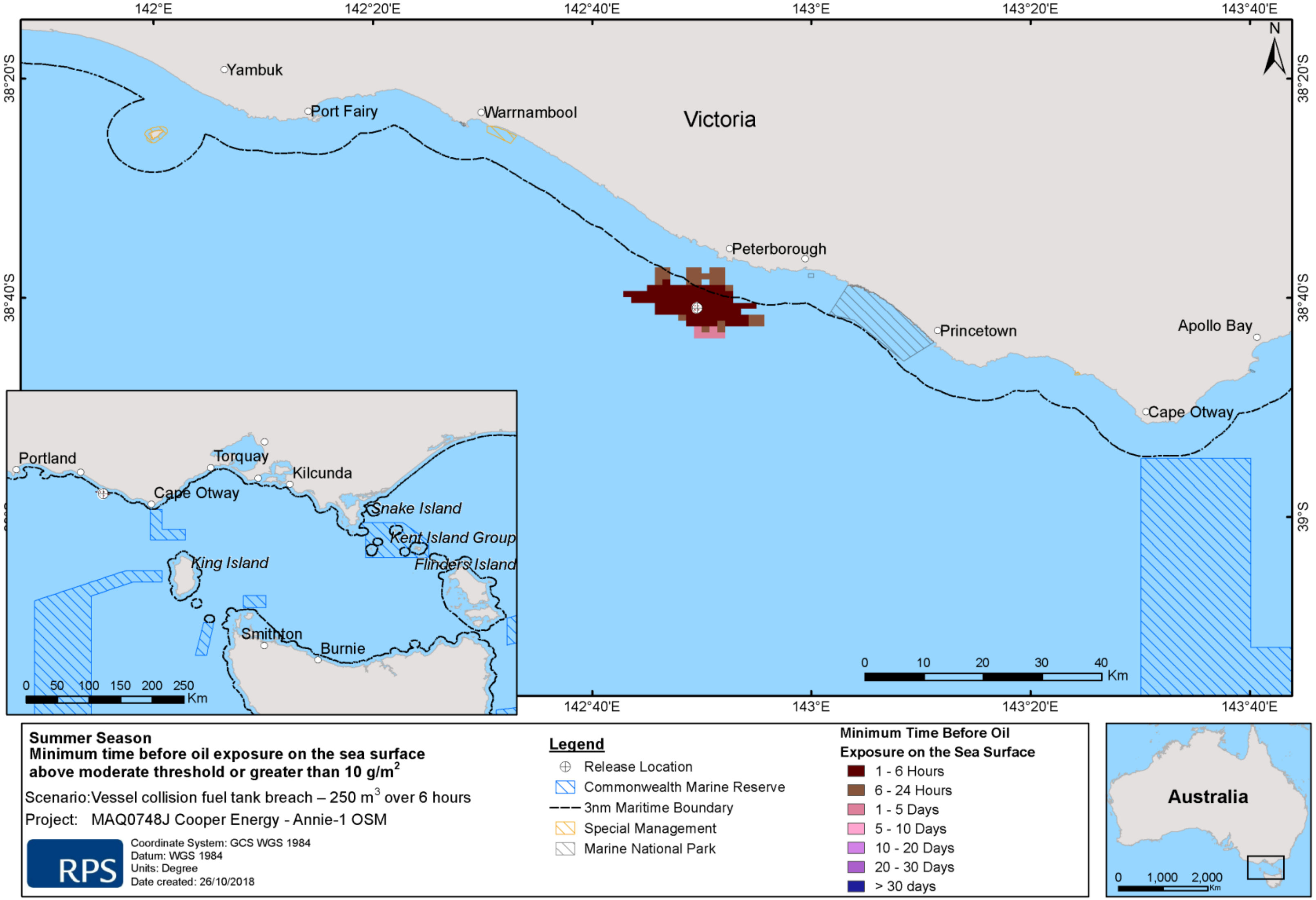

Figure 54 Minimum time before oil exposure on the sea surface for the moderate threshold (10 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

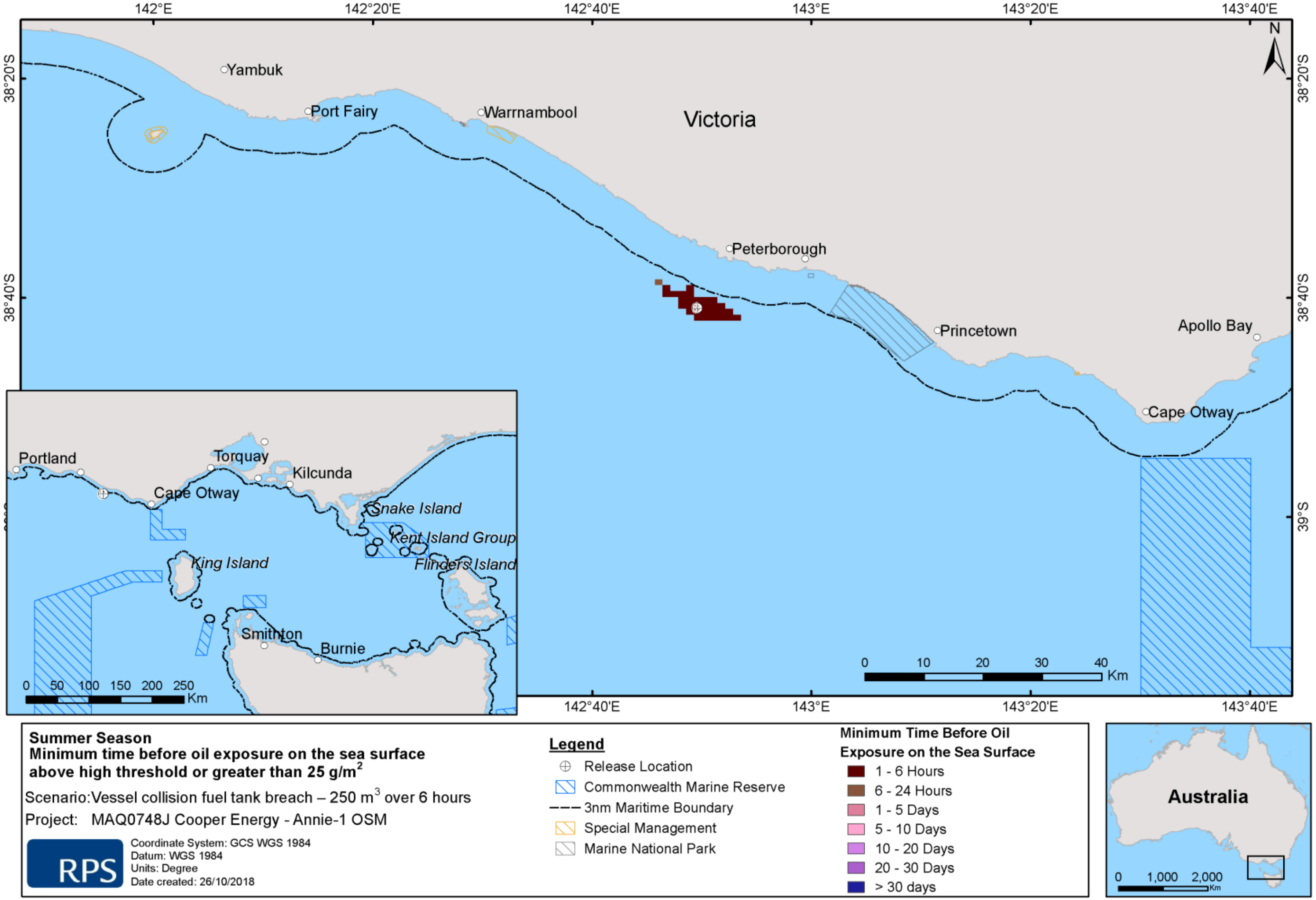

Figure 55 Minimum time before oil exposure on the sea surface for the high threshold (25 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

RPS

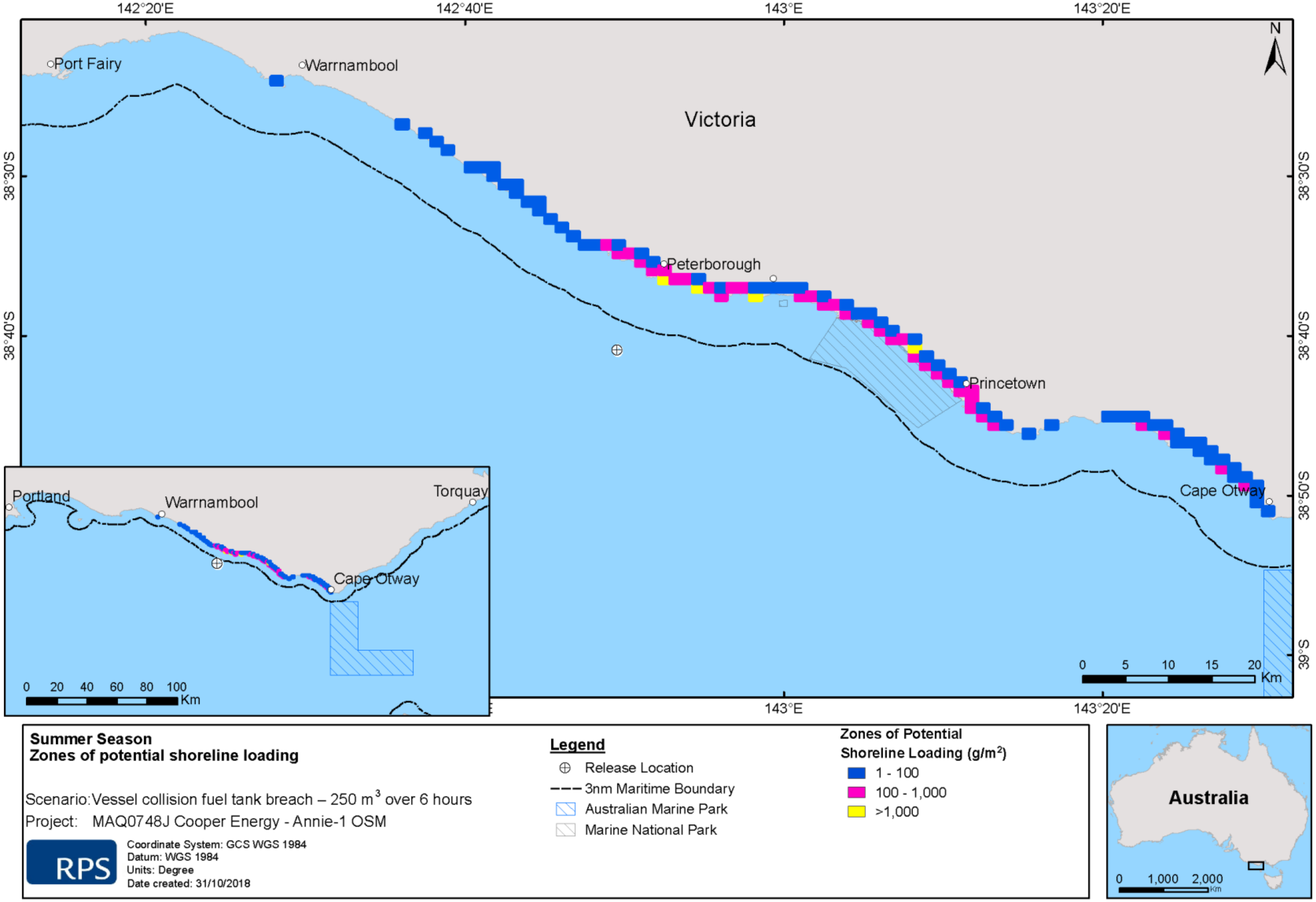

Figure 56 **Maximum potential shoreline loading for the low (1 g/m^2) moderate (100 g/m^2) and high (>1,000 g/m^2) thresholds. Results were based on a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days.**

RPS

8.3.2 Water Column Exposure

8.3.2.1 Dissolved Hydrocarbons

Table 35 to Table 37 summarise the predicted probability (at each threshold) and maximum exposures (instantaneous and time-averaged) to dissolved hydrocarbons to shoreline, environmental and biological receptors for the summer period at the depths of 0-10 m and 10-20m layers, respectively. No dissolved hydrocarbon exposures were predicted at deeper layers.

Figure 57 and Figure 58 shows the potential zones of low (1 ppb), moderate (10 ppb) and high (300 ppb) time-averaged exposure to dissolved hydrocarbons for the summer period. In the 0-10 m depth layer, low dissolved hydrocarbon exposure was predicted to travel up to 39 km towards the northwest and 47 km towards the southeast. Moderate levels of exposure were observed up to 10 km away from the release site in a northeast direction.

RPS

Table 35 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 0–10 m below the sea surface during summer. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Otway West	4	1	1	0	0
SUB-LGA	Moonlight Head	13	5	3	0	0
SUB-LGA	Port Campbell	16	6	5	0	0
SUB-LGA	Bay of Islands	6	3	5	0	0
SUB-LGA	Childers Cove	1	<1	0	0	0
SUB-LGA	Port Fairy	1	<1	0	0	0
IBRA	Warrnambool Plain	16	6	5	0	0
IBRA	Otway Ranges	4	1	1	0	0
IBRA	Otway Plain	2	<1	0	0	0
IMCRA	Otway	68	11	29	1	0
IMCRA	Central Victoria	1	<1	0	0	0
IMCRA	Central Bass Strait	2	<1	0	0	0
State Waters	Victoria State Waters	39	11	15	1	0
AMP	Apollo AMP	1	<1	0	0	0
NP	Twelve Apostles Marine National Park	23	5	12	0	0
KEF	Bonney Coast Upwelling	2	<1	0	0	0

Table 36 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 10–20 m below the sea surface during summer. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Otway West	2	<1	0	0	0
SUB-LGA	Moonlight Head	5	<1	0	0	0
SUB-LGA	Port Campbell	4	1	1	0	0
SUB-LGA	Bay of Islands	2	<1	0	0	0
SUB-LGA	Childers Cove	1	<1	0	0	0
SUB-LGA	Port Fairy	1	<1	0	0	0
IBRA	Warrnambool Plain	5	1	1	0	0
IBRA	Otway Ranges	2	<1	0	0	0
IBRA	Otway Plain	1	<1	0	0	0
IMCRA	Otway	7	1	1	0	0
IMCRA	Central Victoria	1	<1	0	0	0
State Waters	Victoria State Waters	7	1	1	0	0
NP	Twelve Apostles Marine National Park	7	1	1	0	0
KEF	Bonney Coast Upwelling	2	<1	0	0	0

RPS

Table 37 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 20–40 m below the sea surface during summer. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Moonlight Head	1	<1	0	0	0
SUB-LGA	Port Campbell	1	<1	0	0	0
IBRA	Warrnambool Plain	1	<1	0	0	0
IMCRA	Otway	2	<1	0	0	0
State Waters	Victoria State Waters	2	<1	0	0	0
NP	Twelve Apostles Marine National Park	2	<1	0	0	0

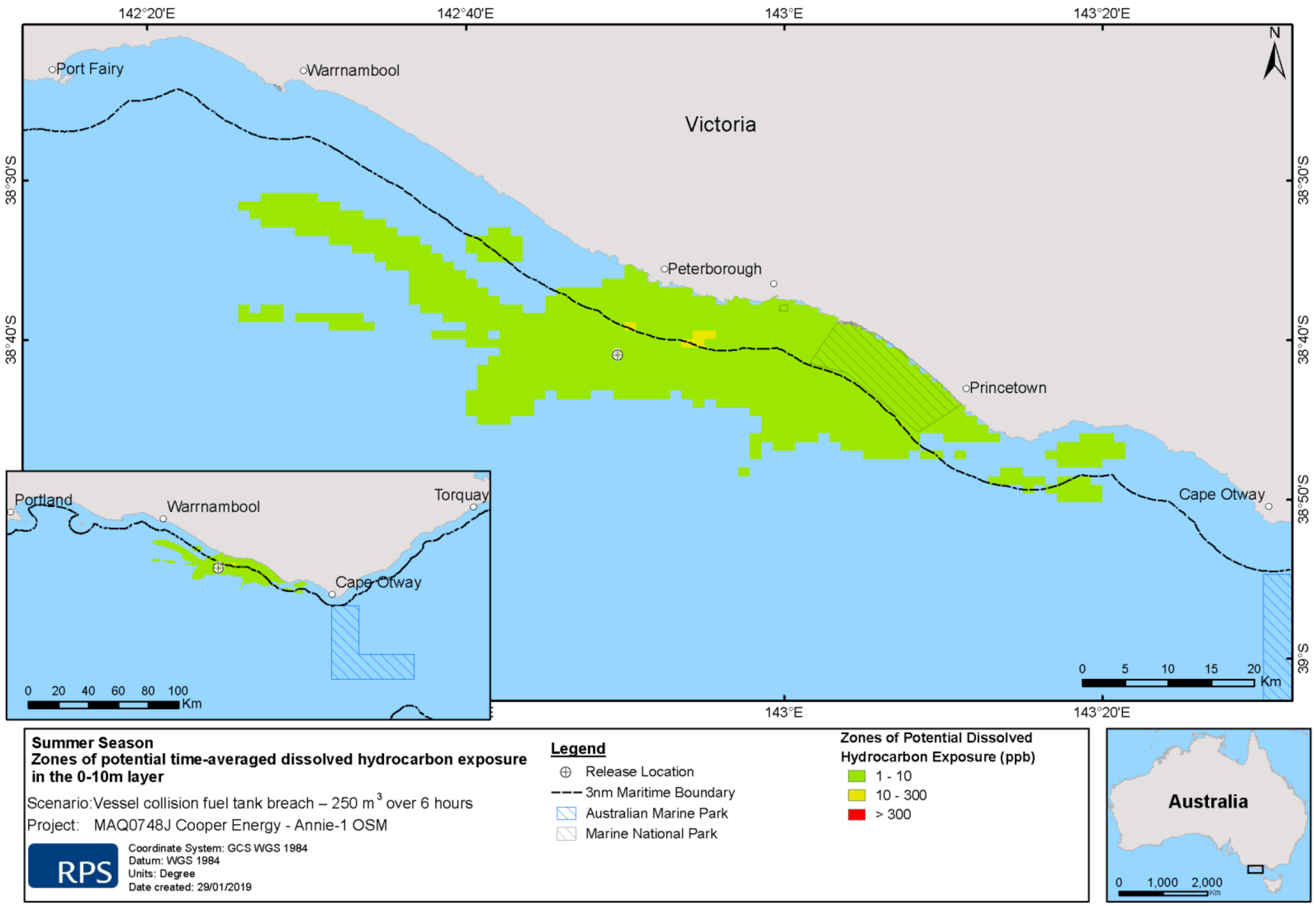

Figure 57 Zones of potential time-averaged dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 250 m³ surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during summer conditions.

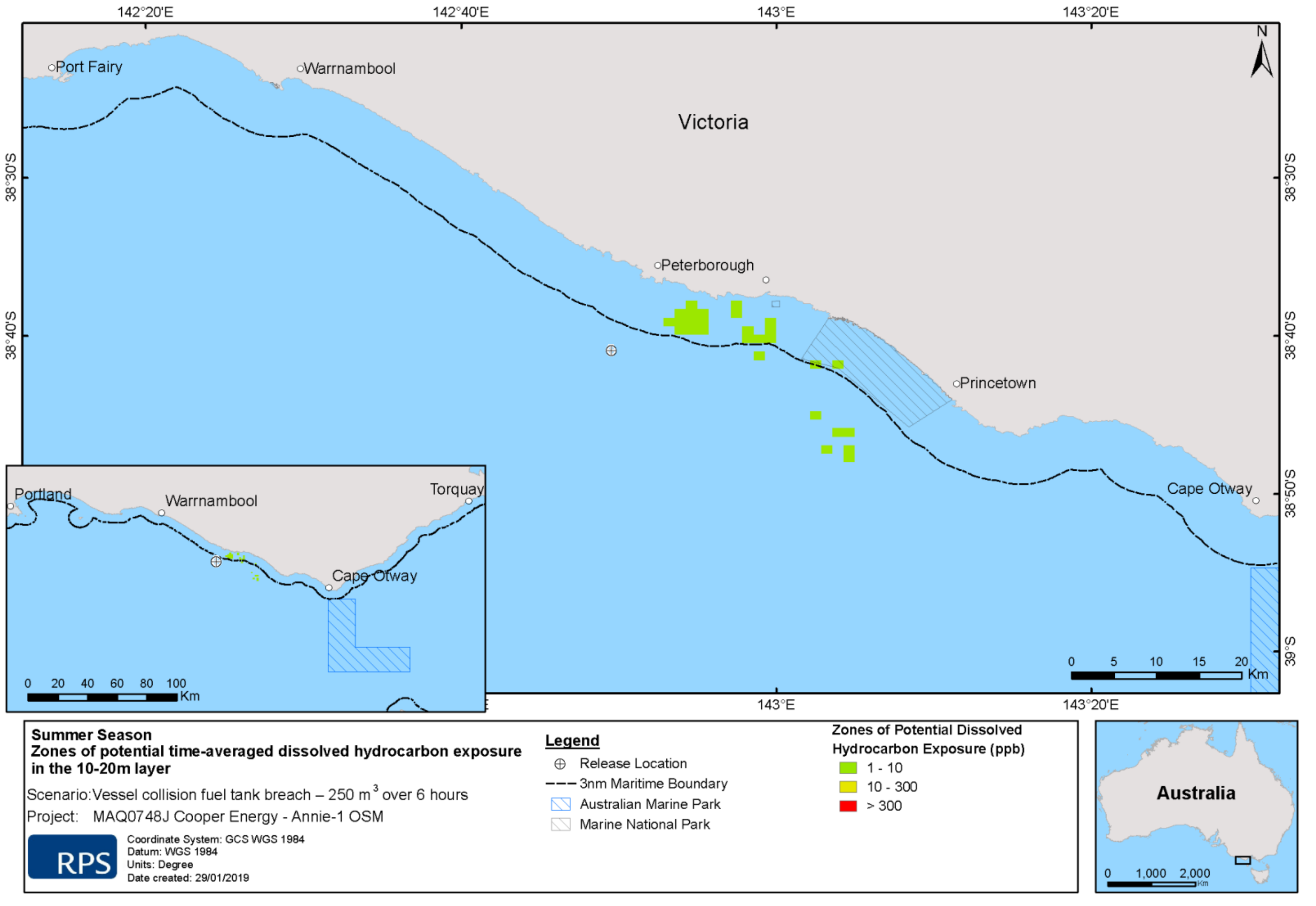

Figure 58 Zones of potential time-averaged dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during summer conditions.

8.3.2.2 Entrained Hydrocarbons

Table 38 summarises the predicted probability (at each threshold) and maximum exposures (instantaneous and time averaged) to entrained hydrocarbons to shorelines, state waters and KEFs for the summer period at the depths of 0-10 m. No entrained hydrocarbons were predicted at deeper layers. Probability of exposure to the low threshold ranged from 1 to 36%. The IMCRA Otway was predicted to have the highest probability of exposure at the low threshold (36%).

Figure 59 show the potential zones of low (100 ppb), moderate (1,000 ppb) and high (30,000 ppb) time-averaged exposure to entrained hydrocarbons for the summer period. In the 0-10 m depth layer, low entrained hydrocarbon exposure extended up to 51 km towards the northwest and 60 km southeast from the release. There was no exposure at the moderate threshold.

RPS

Table 38 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons, at 0–10 m below the sea surface during summer. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
SUB-LGA	Cape Otway West	330	232	3	0	0
SUB-LGA	Moonlight Head	926	510	14	0	0
SUB-LGA	Port Campbell	971	542	14	0	0
SUB-LGA	Bay of Islands	656	358	9	0	0
SUB-LGA	Childers Cove	171	145	1	0	0
SUB-LGA	Port Fairy	114	56	0	0	0
IBRA	Warrnambool Plain	971	542	14	0	0
IBRA	Otway Ranges	384	232	1	0	0
IBRA	Otway Plain	291	204	3	0	0
IMCRA	Otway	4,326	694	36	0	0
IMCRA	Central Victoria	125	31	0	0	0
IMCRA	Central Bass Strait	121	34	0	0	0
State Waters	Victoria State Waters	2,110	577	21	0	0
AMP	Apollo AMP	141	26	0	0	0
NP	Twelve Apostles Marine National Park	1,164	510	16	0	0
KEF	Bonney Coast Upwelling	214	88	0	0	0

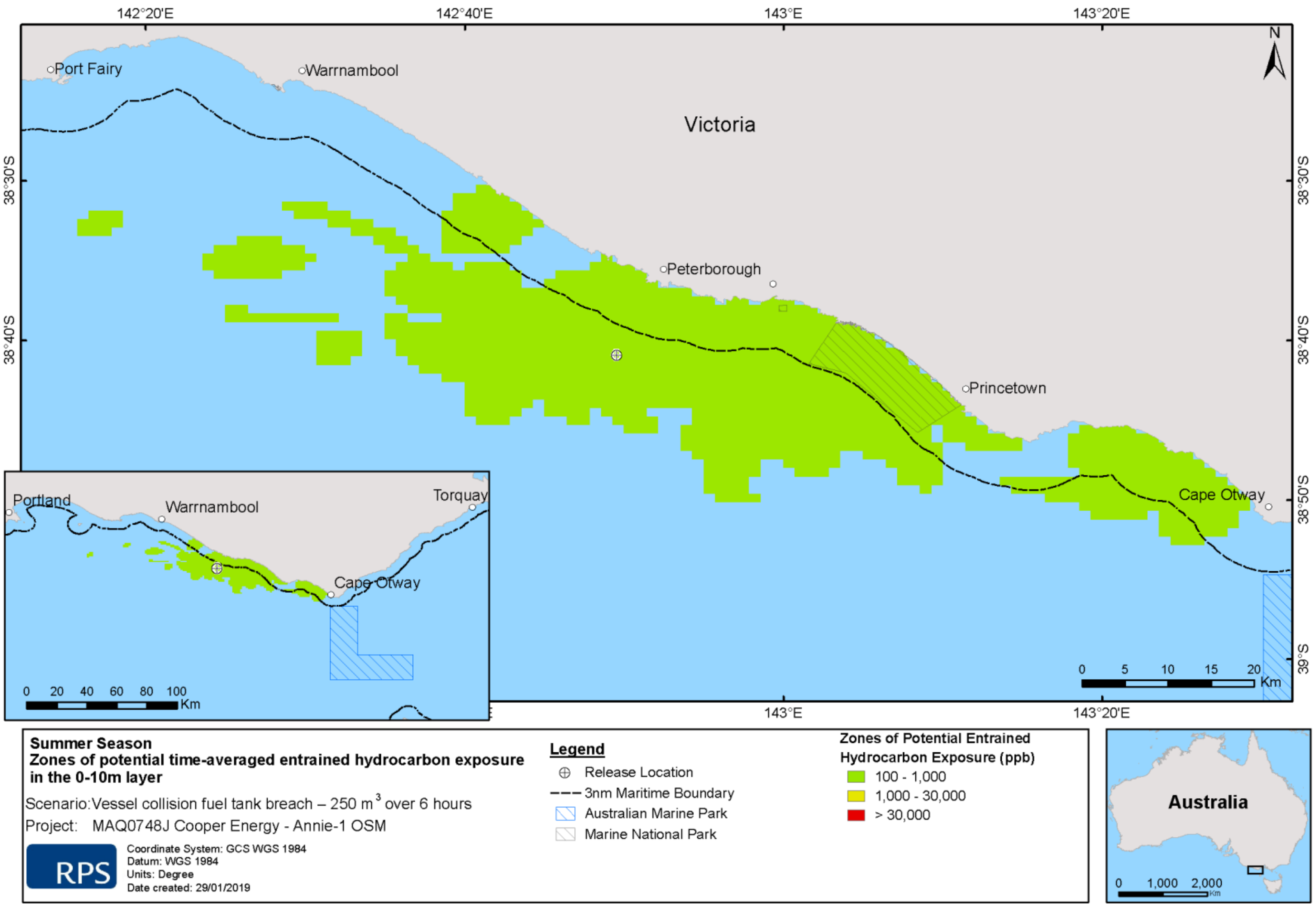

Figure 59 Zones of potential time-averaged entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during winter conditions.

8.4 RESULTS: 250 m^3 SURFACE RELEASE OF DIESEL FROM A LOSS OF VESSEL CONTAINMENT INCIDENT OVER 6HRS UNDER WINTER CONDITIONS

The scenario examined a 250 m^3 release of MDO over 6 hours as a result of support vessels colliding with each other, resulting in the loss of one or more tanks of fuel, track for 30 days. A total of 100 spill trajectories were simulated for the winter period (April to September).

8.4.1 Sea Surface Exposure and Shoreline Contact

Table 39 presents a summary of the maximum distance and direction travelled by oil on the sea surface at the low (0.1–10 g/m^2), moderate (10–25 g/m^2) and high (>25 g/m^2) exposure thresholds. The maximum distance predicted for low, moderate and high sea surface exposure was 193 km (east), 16 km (east) and 6 km (south-east).

Table 40 presents the potential sea surface exposure to individual receptors. The results demonstrate that only the IMCRA – Otway receptor was exposed at the high threshold (>25 g/m^2). This is due the location of the release, within the IMCRA – Otway receptor polygon. Additionally, the Victoria State waters are also exposed at the moderate threshold (10-25 g/m^2). Several receptors are exposed at the low threshold (0.1-10 g/m^2). Zones of sea surface exposure over the modelled period are presented in Figure 60 and were predicted to extend predominantly northwest and southeast of the release site, following the shoreline alignment. Figure 61 to Figure 63 present the probability of oil exposure on the sea surface, while Figure 64 to Figure 66 present the minimum time before oil exposure on the sea surface reported at low, moderate and high thresholds, respectively.

Table 41 presents a summary of the predicted shoreline contact. The predicted probability of contact to any shoreline at, or above, the minimum shoreline contact threshold (1 g/m^2) was 54% (i.e. 54 of the 100 trajectories simulated were predicted to make shoreline contact at the low contact threshold). The minimum time before oil contact was approximately 16 hours and the maximum volume of oil ashore was 42 m^3. The maximum potential shoreline loading above low, moderate and high shoreline thresholds are presented in Figure 67.

Table 42 summarises the shoreline contact to individual receptors. Three IBRA regions were predicted to be contacted by oil at the low (>1 g/m^2) and moderate (>100 g/m^2) thresholds, with Warrnambool Plain predicted to be contacted by oil at the high threshold (>1,000 g/m^2). Multiple LGAs (and sub-LGAs) were predicted to be contacted by oil at different thresholds (see Table 42). Otway Ranges, Otway Plain (IBRAs) and Colac Otway (LGA) were predicted to be the first shoreline receptors to be exposed to visible sea surface exposure, at 1 hour.

Table 39 Maximum distance and direction travelled on the sea surface by a single trajectory from the release location to oil exposure thresholds.

Modelling Period	Distance and direction	Zones of potential sea surface exposure: Low (0.1-10 g/m^2)	Moderate (10-25 g/m^2)	High (>25 g/m^2)
Winter	Max. distance from release site (km)	193	16	6
	Max distance from release site (km) (99th percentile)	176	14	6
	Direction	E	E	SE

RPS

Table 40 Summary of the potential sea surface exposure to receptors.

Receptor		Probability of oil exposure on the sea surface (%) Low (0.1-10 g/m²)	Moderate (10-25 g/m²)	High (>25 g/m²)	Minimum time before oil exposure on the sea surface (hours) Low (0.1-10 g/m²)	Moderate (10-25 g/m²)	High (>25 g/m²)
SUB-LGA	Cape Otway West	9	0	0	31	-	-
SUB-LGA	Moonlight Head	30	0	0	19	-	-
SUB-LGA	Port Campbell	20	0	0	18	-	-
SUB-LGA	Bay of Islands	18	0	0	14	-	-
SUB-LGA	Childers Cove	2	0	0	59	-	-
SUB-LGA	Warrnambool	1	0	0	93	-	-
SUB-LGA	Port Fairy	1	0	0	73	-	-
IBRA	Warrnambool Plain	50	0	0	14	-	-
IBRA	Otway Ranges	17	0	0	22	-	-
IBRA	Otway Plain	7	0	0	31	-	-
IMCRA	Otway	100	92	43	1	1	1
IMCRA	Central Victoria	13	0	0	58	-	-
IMCRA	Central Bass Strait	17	0	0	74	-	-
IMCRA	Flinders	1	0	0	384	-	-
State Waters	Victoria State Waters	69	7	0	4	10	-
AMP	Apollo AMP	10	0	0	48	-	-
NP	Twelve Apostles Marine National Park	33	0	0	13	-	-
KEF	Bonney Coast Upwelling	2	0	0	79	-	-

RPS

Table 41 Summary of oil contact across all shorelines.

Shoreline statistics	
Probability of contact to any shoreline (%)	54
Minimum time for visible oil to shore (hours)	16
Maximum volume of hydrocarbons ashore (m^3)	42
Average volume of hydrocarbons ashore (m^3)	6
Maximum length of the shoreline at **low** (km)	22
Average shoreline length (km) at **low** threshold (km)	11
Maximum length of the shoreline at **moderate** threshold (km)	7
Average shoreline length (km) at **moderate** threshold (km)	5
Maximum length of the shoreline at **high** threshold (km)	2
Average shoreline length (km) at **high** threshold (km)	2

RPS

Table 42 Summary of oil contact to individual shoreline receptors.

Shoreline receptor	Maximum probability of shoreline loading (%)			Minimum time before shoreline accumulation (hours)			Load on shoreline (g/m^2)		Volume on shoreline (m^3)		Mean length of shoreline contacted (km)			Maximum length of shoreline contacted (km)			Minimum time before visible sea surface exposure (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	Mean	Peak	Mean	Peak	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	
Interim Biogeographic Regionalisation for Australia (IBRA)																	
Warrnambool Plain	48	38	5	16	23	40	116	1,702	6	42	22	7	2	9	3	1	14
Otway Ranges	17	8	1	20	23	63	98	1,472	<1	18	6	4	1	3	1	1	1
Otway Plain	7	3	0	29	46	-	51	380	<1	16	10	4	0	6	2	0	1
Local Government Area (LGA)																	
Warrnambool	1	1	0	37	62	-	195	645	<1	25	11	5	0	11	5	0	93
Moyne	20	9	2	16	25	40	73	1,702	1	38	12	4	1	5	2	1	14
Corangamite	46	32	3	19	23	46	105	1,501	5	42	22	7	2	8	3	2	18
Colac Otway	9	3	0	29	46	-	49	380	<1	16	11	5	0	6	4	0	1
Sub-Local Government Area (sub-LGA)																	
Cape Otway West	9	3	0	29	46	-	49	380	<1	16	11	5	0	6	4	0	1
Moonlight Head	30	20	3	19	23	46	114	1,501	3	42	15	6	2	7	3	2	19
Port Campbell	21	12	0	22	29	-	76	930	2	32	22	7	0	7	3	0	18
Bay of Islands	19	8	2	16	25	40	75	1,702	1	38	11	4	1	4	2	1	14
Childers Cove	2	1	0	37	62	-	107	645	<1	25	11	5	0	6	5	0	59
Port Fairy	1	1	0	55	86	-	50	128	<1	6	11	2	0	11	2	0	73

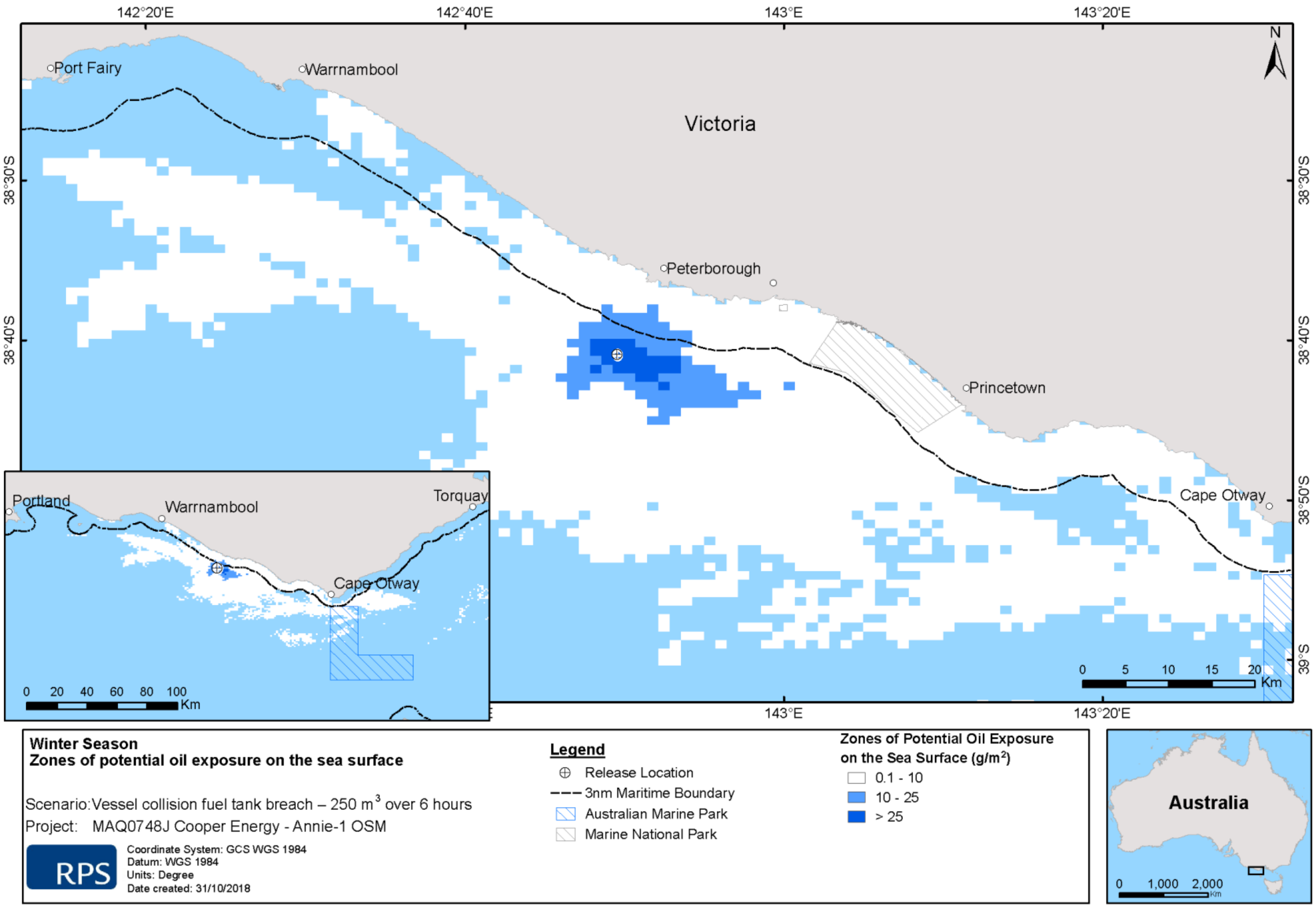

Figure 60 Zones of potential oil exposure on the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

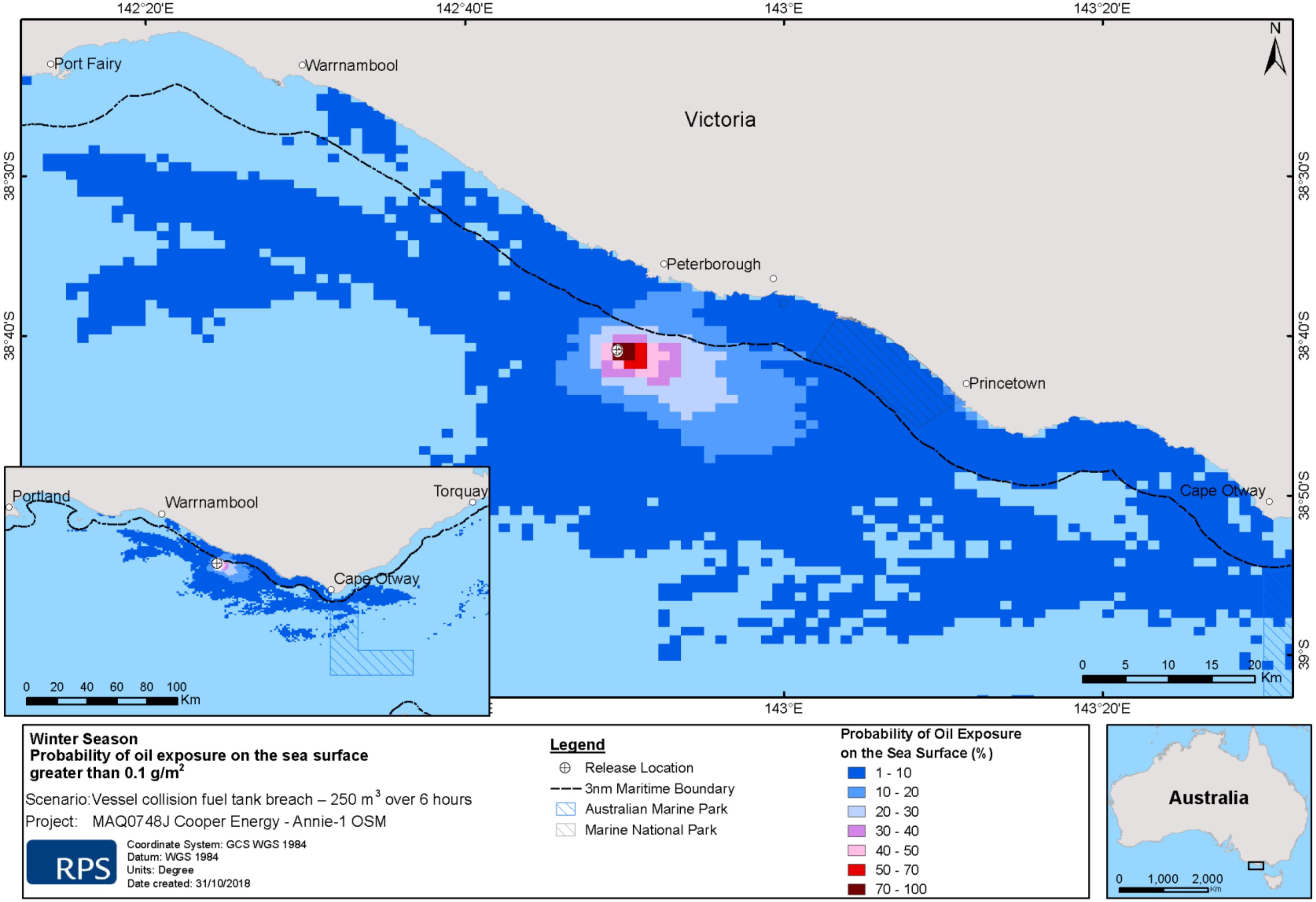

Figure 61 **Probability of oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.**

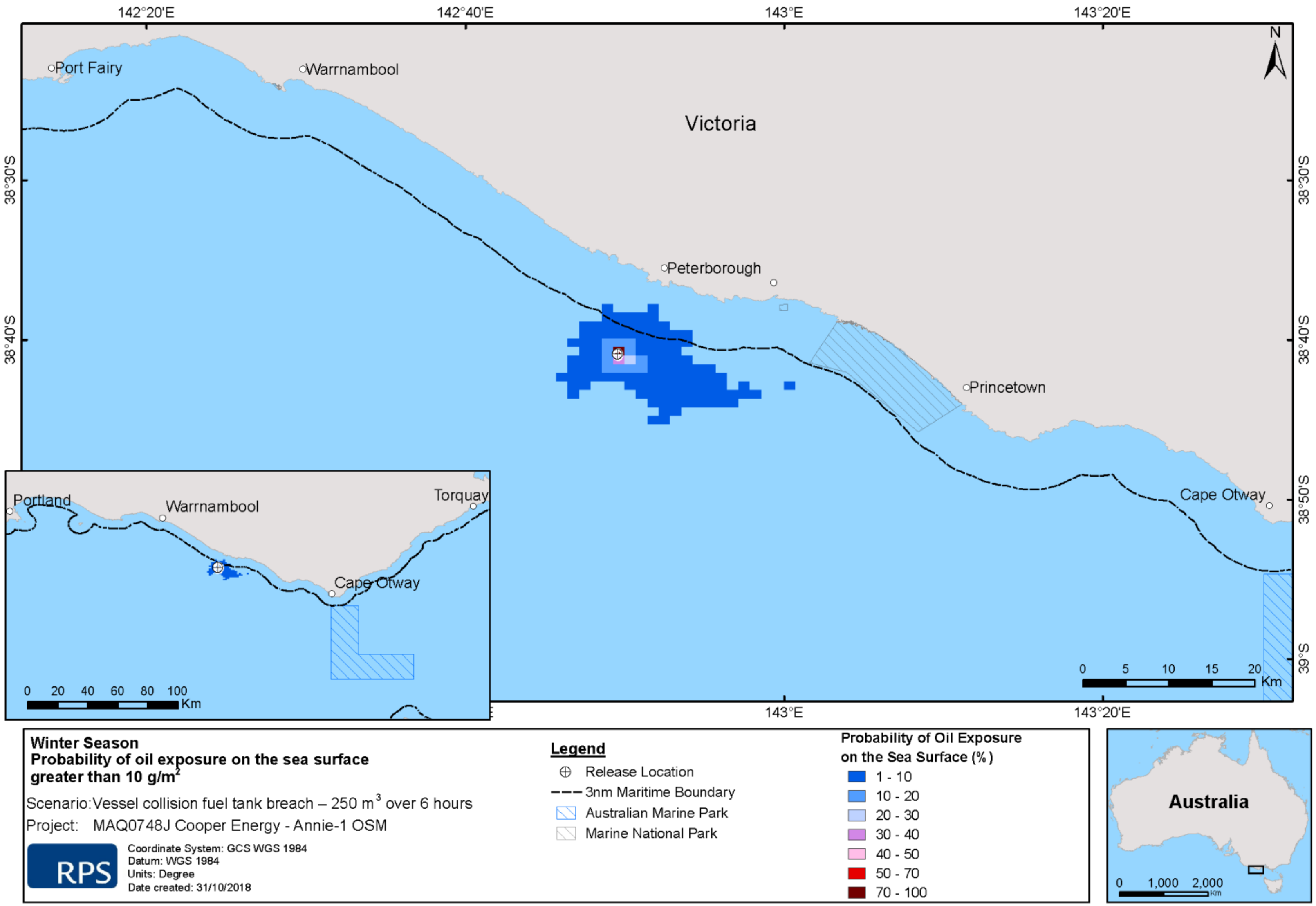

Figure 62 Probability of oil exposure on the sea surface for the moderate threshold (10 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

RPS

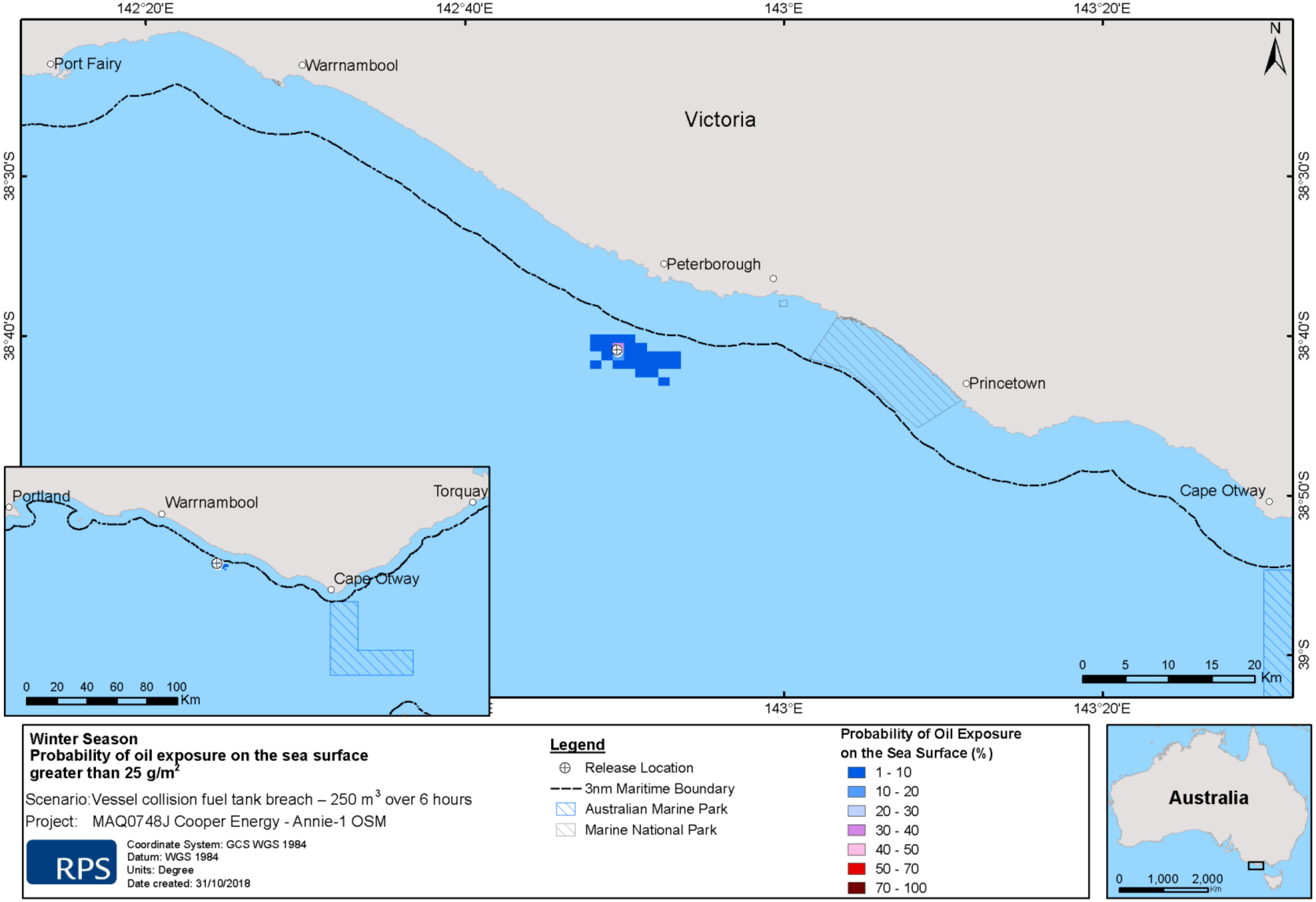

Figure 63 **Probability of oil exposure on the sea surface for the high threshold (25 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.**

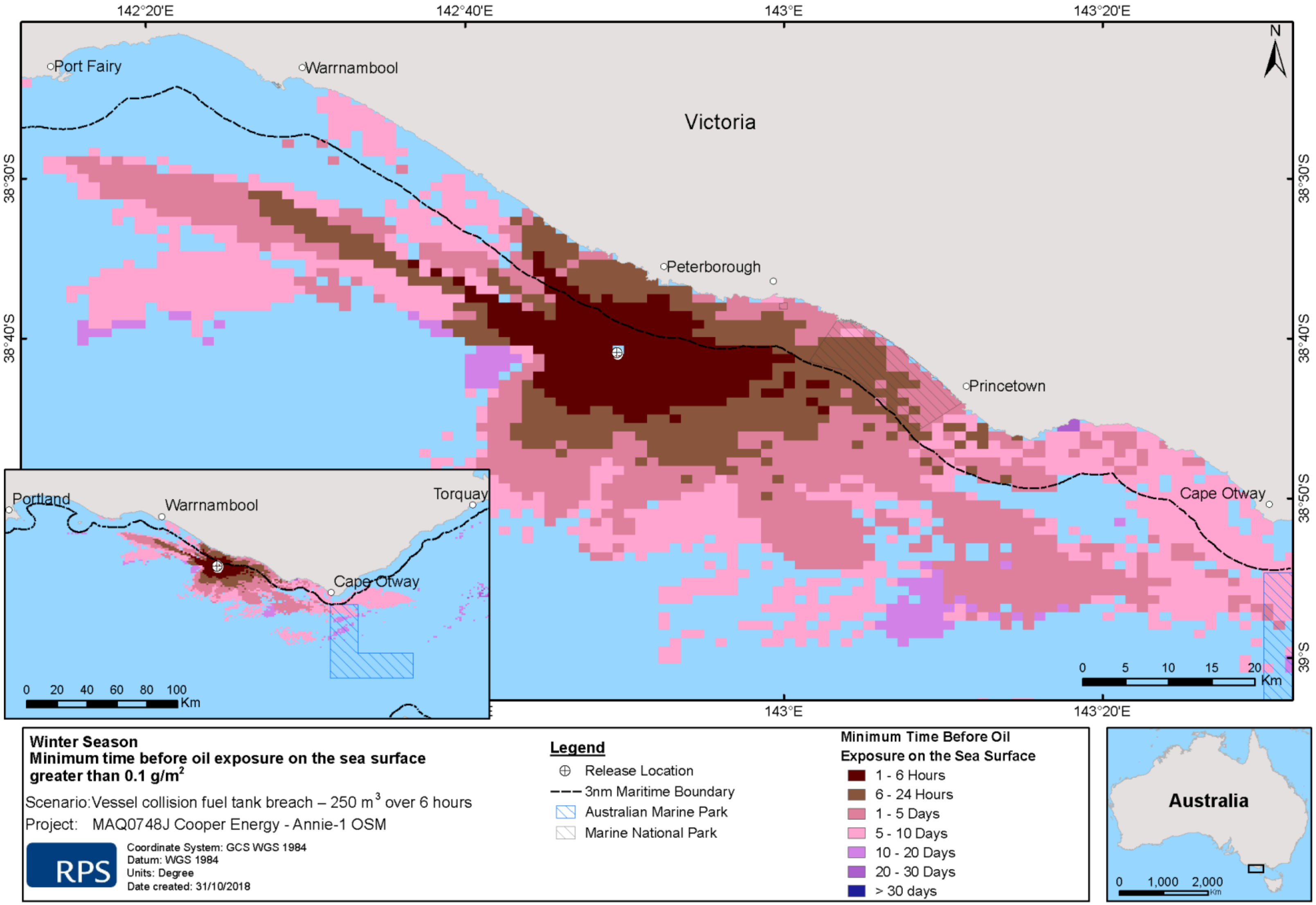

Figure 64 Minimum time before oil exposure on the sea surface for the low threshold (0.1 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.

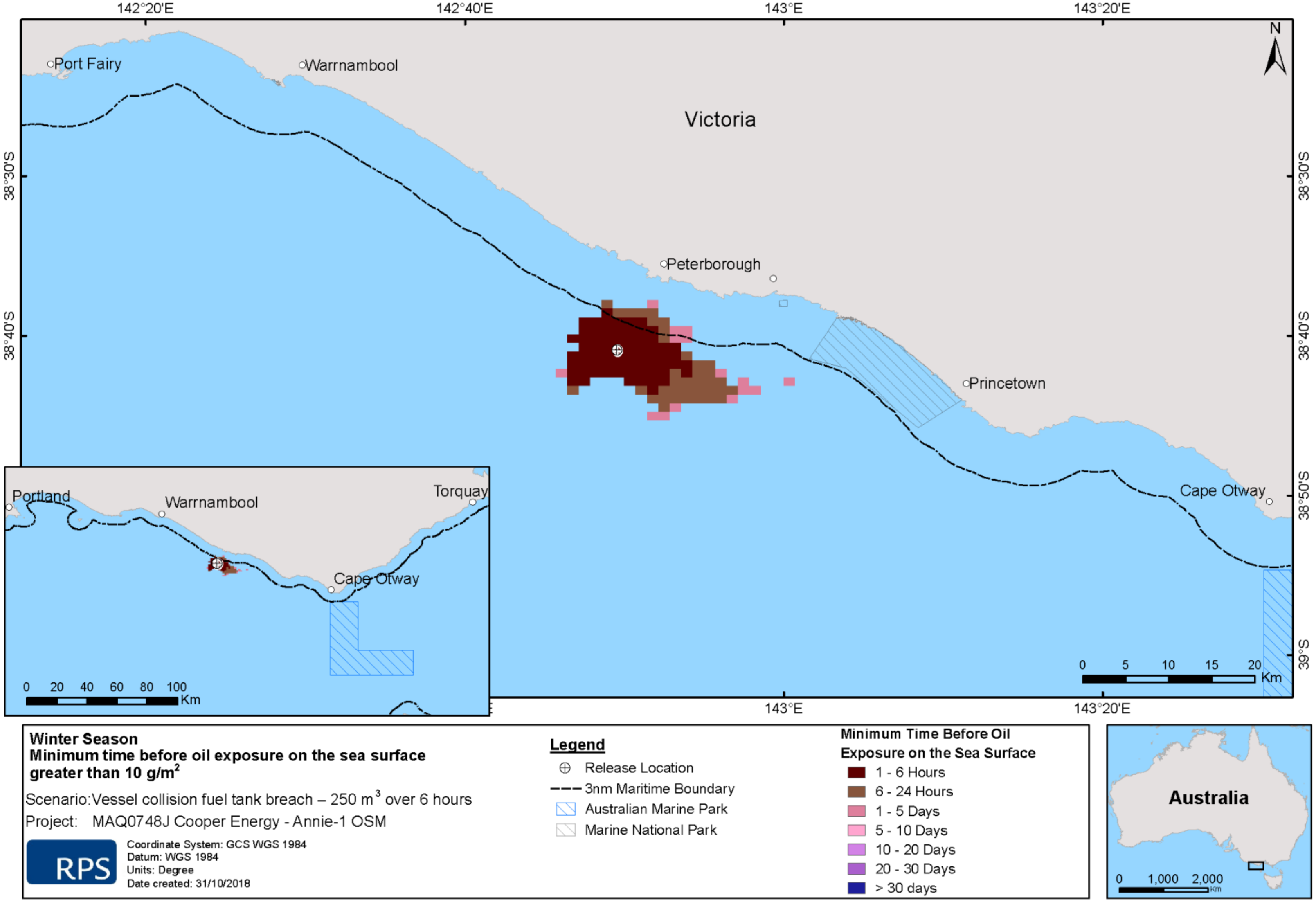

Figure 65 **Minimum time before oil exposure on the sea surface for the moderate threshold (10 g/m^2), in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.**

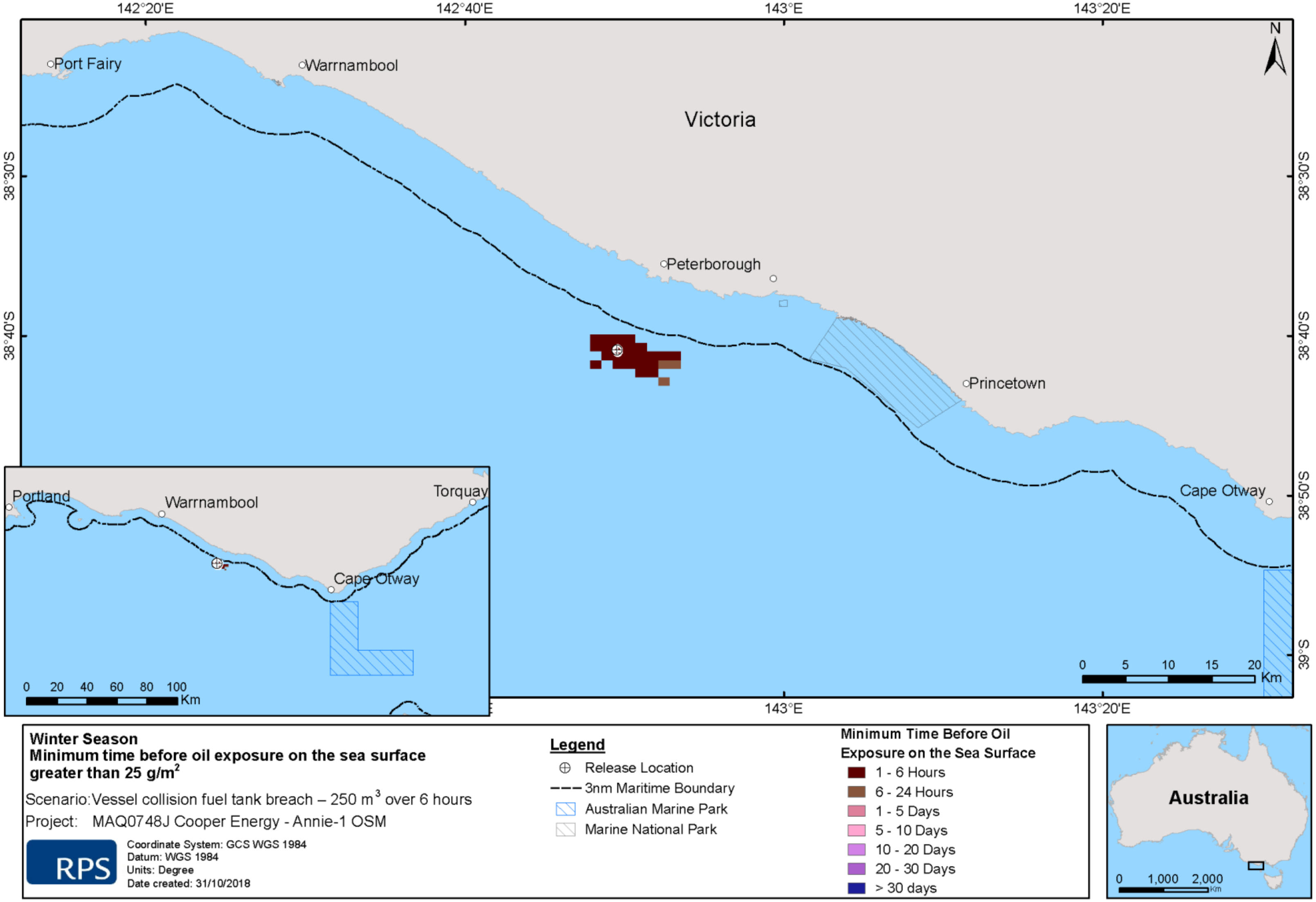

Figure 66 **Minimum time before oil exposure on the sea surface for the high threshold (25 g/m²), in the event of a 250 m³ surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories.**

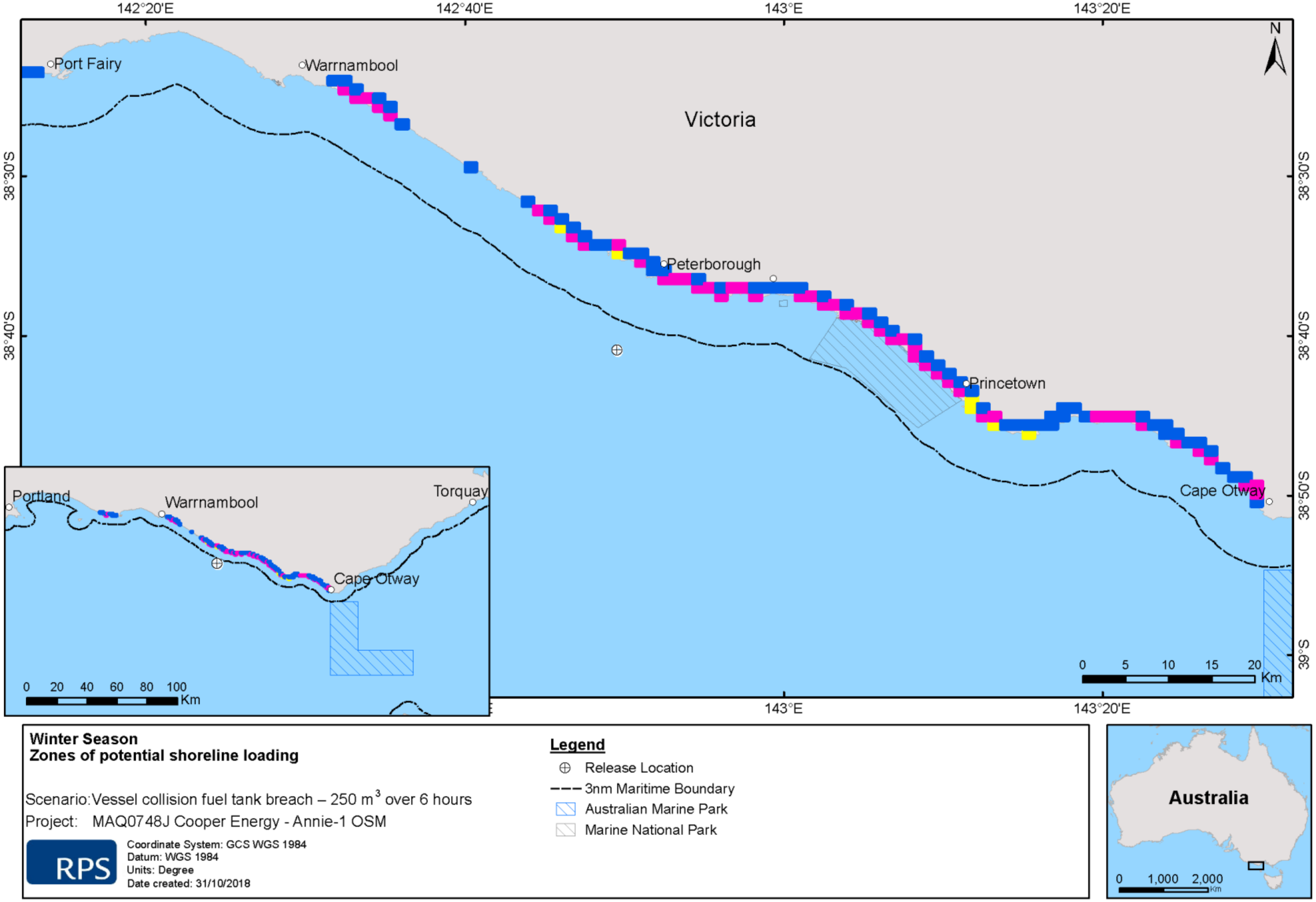

Figure 67 Maximum potential shoreline loading for the low (1 g/m^2) moderate (100 g/m^2) and high (>1,000 g/m^2) thresholds. Results were based on a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days.

8.4.2 Water Column Exposure

8.4.2.1 Dissolved Hydrocarbons

Table 43 to Table 45 summarise the predicted probability (at each threshold) and maximum exposures (instantaneous and time-averaged) to dissolved hydrocarbons to shoreline, environmental and biological receptors for the winter period at the depths of 0-10 m, 10-20 m and 20-40 m, respectively. No dissolved hydrocarbons were predicted at deeper layers.

Figure 68 and Figure 69 show the potential zones of low (1 ppb), moderate (10 ppb) and high (300 ppb) time-averaged exposure to dissolved hydrocarbons for the winter period. In the 0-10 m depth layer, low dissolved hydrocarbon exposure was predicted to travel up to 42 km towards the northwest from the release location and 62 km towards the southeast. Moderate levels were observed up to 11 km from the release site towards the northeast.

RPS

Table 43 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 0–10 m below the sea surface during winter. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Patton	1	<1	0	0	0
SUB-LGA	Apollo Bay	2	<1	0	0	0
SUB-LGA	Cape Otway West	11	2	3	0	0
SUB-LGA	Moonlight Head	17	5	9	0	0
SUB-LGA	Port Campbell	25	11	6	1	0
SUB-LGA	Bay of Islands	8	4	5	0	0
SUB-LGA	Childers Cove	4	2	1	0	0
SUB-LGA	Warrnambool	1	<1	0	0	0
SUB-LGA	Port Fairy	2	<1	0	0	0
IBRA	Warrnambool Plain	25	11	9	1	0
IBRA	Otway Ranges	14	5	4	0	0
IBRA	Otway Plain	6	2	3	0	0
IMCRA	Otway	62	13	31	1	0
IMCRA	Central Victoria	4	<1	0	0	0
IMCRA	Central Bass Strait	3	<1	0	0	0
State Waters	Victoria State Waters	43	13	14	1	0
AMP	Apollo AMP	5	<1	0	0	0

RPS

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
NP	Twelve Apostles Marine National Park	22	6	14	0	0
KEF	Bonney Coast Upwelling	3	<1	0	0	0

RPS

Table 44 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 10–20 m below the sea surface during winter. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Patton	1	<1	0	0	0
SUB-LGA	Apollo Bay	1	<1	0	0	0
SUB-LGA	Cape Otway West	3	<1	0	0	0
SUB-LGA	Moonlight Head	7	1	1	0	0
SUB-LGA	Port Campbell	9	2	2	0	0
SUB-LGA	Bay of Islands	5	<1	0	0	0
SUB-LGA	Port Fairy	1	<1	0	0	0
IBRA	Warrnambool Plain	9	2	2	0	0
IBRA	Otway Ranges	3	<1	0	0	0
IBRA	Otway Plain	3	<1	0	0	0
IMCRA	Otway	11	2	2	0	0
IMCRA	Central Victoria	3	<1	0	0	0
IMCRA	Central Bass Strait	3	<1	0	0	0
State Waters	Victoria State Waters	9	2	2	0	0
AMP	Apollo AMP	3	<1	0	0	0
NP	Twelve Apostles Marine National Park	8	1	1	0	0
KEF	Bonney Coast Upwelling	2	<1	0	0	0

RPS

Table 45 Probability of low, moderate and high exposure to marine based receptors from dissolved hydrocarbons, at 20–40 m below the sea surface during winter. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to dissolved hydrocarbons (ppb)	Maximum time-averaged exposure to dissolved hydrocarbons (ppb)	Probability of exposure to dissolved hydrocarbons (ppb)		
				Low (1 ppb)	Moderate (10 ppb)	High (300 ppb)
SUB-LGA	Cape Otway West	2	<1	0	0	0
SUB-LGA	Moonlight Head	2	<1	0	0	0
SUB-LGA	Port Campbell	2	<1	0	0	0
SUB-LGA	Bay of Islands	1	<1	0	0	0
IBRA	Warrnambool Plain	2	<1	0	0	0
IBRA	Otway Plain	2	<1	0	0	0
IMCRA	Otway	3	<1	0	0	0
State Waters	Victoria State Waters	3	<1	0	0	0
NP	Twelve Apostles Marine National Park	2	<1	0	0	0
NP	Twelve Apostles Marine National Park	8	1	1	0	0
KEF	Bonney Coast Upwelling	2	<1	0	0	0

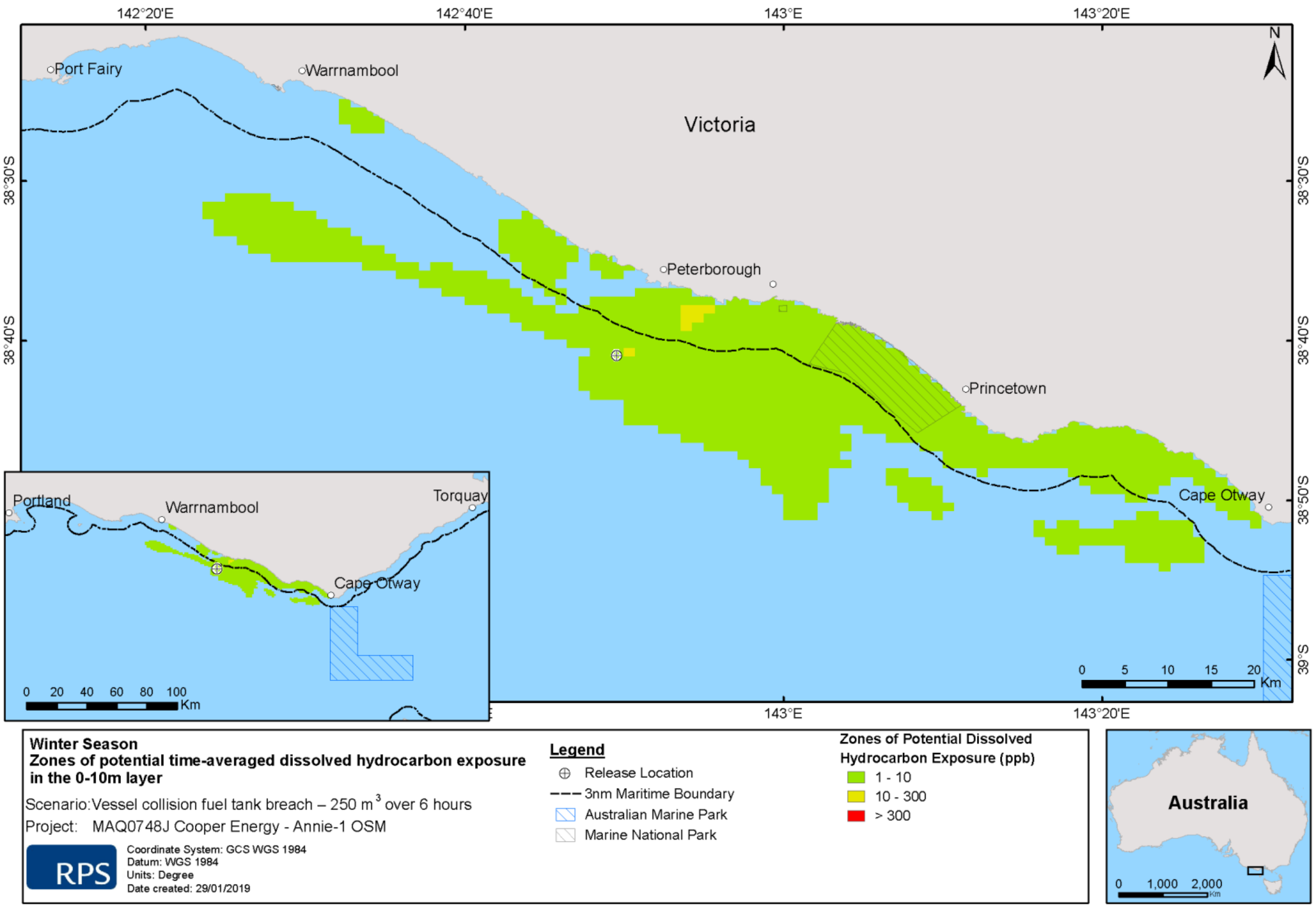

Figure 68 Zones of potential time-averaged dissolved hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during winter conditions.

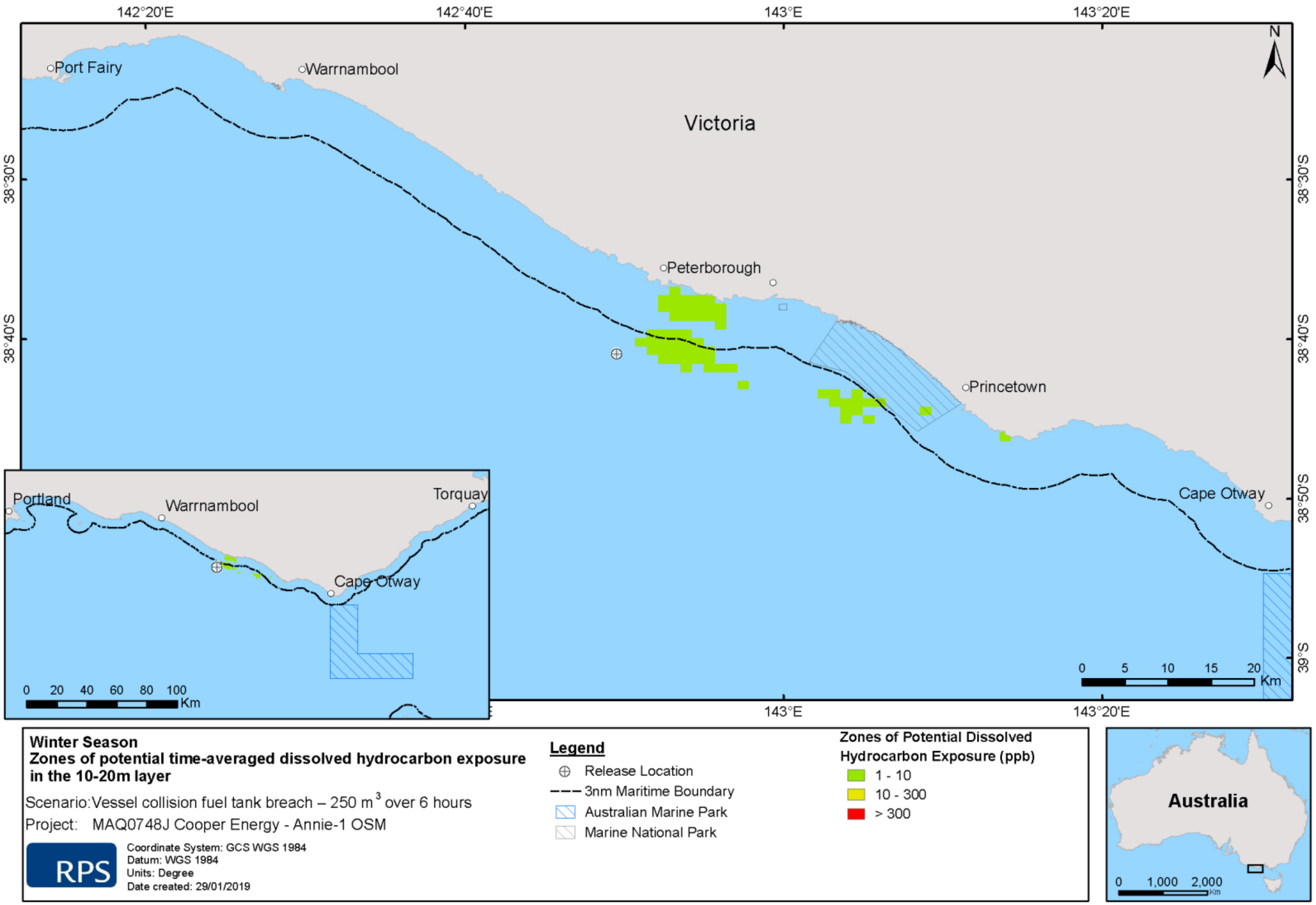

Figure 69 Zones of potential time-averaged dissolved hydrocarbon exposure at 10-20 m below the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during winter conditions.

RPS

8.4.2.2 Entrained Hydrocarbons

Table 46 summarises the predicted probability (at each threshold) and maximum exposures (instantaneous and time averaged) to entrained hydrocarbons to shorelines, state waters and KEFs for the winter period at the depths of 0-10 m. No entrained hydrocarbons were predicted at deeper layers. Probability of exposure to the low threshold ranged from 1 to 29%. The IMCRA Otway, the IBRA Warrnambool Plain and the Victoria State Waters were predicted to have the highest probability of exposure at the low threshold (29%).

Figure 70 show the potential zones of low (100 ppb), moderate (1,000 ppb) and high (30,000 ppb) time-averaged exposure to entrained hydrocarbons for the winter period. In the 0-10 m depth layer, low entrained hydrocarbon exposure was observed up to 69 km towards the northwest and 62 km towards the southeast, near Cape Otway. There was no exposure at the moderate threshold.

RPS

Table 46 Probability of low, moderate and high exposure to marine based receptors from entrained hydrocarbons, at 0–10 m below the sea surface during winter. Results are based on a 250 m^3 surface release of MDO over 6hr at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories (0 = no contact).

Receptor		Maximum instantaneous exposure to entrained hydrocarbons (ppb)	Maximum time-averaged exposure to entrained hydrocarbons (ppb)	Probability of exposure to entrained hydrocarbons (ppb)		
				Low (100 ppb)	Moderate (1,000 ppb)	High (30,000 ppb)
SUB-LGA	Cape Otway West	407	243	4	0	0
SUB-LGA	Moonlight Head	1,131	528	20	0	0
SUB-LGA	Port Campbell	1,273	680	10	0	0
SUB-LGA	Bay of Islands	817	458	8	0	0
SUB-LGA	Childers Cove	549	347	1	0	0
SUB-LGA	Warrnambool	227	136	1	0	0
SUB-LGA	Port Fairy	245	145	1	0	0
IBRA	Warrnambool Plain	1,273	680	20	0	0
IBRA	Otway Ranges	545	283	6	0	0
IBRA	Otway Plain	407	243	4	0	0
IMCRA	Otway	4,209	800	29	0	0
IMCRA	Central Victoria	254	74	0	0	0
IMCRA	Central Bass Strait	249	72	0	0	0
State Waters	Victoria State Waters	2,505	800	20	0	0
AMP	Apollo AMP	278	68	0	0	0
NP	Twelve Apostles Marine National Park	1,073	456	18	0	0
KEF	Bonney Coast Upwelling	167	123	1	0	0

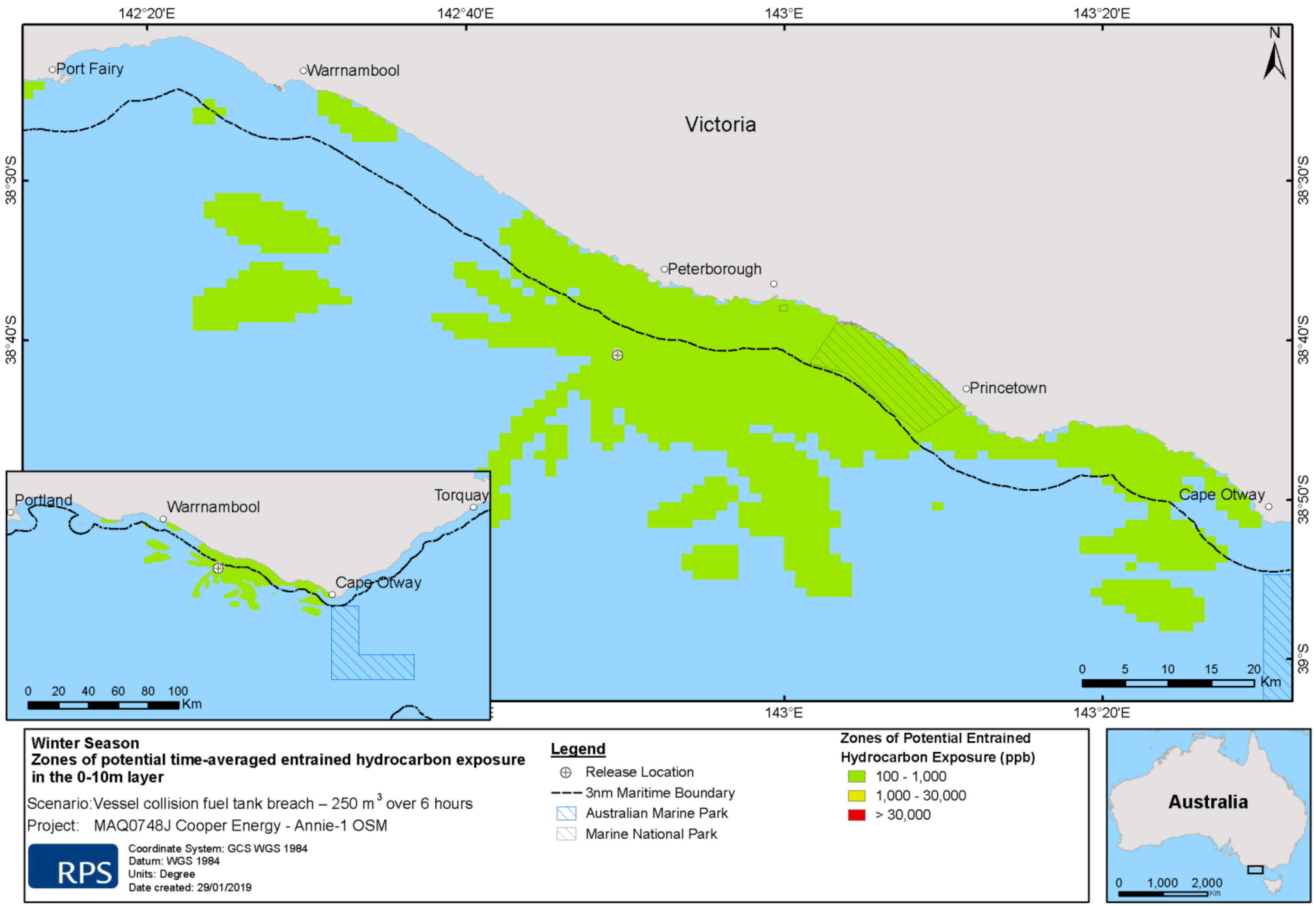

Figure 70 Zones of potential time-averaged entrained hydrocarbon exposure at 0-10 m below the sea surface, in the event of a 250 m^3 surface release of MDO over 6 hours at the Annie-1 release site, tracked for 30 days. The results were calculated from 100 spill trajectories during winter conditions.

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9 DETERMINISTIC ANALYSIS

Deterministic analysis has been used to assess the impact of the individual simulation considered to have a greater impact on the environment. The run has been selected based on the length of shoreline contacted by the condensate at, or above, the shoreline actionable threshold (100 g/m^2) and the greatest volume ashore. This simulation was identified as Model Run 5, for the Blowout scenario during winter season. This simulation commenced at 5 am on the 23th of July 2010.

A summary of shoreline contact from this single deterministic simulation is provided in Table 47. Warrnambool Plain was IBRA receptor was predicted to have the largest length of actionable shoreline oil reaching up to 42 km while Corangamite LGA was predicted to have a total of 27 km.

Zones of exposure from sea surface oil (swept area) and zones of potential shoreline contact, over the entire simulation are presented in Figure 71. Oil exposure was predicted to travel predominantly southeast of the release location.

Figure 72 presents the time series of mass on shore above the low, moderate and high shoreline thresholds.

Figure 73 displays a time series of the area of low surface exposure, the area of actionable surface oil and actionable shoreline oil over the 120-day simulation. The maximum area of exposure on the sea surface at the visible oil threshold occurred throughout the scenario reached its peak within the first four days and was approximately 135 km^2. Additionally, the maximum length of actionable shoreline oil was approximately 35 km.

Figure 74 presents the fates and weathering graph for the corresponding single spill trajectory. A significant portion of the oil was predicted to evaporate upon reaching the water surface. At the conclusion of the simulation period, approximately 20,000 m^3 spilled oil was lost to the atmosphere through evaporation. Approximately 4,000 m^3 of oil was predicted to have decayed by the end of the simulation. Additionally, approximately 500 m^3 remained within the water column. Initial shoreline contact was predicted to occur within 71 hours of the initial release and at the conclusion of the simulation approximately 200 m^3 was predicted to remain on shorelines.

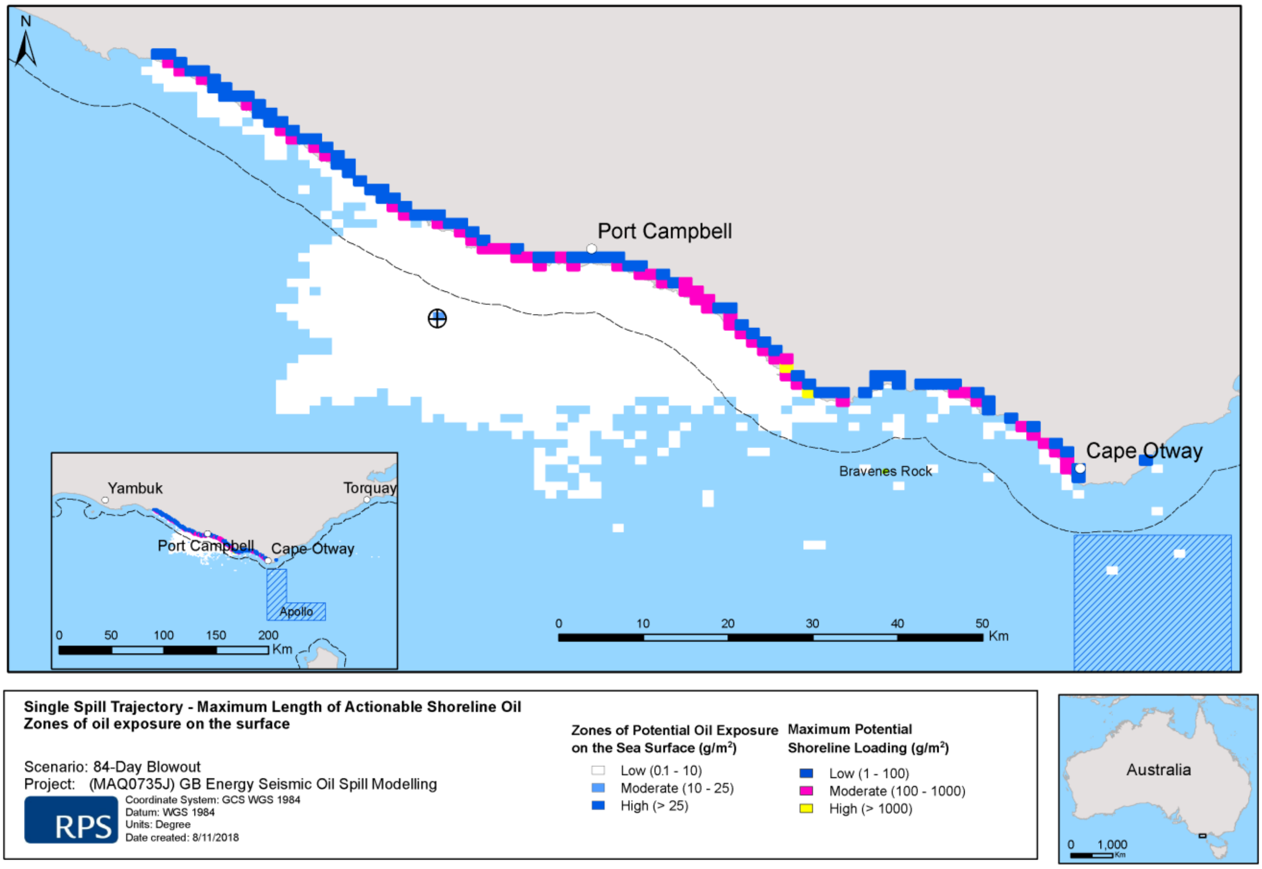

Figure 71 Zones of potential oil exposure on the sea surface and maximum potential shoreline loading for the single spill trajectory representing the worst-case scenario. Results are based on the event of a 24,113 m^3 subsea release of condensate over 84 days at the Annie-1 release site, tracked for 120 days, 5 am on the 23th of July 2010.

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Table 47 Summary of shoreline contact to individual shoreline receptors for the deterministic trajectory representing the worst-case combination of largest length of actionable shoreline oil and greatest volume ashore.

Shoreline Receptor	Time before shoreline accumulation (hours)			Length of shoreline contacted (km)			Load on shoreline (g/m^2)	Volume on shoreline (m^3)	Time before visible oil exposure on the sea surface at littoral zone (hours)
	>1 g/m^2	>100 g/m^2	>1,000 g/m^2	>1 g/m^2	>100 g/m^2	>1,000 g/m^2			
Interim Biogeographic Regionalisation for Australia (IBRA)									
Warrnambool Plain	62	246	747	100	42	2	1,525	180	71
Otway Ranges	69	589	-	13	1	0	789	13	256
Otway Plain	211	263	-	19	9	0	342	24	252
Local Government Area (LGA)									
Warrnambool	453	500	-	12	3	0	159	8	499
Moyne	245	256	-	40	12	0	660	31	248
Corangamite	62	246	747	54	28	2	1,525	167	71
Colac Otway	211	263	-	26	9	0	342	24	252
Sub-Local Government Area (Sub-LGA)									
Apollo Bay	253	-	-	1	0	0	4	0	600
Cape Otway West	211	263	-	25	9	0	342	24	252
Moonlight Head	62	246	747	28	14	2	1,525	113	71
Port Campbell	242	284	-	26	14	0	687	61	235
Bay of Islands	245	256	-	25	8	0	660	30	248
Childers Cove	453	499	-	27	7	0	159	19	456

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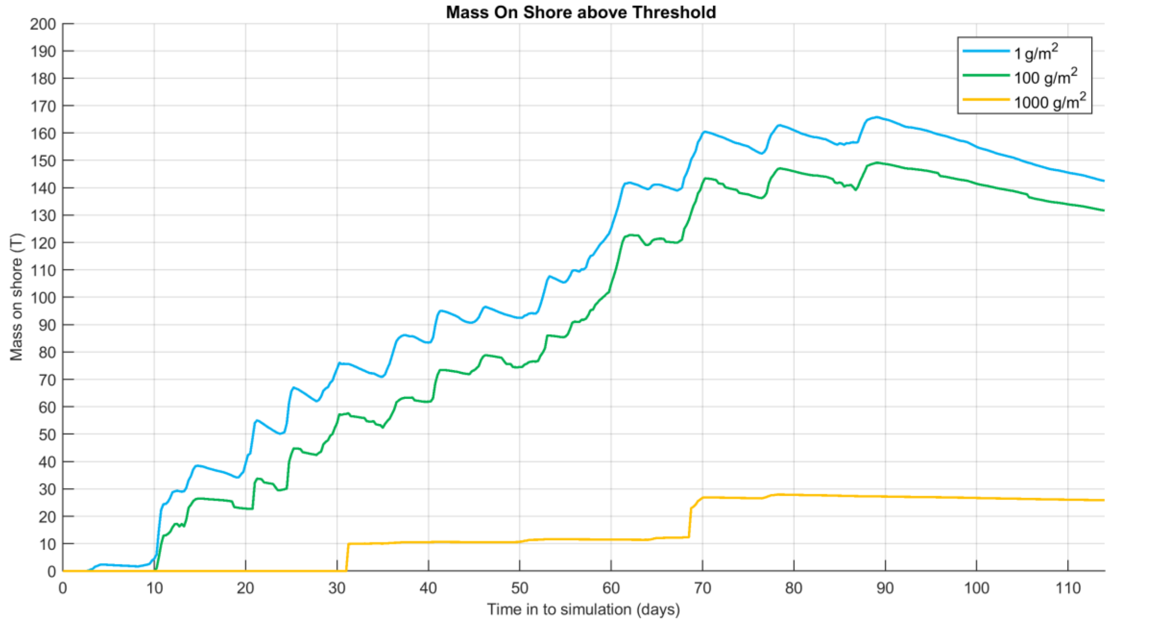

Figure 72 Time series of mass on shore above the low (≥1 g/m²), moderate (≥100 g/m²) and high (≥1,000 g/m²) shoreline thresholds for the single spill trajectory representing the worst-case scenario.

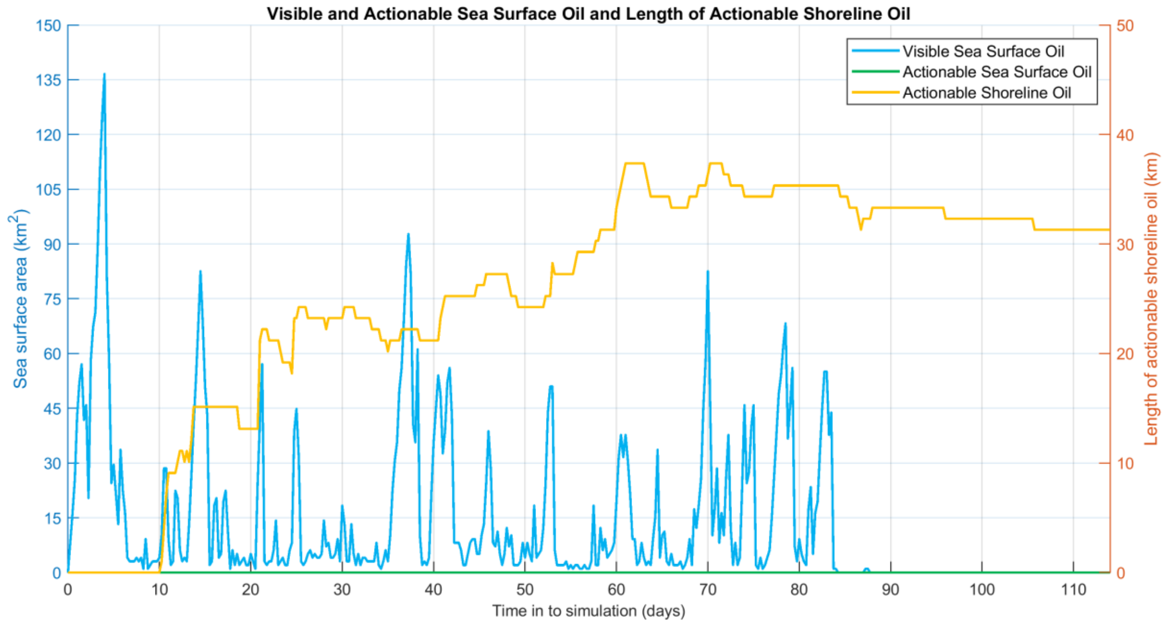

Figure 73 Time series of the area of visible oil on the sea surface (≥0.1 g/m²), and actionable oil on the sea surface above the moderate threshold (10 g/m²), and length of shoreline contacted by actionable shoreline oil above the moderate threshold (≥100 g/m²) for the single trajectory representing the worst-case scenario.

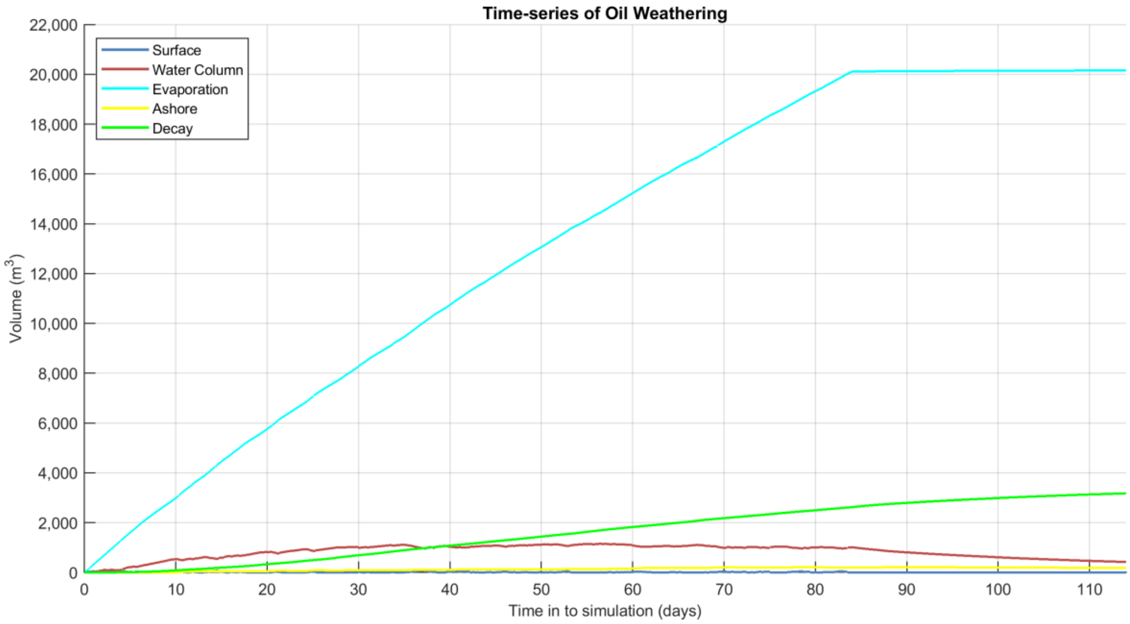

Figure 74 Predicted weathering and fates graph for the single spill trajectory representing the worst-case scenario.

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Appendix 6: Subsea Noise Modelling

Cooper Energy Otway Subsea Noise Modelling

Acoustic Modelling for Assessing Marine Fauna Sound Exposures

JASCO Applied Sciences (Australia) Pty Ltd

12 July 2022

Submitted to:

Joe Morris
Cooper Energy Limited

Authors:

Steven C. Connell
Matthew W. Koessler
Alina M. Muellenmeister
Craig R. McPherson

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Contents

Figures

Tables

Executive Summary

JASCO Applied Sciences (JASCO) performed a modelling study of underwater sound levels associated with Cooper Energy's Otway offshore activities.

The modelling study considers the activities associated with drilling and pipelaying operations. These operations include an anchored Mobile Offshore Drilling Unit (MODU) conducting drilling operations, and an associated Anchor Handling Tug and Supply Vessel (AHTS), conducting re-supply of the MODU under dynamic positioning (DP), and standing by near the MODU, as well as pre-lay, pipelaying and dive support scenarios. This study considered the proposed Annie-2 drilling location.

The study assessed distances from operations where underwater sound levels reached thresholds corresponding to various levels of potential impact to marine fauna. The animals considered here included marine mammals, turtles, and fish. Due to the variety of species considered, there are several different thresholds for evaluating effects, including: mortality, injury, temporary reduction in hearing sensitivity, and behavioural disturbance. Of particular note, whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals.

The modelling methodology considered scenario specific source levels and range-dependent environmental properties. Estimated underwater acoustic levels for non-impulsive (continuous) noise sources presented as sound pressure levels (SPL, L_p), and as accumulated sound exposure levels (SEL, L_E) as appropriate for different noise effect criteria. In this report, the duration of the SEL accumulation is defined as integrated over an 8- or 24-hour period.

The SEL_{24h} is a cumulative metric that reflects the dosimetric impact of noise levels within 24 hours based on the assumption that an animal is consistently exposed to such noise levels at a fixed position. The corresponding SEL_{24h} radii represent an unlikely worst-case scenario. More realistically, marine mammals (as well as fish and turtles) would not stay in the same location for 24 hours. Therefore, a reported radius for SEL_{24h} criteria does not mean that marine fauna travelling within this radius of the source will be injured, but rather that an animal could be exposed to the sound level associated with impairment if it remained in that location for 24 hours.

Maps are provided in the report to assist with contextualising tabulated distances. The key results of this modelling study are summarised in Tables 1 and 2.

Marine mammals:

The maximum distances to the (NOAA) (2019) marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) are presented in Table 1. The results for the criteria from Southall et al. (2019) for marine mammal Permanent Threshold Shift (PTS) and Temporary Threshold Shift (TTS) for MODU and vessel operations are assessed at in-field, the maximum distances and total ensonified areas are presented in Table 2.

Table 1. Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to the marine mammal behavioural response criterion of 120 dB re 1 µPa (SPL) from the most appropriate location for considered sources per scenario. MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel

Location	Operation	Description	R_{max} (km)	$R_{95\%}$ (km)
Annie-2	Drilling Prelays	1x anchor handler within 2km of location DP/slow transit	0.44	0.41
	Mooring	Moored Semi Sub idle (no noise) 1x anchor handler on bridle 2x anchor handle within 2km of location (hooking up anchors)	7.87	7.32
	MODU Drilling	Anchored MODU Drilling	1.10	1.02
	MODU Drilling + OSV Under Standby	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (not DP, minimal thrust)	1.13	1.03
	MODU Drilling Operations with Standby OSV and resupply	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (not DP, minimal thrust) 1x anchor Handler at rig doing resupply	7.46	7.11
Annie-2 & Casino-5	Installation (ISV) Annie EHU	Laying Pipes and umbilicals - 600m/hour	5.97	5.41
Annie-2	Installation (DSV)	DSV + HRV (no noise) stationary on location	2.56	2.30

Table 2. Summary: Maximum (R_{max}) horizontal distances (in km) and ensonified area (km^2) for the frequency-weighted LF-cetacean SEL_{24h} TTS thresholds from the most appropriate location for the considered scenario. MODU: Mobile Offshore Drilling Unit, OSV: Offshore Supply Vessel

Location	Operation	Description	R_{max} (km)	Area (km^2)
Annie-2	Drilling Prelays	1x anchor handler within 2km of location DP/slow transit	0.02	0.082
	Mooring	Moored Semi Sub idle (no noise) 1x anchor handler on bridle 2x anchor handle within 2km of location (hooking up anchors)	3.03	15.46
	MODU Drilling	Anchored MODU Drilling	0.37	0.398
	MODU Drilling + OSV Under Standby	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (not DP, minimal thrust)	0.37	0.531
	MODU Drilling Operations with Standby OSV and resupply	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (not DP, minimal thrust) 1x anchor Handler at rig doing resupply	1.22	4.909
Annie-2 & Casino-5	Installation (ISV) Annie EHU	Laying Pipes and umbilicals - 600m/hour	0.32	7.144
Annie-2	Installation (DSV)	DSV + HRV (no noise) stationary on location	0.77	1.777

Fish:

Sound produced by the MODU and/or vessel operations reach the sound levels associated with physiological effects, recoverable injury, and TTS for some fish species in close proximity to the sound sources (Table 3), but in order for the thresholds to be exceeded, the fish must remain at those distances for either 12 or 48 h.

Table 3. Summary: *SPL*: Maximum (R_{max}) horizontal distances (in km) to sound pressure level (SPL) from most appropriate location for considered sources per scenario.

Location	Maximum (R_{max}) distance to threshold (km)	
	TTS (12 h)	Recoverable injury (48 h)
Annie-2	0.13	0.03

1. Introduction

JASCO Applied Sciences (JASCO) performed a modelling study of underwater acoustic noise levels associated with Cooper Energy's Otway activities along with the site-specific environmental parameters that effect the propagation of underwater sound.

The modelling study specifically predicted the distances from operations at which underwater sound levels reached noise effect thresholds and criteria. The corresponding marine mammal thresholds include levels associated with behavioural response, permanent threshold shift (PTS) and temporary threshold shift (TTS). The marine mammal functional hearing groups considered were low-, high- and very high-frequency cetaceans and otariid seals. Estimated underwater acoustic levels are presented as sound pressure levels (SPL, L_p), and accumulated sound exposure levels (over 24 hours) (SEL_{24h}, $L_{E,24h}$), as appropriate for non-impulsive (continuous) noise sources.

This report is further structured as follows, the remainder of Section 1 provides details on the scenarios considered for modelling, Section 2 explains the metrics used to represent underwater acoustic fields and the effect criteria considered. Section 2.1.1 details the methodology for predicting the source levels and modelling the sound propagation, including the specifications of the considered sound sources and the environmental parameters. Section 4.1 presents the acoustic results as tabulated ranges to thresholds, Section 4.2 provides sound level contour maps. The acoustic modelling results are then discussed in Section 5.

1.1. Modelling Scenarios

This acoustic and exposure study considered the following sound-producing activities associated with the drilling campaign:

- Drilling noise from an anchored Mobile Offshore Drilling Unit (MODU),
- Vessel noise from an Anchor Handling Tug Supply (AHTS) on slow transit in prelay and hookup operations which was modelled as following a random track in a 2x2 km box centred around Annie-2,
- Vessel noise from an Anchor Handling Tug Supply (AHTS) on slow transit in standby operation which was modelled as following a random track and was confined to a 2x4 km area approximately 2 km from Annie-2 or,
- Vessel noise from an AHTS conducting resupply operations under dynamic positioning (DP),
- Vessel noise from an Infield Support Vessel (ISV) conducting pipelay operations,
- Vessel noise from a Dive Support Vessel (DSV) and a Hyperbaric Rescue Vessel (HRV) under DP.

These activities are typical for the facility and are representative of activities that have and will occur over existing and future stages. Figure 1 displays an overview of the modelling area showing the modelled sites, the southern right whale BIA, the pygmy blue whale BIA, and the regional bathymetry. Tables 4 and 5 outline the modelling locations and scenarios.

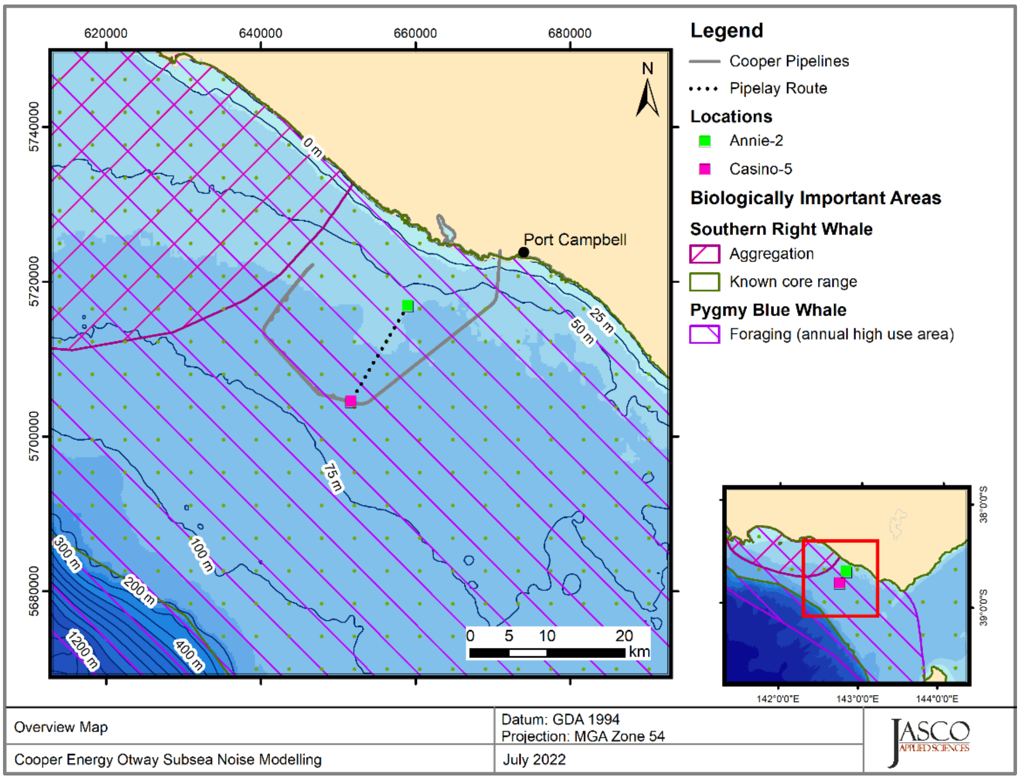

Figure 1. Overview map of the relevant features of the Cooper Energy Otway Offshore Facilities.

Table 4. Modelled site locations and source information.

Site	Source/Vessel	Location	Latitude (°S)	Longitude (°E)	MGA[1] Zone 54		Water depth (m)
					X (m)	Y (m)	
1	AHTS (Transit)	Annie-2	38° 40' 57.6150"	142° 48' 16.3728"	656960	5716892	55.8
2	AHTS (DP)		38° 41' 12.4290"	142° 49' 39.6798"	658964	5716395	59.2
3	AHTS (Transit)		38° 40' 53.7600"	142° 51' 01.7814"	660959	5716931	61.8
4	MODU (Drilling)		38° 40' 56.2182"	142° 49' 39.0972"	658960	5716895	57.9
5	AHTS (Transit)		38° 40' 57.6150"	142° 48' 16.3728"	656960	5716892	55.8
6	AHTS (DP)		38° 40' 57.1902"	142° 49' 39.1506"	658961	5716865	58.0
7	ISV (Pipelay)	Between Annie-2 & Casino-5	38° 44' 19.9746"	142° 47' 12.0264"	6552834	5710684	61.0
8	ISV (Pipelay)	Annie-2	38° 40' 56.2182"	142° 49' 39.0972"	658960	5716895	57.9
9	ISV (Pipelay)	Casino-5	38° 46' 42.4884"	142° 36' 04.2804"	639085	5706589	75.0
10	DSV (Standby)	Annie-2	38° 40' 56.2182"	142° 49' 39.0972"	658960	5716895	58.0

[1]Map Grid of Australia (MGA)

Table 5. Description of vessel modelling scenarios.

Scenario	Site(s)	Location	Operation Name	Operation Description	Operation Time	Vessel(s)
1	1	Annie-2	Drilling Prelays	1x anchor handler within 2km of location DP/slow transit	24h	Anchor Handler
2	1,2,3	Annie-2	Mooring	Moored Semi Sub idle (no noise) 1x anchor handler on bridle 2x anchor handle within 2km of location (hooking up anchors)	24h	Ocean Onyx Anchor Handler x3
3	4	Annie-2	MODU Drilling	Anchored MODU Drilling	24h	Ocean Onyx
4	4,5	Annie-2	MODU Drilling + OSV Under Standby	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (under minimal thrust)	24h	Ocean Onyx Anchor Handler
5	4,5,6	Annie-2	MODU Drilling Operations with Standby OSV and resupply	Anchored MODU Drilling 1x Anchor Handler on standby within 2km (under minimal thrust) 1x anchor Handler at rig doing resupply (under DP)	MODU: 24hr OSV Standby: 24h OSV Resupply: 8h	Ocean Onyx Anchor Handler x2
6	7,8,9	Btw Annie-2 & Casino-5	*Pipeline/Umbilical* installation (ISV) Annie EHU	Laying Pipes and umbilicals – 600 m/hr	24h	ISV
7	10	Annie-2	Installation (DSV + HRV)	DSV + HRV stationary on location	24h	DSV+HRV

2. Noise Effect Criteria

To assess the potential effects of a sound-producing activity, it is necessary to first establish exposure criteria (thresholds) for which sound levels may be expected to have an adverse effect on animals. Whether acoustic levels might injure or disturb marine fauna is an active research topic. Since 2007, several expert groups have developed SEL-based assessment approaches for evaluating auditory injury, with key works including Southall et al. (2007), Finneran and Jenkins (2012), Popper et al. (2014), United States National Marine Fisheries Service (NMFS 2018a) and Southall et al. (2019). The number of studies that investigate the level of behavioural disturbance to marine fauna by anthropogenic sound has also increased substantially.

Two sound level metrics, SPL and SEL, are commonly used to evaluate non-impulsive noise and its effects on marine life. In this report, the duration of the SEL accumulation is defined as integrated over a 24-hour period. Appropriate subscripts indicate any frequency weighting applied (see Appendix A.4). The acoustic metrics in this report reflect the ANSI and ISO standards for acoustic terminology, ANSI S1.1 (2013) and ISO 18405:2017 (2017).

The following thresholds and guidelines for this study were chosen because they represent the best available science:

1. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Southall et al. (2019) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in marine mammals for non-impulsive sound sources.
2. Marine mammal behavioural threshold based on the current interim US National Oceanic and Atmospheric Administration (NOAA) (2019) criterion for marine mammals of 120 dB re 1 µPa (SPL; L_p) for non-impulsive sound sources.
3. Sound exposure guidelines for fish, fish eggs, and larvae (Popper et al. 2014).
4. Frequency-weighted accumulated sound exposure levels (SEL; $L_{E,24h}$) from Finneran et al. (2017) for the onset of permanent threshold shift (PTS) and temporary threshold shift (TTS) in sea turtles.

Section 2.1, along with Appendix A.3 and A.4, expand on the thresholds, guidelines, and sound levels for marine mammals.

2.1. Marine Mammals

The criteria applied in this study to assess possible effects of non-impulsive noise sources on marine mammals are summarised in Table 6. Cetaceans and otariids were identified as the marine mammals requiring assessment. Details on thresholds related to auditory threshold shifts or hearing loss and behavioural response are provided in Appendix A.3, with frequency weighting explained in detail in Appendix A.4. Of particular note, whilst the newly published Southall et al. (2021) provides recommendations and discusses the nuances of assessing behavioural response, the authors do not recommend new numerical thresholds for onset of behavioural responses for marine mammals. As such the interim guidelines from the US National Oceanic and Atmospheric Administration (NOAA) (2019) have been used.

Table 6. Criteria for effects of non-impulsive noise exposure, including vessel noise, for marine mammals: Unweighted SPL and SEL_{24h} thresholds.

Hearing group	NOAA (2019)	Southall et al. (2019)	
	Behaviour	PTS onset thresholds (received level)	TTS onset thresholds (received level)
	SPL (L_p; dB re 1 µPa)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)	Weighted SEL_{24h} ($L_{E,24h}$; dB re 1 µPa^2·s)
Low-frequency (LF) cetaceans	120	199	179
High-frequency (HF) cetaceans		198	178
Very High-frequency (VHF) cetaceans		173	153
Otariid Seals		219	199

L_p denotes sound pressure level period and has a reference value of 1 µPa.
L_E denotes cumulative sound exposure over a 24 h period and has a reference value of 1 µPa^2·s.

2.1.1. Behavioural Response

The NMFS non-pulsed noise criterion was selected for this assessment because it represents the most commonly applied behavioural response criterion by regulators. The distances at which behavioural responses could occur were therefore determined to occur in areas ensonified above an unweighted SPL of 120 dB re 1 µPa (NMFS 2019). Appendix A.4 provides more information about the development of this criteria.

2.1.2. Injury and Hearing Sensitivity Changes

There are two categories of auditory threshold shifts or hearing loss: permanent threshold shift (PTS), a physical injury to an animal's hearing organs; and temporary threshold shift (TTS), a temporary reduction in an animal's hearing sensitivity as the result of receptor hair cells in the cochlea becoming fatigued.

To assist in assessing the potential for effect on marine mammals, this report applies the criteria recommended by Southall et al. (2019), considering both PTS and TTS (see Table 6). Appendix A.3 provides more information about the Southall et al. (2019) criteria.

2.2. Fish, Sea turtles, Fish Eggs, and Fish Larvae

In 2006, the Working Group on the Effects of Sound on Fish and Sea Turtles was formed to continue developing noise exposure criteria for fish and sea turtles, work begun by a NOAA panel two years earlier. The Working Group developed guidelines with specific thresholds for different levels of effects for several species groups (Popper et al. 2014). The guidelines define quantitative thresholds for three types of immediate effects:

- Mortality, including injury leading to death,
- Recoverable injury, including injuries unlikely to result in mortality, such as hair cell damage and minor haematoma, and
- TTS.

Masking and behavioural effects can be assessed qualitatively, by assessing relative risk rather than by specific sound level thresholds. However, as these depend upon activity-based subjective ranges, these effects are not addressed in this report and are included in Table 7 for completeness only. Because the presence or absence of a swim bladder has a role in hearing, fish's susceptibility to injury from noise exposure depends on the species and the presence and possible role of a swim bladder in hearing. Thus, different thresholds were proposed for fish without a swim bladder (also appropriate for sharks and applied to whale sharks in the absence of other information), fish with a swim bladder not used for hearing, and fish that use their swim bladders for hearing. Sea turtles, fish eggs, and fish larvae are considered separately.

2.2.1. Sea Turtles

There is a paucity of data regarding responses of turtles to acoustic exposure, and no studies of hearing loss due to exposure to loud sounds. Popper et al. (2014) suggested thresholds for onset of mortal injury (including PTS) and mortality for sea turtles and, in absence of taxon-specific information, adopted the levels for fish that do not hear well (suggesting that this likely would be conservative for sea turtles).

Finneran et al. (2017) presented revised thresholds for sea turtle injury and hearing impairment (TTS and PTS). Their rationale is that sea turtles have best sensitivity at low frequencies and are known to have poor auditory sensitivity (Bartol and Ketten 2006, Dow Piniak et al. 2012). Accordingly, TTS and PTS thresholds for turtles are likely more similar to those of fishes than to marine mammals (Popper et al. 2014).

Table 7 lists the relevant effects thresholds from Popper et al. (2014) for vessel and drilling noise. Some evidence suggests that fish sensitive to acoustic pressure show a recoverable loss in hearing sensitivity, or injury when exposed to high levels of noise (Scholik and Yan 2002, Amoser and Ladich 2003, Smith et al. 2006); this is reflected in the SPL thresholds for fish with a swim bladder involved in hearing. Finneran et al. (2017) presented revised thresholds for turtle injury, considering frequency weighted SEL, which have been applied in this study for vessels (Table 8).

Table 7. Criteria for non-impulsive (vessel and drilling) noise exposure for fish, adapted from Popper et al. (2014).

Type of animal	Mortality and Potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS	Masking	
Fish: No swim bladder (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder not involved in hearing (particle motion detection)	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) Moderate (I) Moderate (F) Low
Fish: Swim bladder involved in hearing (primarily pressure detection)	(N) Low (I) Low (F) Low	170 dB SPL for 48 h	158 dB SPL for 12 h	(N) High (I) High (F) High	(N) High (I) Moderate (F) Low
Sea turtles	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Moderate (I) Low (F) Low	(N) High (I) High (F) Moderate	(N) High (I) Moderate (F) Low
Fish eggs and fish larvae	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) Low (I) Low (F) Low	(N) High (I) Moderate (F) Low	(N) Moderate (I) Moderate (F) Low

Sound pressure level dB re 1 µPa.
Relative risk (high, moderate, low) is given for animals at three distances from the source defined in relative terms as near (N), intermediate (I), and far (F).

Table 8. Acoustic effects of non-impulsive noise on sea turtles, weighted SEL_{24h}, Finneran et al. (2017).

PTS onset thresholds* (received level)	TTS onset thresholds* (received level)
220	200

3. Methods and Parameters

The modelled sites for the operations considered in this study were located on the continental shelf of south-eastern Australian (refer to wide regional bathymetry in Appendix B.1.1). The modelled sites were situated in water depths of approximately 60 m and represent or are considered representative of Cooper Energy's Otway activity locations.

To allow for operational flexibility, the sound speed profile considered for modelling was selected through a sensitivity analysis considering all months. The month of August was found to be the most favourable for sound propagation and was selected for modelling. Additional detail can be found in Appendix B.1.2.

The seabed beneath the modelled sites will likely consist of variably cemented calcarenite (Port Campbell Limestone), for some sites a thin veneer of overlying coarse sand on top of the variably cemented calcarenite may be present. The geologic and geoacoustic profiles of the seabed were generated using lithographic descriptions from the geotechnical and geophysical reports supplied by the client and considering previous underwater acoustic modelling and measurement studies. Appendix B.1.3 provides additional detail.

The following sections provided a description of the inputs used for this underwater noise modelling study. The sections are divided into subsections detailing the source inputs for the MODU, AHTS, ISV and DSV (Section 3.1) with Sections 3.2– providing details on the applied modelling techniques and model configuration information.

3.1. Vessel and Drilling Noise Sources

For the MODU Drilling, AHTS on DP, AHTS standby transiting, the ISV conducting pipelay operations and the DSV and HRV on DP, Figure 2 presents a summary plot of considered source spectra for comparison purposes; additional detail on the sources is provided in Sections 3.1.1–3.1.2.2.

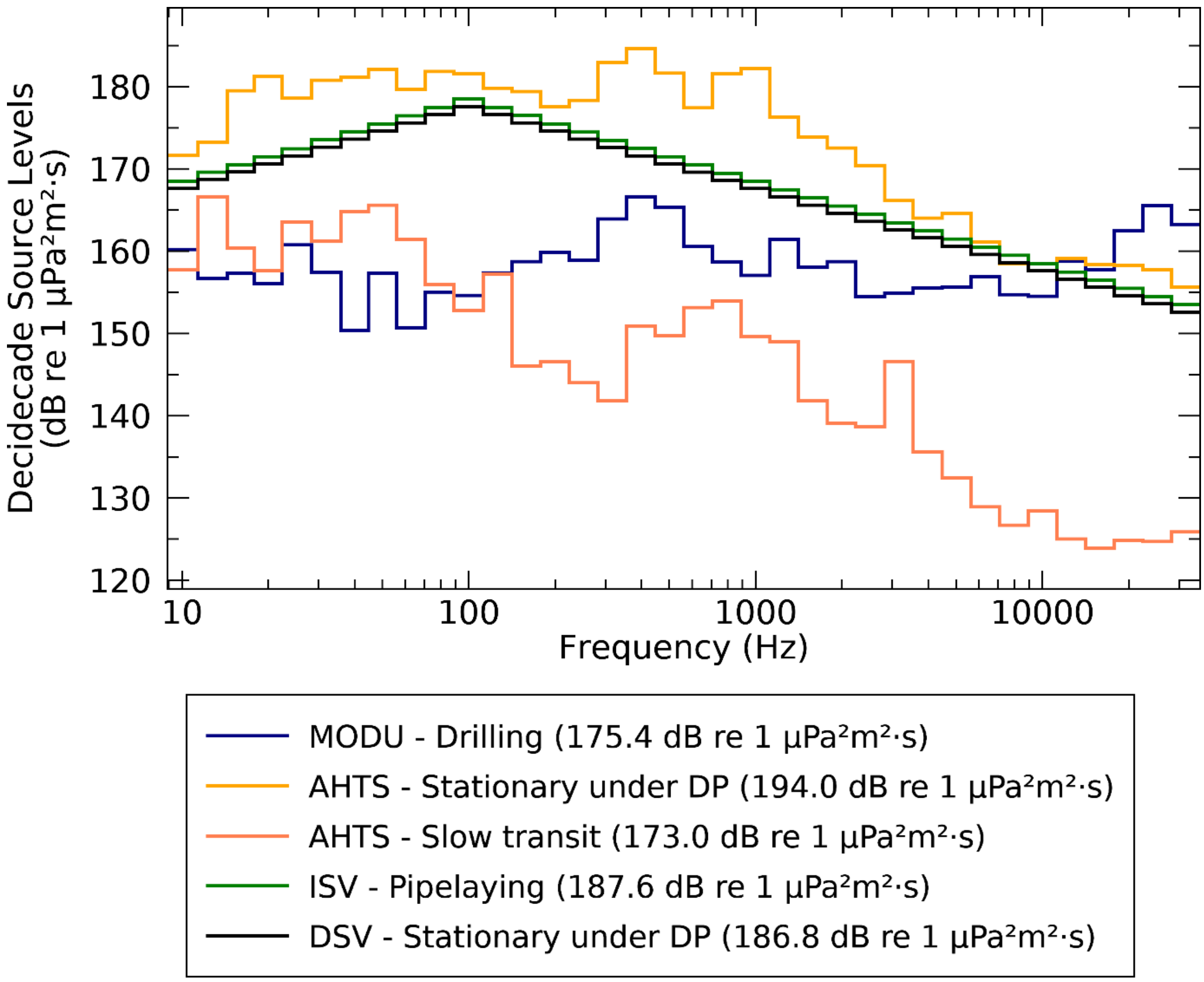

Figure 2. Energy source level (ESL) spectra (in decidecade frequency-band) for all sound sources.

3.1.1. Mobile Offshore Drilling Unit (MODU)

The MODU, or semi-submersible platform, considered in this study is likely similar to the *Ocean Onyx*, (Figure 3). While in operation, it will be held in position via anchors and chains, as opposed to using thrusters. Underwater sound from the MODU while drilling is expected to originate primarily from onboard equipment vibrations, while a smaller portion of the sound is expected to be transmitted directly into the water via the rotating drill string (Austin et al. 2018). Since the dominant vibration sources (e.g. pumps, generators, and machinery) are located on or below the main deck of the platform, the modelled depth of the point source representing the MODU was set to 11.6 m, which is approximately half the draft of the *Ocean Onyx*.

The Ocean Onyx (Figure 3) was measured by JASCO while anchored and drilling (McPherson et al. 2021), and had a broadband (10 Hz to 31 kHz) source level of 175.4 dB re 1 µPa m.

Figure 3. *Ocean Onyx* semi-submersible platform.

3.1.2. Vessel Radiated Noise

Underwater sound that radiates from vessels is produced mainly by propeller and thruster cavitation, with a smaller fraction of noise produced by sound transmitted through the hull, such as by engines, gearing, and other mechanical systems. Sound levels tend to be the highest when thrusters are used to position the vessel and when the vessel is transiting at high speeds. A vessel's sound signature depends on the vessel's size, power output, propulsion system (e.g., conventional propellers vs. Voith Schneider propulsion), and the design characteristics of the given system (e.g., blade shape and size). A vessel produces broadband acoustic energy with most of the energy emitted below a few kilohertz. Sound from onboard machinery, particularly sound below 200 Hz, dominates the sound spectrum before cavitation begins (Spence et al. 2007).

3.1.2.1. Anchor Handling Tug Supply (AHTS)

At this stage, the exact vessel specifications as well as the precise operational scenarios are not known. As such, estimates of the source levels for the Anchor Handling Tug Supply (AHTS) operations were based on a generic design AHTS vessel. The AHTS was based on the Siem VS491 CD design AHTS vessel (Figure 4) and it's specifications (Siem Offshore 2010) were used to form a basis for vessel source level estimation and source depth for acoustic modelling purposes. The general specification of these vessels is that they have a bollard pull of 285-310 t, and an overall length, beam, and draft of 91.0 m, 22.0 m and 7.95 m respectively.

The measured monopole source levels (MSLs) and spectra for the AHTS were from McPherson et al. (2021). For scenarios where the AHTS was under dynamic positioning (DP), the spectra from Section 5.5.2 in McPherson et al. (2021) were used.

Figure 4. Photo of an Anchor Handling Tug Supply (AHTS) vessel (Siem Offshore 2010).

3.1.2.2. Infield Support Vessel (ISV) and Dive Support Vessel (DSV)

As with the AHTS, at this stage the exact vessel specifications are not known. As such, estimates of the source levels for the ISV and DSV were based on a generic source spectrum and scaled based on thruster power comparisons.

3.1.2.2.1. Generic Offshore Vessel Source Spectrum

At the time of this study, the ISV and DSV vessels to be used in the project were unconfirmed and generic source spectrum used the estimate of the acoustic source levels for the ISV and DSV. These were estimated by scaling the spectrum based on the maximum utilised thruster power. The modelled source levels or the ISV and DSV were adjusted using Equation (1).

$$\mathrm{SL} = \mathrm{SL}_{\mathrm{ref}} + 10\log_{10}\left(\frac{P}{P_{\mathrm{ref}}}\right) \tag{1}$$

Here the modelled broadband source level (SL) is estimated from the broadband source level of the generic source (SL_{ref}) and the utilised thruster powers of the modelled ISV (or DSV) and generic sources (P and P_{ref}, respectively). The generic source spectrum for the was determined by the method described in Appendix B.2.

3.1.2.2.2. Infield Support Vessel (ISV)

The estimates of the source levels for the ISV were based on a proxy vessel, the Skandi Acergy (Figure 5) which has a total installed thruster power rating of 16,840 kW, and overall length, beam and draft of 156.9 m, 27.0 m and 8.5 m respectively. The propulsion system of the Skandi Acergy contains the following:

- 2 x 1,920 kW tunnel thrusters,
- 2 x 1,500 kW retractable azimuths,
- 2 x 3,000 kW contra-rotating azimuths,
- 1 x 4,000 kW shaft propeller + rudder.

However, while under DP the single rear main is not likely to be in use; therefore, for power scaling it was omitted. The total maximum thruster power while the ISV was on DP of 12,840 kW was used with Equation (1) for scaling.

Figure 5. Photo of the Skandi Acergy - proxy for an Infield Support Vessel (ISV).

3.1.2.2.3. Dive Support Vessel (DSV)

The estimates of the source levels for the ISV were based on a proxy vessel, the Skandi Singapore (Figure 6) which has a total installed thruster power rating of 10,500 kW, and overall length, beam and draft of 107.1 m, 21.0 m, and 6.6 m respectively. The propulsion system of the Skandi Singapore contains the following:

- 2 x 1500 kW bow tunnel thrusters,
- 1 x 1,500 kW retractable azimuth thruster,
- 2 x 3,000 kW stern azimuths thruster.

The total maximum thruster power while the DSV was on DP of 10,500 kW was used for with Equation (1) for scaling.

Figure 6. Photo of the Skandi Singapore proxy for a Dive Support Vessel (DSV).

3.2. Geometry and Modelled Regions

JASCO's Marine Operations Noise Model (MONM-BELLHOP; see Appendices B.3.2 and B.3.4) was used to predict the acoustic field at frequencies of 10 Hz to 25 kHz for all vessels. To supplement the MONM results, high-frequency results for propagation loss were modelled using Bellhop for frequencies from 1.26 to 25 kHz. The sound field modelling calculated propagation losses up to 100 km from the source, with a horizontal separation of 20 m between receiver points along the modelled radials. The sound fields were modelled with a horizontal angular resolution of $\Delta\theta$ = 2.5° for a total of N = 144 radial planes. Receiver depths were chosen to span the entire water column over the modelled areas, from 2 m to a maximum of 2600 m. To supplement the MONM results, high-frequency results for propagation loss were modelled using BELLHOP (Porter and Liu 1994) for frequencies from 1.25 to 10 kHz. The MONM and BELLHOP results were combined to produce results for the full frequency range of interest.

To produce the maps of received sound level isopleths, and to calculate distances to specified sound level thresholds, the maximum-over-depth level was calculated at each sampling point within the modelled region. The radial grids of maximum-over-depth levels were then resampled (by linear triangulation) to produce a regular Cartesian grid. The contours and threshold ranges were calculated from these grids of the modelled acoustic fields.

3.3. Accumulated SEL

In this study, the sound sources were considered to be continuously operating with new sound energy constantly being introduced to the environment. The reported source levels are usually in terms of sound pressure levels (SPL), representing the average instantaneous acoustic level of a considered source. The evaluation of the cumulative sound field (i.e., in terms of SEL_{24h}) depends on the number of seconds of operation during the accumulation period.

For all stationary source (MODU and vessels), the SPL modelling results were converted to SEL by the duration of the measurement, which is appropriate for a non-impulsive noise source. As SEL was assessed over 24 h and for a stationary vessel over a day, the conversion from SPL was obtained by increasing the levels by $10*\log_{10}(T)$, where T is 86,400 (the number of seconds in 24 h). For scenarios where a vessel was transiting along a track a similar adjustment to the SPL was applied, however the time factor was determined based on the step size along the track and the vessel's speed. See Appendix B.2.2 for detail.

4. Results

The maximum-over-depth sound fields for the modelled scenarios are presented below in two formats: as tables of distances to sound levels and, where the distances are long enough, as contour maps showing the directivity and range to various sound levels.

For the results below, the distances to isopleths/thresholds were reported from either the centroid of several sources or from the most dominant single source. When an isopleth completely envelopes multiple sources the centroid was used. When several closed isopleths exist the most dominant source was used. Maps and are provided in Section 4.2 to assist in with contextualising tabulated distances.

4.1. Tabulated Results

Tables 9, and 10 present the maximum and 95% distances to SPL. The SPL sound footprints presented represent the instantaneous sound field and do not depend on accumulation time. Table 11 and Table 12 present the maximum distances to frequency-weighted SEL_{24h} thresholds, as well as total ensonified area.

Table 9. *Annie-2, SPL*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from most appropriate location for considered sources per scenario. Scenario descriptions are given in Table 5.

SPL (L_p; dB re 1 µPa)	Annie-2									
	Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–	–	–
170[a]	–	–	0.02	0.02	–	–	–	–	0.03	0.03
160	–	–	0.10	0.10	–	–	–	–	0.11	0.11
158[b]	–	–	0.12	0.11	–	–	–	–	0.13	0.12
150	–	–	0.36	0.34	0.02	0.02	0.02	0.02	0.37	0.34
140	0.03	0.03	0.81	0.76	0.11	0.10	0.11	0.10	0.84	0.77
130	0.14	0.13	3.16	2.71	0.42	0.39	0.42	0.39	2.76	2.43
120[c]	0.44	0.41	7.87	7.32	1.10	1.02	1.13	1.03	7.46	7.11
110	0.96	0.92	21.3	18.5	3.54	3.24	4.43	3.99	20.9	18.4
100	2.40	2.13	79.9	61.8	8.30	7.64	9.30	8.18	79.6	61.9

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for LF, HF & VHF-cetacean behavioural response to non-impulsive noise (NOAA 2019).
A dash indicates the level was not reached within the limits of the modelled resolution (20 m).
A slash indicates that $R_{95\%}$ radius to threshold is not reported when the R_{max} is greater than the maximum modelling extent.

Table 10. *Pipeline/Umbilical Lay between Annie-2 and Casino-5 and ISV at Annie-2, SPL*: Maximum (R_{max}) and 95% ($R_{95\%}$) horizontal distances (in km) to sound pressure level (SPL) from most appropriate location for considered sources per scenario. Scenario descriptions are given in Table 5.

SPL (L_p; dB re 1 µPa)	Annie-2 and Casino-5						Annie-2	
	Scenario 6						Scenario 7	
	Site 7		Site 8		Site 9			
	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)	R_{max} (km)	$R_{95\%}$ (km)
180	–	–	–	–	–	–	–	–
170[a]	–	–	–	–	–	–	–	–
160	0.04	0.04	0.04	0.04	0.03	0.03	0.03	0.03
158[b]	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
150	0.17	0.17	0.17	0.16	0.17	0.17	0.16	0.15
140	0.48	0.43	0.48	0.45	0.69	0.66	0.47	0.44
130	1.14	1.07	0.99	0.94	2.08	1.96	0.98	0.93
120[c]	2.72	2.61	2.59	2.33	5.97	5.41	2.56	2.30
110	7.34	7.11	6.61	6.09	20.2	18.2	6.47	6.08
100	21.3	17.9	16.8	15.4	63.7	52.0	17.2	15.6

[a] 48 h threshold for recoverable injury for fish with a swim bladder involved in hearing (Popper et al. 2014).
[b] 12 h threshold for TTS for fish with a swim bladder involved in hearing (Popper et al. 2014).
[c] Threshold for LF, HF & VHF-cetacean behavioural response to non-impulsive noise (NOAA 2019).
A dash indicates the level was not reached within the limits of the modelled resolution (20 m).
A slash indicates that $R_{95\%}$ radius to threshold is not reported when the R_{max} is greater than the maximum modelling extent.

Table 11. *Vessel Scenarios at Annie-2, SEL_{24h}*: Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from most appropriate location for considered sources per scenario and ensonified area (km²).

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Annie-2									
		Scenario 1		Scenario 2		Scenario 3		Scenario 4		Scenario 5	
		R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)	R_{max} (km)	Area (km²)
PTS											
LF cetaceans	199	–	–	0.31	0.285	0.02	0.001	0.02	0.001	0.18	0.064
HF cetaceans	198	–	–	0.02	0.001	0.02	0.001	0.02	0.001	0.05	0.002
VHF cetaceans	173	–	–	0.16	0.075	0.24	0.169	0.24	0.169	0.26	0.193
Otariid Seals	219	–	–	–	–	–	–	–	–	0.05	0.001
Sea turtles	220	–	–	0.02	0.001	–	–	–	–	0.05	0.001
TTS											
LF cetaceans	179	0.02	0.082	3.03	15.46	0.37	0.398	0.37	0.531	1.22	4.909
HF cetaceans	178	–	–	0.12	0.042	0.14	0.055	0.14	0.055	0.16	0.076
VHF cetaceans	153	–	–	0.83	2.087	1.11	3.857	1.15	3.871	1.13	4.026
Otariid Seals	199	–	–	0.08	0.017	0.02	0.001	0.02	0.001	0.07	0.006
Sea turtles	200	–	–	0.29	0.195	0.02	0.001	0.02	0.001	0.13	0.044

A dash indicates the level was not reached within the limits of the modelled resolution (20 m).

Table 12. *Vessel Scenarios for Pipeline/Umbilical Lay between Annie-2 and Casino-5 and ISV at Annie-2, SPL*: Maximum (R_{max}) horizontal distances (in km) to frequency-weighted SEL_{24h} PTS and TTS thresholds based on Southall et al. (2019) and Finneran et al. (2017) from most appropriate location for considered sources per scenario and ensonified area (km^2).

Hearing group	Frequency-weighted SEL_{24h} threshold ($L_{E,24h}$; dB re 1 µPa²·s)	Annie-2 and Casino-5		Annie-2	
		Scenario 6		Scenario 7	
		R_{max} (km)	Area (km^2)	R_{max} (km)	Area (km^2)
PTS					
LF cetaceans	199	0.02	0.23	0.08	0.021
HF cetaceans	198	–	–	0.02	0.001
VHF cetaceans	173	0.03	0.32	0.10	0.030
Otariid Seals	219	–	–	–	–
Sea turtles	220	–	–	0.02	0.001
TTS					
LF cetaceans	179	0.32	7.144	0.77	1.777
HF cetaceans	178	0.02	0.231	0.07	0.013
VHF cetaceans	153	0.24	6.496	0.62	1.161
Otariid Seals	199	–	–	0.02	0.001
Sea turtles	200	0.02	0.231	0.13	0.050

A dash indicates the level was not reached within the limits of the modelled resolution (20 m).

4.2. Sound Field Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields are presented for the modelled vessel scenarios. In some cases, the isopleths had several contours. This can occur as a result of the reflection of the sound field off the seafloor, creating an additional ring around the initial isopleth. The first isopleth is generally axially symmetric since it spreads without the influence of the bathymetry, while the second isopleth is more complex due to the interaction between the sound field and the seabed.

4.2.1. SPL Sound level Contour Maps

Maps of the estimated sound fields, threshold contours, and isopleths of interest for SPL and SEL_{24h} sound fields are presented for the Cooper Energy Otway subsea noise modelling.

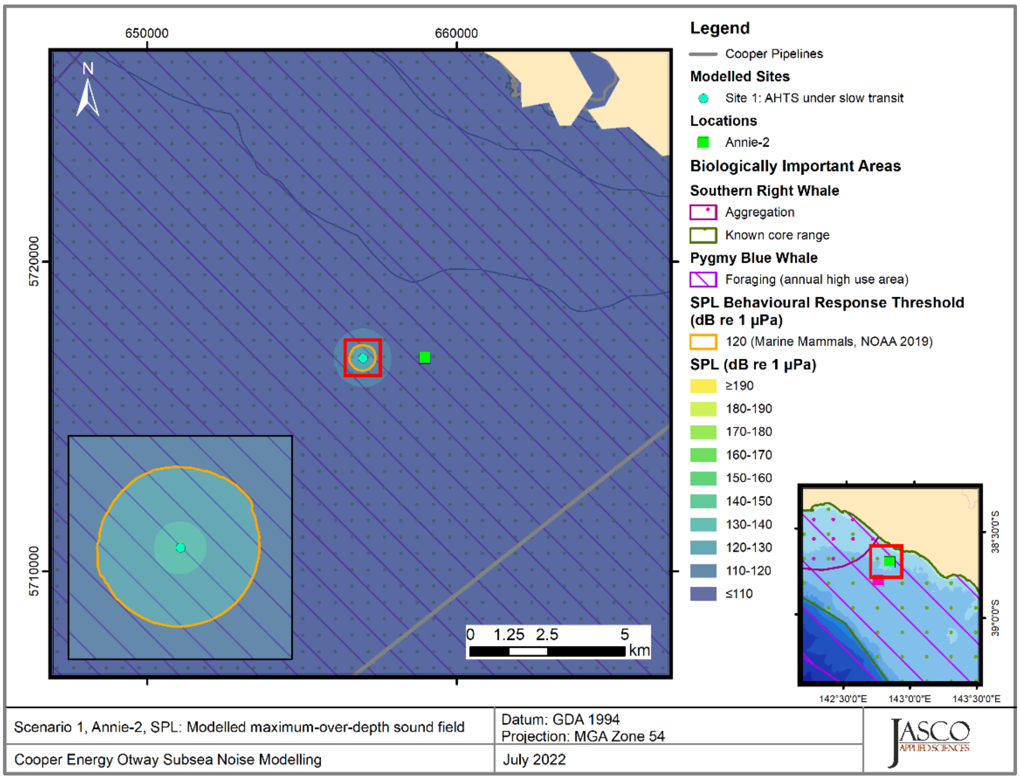

Figure 7. *Scenario 1, Drilling prelays, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

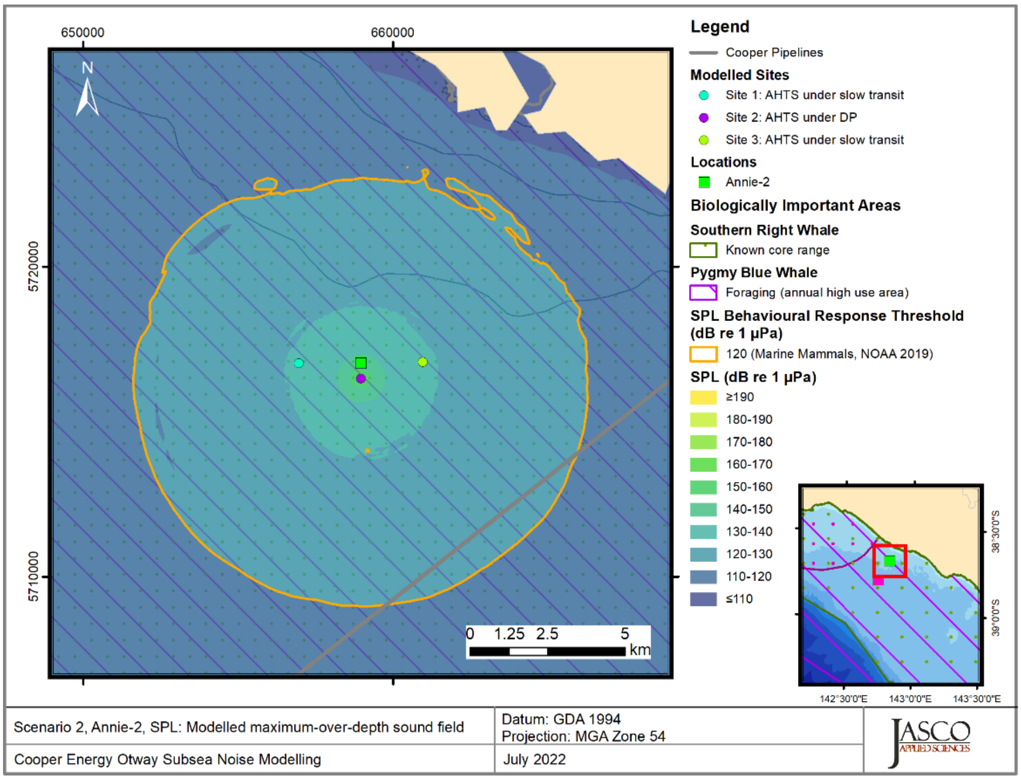

Figure 8. *Scenario 2, Mooring, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

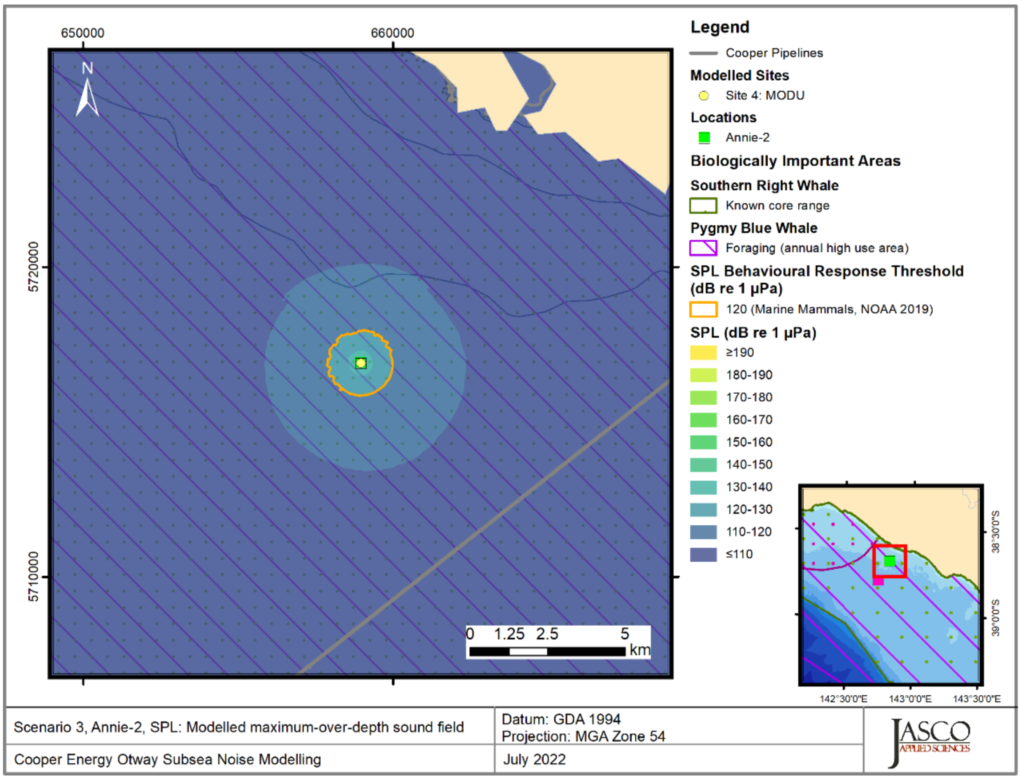

Figure 9. *Scenario 3, MODU Drilling, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

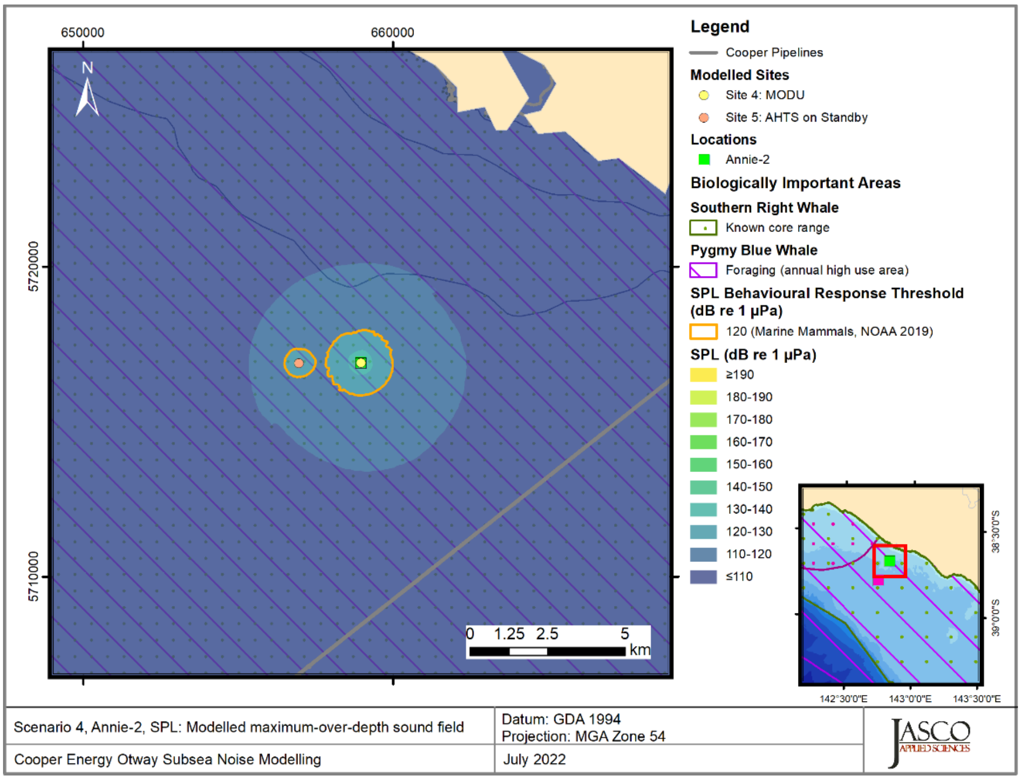

Figure 10. *Scenario 4, Drilling and standby OSV, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

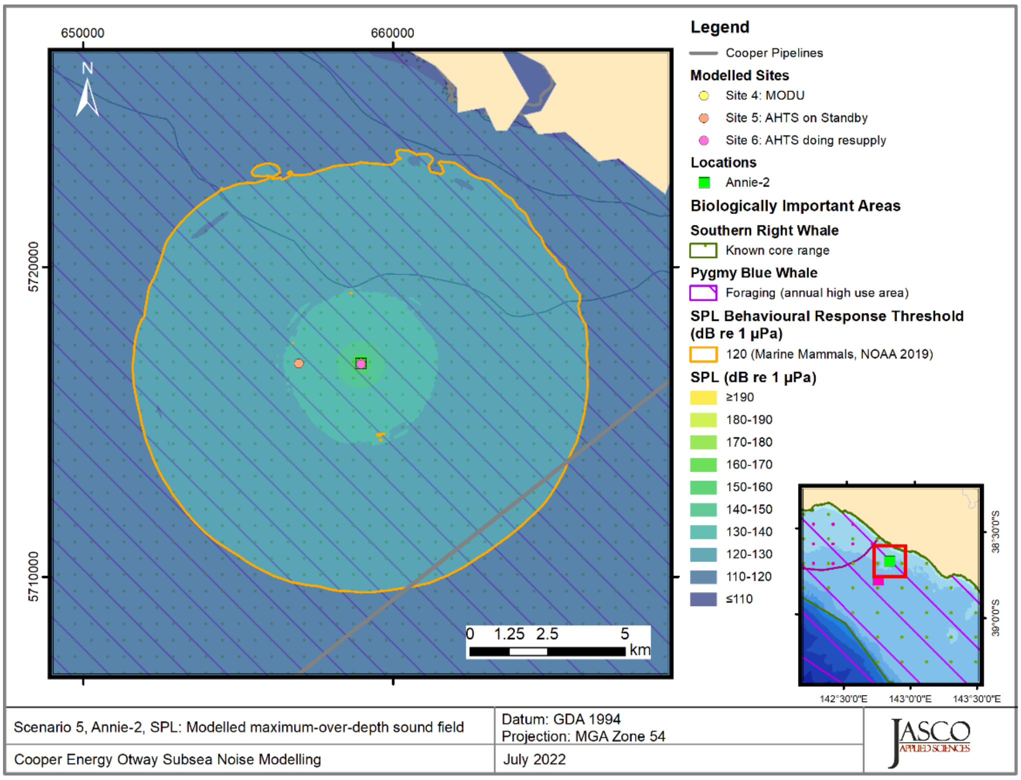

Figure 11. *Scenario 5, Drilling and standby OSV during resupply, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

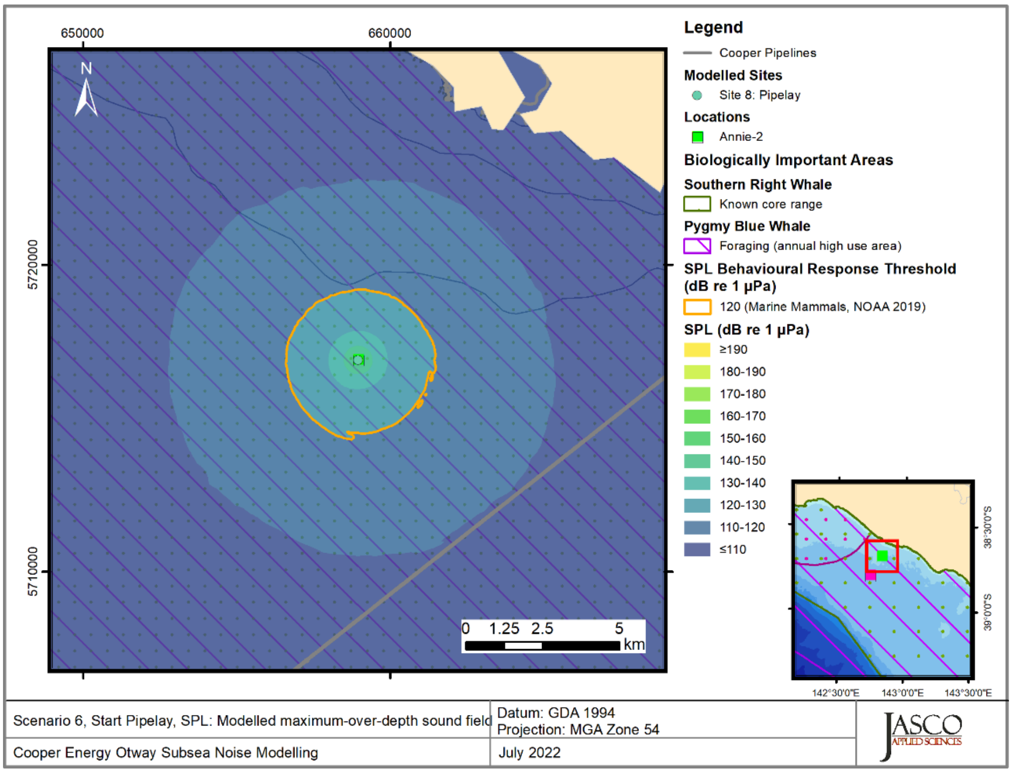

Figure 12. *Scenario 6, Pipelay installation, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

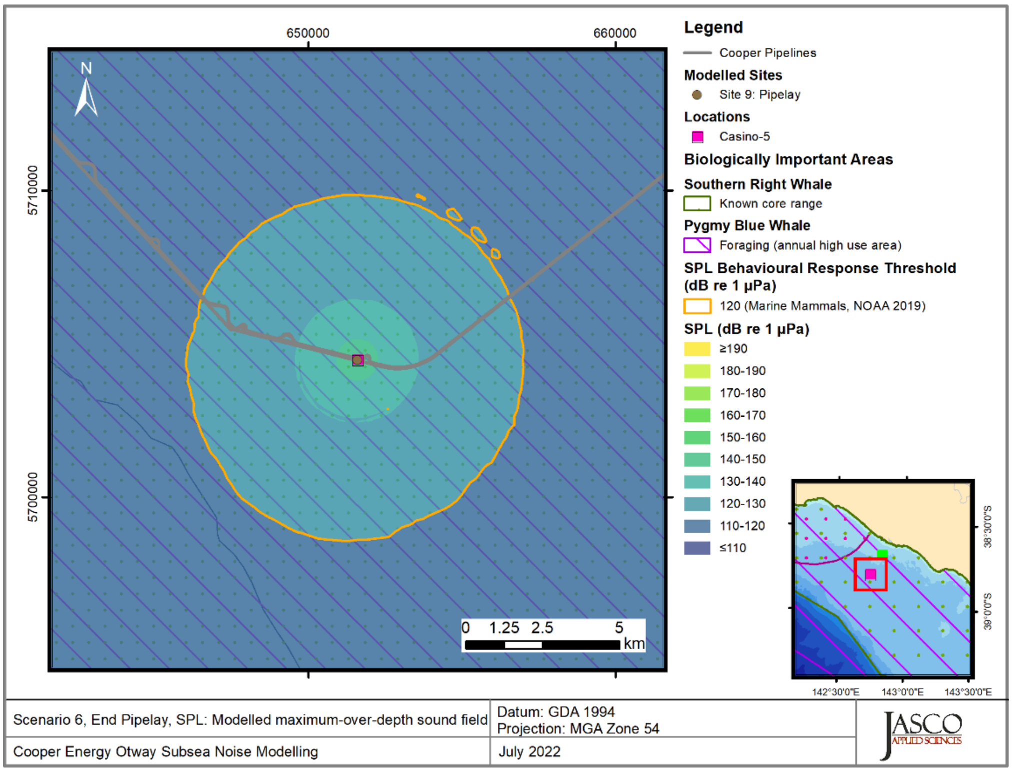

Figure 13. *Scenario 6, Pipelay installation, Casino-5, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

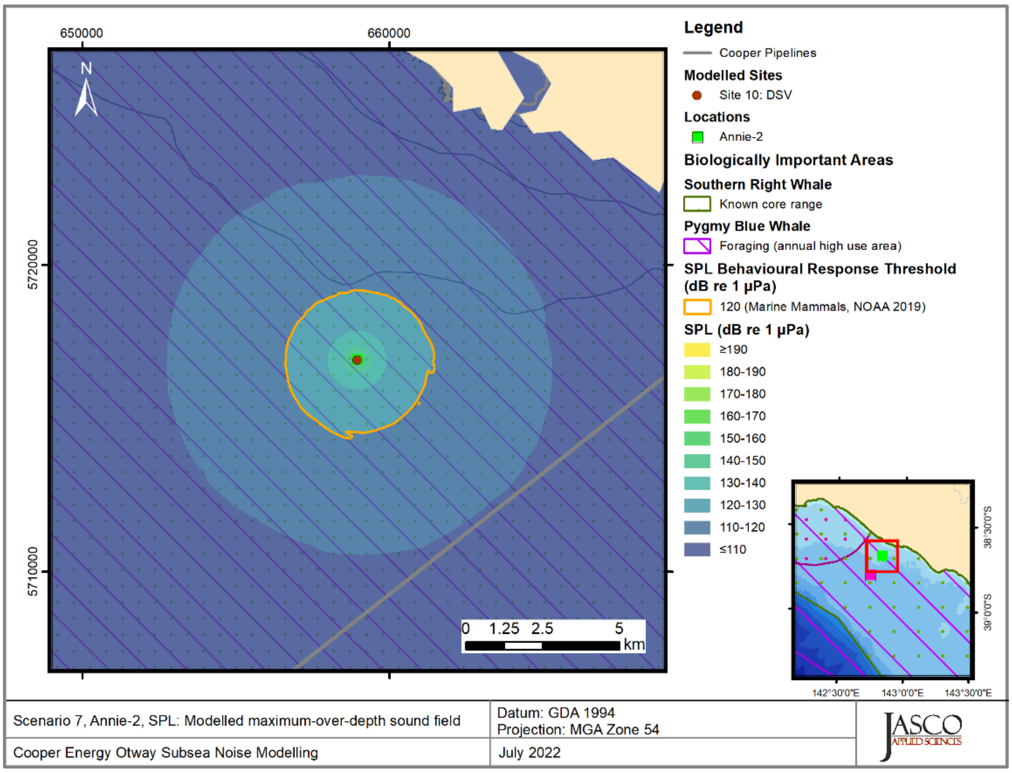

Figure 14. *Scenario 7, Installation, Annie-2, SPL*: Sound level contour map showing the unweighted maximum-over-depth sound field in 10 dB steps, and the isopleths for behavioural response threshold for marine mammals.

4.2.2. Accumulated SEL_{24h} Sound level Contour Maps

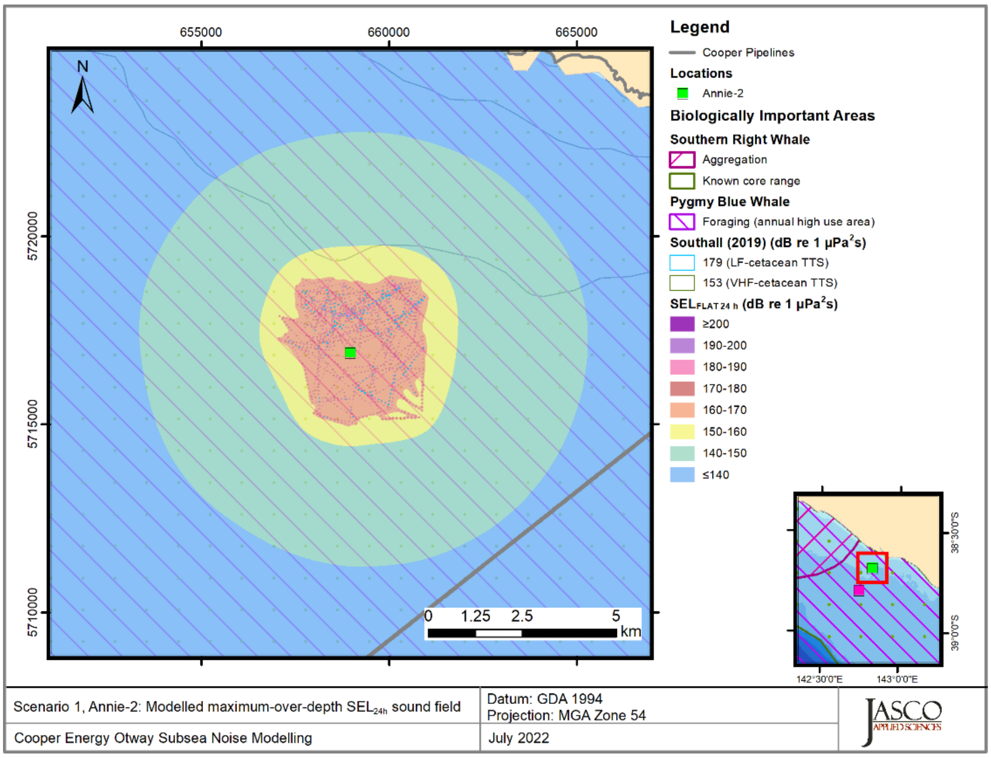

Figure 15. *Scenario 1, Drilling prelays, Annie-2, accumulated SEL_{24h}*: Sound level contour map showing weighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

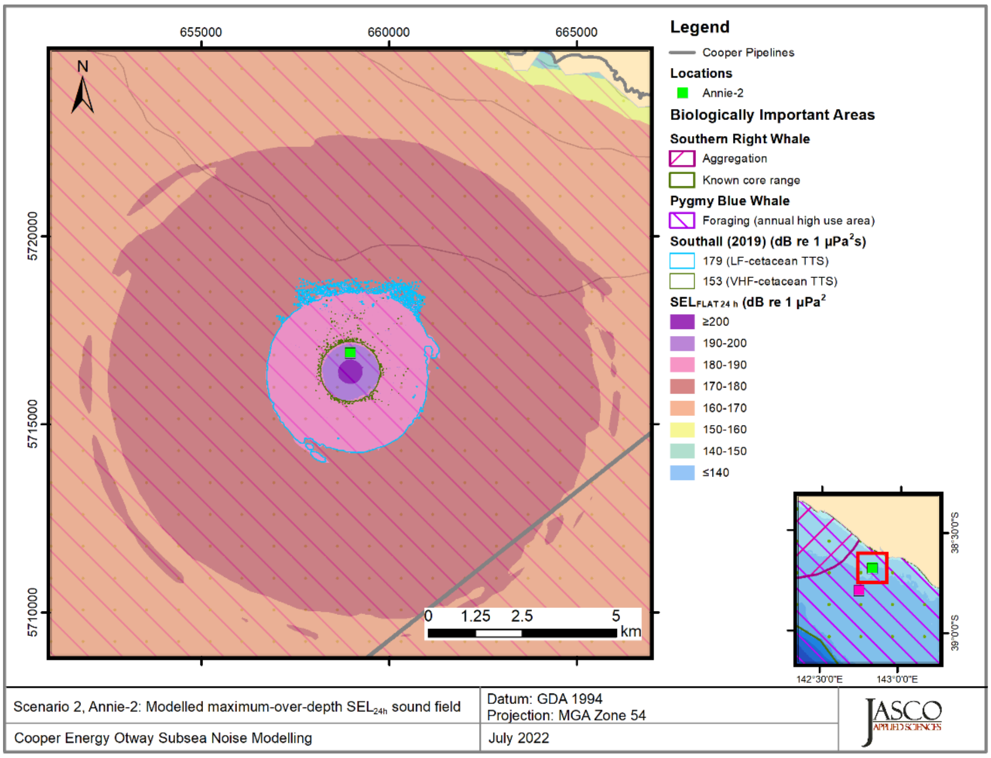

Figure 16. *Scenario 2, Mooring, Annie-2, accumulated SEL_{24h}*: Sound level contour map showing weighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

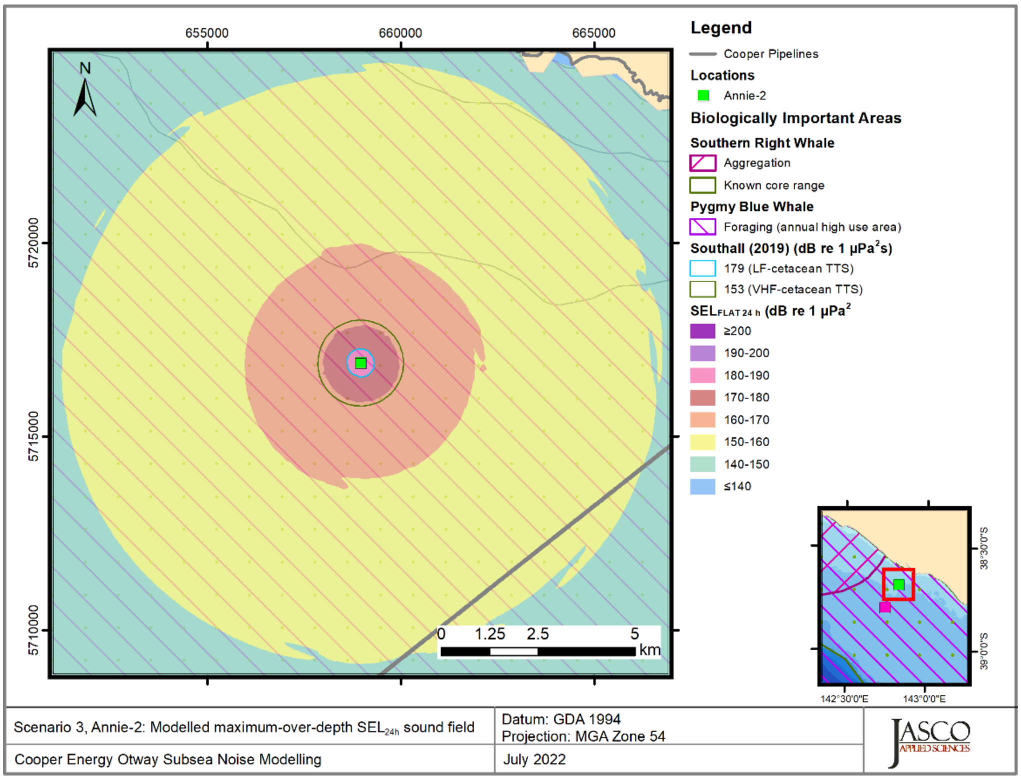

Figure 17. *Scenario 3, MODU Drilling, Annie-2, accumulated SEL_{24h}*: Sound level contour map showing weighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

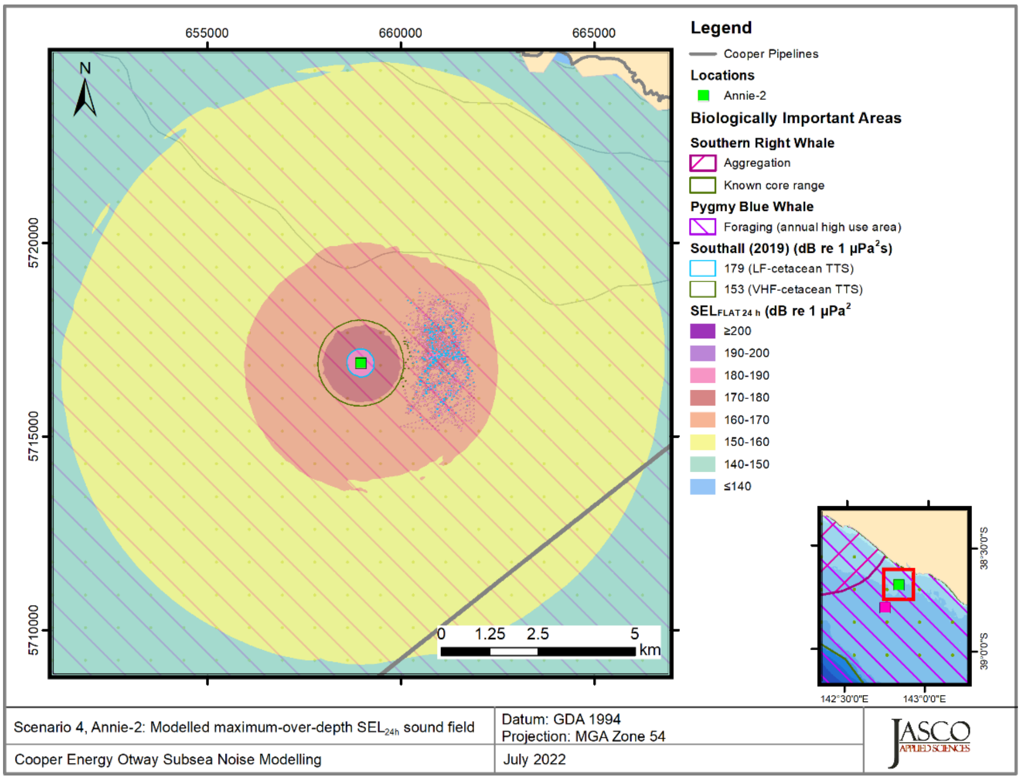

Figure 18. *Scenario 4, Drilling and standby OSV, Annie-2, accumulated SEL_{24h}*: Sound level contour map showing weighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

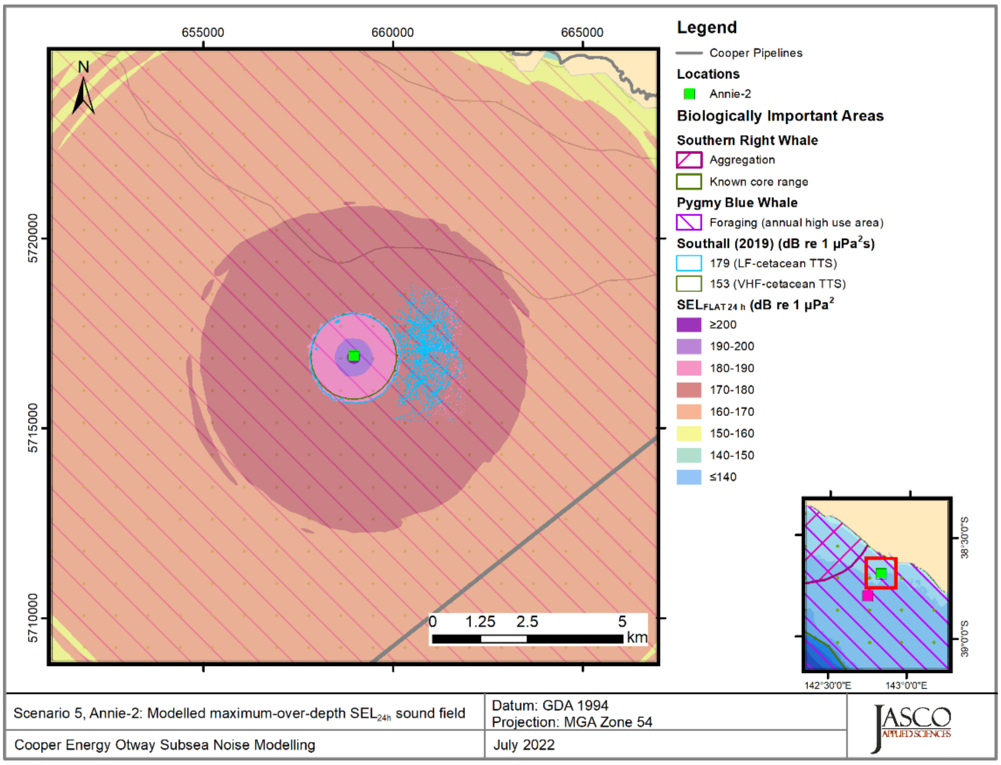

Figure 19. *Scenario 5, Drilling and standby OSV during resupply, Annie-2, accumulated SEL*$_{24h}$: Sound level contour map showing weighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

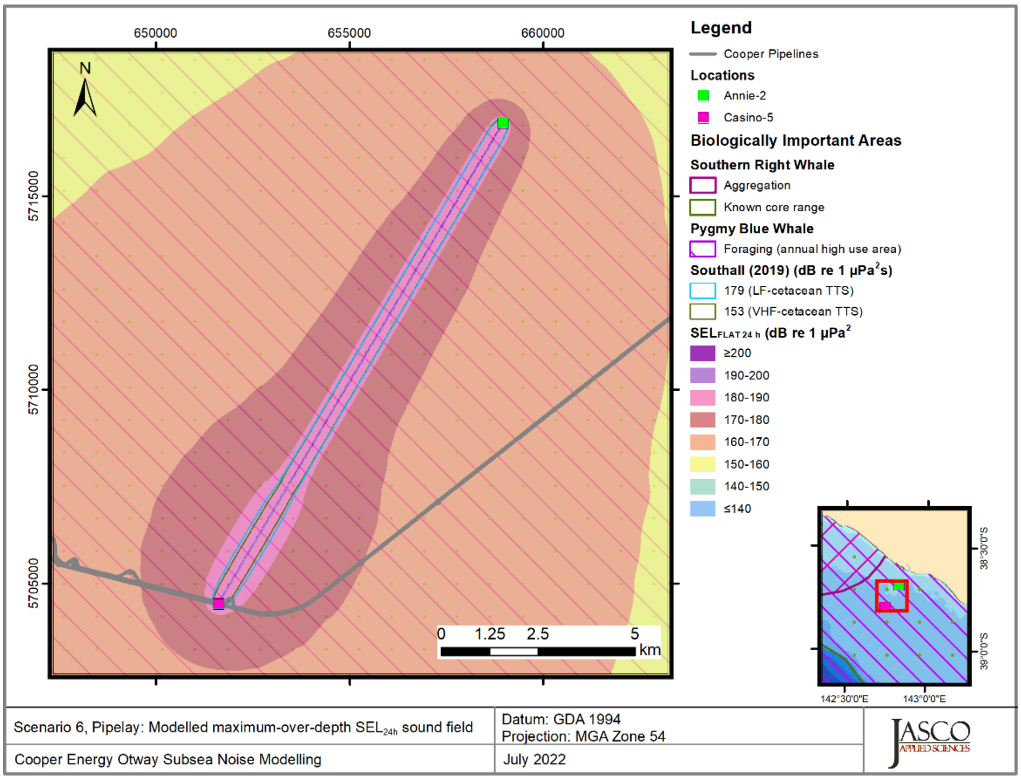

Figure 20. *Scenario 6, Pipeline/Umbilical installation*, Annie-2 & Casino-5*, accumulated SEL*$_{24h}$: Sound level contour map showing weighted maximum-over-depth SEL$_{24h}$ results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

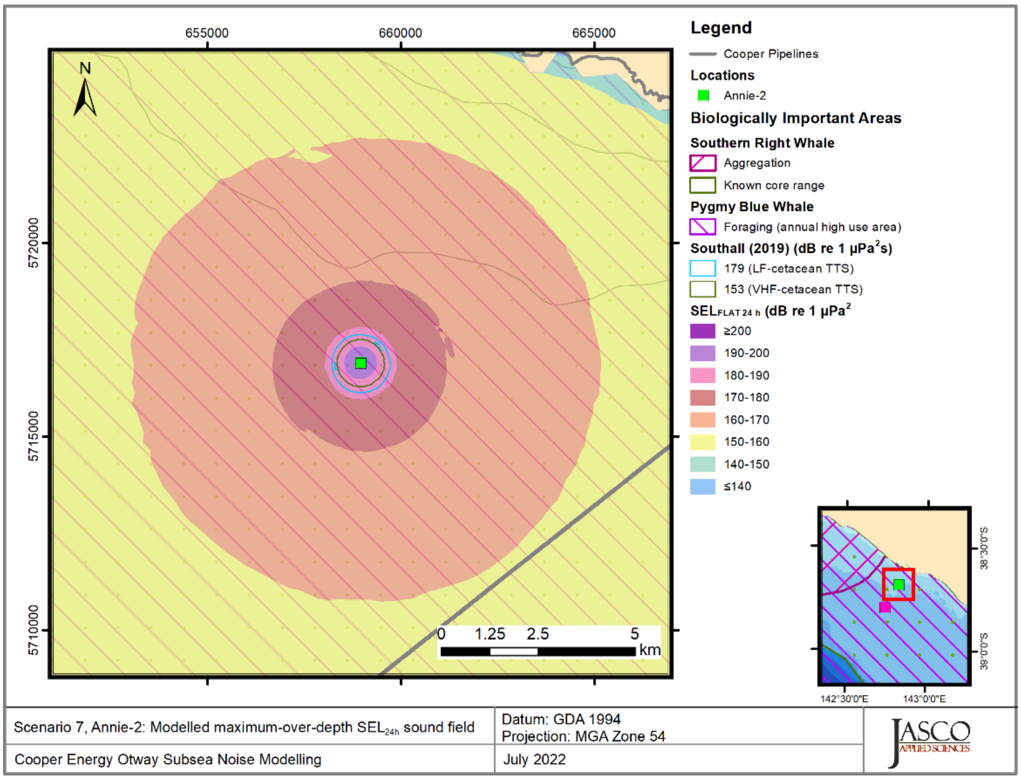

Figure 21. *Scenario 7, Installation, Annie-2, accumulated SEL_{24h}*: Sound level contour map showing weighted maximum-over-depth SEL_{24h} results, along with isopleths for TTS in low and very-high-frequency cetaceans. Thresholds omitted here were not reached or not long enough to display graphically.

5. Discussion and Conclusion

The sound speed profile (Appendix B.1.2) was derived from data from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). The month of August was chosen based on an analysis of the temperature, salinity, and sound speed profiles extracted from this database. The final profile consisted of a combination of three representative profiles within the modelled area to capture the propagation effects associated with shallow and deep-water regimes.

The August sound speed profile was primarily upward refracting between the sea surface and 160 m water depth. The upward refracting section of the profile may result in energy being refracted away from the seabed and back into the water column, which can lead to large distances to isopleths and criteria compared to other months. The upward refracting sound speed profile has the potential trap frequencies above 93 Hz based on the thickness of the refracting layer (Jensen et al. 2011). These frequencies also correspond to the majority of the highest spectral levels for the considered sources detailed in Section 3.1, which can further enhance large distances to isopleths and criteria compared to other months.

Considering activity locations are situated on the continental shelf, variations in bathymetry were generally gradual within the modelled areas. Any variations in the bathymetry had a small effect on the predicted sound field footprints as manifested in the generally symmetric sound field footprints. However, the composition of the seabed used for modelling had a more substantial influence when comparing the threshold radii and sound field footprints between the Annie-2 and Casino-5 modelled areas. The presence of a thin veneer of un-consolidated coarse sand overlying semi-cemented carbonate rock at Casino-5 led to a more reflective seabed and likely led to larger isopleths for low level thresholds than Annie-2. This is most evident for the marine mammal behavioural threshold of 120 dB re 1 µPa (SPL) for non-impulsive sound sources, where the Casino-5 radii and areas are larger than Annie-2 radii and areas. However, the distribution of sand over cemented carbonate appears to be variable in the Otway Basin; (McPherson et al. 2021). Towards the Casino-5 site, for simplicity, modelling has assumed a sand layer throughout the Casino-5 radii and area. In reality, the sand layer may be present or absent depending on exact location and hence radii may be smaller than predicted. In general, the sediment cover along the continental shelf of the Otway region is minimal and non-uniform (James and Bone 2010).

For the results tables presented in Section 4.1, where a dash is used in place of a horizontal distance, these thresholds may or may not be reached. Due to the discretely sampled 20 m calculation grids of the modelled sound fields, distances to these levels could not be estimated for practicable computational purposes. It is likely that SPL isopleths could be reached at distances between the source and the modelled horizontal resolution (20 m); however, distances to injurious accumulated SEL thresholds may not be reached at any range greater than the source due the species-specific frequency weighing functions. Additionally, if close-to-source radii are comparable to the dimensions of the modelled vessel (MODU, AHTS, ISV or DSV) then they may only be reached within close proximity to a vessel, if at all.

Table 13. Summary of maximum (R_{max}) horizontal distances (in km) from the Annie-2 to the behavioural response threshold, temporary threshold shift (TTS) and permanent threshold shift (PTS) for marine mammals. The maximum across all scenarios is reported here.

Hearing group	Modelled distance to effect threshold (R_{max})		
	Behavioural response[a]	TTS[b]	PTS[b]
	Annie-2		
Low-frequency (LF) cetaceans	7.87	3.03	0.31
High-frequency (HF) cetaceans		0.16	0.05
Very High-frequency (VHF) cetaceans		1.15	0.26
Otariid Seals		0.08	0.05

Noise exposure criteria: [a] NOAA (2019) and [b] Southall et al. (2019).

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Appendix A. Acoustic Metrics

This section describes in detail the acoustic metrics, impact criteria, and frequency weighting relevant to the modelling study.

A.1. Pressure Related Acoustic Metrics

Underwater sound pressure amplitude is measured in decibels (dB) relative to a fixed reference pressure of p_0 = 1 μPa. Because the perceived loudness of sound, especially pulsed sound such as from seismic airguns, pile driving, and sonar, is not generally proportional to the instantaneous acoustic pressure, several sound level metrics are commonly used to evaluate sound and its effects on marine life. Here we provide specific definitions of relevant metrics used in the accompanying report. Where possible, we follow International Organization for Standardization definitions and symbols for sound metrics (ANSI 2013, e.g., ISO 2017).

The sound pressure level (SPL or L_p; dB re 1 μPa) is the root-mean-square (rms) pressure level in a stated frequency band over a specified time window (T; s). It is important to note that SPL always refers to an rms pressure level and therefore not instantaneous pressure:

$$L_p = 10\log_{10}\left(\frac{1}{T}\int_T g(t)\,p^2(t)\,dt/p_0^2\right)\ \mathrm{dB} \quad \text{(A-1)}$$

where $g(t)$ is an optional time weighting function. In many cases, the start time of the integration is marched forward in small time steps to produce a time-varying SPL function.

The sound exposure level (SEL or L_E; dB re 1 μPa^2·s) is the time-integral of the squared acoustic pressure over a duration (T):

$$L_E = 10\log_{10}\left(\int_T p^2(t)\,dt/T_0 p_0^2\right)\ \mathrm{dB} \quad \text{(A-2)}$$

where T_0 is a reference time interval of 1 s. SEL continues to increase with time when non-zero pressure signals are present. It is a dose-type measurement, so the integration time applied must be carefully considered for its relevance to impact to the exposed recipients.

SEL can be calculated over a fixed duration, such as the time of a single event or a period with multiple acoustic events. When applied to pulsed sounds, SEL can be calculated by summing the SEL of the N individual pulses. For a fixed duration, the square pressure is integrated over the duration of interest. For multiple events, the SEL can be computed by summing (in linear units) the SEL of the N individual events:

$$L_{E,N} = 10\log_{10}\left(\sum_{i=1}^{N} 10^{\frac{L_{E,i}}{10}}\right)\ \mathrm{dB}\,. \quad \text{(A-3)}$$

If applied, the frequency weighting of an acoustic event should be specified, as in the case of weighted SEL (e.g., $L_{E,LFC,24h}$; Appendix A.4). The use of fast, slow, or impulse exponential-time-averaging or other time-related characteristics should also be specified.

A.2. Decidecade Band Analysis

The distribution of a sound's power with frequency is described by the sound's spectrum. The sound spectrum can be split into a series of adjacent frequency bands. Splitting a spectrum into 1 Hz wide bands, called passbands, yields the power spectral density of the sound. This splitting of the spectrum into passbands of a constant width of 1 Hz, however, does not represent how animals perceive sound.

Because animals perceive exponential increases in frequency rather than linear increases, analysing a sound spectrum with passbands that increase exponentially in size better approximates real-world scenarios. In underwater acoustics, a spectrum is commonly split into decidecade bands, which are one tenth of a decade wide. A decidecade is sometimes referred to as a "1/3 octave" because one tenth of a decade is approximately equal to one third of an octave. Each decade represents a factor 10 in sound frequency. Each octave represents a factor 2 in sound frequency. The centre frequency of the ith band, $f_{\mathrm{c}}(i)$, is defined as:

$$f_{\mathrm{c}}(i) = 10^{\frac{i}{10}}\ \mathrm{kHz} \tag{A-4}$$

and the low (f_{lo}) and high (f_{hi}) frequency limits of the ith decade band are defined as:

$$f_{\mathrm{lo},i} = 10^{\frac{-1}{20}} f_{\mathrm{c}}(i) \quad \text{and} \quad f_{\mathrm{hi},i} = 10^{\frac{1}{20}} f_{\mathrm{c}}(i) \tag{A-5}$$

The decidecade bands become wider with increasing frequency, and on a logarithmic scale the bands appear equally spaced (Figure A-1). The acoustic modelling spans from band 10 ($f_c\,(10)$ = 10 Hz) to band 44 ($f_{\mathrm{c}}(44)$ = 25 kHz).

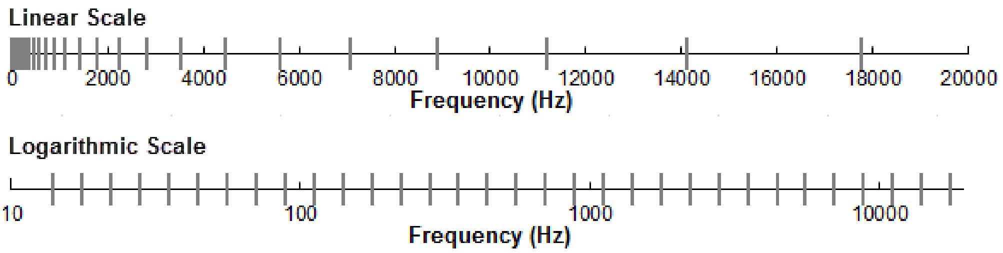


Figure A-1. Decidecade frequency bands (vertical lines) shown on a linear frequency scale and a logarithmic scale.

The sound pressure level in the ith band ($L_{p,i}$) is computed from the spectrum $S(f)$ between $f_{\mathrm{lo},i}$ and $f_{\mathrm{hi},i}$:

$$L_{p,i} = 10\, log_{10} \int_{f_{\mathrm{lo},i}}^{f_{\mathrm{hi},i}} S(f)\, \mathrm{d}f \ \ \mathrm{dB} \tag{A-6}$$

Summing the sound pressure level of all the bands yields the broadband sound pressure level:

$$\text{Broadband SPL} = 10 \log_{10} \sum_i 10^{\frac{L_{p,i}}{10}}\ \mathrm{dB} \tag{A-7}$$

Figure A-2 shows an example of how the decidecade band sound pressure levels compare to the sound pressure spectral density levels of an ambient sound signal. Because the decidecade bands are wider than 1 Hz, the decidecade band SPL is higher than the spectral levels at higher frequencies. Acoustic modelling of decidecade bands requires less computation time than 1 Hz bands and still resolves the frequency-dependence of the sound source and the propagation environment.

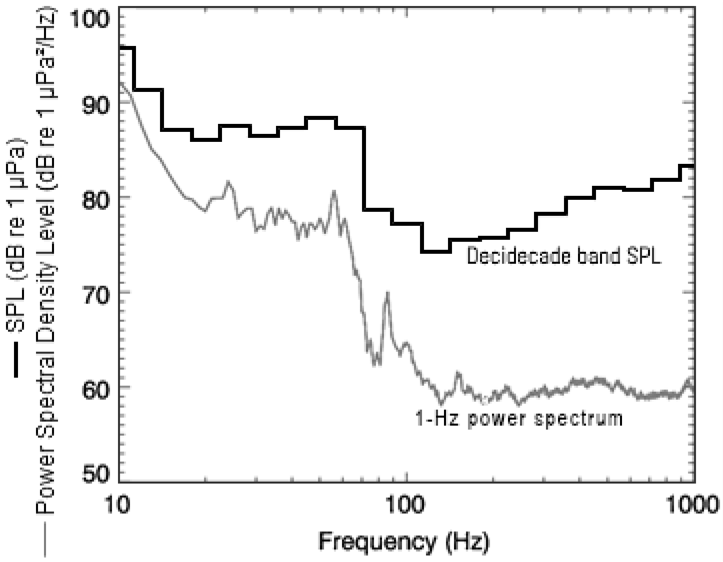


Figure A-2. Sound pressure spectral density levels and the corresponding decidecade band sound pressure levels of example ambient noise shown on a logarithmic frequency scale.Because the decidecade bands are wider with increasing frequency, the decidecade band SPL is higher than the power spectrum.

A.3. Marine Mammal Noise Effect Criteria

It has been long recognised that marine mammals can be adversely affected by underwater anthropogenic noise. For example, Payne and Webb (1971) suggest that communication distances of fin whales are reduced by shipping sounds. Subsequently, similar concerns arose regarding effects of other underwater noise sources and the possibility that impulsive sources—primarily airguns used in seismic surveys—could cause auditory injury. This led to a series of workshops held in the late 1990s, conducted to address acoustic mitigation requirements for seismic surveys and other underwater noise sources (NMFS 1998, ONR 1998, Nedwell and Turnpenny 1998, HESS 1999, Ellison and Stein 1999). In the years since these early workshops, a variety of thresholds have been proposed for auditory injury, impairment, and disturbance. The following sections summarise the recent development of thresholds; however, this field remains an active research topic.

A.3.1. Injury and Hearing Sensitivity Changes

In recognition of shortcomings of the SPL-only based auditory injury criteria, in 2005 NMFS sponsored the Noise Criteria Group to review literature on marine mammal hearing to propose new noise exposure criteria. Some members of this expert group published a landmark paper (Southall et al. 2007) that suggested assessment methods similar to those applied for humans. The resulting recommendations introduced dual auditory injury criteria for impulsive sounds that included peak pressure level thresholds and SEL24h thresholds, where the subscripted 24h refers to the accumulation period for calculating SEL. The peak pressure level criterion is not frequency weighted whereas SEL24h is frequency weighted according to one of four marine mammal species hearing groups: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively) and Pinnipeds in Water (PINN). These weighting functions are referred to as M-weighting filters (analogous to the A-weighting filter for humans; see Appendix A.4). The SEL24h thresholds were obtained by extrapolating measurements of onset levels of Temporary Threshold Shift (TTS) in belugas by the amount of TTS required to produce Permanent Threshold Shift (PTS) in chinchillas. The Southall et al. (2007) recommendations do not specify an exchange rate, which suggests that the thresholds are the same regardless of the duration of exposure (i.e., it implies a 3 dB exchange rate).

Wood et al. (2012) refined Southall et al.'s (2007) thresholds, suggesting lower PTS and TTS values for LF and HF cetaceans while retaining the filter shapes. Their revised thresholds were based on TTS-onset levels in harbour porpoises from Lucke et al. (2009), which led to a revised impulsive sound PTS threshold for HF cetaceans of 179 dB re 1 µPa^2·s. Because there were no data available for baleen whales, Wood et al. (2012) based their recommendations for LF cetaceans on results obtained from MF cetacean studies. In particular they referenced the Finneran and Schlundt (2010) research, which found mid-frequency cetaceans are more sensitive to non-impulsive sound exposure than Southall et al. (2007) assumed. Wood et al. (2012) thus recommended a more conservative TTS-onset level for LF cetaceans of 192 dB re 1 µPa^2·s.

As of present, a definitive approach is still not apparent. There is consensus in the research community that an SEL-based method is preferable, either separately or in addition to an SPL-based approach to assess the potential for injuries. In August 2016, after substantial public and expert input into three draft versions and based largely on the above-mentioned literature (NOAA 2013, 2015, 2016), NMFS finalised technical guidance for assessing the effect of anthropogenic sound on marine mammal hearing (NMFS 2016). The guidance describes auditory injury criteria with new thresholds and frequency weighting functions for the five hearing groups described by Finneran and Jenkins (2012). The latest revision to this work was published in 2018 (NMFS 2018a). Southall et al. (2019) revisited the interim criteria published in 2007. All noise exposure criteria in NMFS (2018a) and Southall et al. (2019) are identical (for impulsive and non-impulsive sounds); however, the mid-frequency cetaceans from NMFS (2018a) are classified as high-frequency cetaceans in Southall et al. (2019), and high-frequency cetaceans from NMFS (2018a) are classified as very-high-frequency cetaceans in Southall et al. (2019).

A.3.2. Behavioural Response

Numerous studies on marine mammal behavioural responses to sound exposure have not resulted in consensus in the scientific community regarding the appropriate metric for assessing behavioural reactions. However, it is recognised that the context in which the sound is received affects the nature and extent of responses to a stimulus(Southall et al. 2007, Ellison and Frankel 2012, Southall et al. 2016).

NMFS currently uses step function (all-or-none) threshold of 120 dB re 1 µPa SPL (unweighted) for non-impulsive sounds to assess and regulate noise-induced behavioural impacts on marine mammals (NOAA 2019). The 120 dB re 1 µPa threshold is associated with continuous sources and was derived based on studies examining behavioural responses to drilling and dredging (NOAA 2018b), referring to Malme et al. (1983), Malme et al. (1984), and Malme et al. (1986), which were considered in Southall et al. (2007). Malme et al. (1986) found that playback of drillship noise did not produce clear evidence of disturbance or avoidance for levels below 110 dB re 1 µPa (SPL), possible avoidance occurred for exposure levels approaching 119 dB re 1 µPa. Malme et al. (1984) determined that measurable reactions usually consisted of rather subtle short-term changes in speed and/or heading of the whale(s) under observation. It has been shown that both received level and proximity of the sound source is a contributing factor in eliciting behavioural reactions in humpback whales (Dunlop et al. 2017, Dunlop et al. 2018).

A.4. Marine Mammal Frequency Weighting

The potential for noise to affect animals depends on how well the animals can hear it. Noises are less likely to disturb or injure an animal if they are at frequencies that the animal cannot hear well. An exception occurs when the sound pressure is so high that it can physically injure an animal by non-auditory means (i.e., barotrauma). For sound levels below such extremes, the importance of sound components at particular frequencies can be scaled by frequency weighting relevant to an animal's sensitivity to those frequencies (Nedwell and Turnpenny 1998, Nedwell et al. 2007).

A.4.1. Marine Mammal Frequency Weighting Functions

In 2015, a US Navy technical report by Finneran (2015) recommended new auditory weighting functions. The overall shape of the auditory weighting functions is similar to human A-weighting functions, which follows the sensitivity of the human ear at low sound levels. The new frequency-weighting function is expressed as:

$$G(f) = K + 10\log_{10}\left[\left(\frac{(f/f_{lo})^{2a}}{\left[1+(f/f_{lo})^2\right]^a\left[1+(f/f_{hi})^2\right]^b}\right)\right] \tag{A-8}$$

Finneran (2015) proposed five functional hearing groups for marine mammals in water: low-, mid- and high-frequency cetaceans (LF, MF, and HF cetaceans, respectively), phocid pinnipeds, and otariid pinnipeds. The parameters for these frequency-weighting functions were further modified the following year (Finneran 2016) and were adopted in NOAA's technical guidance that assesses acoustic impacts on marine mammals (NMFS 2018a), and in the latest guidance by Southall (2019). The updates did not affect the content related to either the definitions of frequency-weighting functions or the threshold values, however, the terminology for mid- and high-frequency cetaceans was changed to high- and very high-frequency cetaceans. Table A-1 lists the frequency-weighting parameters for each hearing group relevant to this assessment, and Figure A-3 shows the resulting frequency-weighting curves.

Table A-1. Parameters for the auditory weighting functions used in this project as recommended by Southall et al. (2019).

Hearing group	a	b	flo (Hz)	fhi (kHz)	*K* (dB)
Low-frequency cetaceans (baleen whales)	1.0	2	200	19,000	0.13
High-frequency cetaceans (most dolphins, plus sperm, beaked, and bottlenose whales)	1.6	2	8,800	110,000	1.20
Very-high-frequency cetaceans (true porpoises, *Kogia*, river dolphins, *Cephalorhynchus* spp., *Lagenorhynchus cruciger* and *L. australis*)	1.8	2	12,000	140,000	1.36
Otariid Seals in water	2.0	2	940	25,000	0.64

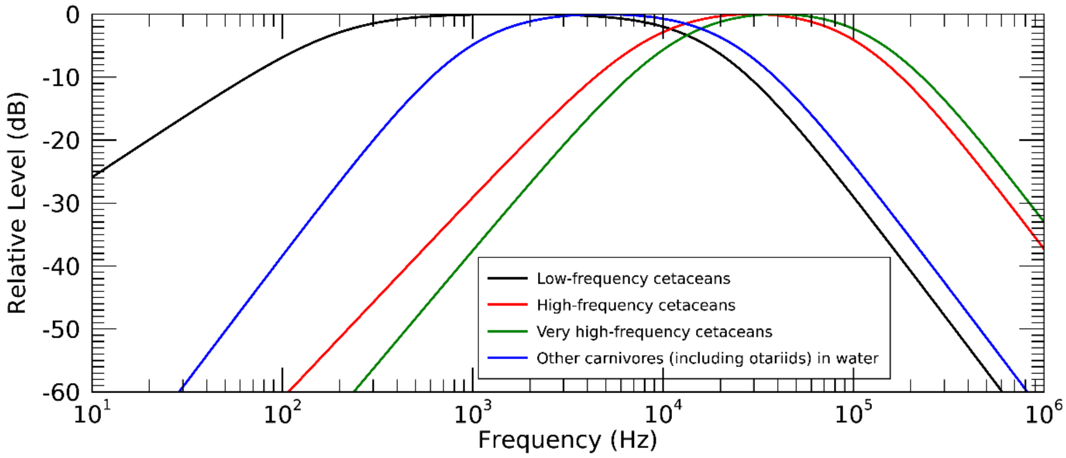


Figure A-3. Auditory weighting functions for functional marine mammal hearing groups used in this project as recommended by Southall et al. (2019).

Appendix B. Methods and Parameters

B.1. Environmental Parameters

B.1.1. Bathymetry

Bathymetry throughout the modelled area was extracted from the Australian Bathymetry and Topography Grid, a 9 arc-second grid rendered for Australian waters (Whiteway 2009). Bathymetry data were re-gridded and combined onto a Map Grid of Australia (MGA) coordinate projection (Zone 54) with a regular grid spacing of 250 × 250 m (Figure B-1).

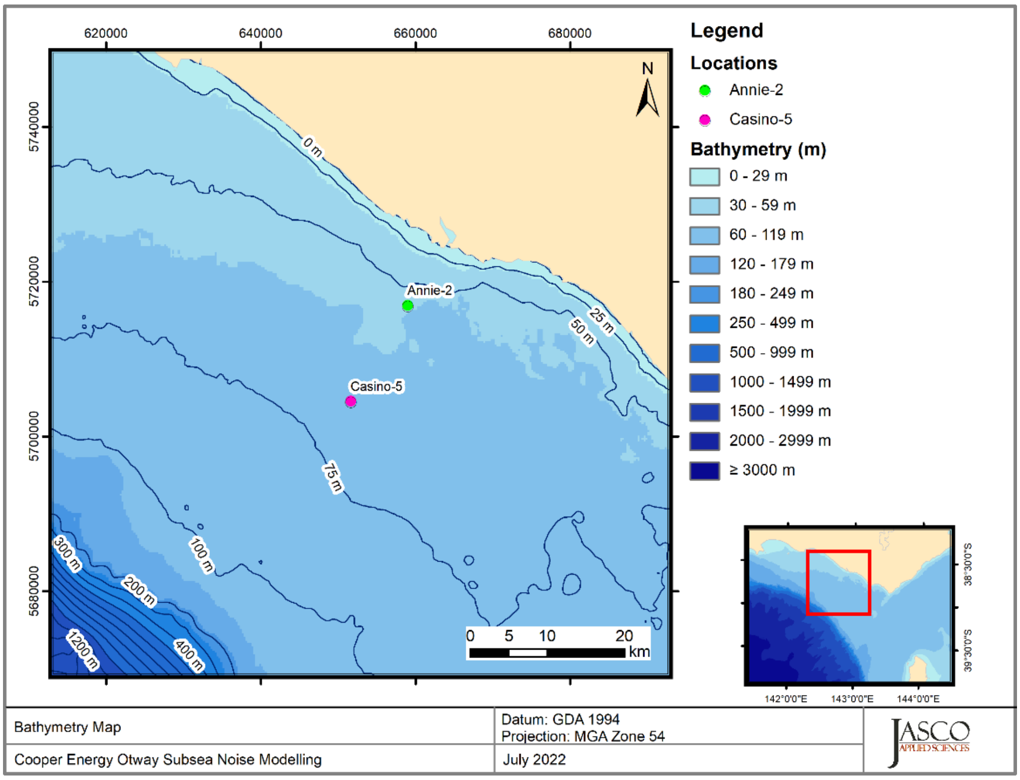


Figure B-1. Bathymetry in the modelled area.

B.1.2. Sound Speed Profile

The sound speed profile in the area was derived from temperature and salinity profiles from the U.S. Naval Oceanographic Office's Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009). GDEM provides an ocean climatology of temperature and salinity for the world's oceans on a latitude-longitude grid with 0.25° resolution, with a temporal resolution of one month, based on global historical observations from the U.S. Navy's Master Oceanographic Observational Data Set (MOODS). The climatology profiles include 78 fixed depth points to a maximum depth of 6800 m (where the ocean is that deep). The GDEM temperature-salinity profiles were converted to sound speed profiles according to Coppens (1981).

Mean monthly sound speed profiles were derived from the GDEM profiles at distances less than 40 km around the modelled site. The August sound speed profile is expected to be most favourable to longer-range sound propagation across the entire year which was determined by modelling a reduced number of transects for every month and comparing the ranges to thresholds. As such, August was selected for sound propagation modelling to ensure precautionary estimates of distances to received sound level thresholds. Figure B-2 shows the resulting profile, which was used as input to the sound propagation modelling.

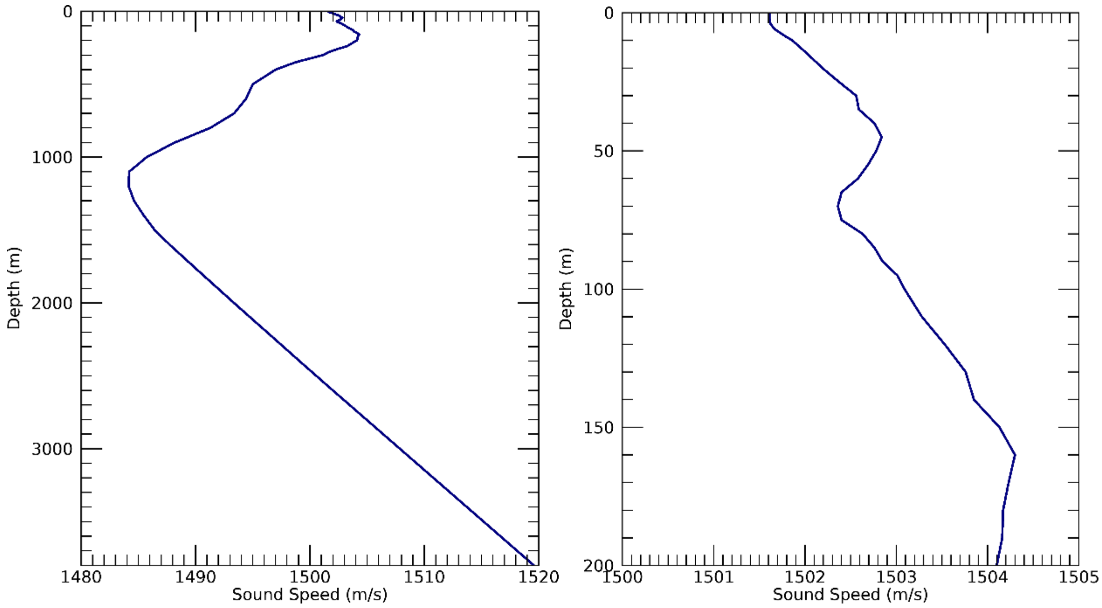


Figure B-2. The modelling sound speed profile corresponding to August: full profile (left) and top 200 m (right) Profiles are calculated from temperature and salinity profiles from Generalized Digital Environmental Model V 3.0 (GDEM; Teague et al. 1990, Carnes 2009).

B.1.3. Geoacoustics

The propagation model used in this study consider a single geoacoustic profile for each well site area. These profiles determine how sound is reflected from the seabed, as well as how it is transmitted, reflected and absorbed into the sediment layers. Similar to previous modelling studies in the region (Wood and McPherson 2018, Koessler et al. 2020, Matthews et al. 2020, McPherson et al. 2021), two seabed types were considered for modelling. Both seabed profiles are indicative of benthic an environment located on the continental shelf and are consistent with larger scale geological data and interpretations of the Australian continental shelf environment (James and Bone 2010).

The geoacoustic profiles Casino-5 and Annie-2 well sites were generated using lithographic descriptions from the geotechnical and geophysical reports supplied by the client and considering previous underwater acoustic modelling and measurement studies (Koessler et al. 2020, Matthews et al. 2020, McPherson et al. 2021). Within the vicinity of Annie-2 the seabed is likely to consist of a well-cemented calcarenite caprock over a semi-cemented calcarenite. Near the Casino-5 location, the seabed is likely to consist of a thin layer of coarse sand overlying a similar calcarenite structure. This sand layer may not be consistently present. In all cases, the calcarenite layering likely extended to many hundreds of metres below the seafloor.

Table B-1 and Table B-2 present the geoacoustic profiles used modelled sites in each respective development area.

Table B-1. Geoacoustic profile for Annie-2 associated modelled sites.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0-1	Well-cemented carbonate caprock	2.7	2600	0.5	1200	0.5
1-20	Increasingly cemented calcarenite	2.2	2000	0.30	900	0.27
20-40		2.3	2120	0.34	960	0.31
40-60		2.4	2240	0.38	1020	0.36
60-80		2.5	2360	0.42	1080	0.41
80-10		2.6	2480	0.46	1140	0.45
>100	Well-cemented calcarenite	2.7	2600	0.50	1200	0.50

Table B-2. Geoacoustic profile for Casino-5 associated modelled sites.

Depth below seafloor (m)	Material	Density (g/cm^3)	P-wave speed (m/s)	P-wave attenuation (dB/λ)	S-wave speed (m/s)	S-wave attenuation (dB/λ)
0-1.5	Coarse carbonate sand	2.0	1800	0.85	300	3.68
1.5-2.5	Well-cemented carbonate caprock	2.7	2600	0.50	1200	0.50
2.5-22.5	Increasingly cemented calcarenite	2.2	2000	0.3	900	0.27
22.5-42.5		2.3	2120	0.34	960	0.31
42.5-62.5		2.4	2240	0.38	1020	0.36
62.5-82.5		2.5	2360	0.42	1080	0.41
82.5-102.5		2.6	2480	0.46	1140	0.45
>102.5	Well-cemented calcarenite	2.7	2600	0.50	1200	0.50

B.2. Estimated Vessel Source Levels

At the time of this study, the Platform Support Vessel (ISV) and Dive Support Vessel (DSV) to be used in the project were unconfirmed and a generic source level was proposed. Similar to the approach detailed Connell et al. (2021) in different vessels were identified as either potential ISV or RDSV vessels, therefore the source level and spectrum used to represent any of these four vessels was based on the nominal specifications for all indicated vessels, due to similarity in dimensions and total installed power ratings. This nominal vessel has an 89.2 m overall length, 20 m breadth, and 7.6 m maximum draft.

A main propulsion system is this generic vessel comprised of the following specifications.

Two stern propellers with

- 3.2 m propeller diameter,
- 165 rpm nominal propeller speed,

- 2,200 kW maximum continuous power input, and
- Typical DP operation at 26% MRC.

Additional thruster modules active during DP operations may include bow tunnel thrusters and a bow azimuth thruster. The two bow tunnel thrusters for the generic vessel were comprised of:

- 2.0 m propeller diameter,
- 318 rpm nominal propeller speed,
- 1,000 kW maximum continuous power input, and
- Typical DP operation at 17% MRC.

The bow azimuth thruster generic vessel was comprised of:

- 1.65 m propeller diameter,
- 373 rpm nominal propeller speed,
- 830 kW maximum continuous power input, and
- Typical DP operation at 21% MRC

Estimates of the acoustic source levels were based on the parameters of the propulsion system together with the method descripted in Appendix B.2.1, and the percent of Maximum Continuous Rating (MCR) for the vessel operating at during typical DP operations, as provided by the potential vessel operators.

B.2.1. Thruster Source Level Estimation

A vessel equipped with propellers/thrusters has two primary sources of sound that propagate from the unit: the machinery and the propellers. For thrusters operating in the heavily loaded conditions, the acoustic energy generated by the cavitation processes on the propeller blades dominates (Leggat et al. 1981). The sound power from the propellers is proportional to the number of blades, the propeller diameter, and the propeller tip speed.

Based on an analysis of acoustic data, Ross (1976) provided the following formula for the sound levels from a vessel's propeller, operating in calm, open ocean conditions:

$$L_{100} = 155 + 60\log(u/25) + 10\log(B/4)\,, \tag{B-1}$$

where L_{100} is the spectrum level at 100 Hz, u is the propeller tip speed (m/s), and B is the number of propeller blades. Equation B-1 gives the total energy produced by the propeller cavitation at frequencies between 100 Hz and 10 kHz. This equation is valid for a propeller tip speed between 15 and 50 m/s. The spectrum is assumed to be flat below 100 Hz. Its level is assumed to fall off at a rate of −6 dB per octave above 100 Hz (Figure B-3).

Another method of predicting the source level of a propeller was suggested by Brown (1977). For propellers operating in heavily loaded conditions, the formula for the sound spectrum level is:

$$\mathrm{SL}_B = 163 + 40\log D + 30\log N + 10\log B + 20\log f + 10\log(A_c/A_D)\,, \tag{B-2}$$

where D is the propeller diameter (m), N is the propeller revolution rate per second, B is the number of blades, A_C is the area of the blades covered by cavitation, and A_D is the total propeller disc area. Similar to Ross's approach, the spectrum below 100 Hz is assumed to be flat. The tests with a naval propeller operating at off-design heavily loaded conditions showed that Equation B-2 should be used with a value of $(A_c/A_D) = 1$ (Leggat et al. 1981).

The combined source level for multiple thrusters operating together can be estimated using the formula:

$$\mathrm{SL}_{\mathrm{total}} = 10\log_{10}\sum_i 10^{\frac{SL_i}{10}}, \tag{B-3}$$

where $SL_{1,\dots,N}$ are the source levels of individual thrusters. If the vessel is equipped with the same type of thrusters, the combined source level can be estimated using the formula:

$$\mathrm{SL}_N = \mathrm{SL} + 10\log N \tag{B-4}$$

where N is the total number of thrusters of the same type.

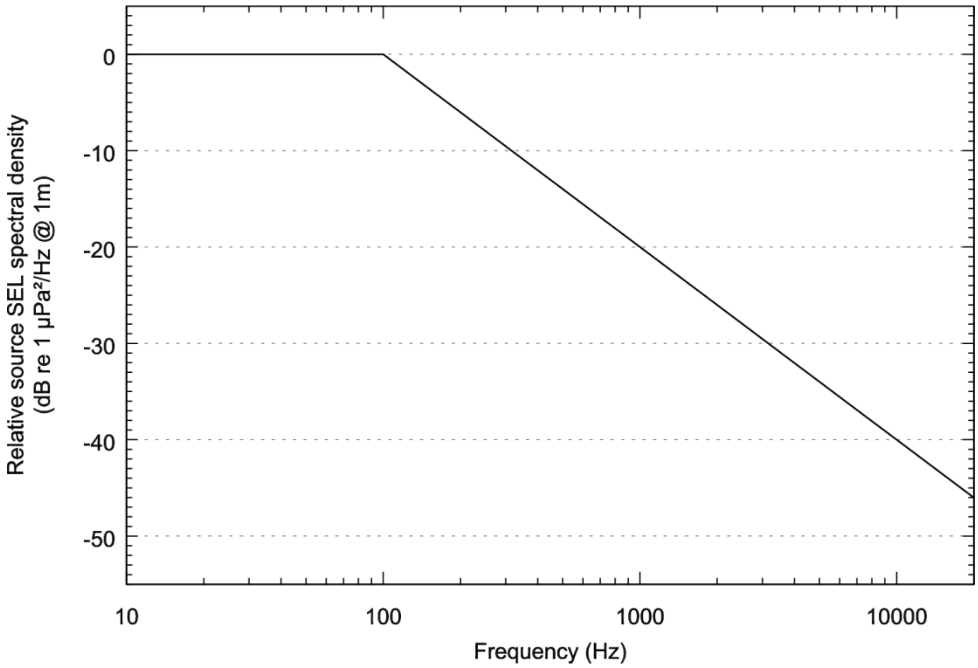


Figure B-3. Estimated sound spectrum from cavitating propeller (Leggat et al. 1981).

B.2.2. Estimating Sound Field from Moving Vessels

During vessel transit, new sound energy is constantly being introduced to the environment. The noise footprint for the transiting vessels considered in this report were estimated by modelling the 1-s SEL for the vessel at one location, and by translating and summing these footprints along the vessel transit routes. The vessel locations along the tracks were spaced uniformly, with an approximate step of $\Delta s \approx 100$ m.

The SEL sound field at any given point along the path is dependent upon the duration of exposure, which with a fixed footprint spacing depends upon the speed of the vessel during each segment of the transit. The 1-s SEL footprint at each vessel location (i) were therefore scales based on the speed of the vessel following:

$$\mathrm{SEL}_i = \mathrm{SEL}_{1s} + 10\log_{10}\left(\frac{\Delta s}{v}\right). \tag{B-5}$$

where v represents the vessel speed in m/s.

The present method acceptably reflects large-scale sound propagation features, primarily dependent on water depth, which dominate the cumulative field and is thus considered to provide a meaningful estimate of the SEL_{24h} field.

B.3. Sound Propagation Models

B.3.1. Propagation Loss

The propagation of sound through the environment was modelled by predicting the acoustic propagation loss—a measure, in decibels, of the decrease in sound level between a source and a receiver some distance away. Geometric spreading of acoustic waves is the predominant way by which propagation loss occurs. Propagation loss also happens when the sound is absorbed and scattered by the seawater, and absorbed scattered, and reflected at the water surface and within the seabed. Propagation loss depends on the acoustic properties of the ocean and seabed; its value changes with frequency.

If the acoustic energy source level (ESL), expressed in dB re 1 μPa^2·s m^2, and propagation loss (PL), in units of dB, at a given frequency are known, then the received level (RL) at a receiver location can be calculated in dB re 1 μPa^2·s by:

$$\mathrm{RL} = \mathrm{SL} - \mathrm{PL}. \qquad \text{(B-6)}$$

B.3.2. MONM-BELLHOP

Long-range sound fields were computed using JASCO's Marine Operations Noise Model (MONM). While other models may be more accurate for steep-angle propagation in high-shear environment, MONM is well suited for effective longer-range estimation. This model computes sound propagation at frequencies of 10 Hz to 1.6 kHz via a wide-angle parabolic equation solution to the acoustic wave equation (Collins 1993) based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM), which has been modified to account for a solid seabed (Zhang and Tindle 1995). MONM computes sound propagation at frequencies > 1.6 kHz via the BELLHOP Gaussian beam acoustic ray-trace model (Porter and Liu 1994).

The parabolic equation method has been extensively benchmarked and is widely employed in the underwater acoustics community (Collins et al. 1996). MONM accounts for the additional reflection loss at the seabed, which results from partial conversion of incident compressional waves to shear waves at the seabed and sub-bottom interfaces, and it includes wave attenuations in all layers. MONM incorporates the following site-specific environmental properties: a bathymetric grid of the modelled area, underwater sound speed as a function of depth, and a geoacoustic profile based on the overall stratified composition of the seafloor.

MONM computes acoustic fields in three dimensions by modelling propagation loss within two-dimensional (2-D) vertical planes aligned along radials covering a 360° swath from the source, an approach commonly referred to as N×2-D. These vertical radial planes are separated by an angular step size of $\Delta\theta$, yielding N = 360°/$\Delta\theta$ number of planes (Figure B-4).

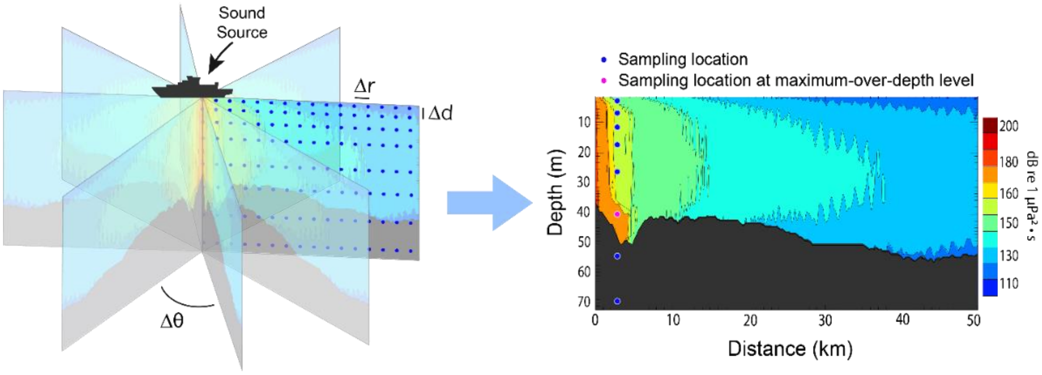


Figure B-4. The N×2-D and maximum-over-depth modelling approach used by MONM.

MONM treats frequency dependence by computing acoustic propagation loss at the centre frequencies of decidecade bands. Sufficiently many decidecade frequency-bands, starting at 10 Hz, are modelled to include most of the acoustic energy emitted by the source. At each centre frequency, the propagation loss is modelled within each of the N vertical planes as a function of depth and range from the source. The decidecade received per-second SEL are computed by subtracting the band propagation loss values from the directional source level in that frequency band. Composite broadband received per-second SEL are then computed by summing the received decidecade levels.

The received 1-s SEL sound field within each vertical radial plane is sampled at various ranges from the source, generally with a fixed radial step size. At each sampling range along the surface, the sound field is sampled at various depths, with the step size between samples increasing with depth below the surface. The step sizes are chosen to provide increased coverage near the depth of the source and at depths of interest in terms of the sound speed profile. For areas with deep water, sampling is not performed at depths beyond those reachable by marine mammals. The received per-second SEL at a surface sampling location is taken as the maximum value that occurs over all samples within the water column, i.e., the maximum-over-depth received per-second SEL. These maximum-over-depth per-second SEL are presented as colour contours around the source.

B.3.3. Wavenumber Integration Model

VSTACK computes propagation loss versus depth and range for arbitrarily layered, range-independent acoustic environments using the wavenumber integration approach to solve the exact (range-independent) acoustic wave equation. This model is valid over the full angular range of the wave equation and can fully account for the elasto-acoustic properties of the sub-bottom. Wavenumber integration methods are extensively used in the field of underwater acoustics and seismology where they are often referred to as reflectivity methods or discrete wavenumber methods. VSTACK computes sound propagation in arbitrarily stratified water and seabed layers by decomposing the outgoing field into a continuum of outward-propagating plane cylindrical waves. Seabed reflectivity in the model is dependent on the seabed layer properties: compressional and shear wave speeds, attenuation coefficients, and layer densities. Additionally, VSTACK assumes range-invariant bathymetry with a horizontally stratified medium (i.e., a range-independent environment) which is azimuthally symmetric about the source. Typically, VSTACK is best suited to modelling the sound field near the source; however, it can also be used in conjunction with MONM to account for additional bottom loss in high shear speed seabeds as described in Section B.3.4.

B.3.4. Limestone Seabed Propagation Loss

For sites where the seabed geoacoustic model consisted of bare calcarenite, an additional broadband correction was applied to the propagation loss results from MONM to better account for the additional propagation loss associated with a limestone (calcarenite) seabed (Duncan et al. 2009). The accuracy of the broadband calculated propagation loss for the South-eastern continental shelf of Australia depends significantly upon the frequency content of the radiating sound source together with thickness of any overlying layers of unconsolidated sediment (e.g. sand) on top of calcarenite likely to occur within the region.

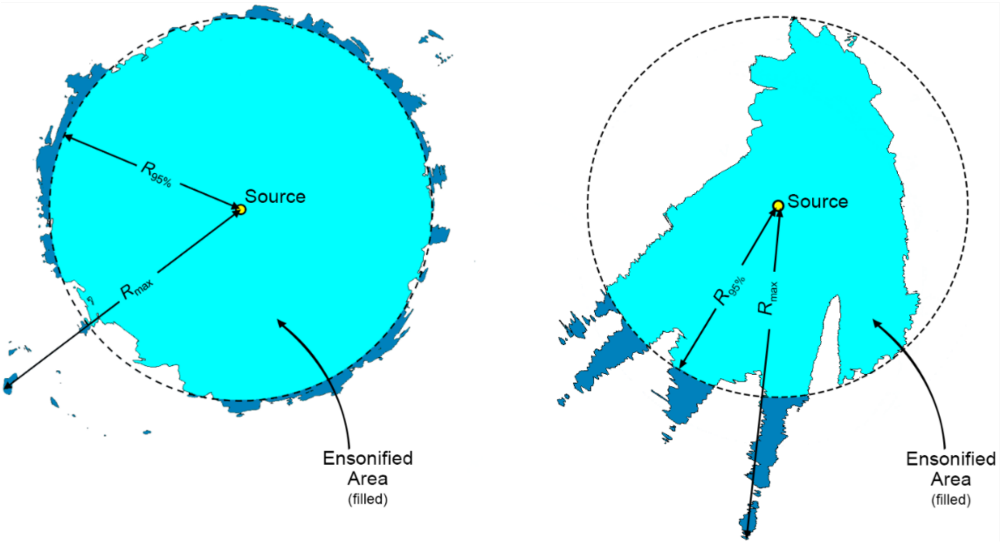
In general, the thinner the sand layer, the greater the overall propagation loss. When comparing SPL data McPherson et al. (2021), higher rates of propagation loss were observed and were attributed to, an absorptive carbonate (calcarenite) seabed. In this study, comparisons were conducted using JASCO's Marine Operations Noise Model (MONM), a wide-angle parabolic equation model which applies the BELLHOP Gaussian beam acoustic ray-trace model at higher frequencies, and JASCO's wavenumber integration model (VSTACK, Appendix B.3.3) which can fully account for the elasto-acoustic properties of the sub-bottom.

To account for the additional propagation loss associated with a cemented calcarenite seabed, an additional broadband correction was applied to the propagation loss results from MONM to account for the higher rates of loss when the full for the elasto-acoustic properties of the sub-bottom are consider. The differences between the broadband SPL from MONM and VSTACK were extracted at the same modelled ranges and depths that corresponded range independent predictions. The 90th percentile of the resultant dB differences in 250 m range bins were selected to generate a correction function for each individual site/source to be modelled. The conversion functions were applied after the propagation loss calculation from MONM but before summing decidecade band levels, gridding, and radii calculations for each modelled site in each modelled scenario considered.

B.4. Estimating Range to Thresholds Levels

Sound level contours were calculated based on the underwater sound fields predicted by the propagation models, sampled by taking the maximum value over all modelled depths above the sea floor for each location in the modelled region. The predicted distances to specific levels were computed from these contours. Two distances relative to the source are reported for each sound level: 1) R_{max}, the maximum range to the given sound level over all azimuths, and 2) $R_{95\%}$, the range to the given sound level after the 5% farthest points were excluded (see examples in Figure B-5).

The $R_{95\%}$ is used because sound field footprints are often irregular in shape. In some cases, a sound level contour might have small protrusions or anomalous isolated fringes. This is demonstrated in the image in Figure B-5(a). In cases such as this, where relatively few points are excluded in any given direction, R_{max} can misrepresent the area of the region exposed to such effects, and $R_{95\%}$ is considered more representative. In strongly asymmetric cases such as shown in Figure B-5(b), on the other hand, $R_{95\%}$ neglects to account for significant protrusions in the footprint. In such cases R_{max} might better represent the region of effect in specific directions. Cases such as this are usually associated with bathymetric features affecting propagation. The difference between R_{max} and $R_{95\%}$ depends on the source directivity and the non-uniformity of the acoustic environment.



(a) (b)

Figure B-5. Sample areas ensonified to an arbitrary sound level with R_{max} and $R_{95\%}$ ranges shown for two different scenarios. (a) Largely symmetric sound level contour with small protrusions. (b) Strongly asymmetric sound level contour with long protrusions. Light blue indicates the ensonified areas bounded by $R_{95\%}$; darker blue indicates the areas outside this boundary which determine R_{max}.

B.5. Model Validation Information

Predictions from JASCO's propagation models (MONM, FWRAM, and VSTACK) have been validated against experimental data from a number of underwater acoustic measurement programs conducted by JASCO globally, including the United States and Canadian Artic, Canadian and southern United States waters, Greenland, Russia and Australia (Hannay and Racca 2005, Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Racca et al. 2012a, Racca et al. 2012b, Matthews and MacGillivray 2013, Martin et al. 2015, Racca et al. 2015, Martin et al. 2017a, Martin et al. 2017b, Warner et al. 2017, MacGillivray 2018, McPherson et al. 2018, McPherson and Martin 2018).

In addition, JASCO has conducted measurement programs associated with a significant number of anthropogenic activities that have included internal validation of the modelling (including McCrodan et al. 2011, Austin and Warner 2012, McPherson and Warner 2012, Austin and Bailey 2013, Austin et al. 2013, Zykov and MacDonnell 2013, Austin 2014, Austin et al. 2015, Austin and Li 2016, Martin and Popper 2016).