Overview of the potential ecological impacts of three offshore locations for wind farms in Aotearoa New Zealand

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Executive summary

The New Zealand Government has committed to enabling an increase in renewable energy. Offshore wind farming is identified as an attractive opportunity, with developers scoping locations of interest.

Offshore wind farming is a new industry for Aotearoa New Zealand, and the siting, construction and operation of wind farms should be assessed in the context of the country's environment and fauna. The diversity and abundance of marine life in New Zealand waters mean that the underwater environment is potentially very sensitive.

This report provides an overview and general comments about threatened and at-risk bird, marine fish, reptile and marine mammal species, and ecologically important benthic biodiversity for the three currently identified 'locations of interest' for offshore wind farm development. These locations are in the North and South Taranaki Bights, the Waikato region, and Southland's Te Ara-a-Kiwa / Foveaux Strait and waters near Stewart Island / Rakiura.

Available data and overseas studies are not sufficient to adequately assess the impacts of offshore wind farming in these locations. This report recommends further work to support site-based comprehensive environmental assessments before wind farm developments proceed.

1. Purpose

This report provides an overview and general comments about the potential ecological impacts at three locations where there is interest in developing offshore wind farms in Aotearoa New Zealand.

It assesses the impacts on:

- bird, marine fish, reptile and marine mammal species that are classified as Threatened or At Risk[1]
- ecologically important benthic[2] biodiversity

and identifies:

- potential impacts from offshore wind farms in these locations of interest
- research knowledge gaps and considerations for environmental impact assessments.

2. Aotearoa New Zealand interest in offshore wind

The New Zealand Government is intent on New Zealand becoming a low-emissions economy to reduce the impacts of climate change and to meet the country's international climate obligations. As part of this, the Government has committed to several targets, including 50% of total energy coming from renewable sources by 2035. The Government is therefore focused on increasing renewable energy generation.

Offshore wind farming is identified as an attractive opportunity because New Zealand has a large marine area and high average offshore wind speeds compared with other countries (MBIE 2022). This means that more energy can be produced here per wind farm than elsewhere in the world. This is a significant opportunity, which makes the marine environment particularly attractive for offshore energy generation using wind power.

In preparing this report, locations of potential interest for offshore wind farm development outlined by the Ministry for Business, Innovation & Employment (MBIE 2022) were used as a baseline. These locations are Southland, Taranaki and the west coast of the Waikato region (Appendix 1).

1 The vulnerability of species to extinction is assessed using the New Zealand Threat Classification System (nztcs.org.nz). The conservation statuses of the species mentioned in this report are included in Tables 1 and 2 in section 5.

2 Habitat at the lowest depths of a body of water.

3. Potential ecological impacts of offshore wind farms

The development of offshore wind farms has several known potential impacts on marine species and communities:

- The death and injury of airborne birds through collisions with wind turbines and related structures. This is of particular importance for threatened species within New Zealand and for migratory species on their flyways. Attraction to the lights on wind farm structures and vessels increases the collision risk for birds at night.
- The death, injury and displacement of marine mammals and other mobile fauna – particularly threatened and at-risk species – resulting from structures occupying habitats, collision with vessels or floating wind farm mooring structures, or entanglement in floating foundations.
- Cumulative and continuous underwater noise impacting marine mammals, diving seabirds, turtles, and some fishes and invertebrates. Noise would be emitted through all phases of offshore wind farm development (pre-construction surveys, construction phase involving large-scale marine pile driving, operational phase and decommissioning).
- Modification, degradation or loss of habitat, including physical disturbance, occupancy, and impacts from increased sedimentation, pollution, vibration, scour/abrasion and invasive species, which may change ecosystem functioning, as well as impacts from the direct and indirect effects of exploration, construction, operation of offshore wind farms and electromagnetic radiation from trenched cabling.

More information about the ecological impacts is included in the appendices: Appendix 2 provides a non-exhaustive list of potential impacts, Appendix 3 details the impacts of underwater noise, and Appendix 4 provides a list of additional reports and grey literature (information produced outside traditional scientific publishing channels).

In addition to understanding the risk and magnitude of the potential impacts on species outlined above, from a conservation perspective it is particularly important to assess if there would be impacts on threatened species that would:

- increase mortality rates
- lower the reproductive success of individuals.

These may include displacement from key habitats, the introduction of environmental stressors or factors that increase the risk of mortality from other causes. For example, species classified as Threatened – Nationally Critical under the New Zealand Threat Classification System cannot afford to lose any potential breeders, as these mortalities will be additional to existing threats and could mean that local populations go extinct (which will increase the risk of species extinctions). In addition to the threatened species, some non-threatened species are listed as taonga (treasured) species in the Ngāi Tahu Claims Settlement Act 1998 for which specific responsibilities for kaitiaki (care and management) may be required, as these species are significant to the culture or identity of Iwi Māori or hapū.

Evaluating the risk to threatened and taonga species, and any species that is absolutely protected under the Wildlife Act 1953, will require site-specific investigation. The direct impacts of offshore wind farms on benthic habitats and species will vary depending on the phase of the life cycle of the wind farm and the associated activities during pre-construction, construction, operation, maintenance and any decommissioning phases. The way in which impacts will vary with the life cycle of the wind farm should be considered in any evaluation.

4. Challenges using overseas studies to assess wind farm impacts in Aotearoa New Zealand

Much of the existing work examining the impacts of offshore wind farms is based on developments in the North Sea. More recent studies are also available from, for example, the US east coast (Galparsoso et al. 2022). Applying the findings from overseas studies in a New Zealand context can be challenging for two reasons.

Firstly, the species and habitats found in New Zealand – and the legislation to protect them – differ significantly from the areas considered in other studies, such as the North Sea:

- New Zealand is a biodiversity hotspot for seabirds[3] and has more endemic seabird species than all other countries combined.
- There are proportionately more nocturnally active seabirds in New Zealand than any other country.
- New Zealand has more winter-breeding seabirds than any other country, including 19 species that initiate or continue their breeding activities throughout winter. By contrast, most seabirds in the Northern Hemisphere are summer breeders and migrate away from land in winter and/or roost in colonies at night.
- More than half of all whale and dolphin species occur in New Zealand waters, so the country is recognised as a global hotspot for cetaceans.
- Some cetacean species can be found in New Zealand all year round. Other species migrate predictably through or to New Zealand waters or are vagrant.
- Many cetacean species have been assessed as Data Deficient under the New Zealand Threat Classification System, meaning there are significant unknowns about their abundance, range and ecology in a New Zealand context.
- New Zealand does not have a formal list of at-risk or threatened marine habitats or ecosystems, but the importance of the country's biogenic marine habitats[4] (including the habitat-forming species within them) is well recognised. MacDiarmid et al. (2013) and Anderson et al. (2019) provide useful commentaries about the significance and state of various biogenic habitats around New Zealand, of which several are threatened and/or declining.
- The Wildlife Act 1953 absolutely protects marine species listed in Schedule 7A, including several coral taxa. This includes the corals from the orders Antipatharia, Gorgonacea and Scleractinia, and the hydrocorals from the family Stylasteridae. An assessment of the environmental impacts at wind farm sites will need to include these species.
- Schedule 6 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects – Permitted Activities) Regulations 2013 lists sensitive environments that will need specific assessment.
- Around 1,700 benthic species have been assessed under the New Zealand Threat Classification System, of which around 50% have been classified as Data Deficient and around 30% as At Risk or Threatened.

Secondly, it is difficult to compare impacts between sites because scientific papers often do not include specifics about wind farm design or size. Also, the distribution of offshore wind farms globally has increased rapidly, and the scale of the farms and the turbines continues to evolve.

3 'Seabird' in the context of this report is a collective name for species included in the orders Procellariiformes (tube-nosed petrels), Sphenisciformes (penguins) and Suliformes (gannets and shags), and in the family Laridae (gulls and terns).

4 Biogenic marine habitats are habitats created by plants and animals in the marine environment.

New foundation types are being explored, and it is not yet confirmed which will be proposed in the locations of interest. Some new foundations may open areas that were previously unavailable to offshore wind farms (e.g. through floating turbines in deeper waters). The impacts of these large-scale farms are still poorly understood globally. It is uncertain how transferable overseas information will be for the installation of offshore wind farms in New Zealand areas with different species of concern and species assemblages.

5. Biological and ecological values to consider

> Biodiversity is inherently valuable. It is central to the identity of New Zealanders and is fundamental to Māori who are intrinsically intertwined with the natural world through whakapapa (genealogy) … Nature supports life and human activity, and all aspects of our wellbeing – physical, cultural, social and economic – are dependent on the natural world and services that it provides.
>
> **(DOC 2020)**

New Zealand has exceptional concentrations of species, many of which are endemic (found nowhere else on Earth) and under threat.

Marine life is diverse and abundant in New Zealand. The underwater environment is sensitive in some places and its conservation has global importance. The impacts of offshore wind farm construction and operation may extend well beyond the footprint of the development. Impacts should therefore be rigorously assessed and quantified for all fauna groups by a thorough environmental assessment process before any work starts.

To assess the potential impacts of offshore wind farms on species or species groups, we need to understand which species use the proposed area and for what activities.

5.1 Species

There are considerable data gaps around distributions for most New Zealand species. Here, we present the likely presence of key groups of species for the three identified locations of interest for wind farm development based on a range of datasets.

Tables 1, 2 and 3 show species that may be found within the three locations of interest and may therefore be adversely impacted by wind farm developments.

Table 1 lists all bird species that are expected to be present within the three locations of interest. It is based on summary data from the eBird New Zealand database[5] and expert knowledge. This table includes species classified as Threatened and At Risk under the New Zealand Threat Classification System, as well as species classified as 'absolutely protected' under the Wildlife Act 1953.

Table 2 provides similar information for marine mammals, and Table 3 lists protected fishes and reptiles. Many marine mammal species have been classified as Data Deficient under the New Zealand Threat Classification System, in part because of their cryptic behaviour (e.g. beaked whales), which can make detecting them difficult, but also due to the historic lack of investment in dedicated surveys. Because such a high proportion of marine mammal, fish and reptile species are in this category, the International Union for Conservation of Nature (IUCN) classifications (IUCN 2023) are also included in Tables 2 and 3 to illustrate the internationally assessed threat status of these species.

5 ebird.org

The data in Tables 1, 2 and 3 suffer from incomplete coverage and a bias towards shore observations. Additionally, offshore surveys have mostly consisted of single isolated trips without seasonal coverage or *ad hoc* reports from transiting vessels. This means that there is a risk of overlooking the use of any given site by an individual species if the offshore observation trips were at the wrong time of year or lacked appropriate design, the specific monitoring tools and/or expert observers. There is a particular lack of data on winter habitat usage, as offshore observations are usually made in summer.

Several bird species have been recorded in coastal areas adjacent to the locations of interest. There is some evidence that tarāpunga / red-billed gull (*Chroicocephalus novaehollandiae scopulinus*), tarāpuka / black-billed gull (*Chroicocephalus bulleri*), tara / white-fronted tern (*Sterna striata*) and tarapirohe / black-fronted tern (*Chlidonias albostriatus*) assemble in post-breeding aggregations, roost in coastal areas and then disperse offshore to feed. Taranui / Caspian terns (*Hydroprogne caspia*) are recognised as mainly coastal breeders that disperse or migrate in autumn.

Five species of sea turtles and four species of sea snakes and kraits are found in New Zealand waters, all of which are protected under the Wildlife Act 1953. None breed here, but two species of turtles use important foraging grounds in New Zealand for parts of their life cycle. They are all highly migratory and New Zealand collaborates internationally on sea turtle conservation.

Leatherback turtle (*Dermochelys coriacea*) is the most likely reptile species to be impacted by offshore wind farms. Leatherback turtles are found around the entire coastline of New Zealand but mostly occur in offshore areas. The Western Pacific sub-population that is found in New Zealand waters is listed as Critically Endangered, nearing extinction, on the IUCN Red List. Very little is known about the abundance of turtles in New Zealand waters, or their distribution and habitat use over time. Given the threat status and large gaps in physiological and ecological knowledge for this species, a precautionary approach is appropriate.

5.2 Benthic ecological values

A small fraction of the seafloor environment around New Zealand has been surveyed to date, and where ecological information is available, it is highly variable in nature, quality and extent. Knowledge of benthic habitats and species in particular locations is therefore highly variable and incomplete. Data have been collected for various purposes, and this has determined the locations of data collection and the methods used. This can limit the direct applicability of the available data to assessments for other purposes. For example, fisheries bycatch records will not provide an accurate representation of the benthic habitats present in a location because fishing gear is not designed to sample the benthic environment and the records can be decades old.

This general overview used data sources that are useful for understanding benthic ecological values in a location (Appendix 5). These included databases of collection records, habitat classifications, reviews of biogenic habitat distributions and benthic surveys.

This report does not provide summary information for all three locations; it only provides a summary of some of the benthic data available for the South Taranaki Bight. This example is used because the amount and quality of information there is relatively high compared with many other areas around New Zealand.

Before any offshore wind development, it will be essential to undertake a comprehensive site-specific survey to identify benthic habitats and species present to assess potential impacts and the suitability of a site. Any offshore development should avoid sensitive benthic habitats (notably biogenic habitats) and protected species (e.g. cold-water corals) that are vulnerable to disturbance.

Table 1. Bird species that may be present at the three locations of interest for offshore wind farming. Potential risk: 'High' = highly likely that significant populations use or move through the area and/or within the rotor strike area of turbines; 'Moderate' = likely that moderate numbers use or move through the area and/or within the rotor strike area of turbines; 'Low' = unlikely to be present or likely to be present in insignificant numbers within the rotor strike area of turbines; '–' = not known to be present in the area. New Zealand Threat Classification System (NZTCS) classifications are taken from Robertson et al. (2021). Note: Vagrant, trans-equatorial shorebirds are not listed, as the actual risk to these species cannot be determined without further information.

Common name	Scientific name	NZTCS classification	Potential risk		
			Southland	Taranaki	Waikato
Pukunui / southern New Zealand dotterel	*Charadrius obscurus obscurus*	Threatened – Nationally Critical	Moderate	–	–
Tara iti / New Zealand fairy tern	*Sternula nereis davisae*	Threatened – Nationally Critical	–	–	Low
Kuaka Whenua Hou / Whenua Hou diving petrel	*Pelecanoides georgicus whenuahouensis*	Threatened – Nationally Critical	High	–	–
Toroa / Antipodean albatross	*Diomedea antipodensis antipodensis*	Threatened – Nationally Critical	Low	Low	Low
Toroa / Gibson's albatross	*Diomedea antipodensis gibsoni*	Threatened – Nationally Critical	Low	Moderate	Low
Toroa / Salvin's mollymawk	*Thalassarche salvini*	Threatened – Nationally Critical	High	Low	Low
Tarapirohe / black-fronted tern	*Chlidonias albostriatus*	Threatened – Nationally Endangered	Low	Low	Low
Hoiho / yellow-eyed penguin	*Megadyptes antipodes antipodes*	Threatened – Nationally Endangered	High	–	–
Kawau tikitiki / spotted shag	*Phalacrocorax punctatus*	Threatened – Nationally Vulnerable	Moderate	Low	–
Mapo / Foveaux shag	*Leucocarbo stewarti*	Threatened – Nationally Vulnerable	High	–	–
Taranui / Caspian tern	*Hydroprogne caspia*	Threatened – Nationally Vulnerable	Low	Low	Low
Kaikōura tītī / Hutton's shearwater	*Puffinus huttoni*	Threatened – Nationally Vulnerable	Low	Low	Low
Toroa / southern royal albatross	*Diomedea epomophora*	Threatened – Nationally Vulnerable	High	Low	Low
Toroa / northern royal albatross	*Diomedea sanfordi*	Threatened – Nationally Vulnerable	Low	Low	Low
Ngutu pare / wrybill	*Anarhynchus frontalis*	Threatened – Nationally Increasing	–	High	Moderate
Tōrea / South Island pied oystercatcher	*Haematopus finschi*	At Risk – Declining	Low	High	Moderate
Pohowera / banded dotterel	*Charadrius bicinctus bicinctus*	At Risk – Declining	Moderate	Moderate	Moderate
Kuaka / eastern bar-tailed godwit	*Limosa lapponica baueri*	At Risk – Declining	–	Moderate	High
Huahou / red knot	*Calidris canutus rogersi*	At Risk – Declining	–	Moderate	High
Tarāpunga / red-billed gull	*Chroicocephalus novaehollandiae scopulinus*	At Risk – Declining	Moderate	Moderate	Moderate
Tarāpuka / black-billed gull	*Chroicocephalus bulleri*	At Risk – Declining	Low	Low	Low
Tara / white-fronted tern	*Sterna striata*	At Risk – Declining	Moderate	Moderate	Moderate
Tawaki / Fiordland crested penguin	*Eudyptes pachyrhynchus*	At Risk – Declining	High	–	–
Kororā / New Zealand little penguin	*Eudyptula minor minor*	At Risk – Declining	Moderate	Moderate	Moderate
Toroa / southern Buller's mollymawk	*Thalassarche bulleri bulleri*	At Risk – Declining	High	Low	Low

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Table 1 continued

Common name	Scientific name	NZTCS classification	Potential risk		
			Southland	Taranaki	Waikato
Toroa / New Zealand white-capped albatross	*Thalassarche cauta steadi*	At Risk – Declining	High	Moderate	Moderate
Rako / Buller's shearwater	*Ardenna bulleri*	At Risk – Declining	Low	Low	High
Tītī / sooty shearwater	*Ardenna grisea*	At Risk – Declining	High	Low	Low
Pāngurunguru / northern giant petrel	*Macronectes halli*	At Risk – Recovering	High	Moderate	Low
Kāruhiruhi / pied shag	*Phalacrocorax varius varius*	At Risk – Recovering	High	Moderate	Moderate
Toanui / flesh-footed shearwater	*Ardenna carneipes*	At Risk – Relict	–	High	High
Reoreo / grey-backed storm petrel	*Garrodia nereis*	At Risk – Relict	Moderate	Low	–
Takahikare / white-faced storm petrel	*Pelagodroma marina maoriana*	At Risk – Relict	Moderate	Low	Low
Tītī / southern Cook's petrel	*Pterodroma cookii orientalis*	At Risk – Relict	High	–	–
Tītī / northern Cook's petrel	*Pterodroma cookii cookii*	At Risk – Relict	–	Low	Moderate
Kōrure / mottled petrel	*Pterodroma inexpectata*	At Risk – Relict	Moderate	Low	–
Kuaka / southern diving petrel	*Pelecanoides urinatrix chathamensis*	At Risk – Relict	High	–	–
Pararā / broad-billed prion	*Pachyptila vittata*	At Risk – Relict	High	Low	Low
Tītī wainui / fairy prion	*Pachyptila turtur*	At Risk – Relict	High	High	Low
Pakahā / fluttering shearwater	*Puffinus gavia*	At Risk – Relict	Low	Moderate	Moderate
Kuaka / northern diving petrel	*Pelecanoides urinatrix urinatrix*	At Risk – Relict	–	High	Low
Tāiko / Westland petrel	*Procellaria westlandica*	At Risk – Naturally Uncommon	Moderate	Moderate	Low
Soft-plumaged petrel	*Pterodroma mollis*	At Risk – Naturally Uncommon	Low	Low	–
Keretai hurukoko / Snares Cape petrel	*Daption capense australe*	At Risk – Naturally Uncommon	Moderate	Low	–
Toroa / Campbell black-browed albatross	*Thalassarche impavida*	At Risk – Naturally Uncommon	Low	Low	Low
Karoro / southern black-backed gull	*Larus dominicanus*	Not Threatened	Low	Moderate	Moderate
Ōi / grey-faced petrel	*Pterodroma gouldi*	Not Threatened	Low	Low	Moderate
Karetai kauae mā / white-chinned petrel	*Procellaria aequinoctialis*	Not Threatened	Moderate	Low	–
Tākapu / Australasian gannet	*Morus serrator*	Not Threatened	High	High	High
Poaka / pied stilt	*Himantopus himantopus leucocephalus*	Not Threatened	Low	Medium	Low
Pāngurunguru / southern giant petrel	*Macronectes giganteus*	Non-resident Native – Migrant	Low	Low	Low
Ruddy turnstone	*Arenaria interpres interpres*	Non-resident Native – Migrant	–	Moderate	High
Toroa / black-browed albatross	*Thalassarche melanophris*	Non-resident Native – Coloniser	Low	Low	Low

Table 2. Marine mammal species that may be present in the three locations of interest for wind farming. Potential risk: 'High' = highly likely that significant populations use or move through the area; 'Medium' = likely that moderate numbers of individuals use or move through the area; 'Low' = unlikely to be present or likely to be present in insignificant numbers; '–' = known to not be present; 'Unknown' = unknown if present – the actual risk to these species cannot be determined without further information. New Zealand Threat Classification System (NZTCS) classifications are taken from Lundquist et al. (2025), and International Union for Conservation of Nature (IUCN) assessments are taken from IUCN (2023).

Common name	Scientific name	NZTCS classification	IUCN assessment	Potential risk		
				Southland	Taranaki	Waikato
Aihe Maaui / Māui dolphin	*Cephalorhynchus hectori maui*	Threatened – Nationally Critical	Critically Endangered	–	Medium	High
Ihu koropuku / southern elephant seal	*Mirounga leonina*	Threatened – Nationally Critical	Least Concern	Unknown	Low	Low
Kākahi / killer whale / orca	*Orcinus orca*	Threatened – Nationally Critical	Data Deficient	Unknown	Unknown	Unknown
Terehu / bottlenose dolphin	*Tursiops truncatus*	Threatened – Nationally Vulnerable	Least Concern	Unknown	Unknown	Unknown
Tūpoupou / Hector's dolphin	*Cephalorhynchus hectori hectori*	Threatened – Nationally Vulnerable	Endangered	High	Low	Low
Pakake / New Zealand sea lion	*Phocarctos hookeri*	Threatened – Nationally Endangered	Endangered	High	–	–
Tohorā / southern right whale	*Eubalaena australis*	Threatened – Nationally Increasing	Least Concern	High	Unknown	Unknown
Popoiangore / leopard seal	*Hydrurga leptonyx*	Non-resident Native – Migrant	Least Concern	Unknown	Unknown	Unknown
False killer whale	*Pseudorca crassidens*	At Risk – Uncommon	Near Threatened	Unknown	Unknown	Unknown
Kekeno / New Zealand fur seal	*Arctocephalus forsteri*	Not Threatened	Least Concern	High	High	High
Hakurā / Gray's beaked whale	*Mesoplodon grayi*	Not Threatened	Least Concern	Unknown	High	High
Aihe / common dolphin	*Delphinus delphis*	Not Threatened	Least Concern	Unknown	High	High
Dusky dolphin	*Aethalodelphis obscurus*	Not Threatened	Least Concern	Unknown	Medium	Unknown
Paikea / humpback whale	*Megaptera novaeangliae australis*	Non-resident Native – Migrant	Least Concern	Unknown	High	Unknown
Pantropical spotted dolphin	*Stenella attenuata*	Non-resident Native – Vagrant	Least Concern	–	Unknown	Unknown
Antarctic blue whale	*Balaenoptera musculus intermedia*	Non-resident Native – Migrant	Critically Endangered	Unknown	Unknown	Unknown
Sei whale	*Balaenoptera borealis schlegelii*	Non-resident Native – Migrant	Endangered	Unknown	Unknown	Unknown
Parāoa / sperm whale	*Physeter macrocephalus*	At Risk – Declining	Vulnerable	Unknown	Unknown	Unknown
Fin whale	*Balaenoptera physalus quoyi*	Non-resident Native – Migrant	Vulnerable	Unknown	Unknown	Unknown
Antarctic minke whale	*Balaenoptera bonaerensis*	Non-resident Native – Migrant	Near Threatened	Unknown	Unknown	Unknown
Spectacled porpoise	*Phocoena dioptrica*	Data Deficient	Least Concern	Unknown	Unknown	–
Pygmy right whale	*Caperea marginata*	Data Deficient	Least Concern	Unknown	Unknown	Unknown
Upokohue / long-finned pilot whale	*Globicephala melas edwardii*	Not Threatened	Least Concern	High	High	Unknown
Arnoux's beaked whale	*Berardius arnuxii*	Data Deficient	Least Concern	Unknown	Unknown	Unknown
Goose-beaked whale	*Ziphius cavirostris*	At Risk – Uncommon	Least Concern	Unknown	Medium	Unknown
Southern right whale dolphin	*Lissodelphis peronii*	At Risk – Uncommon	Least Concern	Unknown	Unknown	Unknown
Strap-toothed whale	*Mesoplodon layardii*	Data Deficient	Least Concern	Unknown	Medium	Unknown

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Table 2 continued

Common name	Scientific name	NZTCS classification	IUCN assessment	Potential risk		
				Southland	Taranaki	Waikato
Southern bottlenose whale	*Hyperoodon planifrons*	Data Deficient	Least Concern	Unknown	Unknown	Unknown
Striped dolphin	*Stenella coeruleoalba*	Data Deficient	Least Concern	–	Unknown	Unknown
Risso's dolphin	*Grampus griseus*	Data Deficient	Least Concern	Unknown	Unknown	Unknown
Pygmy sperm whale	*Kogia breviceps*	At Risk – Uncommon	Least Concern	Unknown	Unknown	Unknown
Dwarf minke whale	*Balaenoptera acutorostrata* "dwarf"	Data Deficient	Least Concern	Unknown	Unknown	Unknown
Pygmy blue whale	*Balaenoptera musculus brevicauda*	Threatened – Nationally Vulnerable	Data Deficient	Unknown	High	Unknown
Andrew's beaked whale	*Mesoplodon bowdoini*	Data Deficient	Data Deficient	Unknown	Unknown	Unknown
Genus *Mesoplodon*	*Mesoplodon* spp.	Data Deficient	Data Deficient	Unknown	Unknown	Unknown
Shepherd's beaked whale	*Tasmacetus shepherdi*	Data Deficient	Data Deficient	Unknown	Unknown	Unknown
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	Data Deficient	Data Deficient	Unknown	Unknown	Unknown
Hector's beaked whale	*Mesoplodon hectori*	Data Deficient	Data Deficient	Unknown	Unknown	Unknown

Table 3. Fish and reptile species that are classified as absolutely protected wildlife in Aotearoa New Zealand and which may be present in the three locations of interest for wind farming. Potential risk: 'High' = highly likely that significant populations use or move through the area; 'Medium' = likely that moderate numbers use or move through the area; 'Low' = unlikely to be present or likely to be present in insignificant numbers; 'Unknown' = unknown if present – the actual risk cannot be determined without further information. New Zealand Threat Classification System (NZTCS) classifications are taken from Duffy et al. (2018) and Hitchmough et al. (2021).

Common name	Scientific name	NZTCS classification	IUCN assessment	Potential risk		
				Southland	Taranaki	Waikato
Great white shark	*Carcharodon carcharias*	Threatened – Nationally Endangered	Vulnerable	Medium	Medium	Medium
Basking shark	*Cetorhinus maximus*	Threatened – Nationally Vulnerable	Endangered	Medium	Low	Low
Smalltooth sand tiger	*Odontaspis ferox*	At Risk – Naturally Uncommon	Endangered – Decreasing	Low	Low	Low
Leatherback turtle (West Pacific sub-population)	*Dermochelys coriacea*	Non-resident Native – Migrant	Critically Endangered	Medium	Medium	Medium
Spinetail devil ray	*Mobula mobular*	Data Deficient	Endangered	Low	Low	Medium
Giant manta ray	*Manta birostris*	Not assessed	Endangered	Unknown	Unknown	Low
Oceanic whitetip shark	*Carcharhinus longimanus*	Non-resident Native – Migrant	Critically Endangered	Low	Low	Low
Giant grouper	*Epinephelus lanceolatus*	Not assessed	Data Deficient – Decreasing	Low	Low	Low
Spotted black grouper	*Epinephelus daemelii*	Not assessed	Near Threatened	Low	Low	Low
Yellow-bellied sea snake	*Hydrophis platurus*	Not Threatened	Least Concern	Low	Low	Low

5.3 Statutory spatial tools to manage human impacts on biological and ecological values

The Department of Conservation Te Papa Atawhai (DOC) has responsibilities under the Marine Reserves Act 1971 and the Marine Mammals Protection Act 1978. These set out provisions for protecting areas to manage risks to biological and ecological features.

Marine reserves and marine mammal sanctuaries provide legal protection for marine ecosystems, habitats and species. They do not capture all significant ecological values for an area but do provide insight into the species or areas they are designed to manage.

5.3.1 Marine reserves

Marine reserves provide the highest level of marine protection in New Zealand. Created under the Marine Reserves Act 1971, they are designated areas that are completely protected from the sea surface to the seafloor, including the foreshore. The entire area is strictly 'no take', meaning nothing may be removed from the reserve, including marine life, shells and rocks.

Marine reserves within the locations of interest include:

- Tapuae Marine Reserve and Parininihi Marine Reserve in the location of interest in the Taranaki region (Fig. 1)
- Ulva Island – Te Wharawhara Marine Reserve at Stewart Island / Rakiura in the Southland location of interest.

5.3.2 Marine mammal sanctuaries

Marine mammal sanctuaries are designed to protect marine mammals from harmful human-induced impacts. In New Zealand, a marine mammal sanctuary is defined in section 22 of the Marine Mammals Protection Act 1978.

Marine mammal sanctuaries impose rules and exemptions for particular activities that may be harmful to marine mammals, such as seismic surveying, for which DOC has developed a code of conduct for minimising the disturbance of marine mammals.

Marine mammal sanctuaries within the locations of interest include:

- the West Coast North Island Marine Mammal Sanctuary, which spans most of the west coast of Te Ika-a-Māui / the North Island, including Taranaki and Waikato from the mean high-water springs to the 12 nautical mile territorial sea limit (Fig. 1)
- Te Waewae Bay Marine Mammal Sanctuary and the Catlins Coast Marine Mammal Sanctuary in Southland (Fig. 2).

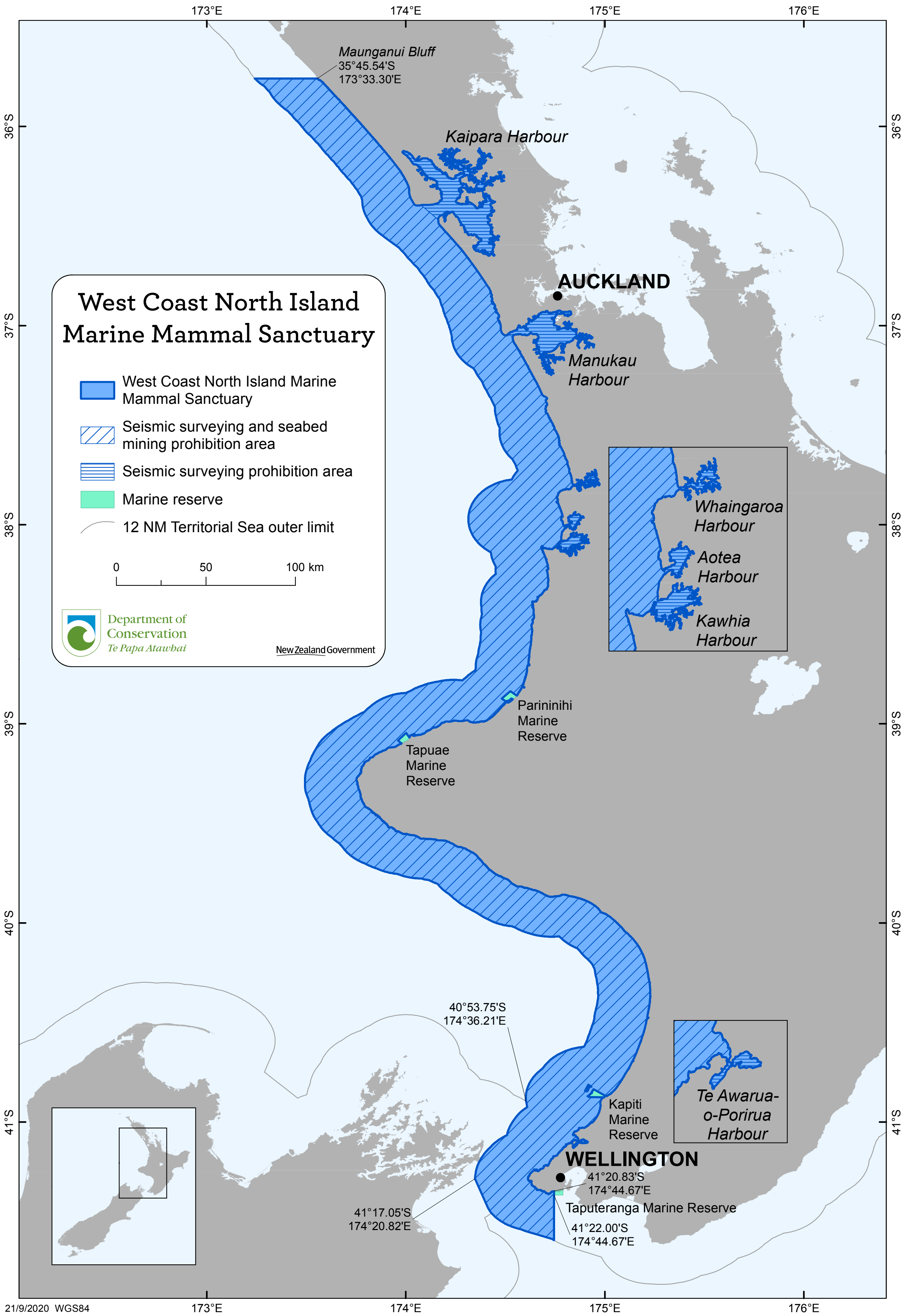

Figure 1. Locations of Tapuae Marine Reserve, Parininihi Marine Reserve and the West Coast North Island Marine Mammal Sanctuary boundaries in 2020.

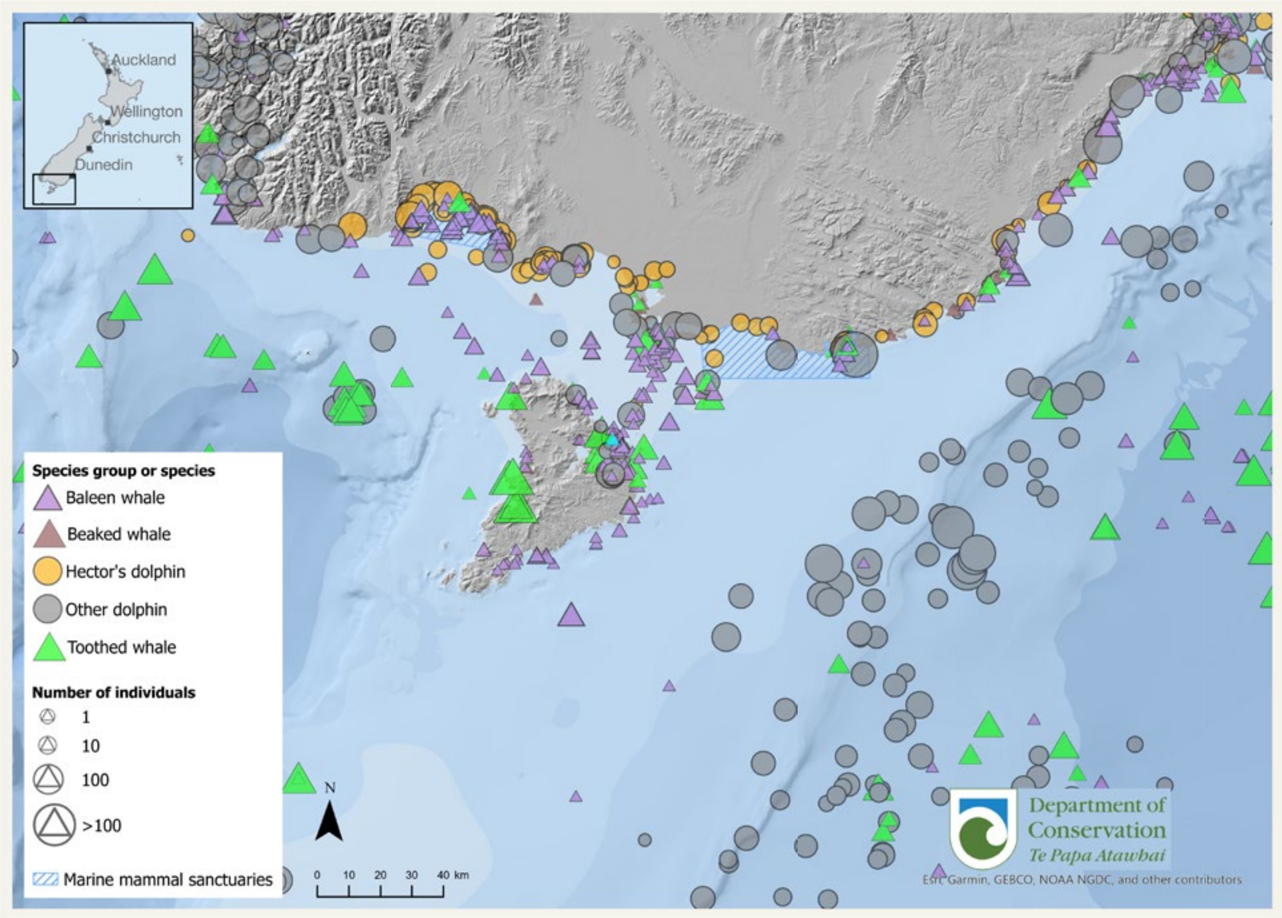

Figure 2. Locations of Te Waewae Bay Marine Mammal Sanctuary to the west and Catlins Coast Marine Mammal Sanctuary to the east (hatched areas). Ulva Island – Te Wharawhara Marine Reserve (not shown) is located off the northeastern coast of Stewart Island / Rakiura. Survey and opportunistic marine mammal sightings (1899–2023) and strandings (1839-2023) from Te Ara-a-Kiwa / the Foveaux Strait are also shown. *Data source: New Zealand Marine Mammal Database, Department of Conservation*

6. Species found in the three locations of interest for offshore wind farming

6.1 Southland

The location of interest for developing offshore wind farming in Southland is in Te Ara-a-Kiwa / the Foveaux Strait to the north of Rakiura (Appendix 1). The Foveaux Strait is a channel separating Te Waipounamu / the South Island from Rakiura.

This section provides an indication of the likely species that occur within this location of interest. Where possible, consideration of the ecological value of the area to these species is also provided. These data were collated from a range of sources, and some information was inferred from sparse data, as dedicated surveys are lacking for many species.

6.1.1 Birds

In total, 42 seabird and shorebird species have been recorded in the wider Foveaux Strait region. Eleven of these are classified as Threatened and 26 as At Risk under the New Zealand Threat Classification System. These include petrels, shearwaters, albatrosses, penguins, terns, gulls, national and international migrant species, and resident coastal species.

Nearby, there are important seabird colonies for tītī / sooty shearwater (*Ardenna grisea*), toroa / Salvin's mollymawk (*Thalassarche salvini*), toroa / southern Buller's mollymawk (*Thalassarche bulleri bulleri*), kōrure / mottled petrel (*Pterodroma inexpectata*), tītī / southern Cook's petrel (*Pterodroma cookii orientalis*), kuaka Whenua Hou / Whenua Hou diving petrel (*Pelecanoides georgicus whenuahouensis*), tawaki / Fiordland crested penguin (*Eudyptes pachyrhynchus*) and mapo / Foveaux shag (*Leucocarbo stewartia*). There are also several seabird breeding sites within flying distance, and seabirds will enter the area from colonies located in the subantarctic islands.

Estuaries in the area are valuable foraging and roosting sites for shorebirds, including potentially for international migratory species.

Southland is a core foraging zone for Whenua Hou diving petrels (population 200 birds; Fig. 3). This zone is also just east of the major breeding colony of southern Buller's mollymawk on Solander Island / Hautere. This species is already in decline from fisheries impacts.

The sole breeding site of the southern subspecies of Cook's petrel is on nearby Codfish Island / Whenua Hou. The largest colonies of mottled petrels in the world (on Whenua Hou) and kuaka / southern diving petrels (*Pelecanoides urinatrix chathamensis*; on Little Solander Island) occur just west of the proposed wind farm area.

The largest sooty shearwater colonies are at the Snares Islands / Tini Heke (estimated at 26% of the New Zealand population of this species), with a further 41% of the New Zealand population around Rakiura (e.g. 1,120,000 breeding pairs on Taukihepa / Big South Cape Island alone; Newman et al. 2009). Flocks of more than 50,000 birds forage in the Te Waewae Bay area in summer.

The location of interest for offshore wind farming is at the western distributional limit for hoiho / yellow-eyed penguins (*Megadyptes antipodes antipodes*) (Mattern 2020).

Foveaux shag is endemic to the southern Foveaux Strait area. Breeding sites include Rarotoka Island (Centre Island) and Fife Rock (Rexer Huber and Parker 2023). Detailed information about habitat usage is not available for this species, but it is expected that the proposed wind farm area in the Foveaux Strait is within its normal foraging habitat.

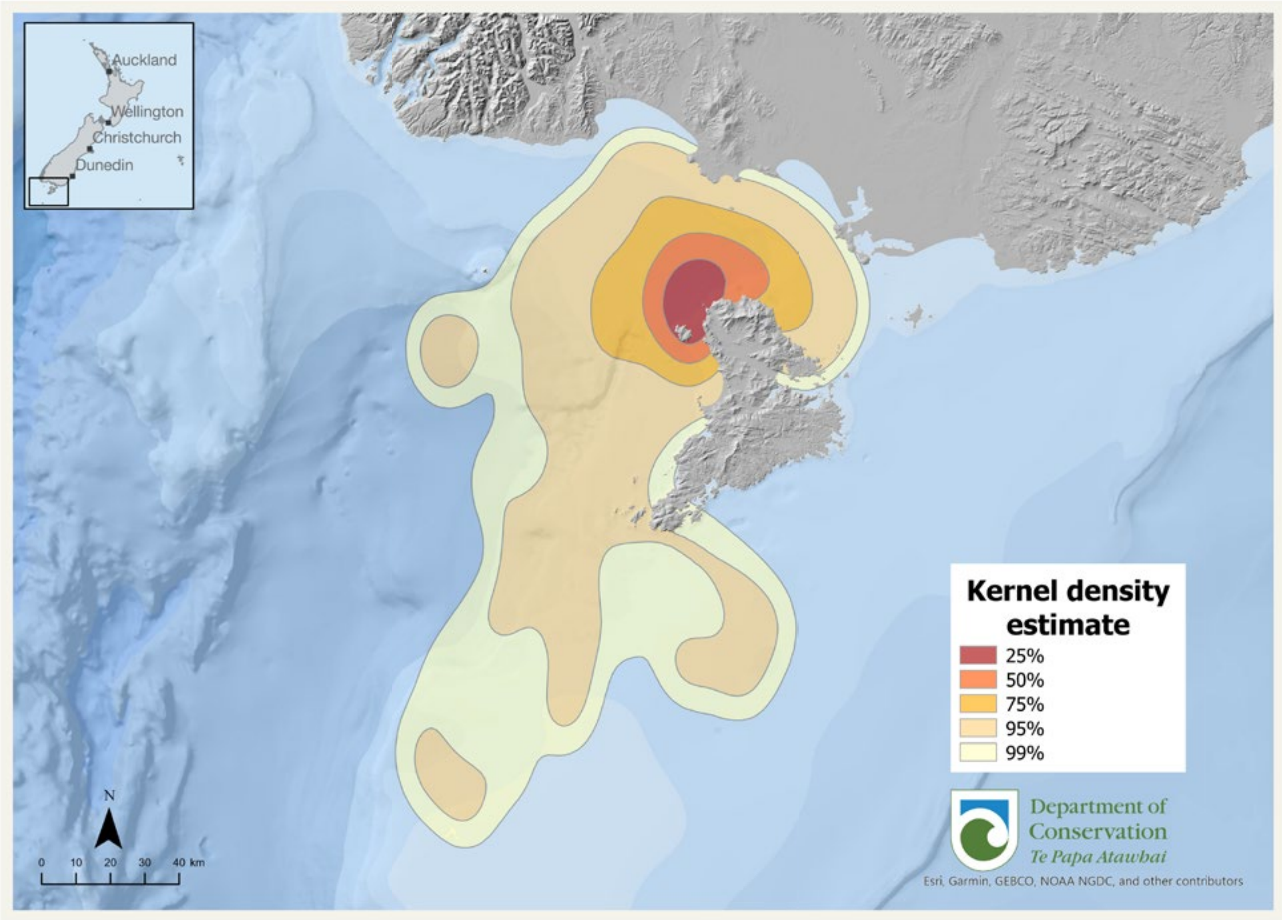

Figure 3. Foraging distribution of kuaka Whenua Hou / Whenua Hou diving petrel (*Pelecanoides georgicus whenuahouensis*), tracked with GPS loggers from Codfish Island / Whenua Hou during the 2023 breeding season (October to December; *n* = 25), showing kernel density estimates (25%, 50%, 75%, 95% and 99% contours). *Data source: Te Arawhetu Waipoua, University of Otago, unpublished*

Toroa / southern royal albatrosses (*Diomedea epomophora*) are observed throughout the Foveaux Strait and along the coasts of the South Island. They nest on Campbell Island / Motu Ihupuku and range widely around the Southern Ocean and the coasts of New Zealand during both the breeding and non-breeding seasons.

Like southern royal albatross, sightings have been recorded of Salvin's mollymawk throughout the Foveaux Strait. Salvin's mollymawks are endemic breeders in New Zealand with colonies at the Bounty Islands and the Snares Islands. Non-breeding birds range as far as eastern Australia, Chile and Peru. The causes of decline for this species are poorly understood.

Forest & Bird identify 'Important Bird Areas' as sites that have a regular presence of threatened species or more than 1% of the global population. The western entrance to the Foveaux Strait is classified as part of the 'Fiordland – West Coast South Island Important Bird Area'. Separately, the 'Rakiura Important Bird Area' includes all of the Foveaux Strait and eastwards to include Ruapuke Island (Table 4).

Table 4. Species found in two of the Important Bird Areas in Southland identified in Forest & Bird (2014). The assessment methods show how the activities of each species were recorded.

Species and activity	Assessment method		
	Observations	Geo-locator tags	GPS observations
Fiordland – West Coast South Island			
Fiordland crested penguin – foraging	✓		
Mottled petrel – passage through		✓	
Cook's petrel – passage through		✓	
Sooty shearwater – foraging and passage through	✓		
Southern Buller's mollymawk – foraging and passage through			✓
Salvin's mollymawk – foraging and passage through	✓	✓	
Whenua Hou diving petrel – foraging			✓
Stewart Island / Rakiura			
Hoiho – foraging and passage through			✓
Fiordland crested penguin – foraging	✓		
Foveaux shag (also known as Stewart Island shag) – foraging	✓		
Northern royal albatross – foraging and passage through	✓		✓
Southern royal albatross – foraging and passage through	✓		
Antipodean albatross – foraging and passage through	✓		✓
White-capped albatross – foraging and passage through	✓	✓	✓
Salvin's mollymawk – foraging and passage through	✓	✓	
Buller's mollymawk – foraging and passage through	✓	✓	✓
Cook's petrel – passage through	✓	✓	
Mottled petrel – passage through	✓	✓	
Sooty shearwater – foraging and passage through	✓	✓	✓

6.1.2 Marine mammals

A total of 21 marine mammal species or subspecies have been recorded in the Foveaux Strait area (DOC New Zealand Marine Mammal Database). These include the Threatened – Nationally Critical kākahi / killer whale / orca (*Orcinus orca*) and ihu koropuku / southern elephant seal (*Mirounga leonina*), the Threatened – Nationally Endangered pakake / New Zealand sea lion (*Phocarctos hookeri*), the Threatened – Nationally Vulnerable terehu / bottlenose dolphin (*Tursiops truncatus*) and tūpoupou / Hector's dolphin (*Cephalorhynchus hectori hectori*), and the Threatened – Nationally Increasing tohorā / southern right whale (*Eubalaena australis*) (Lundquist et al. 2025). A range of Non-resident Native – Migrant, Data Deficient and Not Threatened species have also been recorded throughout this area.

Dolphins

Three large bays (Te Waewae, Toetoes and Porpoise Bays) are the main habitat of the distinct sub-population of Hector's dolphins on the south coast of the South Island. Hector's dolphins across all three bays are genetically different from the other sub-populations of Hector's dolphins found around the South Island (Hamner et al. 2012). An aerial survey in 2018 provided an estimate of 332 Hector's dolphins (95% confidence interval = 217–508) along the south coast of the South Island (MacKenzie and Clement 2019). Their genetic distinctiveness and low abundance suggest that this sub-population is extremely vulnerable, and their offshore distribution, particularly in winter, remains poorly understood. Hector's dolphins are protected through fishing restrictions and by Te Waewae Bay and Catlins Coast Marine Mammal Sanctuaries (Fig. 2).

Whales

Historic whaling data describe the migration routes and movements of paikea / humpback whales (*Megaptera novaeangliae australis*) through this area, including on their northward migration from May to August and their southern migration from September to December (Dawbin 1956).

Parāoa / sperm whales (*Physeter macrocephalus*) generally occur to the west of Rakiura (Gaskin 1973) and have been recorded in the area from strandings.

Southern right whales were reported historically to calve around the New Zealand mainland in winter. Records show that they returned to this region post-whaling, notably in Te Waewae Bay (Carroll et al. 2013, 2014).

Recent research demonstrates that this area remains part of important migratory pathways for baleen whales, including humpback whales (Gibbs and Childerhouse 2000), southern right whales (Carroll et al. 2015, 2016; Riekkola et al. 2019; Mackay et al. 2020) and blue whales (*Balaenoptera musculus*) (Goetz et al. 2018).

The upokohue / long-finned pilot whale (*Globicephala melas edwardsii*) is the most common mass-stranding cetacean in New Zealand and in this region, and regular large strandings of more than 100 individuals have been recorded from Rakiura. Seasonal productivity may influence pilot whale presence here, with changes in temperature and ocean dynamics potentially contributing to their increased habitat use (Betty et al. 2019). The combination of shallow coastal shelf waters and adjacent deep, submarine canyons provide ideal habitat for several other cetaceans, with regular sightings of Arnoux's beaked whales (*Berardius arnuxii*), including cow and calf pairs, and records of other beaked whale species, as well as pygmy right whales (*Caperea marginata*).

Pinnipeds

Pinnipeds in this region include occasional sightings of the Threatened – Nationally Critical southern elephant seal, the Threatened – Nationally Endangered New Zealand sea lion, the Not Threatened kekeno / New Zealand fur seal (*Arctocephalus forsteri*) and the Non-resident Native – Migrant popoiangore / leopard seal (*Hydrurga leptonyx*).

Rakiura is the largest breeding area of the endemic New Zealand sea lion outside the subantarctic islands (Chilvers 2017) and the third largest overall (Roberts and Doonan 2016). Despite the small size of this population (approximately 2% of the total population), it is significant for species security (Chilvers 2023).

New Zealand fur seal breeding colonies of significance have been recorded on offshore islands around the Foveaux Strait and Rakiura (Baird 2011).

Over recent years, there has been an increase in reported sightings of leopard seals in New Zealand, including from the south and southeast coasts (Hupman et al. 2019). Elephant seals are also recorded occasionally from the region. Other Antarctic seals have occasionally been reported as vagrants in this area.

6.1.3 Protected fishes

Rakiura is a recognised global hotspot for great white sharks (*Carcharodon carcharias*). Satellite tagging of sharks aggregating around the Tītī / Muttonbird Islands in the Foveaux Strait and in New South Wales shows that this species makes regular seasonal movements between New Zealand, Australian waters and New Caledonia through this part of the Foveaux Strait (Duffy et al. 2012; Francis et al. 2015; Spaet et al. 2020).

A lack of fine-scale tracking of great white sharks in the Foveaux Strait means that the significance of this area as part of the migratory corridor, and as a foraging area, cannot be determined.

Basking sharks (*Cetorhinus maximus*) have occasionally been observed in the Foveaux Strait, both individually and in small schools (Francis and Duffy 2002). There have been no reported sightings or captures of this species in this location since the late 1990s, but there is ongoing bycatch in a squid trawl fishery in the Southern Ocean. The species appears to have disappeared from inshore waters throughout New Zealand. The reason for this disappearance is unknown, and elsewhere in their range, basking sharks have been known to suddenly reappear after absences of several decades.

6.2 Taranaki

6.2.1 Birds

A total of 69 seabird and shorebird species have been recorded in the location of interest for offshore wind farming in the Taranaki region, including 13 Threatened and 34 At Risk species. These include petrels, shearwaters, albatrosses, penguins, terns, gulls, national and international migrant shorebirds, and resident coastal species such as shags.

There are no large seabird colonies nesting on the South Taranaki mainland, apart from karoro / southern black-backed gulls (*Larus dominicanus*). There are, however, several large seabird breeding colonies on the islands offshore from New Plymouth (Ngā Motu / Sugar Loaf Islands) and on offshore islands in the Marlborough Sounds and at Onetahua / Farewell Spit, which are within foraging distance of the location of interest for offshore wind farms. Seabirds will enter the area from local colonies in Te Moana-o-Raukawa / the Cook Strait and the Taranaki region, and from elsewhere in New Zealand.

Researchers have tracked individuals belonging to several species that have originated from northern colonies foraging in this area, and birds from Rēkohu / Wharekauri / the Chatham Islands and New Zealand's subantarctic islands will also pass through. Recent tracking studies of tākapu / Australasian gannets (*Morus serrator*) breeding at Farewell Spit show extensive use of the seas offshore from the Taranaki coast. The time spent by these birds in the area depends on available food, seasonality of the food supply, wind direction and strength, and whether the birds are migrating, breeding or simply exploring for suitable habitat.

The colonies of toanui / flesh-footed shearwaters (*Ardenna carneipes*) and diving petrels on the Sugar Loaf Islands will possibly interact with the location of interest for offshore wind farming. There are also seabirds passing through, flying from the Cook Strait towards Te Ikaroa-a-Māui / Cape Egmont. The location of interest may be far enough east to be outside the main flight path of seabirds heading out into Te Tai-o-Rehua / the Tasman Sea but would be directly under the flight path of migrating tōrea / South Island pied oystercatchers (*Haematopus finschi*), and possibly ngutu pare / wrybills (*Anarhynchus frontalis*), poaka / pied stilts (*Himantopus himantopus leucocephalus*) and pohowera / banded dotterels (*Charadrius bicinctus bicinctus*) travelling from South Island rivers to northern harbours and back again.

In general, estuaries in the area are valuable foraging and roosting sites for migrating shorebirds, possibly including international migratory species.

The location of interest in offshore Taranaki is within the 'Cook Strait Important Bird Area' listed in Forest & Bird (2014). Species found within this area are shown in Table 5.

Table 5. Species observed in the 'Cook Strait Important Bird Area' identified in Forest & Bird (2014). The assessment methods show how the activities of species were recorded.

Species and activity	Assessment method		
	Observations	Geo-locator tags	GPS observations
Wider Cook Strait			
Fairy prion – foraging	✓		
Fluttering shearwater – foraging		✓	
Sooty shearwater – foraging and passage through	✓	✓	
Australasian gannet – foraging	✓		✓
Black-billed gull – post-breeding foraging	✓		
Black-fronted tern – post-breeding foraging	✓		
Gibson's albatross – passage through	✓		✓
Northern royal albatross – passage through	✓		
White-capped albatross – passage through	✓		
Salvin's mollymawk – passage through	✓		
Westland petrel – passage through	✓		✓
White-chinned petrel – passage through	✓		
Buller's shearwater – passage through	✓	✓	
Hutton's shearwater – passage through	✓	✓	

6.2.2 Marine mammals

Stranding and sighting records from the South Taranaki Bight include at least 35 species of cetaceans (DOC New Zealand Marine Mammal Database) and three species of pinnipeds, and colonies of New Zealand fur seals also occur in this region.

Cool plumes of nutrient-rich upwelled water originating near the Kahurangi Shoals on the west coast of the South Island are carried by the D'Urville Current into the greater Cook Strait and the South Taranaki Bight (Stevens et al. 2021). This is known as the Kahurangi upwelling system.[6] This plume of nutrients supports dense aggregations of krill and copepod biomass (James and Wilkinson 1988) that make the area an important feeding area for many marine mammal species.

Whales

This area is significant for a resident population of pygmy blue whales (*Balaenoptera musculus brevicauda*) (Barlow et al. 2021). Strandings and sightings (Fig. 4) suggest that this area may also be important for species that depend on dense aggregations of zooplankton, including other species of baleen whales like fin whale (*Balaenoptera physalus quoyi*), sei whale (*Balaenoptera borealis schlegelii*) and pygmy right whale.

The South Taranaki Bight was historically a calving area for southern right whales. The upwelling may also influence the presence of long-finned pilot whales and various other delphinids, including orca and aihe / common dolphins (*Delphinus delphis*). Despite the relatively shallow nature of the South Taranaki Bight (with depths mostly less than 150 m), a high diversity of beaked whales (species generally associated with deep-water environments) has been recorded from the region, including Shepherd's beaked whale (*Tasmacetus shepherdi*).

The population of pygmy blue whales in New Zealand is genetically distinct and isolated from populations elsewhere in the world. They have a year-round presence in this region (Fig. 5), which is a critical foraging ground and presumed to be used for calving and nursing (Barlow et al. 2018).

6 An upwelling system occurs where the wind blows along the coast, surface waters are pushed offshore and cold, nutrient-rich water is drawn up from below as a result.

The wider Cook Strait and South and North Taranaki Bight area is also an important migratory pathway for humpback whales (Gibbs and Childerhouse 2000).

Dolphins

The Threatened – Nationally Vulnerable Hector's dolphin and Threatened – Nationally Critical Āihe Maaui / Māui dolphin (*Cephalorhynchus hectori maui*) are found in the coastal waters of the North and South Taranaki Bights. Both species are protected in the area by a marine mammal sanctuary (Fig. 1) and fishing restrictions.

The South Taranaki Bight was historically more significantly part of the range of Māui dolphins, which spanned from the northern Cook Strait to Te Oneroa-a-Tōhē / Ninety Mile Beach (Baker et al. 2002). Genetic studies supported by recent records have shown the occasional presence of Hector's dolphins within the range of Māui dolphins, prompting the extension of the West Coast North Island Marine Mammal Sanctuary and fishing restrictions in 2020 based on the precautionary assumptions that:

- both the Hector's and Māui dolphin subspecies are present within this region
- the sanctuary corridor between Taranaki and Wellington may be important to maintain connectivity and provide opportunity for populations to recover former parts of the Māui dolphin range.

These protections were put in place to help meet the objectives of the *Hector's and Māui dolphin Threat Management Plan 2020* (DOC and Fisheries New Zealand 2020).

The most frequently reported marine mammal in the region is the common dolphin, which is regular bycatch in commercial trawl fisheries (primarily for jack mackerel [*Trachurus* spp.]), showing that this is an important feeding area for them.

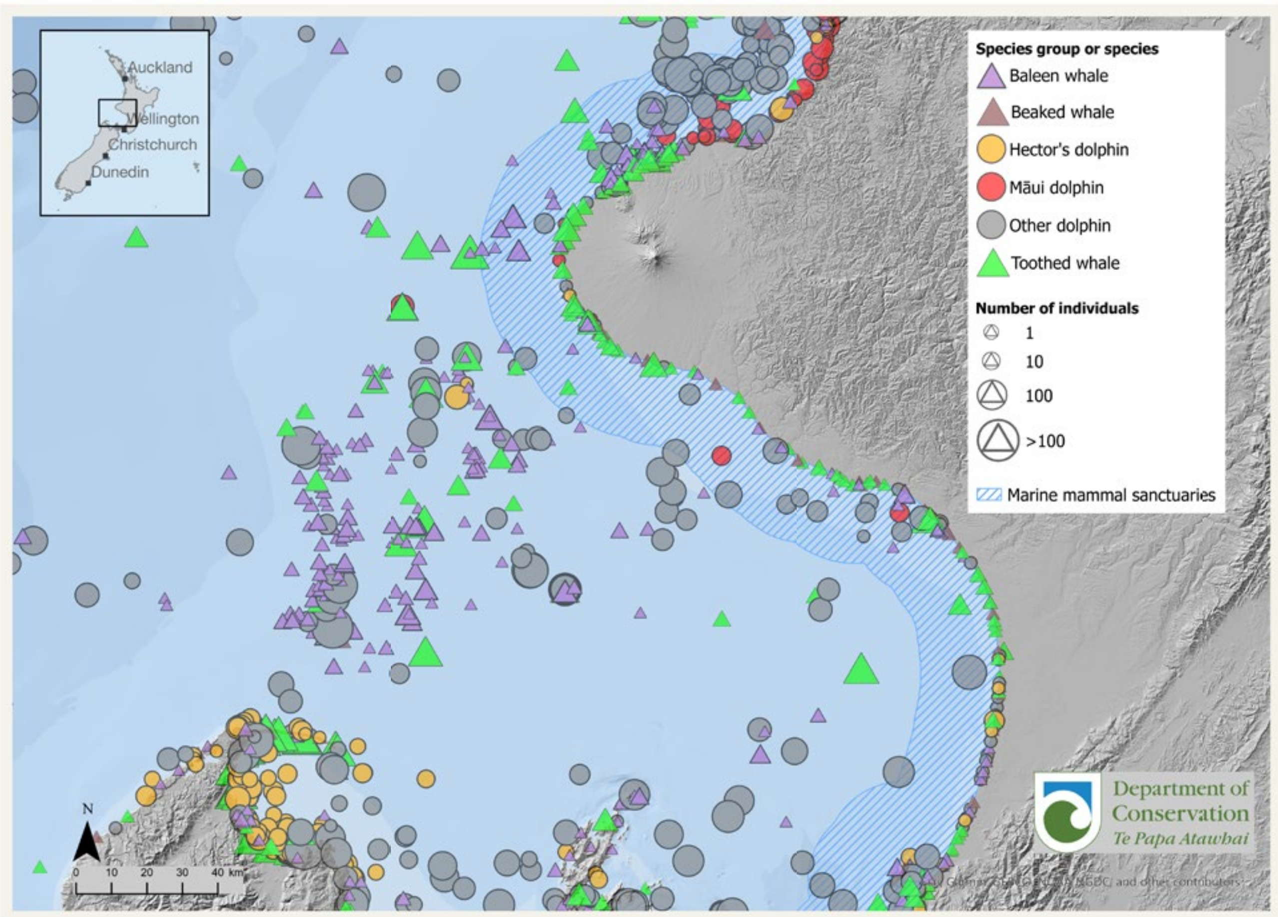

Figure 4. Survey and opportunistic marine mammal sightings (1899–2023) and strandings (1839–2023) from Taranaki. *Data source: New Zealand Marine Mammal Database, Department of Conservation*

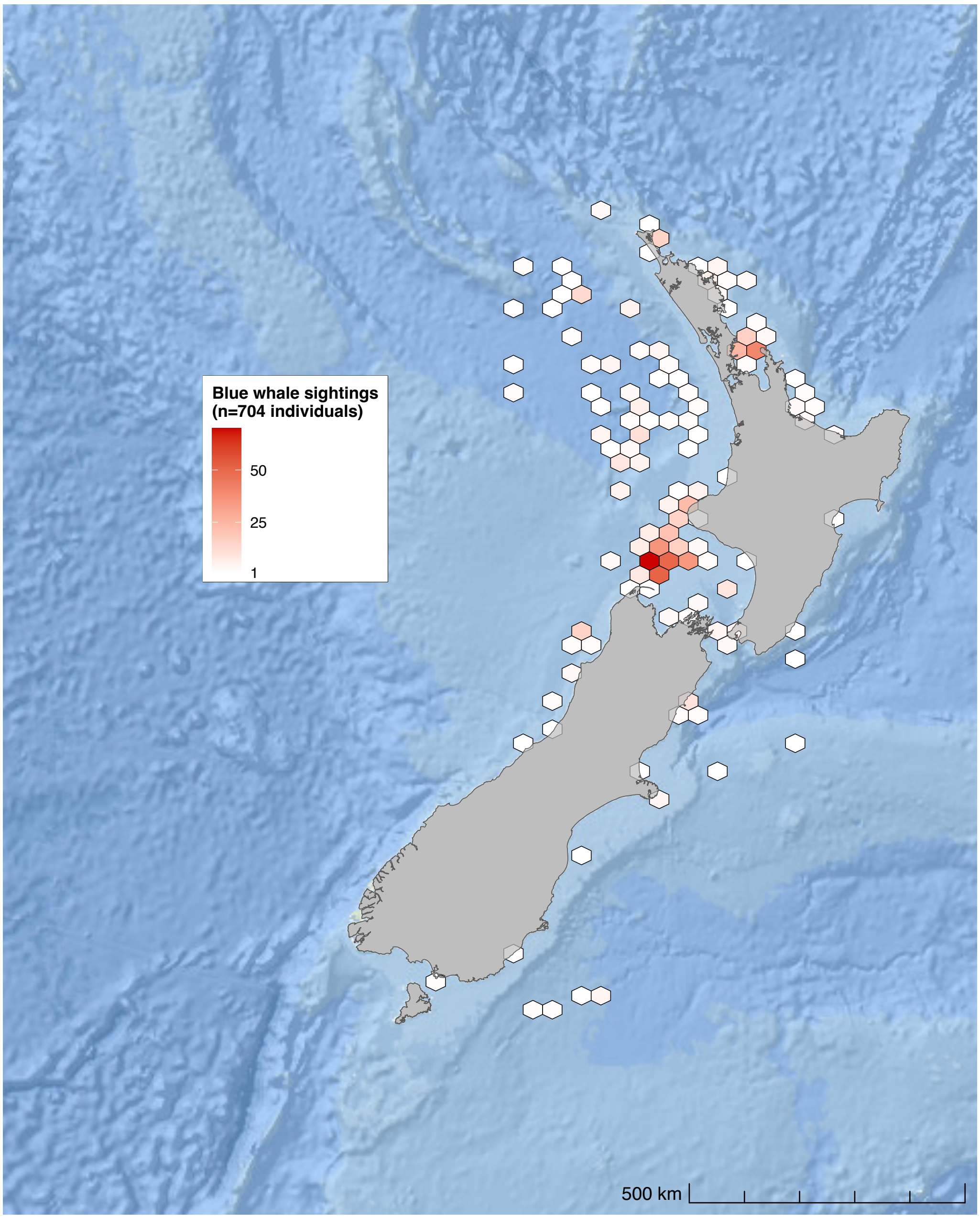

Figure 5. Spatial distribution of blue whale sightings showing where large numbers of pygmy blue whales (*Balaenoptera musculus brevicauda*) have been observed near the South Taranaki Bight. The area of each hexagon is approximately 1,000 km^2. *Data source: New Zealand Marine Mammal Database, Department of Conservation*

6.2.3 Fishes and marine reptiles

The South Taranaki Bight has historically been considered an area with low numbers of protected and threatened fishes and marine reptiles; however, this has been based on little data or information.

Sharks

Reported incidental captures of adult and juvenile great white sharks indicate that they are widely distributed in this area, but the significance of the area for this species is unknown. In the summer of 2025, sightings of great white sharks in harbours along the west cost of the North Island near the South and North Taranaki Bights increased significantly from previous years.

Historic sightings and reported bycatch of basking sharks are concentrated around the Cook Strait and New Plymouth (Francis and Duffy 2002).

Turtles

Leatherback turtles from the Western Pacific population migrate annually from nesting beaches in the Southwest Pacific, and some individuals feed in regions of high ocean productivity around New Zealand. The productivity of the area influenced by the Kahurangi upwelling system suggests that leatherback turtles could be expected to regularly occur there. However, records of the species from this area are limited to a small number of live sightings in the outer Marlborough Sounds and Cook Strait, along with scattered strandings and entanglements throughout the region (Duffy and Brown 1994; DOC, unpublished data).

Leatherback turtles are caught in commercial fisheries every year. Figure 6 shows fisheries bycatch for the species, which indicates its presence along the west coast of the North Island. These turtles are also likely to occur outside areas being fished. DOC is currently leading tagging programmes for leatherback turtles and green turtles (*Chelonia mydas*) to investigate their habitat use in New Zealand waters. Results will help identify important foraging or migration pathways for these species and if there is overlap with areas of interest for wind farm development.

Distribution and climate change

Climate change is causing changes to distribution patterns for many species, including fishes and marine reptiles. Many species are now more abundant in New Zealand waters and are being found in habitats where they were previously not commonly seen. With increased competition for resources (e.g. prey species), range expansion is likely to occur. It is not known how this will affect the distribution of fishes and marine reptiles, which were previously recorded in low numbers in the South Taranaki Bight compared with other areas of New Zealand.

Relying on abundance figures from historical sighting data will likely result in an underestimate of true population numbers, as these data are strongly correlated to changes in sighting effort and do not account for variables such as climate change.

6.2.4 Benthic communities

Figure 7 shows a selection of benthic species and habitat information for the marine area off the Taranaki coast. These records were collected over the last 50 years from marine taxonomic and biodiversity research. Data were collected from incidental species records from trawl surveys, dedicated field surveys and studies of local ecological knowledge.

Benthic invertebrate records sourced from the invertebrate collection held in NIWA's Ocean Biodiversity Information System (OBIS) database (Appendix 5) include:

- marine invertebrates protected under the Wildlife Act 1953: black corals, gorgonian corals, stony corals and hydrocorals
- other benthic invertebrate records for three phyla: Porifera, Cnidaria and Echinodermata.

Other data sources include trawl surveys and the vulnerable marine ecosystems invertebrate dataset compiled by NIWA (Appendix 5).

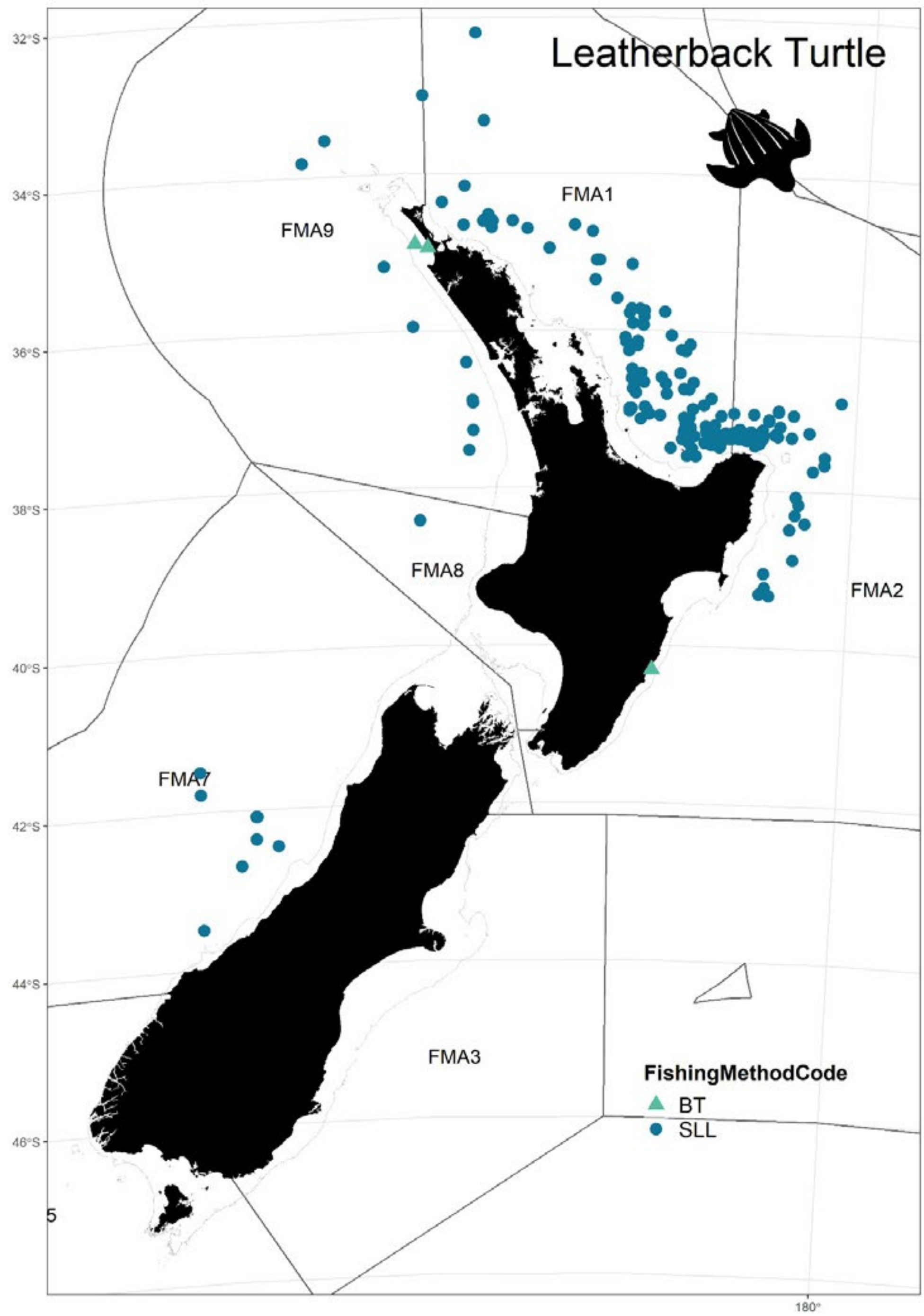

Figure 6. Leatherback turtle (*Dermochelys coriacea*) bycatch in commercial fisheries, 2007–2021. SLL = surface longline, BT = bottom trawl, FMA = Fisheries Management Area. Reproduced from Dunn et al. (2022).

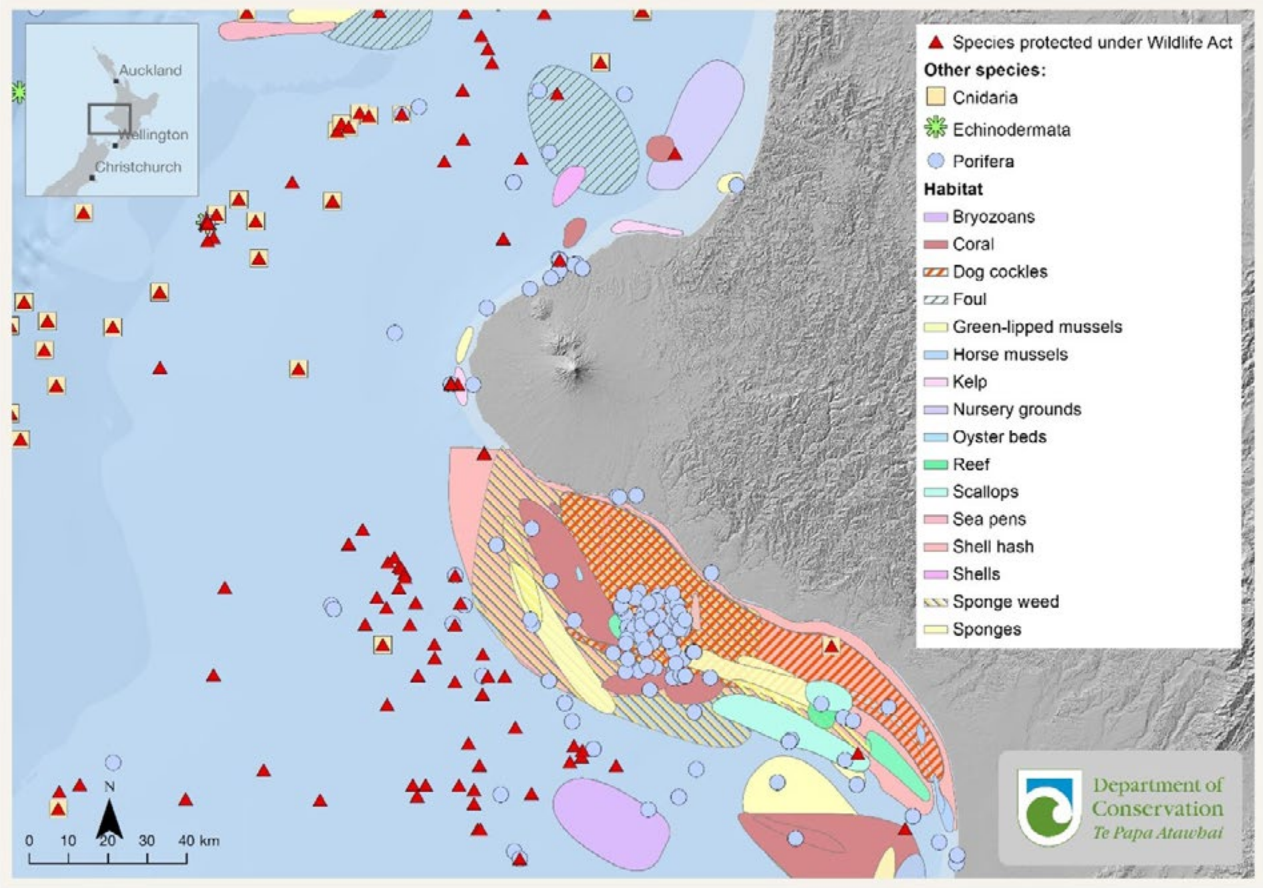

Figure 7. Distribution of a selection of benthic species and habitats in offshore Taranaki based on invertebrate records and polygons from studies of local ecological knowledge.

Many of these data were collected opportunistically or for a specific survey purpose. Consequently, while site-specific records provide an indication of the species that are present at a particular location, they are not useful for estimating abundance and, more importantly, the absence of records at a location does not mean a species is not present – it may simply mean that the sampling was inadequate or not undertaken at all.

It should also be noted that an invertebrate record that is visible as a single data point in Fig. 7 may not be the only record at that location; there could have been tens or hundreds of records there (e.g. if observations were collected during a trawl survey).

The habitats mapped in Fig. 7 are derived from data of biogenic habitats on New Zealand's continental shelf provided by NIWA in a report for the Ministry for Primary Industries (Jones et al. 2016). These data were based on local ecological knowledge from interviews with 50 trawl fishers from around New Zealand to record their knowledge of biogenic habitat. This means that there is inherent uncertainty and bias in the data. The non-random approach of selecting interviewees potentially created a bias in the expert pool interviewed, and the knowledge base for some regions was under-represented (Jones et al. 2016). The report describes the caveats to the data and presents maps and site descriptions as a valuable but, in many places, unverified indication of where biogenic habitats might exist on the New Zealand continental shelf. The data are intended only to inform the design of future field sampling (Jones et al. 2016).

Interest in seabed mining in the South Taranaki Bight area means there is a comparatively high level of available benthic information compared with most other areas around New Zealand. A report on the benthic flora and fauna of the Pātea Banks for the mining company Trans-Tasman Resources Limited recorded 161 species of bryozoans from dredge sampling, with large numbers at some of the deeper sites and relatively high species richness in the 60–80 m depth zone (Beaumont et al. 2013), as well as 47 species of sponges, 12 species of ascidians, and several species of algae and cnidaria. The same study also found that much of the inner- and mid-shelf habitat in the area surveyed was sand, with very few visible epifauna. Comparatively diverse epibenthic assemblages were recorded on small and scattered rock outcrops in the inner shelf area, and infaunal[7] tubeworms were patchily distributed in the mid-shelf zone. The deeper areas offshore were characterised by two types of biogenic habitats (the remains of bivalves and bryozoa, respectively), which supported diverse benthic suspension-feeding communities and provided structural habitat for a range of mobile species.

Morrison et al. (2022) surveyed and characterised subtidal rocky reef habitats on Pātea Bank, South Taranaki. Here, they found multiple subtidal reefs that they considered unique and relatively pristine due to their distance from shore. The reefs supported large areas of biogenic habitat, including *Ecklonia*, *Caulerpa* and mixed macroalgal areas, as well as bryozoans and sponge gardens, and contained diverse fish assemblages, including species that are important to fisheries.

In an investigation of sensitive habitats and threatened species in the Taranaki coastal marine area (out to 12 nautical miles offshore) using existing data, Johnston (2016) found that there were no threatened invertebrate species within this coastal marine area but reported five records within 200 km of the boundary. Schedule 6 of the Exclusive Economic Zone and Continental Shelf (Environmental Effects – Permitted Activities) Regulations 2013 defines 13 'sensitive environments'. Johnston (2016) cross-referenced Taranaki regional taxon lists and the indicator taxa listed in Schedule 6 that make up the sensitive environments. Taxon matches showed that 11 of the 13 sensitive environments occur within, or in the regional vicinity of, the Taranaki coastal marine area, indicating that sensitive marine habitats and threatened taxa likely exist here. However, further physical investigation is required to confirm the records, species densities and spatial extents of these environments (Johnston 2016).

6.3 Waikato

6.3.1 Birds

A total of 37 seabird and shorebird species have been recorded in the Waikato region location of interest for offshore wind farming (Appendix 1). Eight of these species are Threatened and 21 are At Risk under the New Zealand Threat Classification System. These include petrels, shearwaters, albatrosses, penguins, terns, gulls, national and international migrant shorebirds, and resident coastal species such as shags.

There is regular movement of ōi / grey-faced petrels (*Pterodroma gouldi*) along the west coast from colonies in this area (DOC, unpublished tracking data). A grey-faced petrel colony studied by DOC is situated northeast of the location of interest. The birds fly in from the southwest through this location each night during the breeding season.

Australasian gannets from Muriwai (west Auckland) and Kārewa / Gannet Island near Kawhia and a range of other seabirds use the area (DOC, unpublished data). GPS tracking of flesh-footed shearwaters from colonies in the Hauraki Gulf / Tīkapa Moana showed that this area is important as a foraging zone (Crowe 2020). Being off the west coast in exposed seas, there is little recreational boating and correspondingly few sightings in this area, resulting in scarce information on species diversity and abundance.

The location of interest for wind farming in the Waikato is part of the 'West Coast North Island Important Bird Area' in Forest & Bird (2014). Australasian gannets have been observed foraging in this area, and tara iti / New Zealand fairy terns (*Sternula nereis davisae*) have been seen foraging inshore.

7 'Infaunal' describes organisms dwelling within sediments.

6.3.2 Marine mammals

The west coast of the North Island is ecologically significant, with multiple estuarine and river systems (Hunt and Jones 2020). The continental shelf along this coast varies in width from about 10 km in the north to about 100 km around the Taranaki region (Stevens et al. 2019). At least 20 different marine mammal species and subspecies have been recorded in this area (Fig. 8).

Dolphins

This area includes the core habitat of the Māui dolphin. A 2020–2021 survey of Māui dolphins estimated that there were around 54 individuals over 1 year of age (Constantine et al. 2021). This confirms the species' Threatened – Nationally Critical status under the New Zealand Threat Classification System. It is not known whether the population is stable, increasing or decreasing, and this subspecies is vulnerable if there are any deaths due to its very small population size.

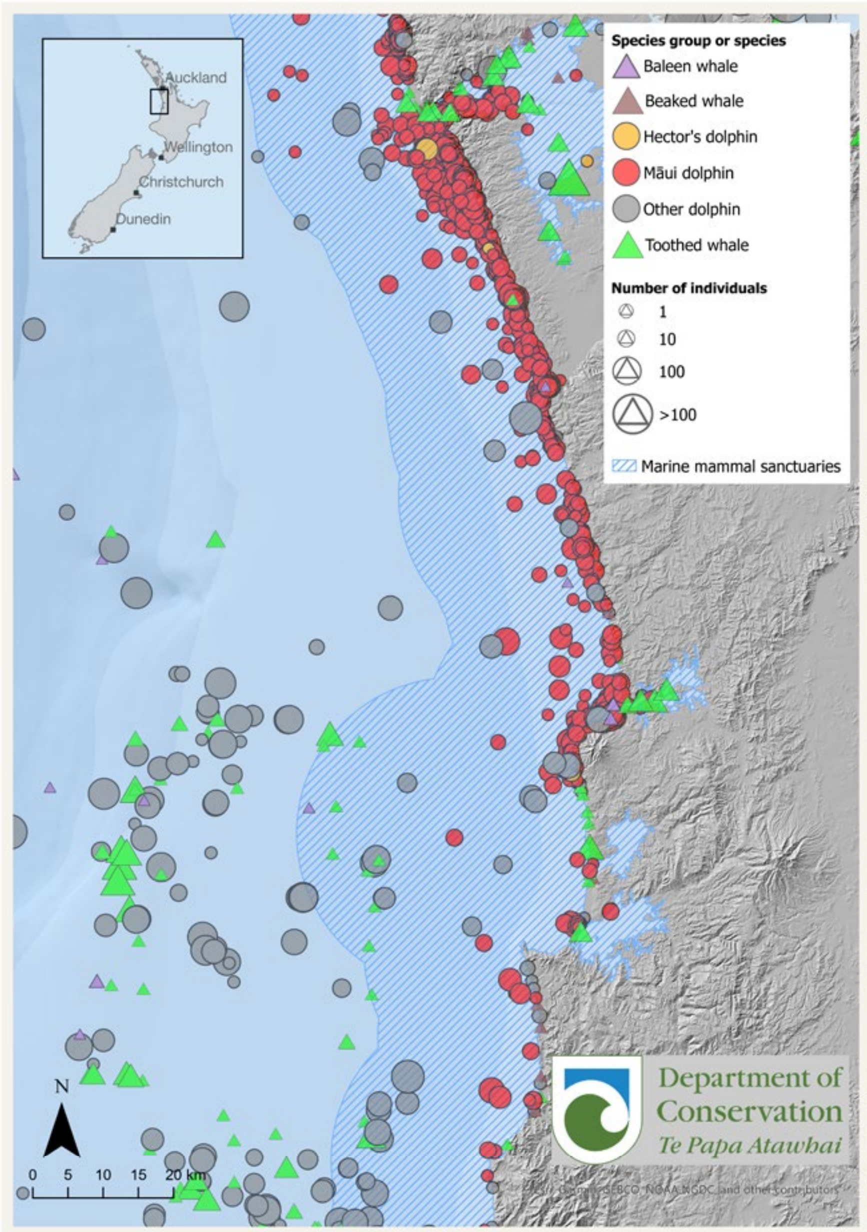

Figure 8. Survey and opportunistic marine mammal sightings (1899–2023) and strandings (1839–2023) from the west coast of Te Ika-a-Māui / the North Island. *Data source: New Zealand Marine Mammal Database, Department of Conservation*

The core range of Māui dolphins is thought to be mainly within 12 nautical miles offshore along approximately 250 km of coastline between Kaipara Harbour and Raglan. Hector's and Māui dolphins have been recorded outside this core range, and impacts on these dolphins are managed under the *Hector's and Māui Dolphin Threat Management Plan* (DOC and Fisheries New Zealand 2020).

The West Coast North Island Marine Mammal Sanctuary that was established in 2008 under the Marine Mammals Protection Act 1978 as part of the threat management plan for Hector's and Māui dolphins was expanded in 2020 following the review of the plan (Fig. 1). The sanctuary is intended to help manage the human-induced risks to these dolphins, complementing the management of fisheries risks under the Fisheries Act 1996. The sanctuary places a ban on seismic surveying and seabed mining with exemptions to help manage human-induced noise and the effects of sedimentation plumes. These bans do not include the harbours on the west coast of the North Island.

Māui and Hector's dolphins prefer turbid waters, and their primary habitat is within river and estuary outflows. The winter distribution of the dolphins is not well understood and may extend further offshore. The dolphins' preferred prey are small demersal and benthic fishes,[8] particularly āhuru (*Auchenoceros punctatus*) and pātiki rore / New Zealand sole (*Peltorhamphus novaezeelandiae*) (Roberts et al. 2019).

This coast, including the harbours, is also used by common dolphins, bottlenose dolphins and orca. Common dolphins in the northern Taranaki region prey on open ocean schooling fishes such as jack mackerel, an important catch in the region, and use the nearshore coastal waters.

Whales

The offshore waters in this region include a range of deep-water species (e.g. sperm whales, pygmy sperm whales [*Kogia breviceps*] and a range of beaked whales) that may spend some time in coastal waters periodically. Migrating humpback whales have also been recorded, along with at least four other baleen whale species. The Tasman Sea is thought to be a globally important region for pygmy right whales, and live strandings of this species (including neonates) have occurred in the area (Kemper 2002).

6.3.3 Fishes and marine reptiles

Reported fisheries interactions and satellite tagging have shown that adult and juvenile great white sharks are present throughout the Waikato offshore area at all times of the year (Spaet et al. 2020; Finucci et al. 2022; C Duffy, unpublished data). Several juvenile great white sharks of 2.1–2.8 m total length were satellite tagged in Manukau and Kaipara Harbours and were tracked south over the Waikato and North Taranaki shelf. They tended to spend most of their time at 50–70 m depth, moving frequently between the bottom and surface, but they also spent time swimming along the shelf break and upper slope, sometimes diving as deep as 600 m (C Duffy, unpublished data).

Basking shark, smalltooth sand tiger (*Odontaspis ferox*), spinetail devil ray (*Mobula mobular*) and leatherback turtles have all been reported in or adjacent to the Waikato offshore area. However, records of these species from the region are sparse and its significance to them as habitat is unknown (Francis and Duffy 2002; Finucci et al. 2022; Dunn et al. 2022, 2023). Leatherback turtles have been caught as bycatch in surface longline fishing activities beyond the shelf break (Fig. 6). However, how frequently this species occurs over the mid- to outer shelf is not known because of the lack of fishery-independent surveys of the area (Dunn et al. 2022, 2023).

8 Demersal fishes live and feed in the waters near the bottom of a body of water; benthic fishes include those species living on or in the ocean floor.

7. Data gaps and priority research needs

The previous sections highlight the challenges of adequately assessing the biological impacts of offshore wind farms in New Zealand at present, which include the following:

- There are gaps in our knowledge about the species and ecosystems in the three locations of interest due to the availability of, and biases in, the data.
- There are fundamental differences in species and ecosystems between New Zealand and other countries, making it difficult for data from elsewhere to be used in a New Zealand context.
- There are gaps in our knowledge about how species and ecosystems would be impacted by the known threats introduced by wind farming.
- Although there are existing Northern Hemisphere assessments of the impacts of wind farming, their use is inappropriate without critical evaluation of their relevance in the New Zealand biological context.

In this section, we identify the research required to more fully ascertain the impacts of offshore wind farming on species and ecosystems in New Zealand. For a more extensive (but non-exhaustive) list of the potential impacts of offshore wind farming, see Appendix 2.

7.1 Species and ecosystem impacts

Overall, knowledge gaps about the presence of species still need to be addressed across spatial and temporal scales for most species and species groups. There is a fundamental need to understand how and when locations of interest for offshore wind farming are used by individuals and populations of each species, including any behaviours that may increase the risk to species.

For benthic environments, a comprehensive environmental impact assessment framework is needed, as well as research on developing monitoring programmes of relevance to the New Zealand context.

In this section, we summarise current data gaps and the future research needed for marine species groups and benthic environments.

7.1.1 Seabirds

There is currently a lack of understanding and data about how seabirds use space over time. As a priority, tracking is needed for a wider range of seabirds and shorebirds to understand the risks and to improve our understanding of how birds at sea use their habitats seasonally.

Obtaining information about species that breed close to the locations of interest for offshore wind farm development is a priority, followed by information on threatened species at distant colonies that are known to pass through these areas.

High-accuracy GPS tags are needed to define how seabirds use habitats in the locations of interest. Tags with high sampling rates (minutes or seconds) can demonstrate how seabirds use areas for foraging. This includes data on:

- time spent in continuous flight
- sinuosity (moving around in circles or from side to side rather than in straight lines)
- the frequency of landings and take-offs to define foraging activity
- time spent resting for short periods or roosting on the sea surface for longer periods (e.g. overnight).

This information can be overlaid on maps showing bathymetric features and currents to help explain the regular use of certain marine areas and inform the risks of exposure to turbines.

To determine annual migration paths used by species, other types of tags with lower position accuracy / sampling rates can provide sufficient detail to see whether seabirds are likely to go through a proposed area.

GPS technology does provide some information on altitude, but it is not very accurate. Getting accurate positions is most useful once firm plans for a wind farm are in place and the location of planned turbines has been mapped. Then, a large sample of birds from potentially impacted species using the area can be assessed.

Tags with barometric pressure recorders are needed for more accurate assessments of seabird flight height. Sampling methods like accelerometers can accurately define actual movement behaviour to see whether birds can stall in flight, turn or veer quickly away from an object directly ahead. Seawater contact sensors on tags can provide precise daily information on time spent resting on the sea surface versus time in flight.

GPS tags and sea-surface sensors also provide important information on how birds behave at night and whether they roost on the sea, land at night or continue to actively forage. This will inform the likelihood of collision risk when light levels are low and visibility may be at its poorest (e.g. on dark nights with no moonlight, in fog or during rainfall).

7.1.2 Marine mammals

A lack of data is a key issue preventing assessment of the risk to marine mammal species from wind farm development in New Zealand. Many species are listed as Data Deficient under the New Zealand Threat Classification System because there are insufficient data to determine their conservation status (i.e. how vulnerable they are to becoming extinct). For example, 70% of the baleen whales that occur in New Zealand waters are considered Data Deficient at a national scale, including the Red-listed Critically Endangered Antarctic blue whale (*Balaenoptera musculus intermedia*) (Baker et al. 2019; Lundquist et al. 2025). Similarly, most pelagic deep-water toothed whale species, such as offshore dolphins and beaked whales, are also Data Deficient in a New Zealand context.

The lack of information about the ecology, movements, abundances and habitat preferences of these species means that it is not possible to confidently predict the effects of any new human-induced activity. Indeed, behavioural data are scant even for animals that have sufficient information to be assessed under the New Zealand Threat Classification System.

To assess the impacts of offshore wind farms on marine mammal species, including those currently classified as Data Deficient, it will be important to collect key biological and behavioural information such as their:

- population size and structure
- distribution over time and by location at different scales
- seasonal sensitivities (e.g. spawning/calving, nursery grounds, migratory routes, resting areas, feeding areas)
- hearing sensitivities.

Aerial- and boat-based surveys may provide useful data. However, many species have cryptic behaviours that make them difficult to detect. Given the paucity of information relating to the underwater noise environment – and the temporal and spatial distributions of marine mammals in New Zealand – a comprehensive programme of biological (possibly including genetic approaches) and acoustic baseline monitoring is likely needed to inform a detailed assessment of the effects of subsequent wind farming activities.

7.1.3 Protected fishes and marine reptiles

To understand the impacts of wind farm activity on the protected species of fishes and marine reptiles in the locations of interest, information is required on:

- species distribution patterns
- migration pathways
- hearing thresholds
- sensitivity to electromagnetic fields
- impacts of electromagnetic fields, including adaptive responses resulting in habitat exclusion or avoidance behaviours
- habitats of significance, including foraging and breeding areas and potential population impacts due to exclusion zones.

The main priority should be to conduct studies on the biology of these species to fill knowledge gaps around their hearing thresholds and sensitivity to electromagnetic fields.

7.1.4 The benthic environment

Offshore wind developments will have a range of impacts on the benthic environment and water column during the construction, operation and decommissioning phases. See Appendix 2 for a list of some of the potential impacts.

Little of the seafloor environment around New Zealand has been surveyed, and where environmental information is available, it is highly variable in its nature, quality and extent. In this context of data deficiency, significant investment in comprehensive site assessments is needed. These would involve characterising the biotic and abiotic[9] environments in the area through in situ surveys using a variety of research methods and instrumentation and through modelling.

There will also need to be research on appropriate monitoring measures, and the development of monitoring programmes relevant for the New Zealand marine environment and context. Monitoring programmes should be designed to:

- measure the impacts of wind farming
- trigger adaptive management of wind farming activities to prevent any unacceptable impacts on benthic habitats, biological productivity and functioning
- ensure that any loss or disturbance is no greater than predicted and approved
- enable the verification of impact predictions (e.g. physical processes such as sediment dynamics)
- inform the need for additional or different management (DCCEEW 2023).

7.2 Cumulative impacts

The multiple stressors that could be introduced by wind farming activities may affect wildlife and environmental processes – and stressors from individual human-induced activities or processes, and their products or by-products, may add up to produce population-level consequences.

With respect to noise, there is increasing awareness that not only do the effects of individual projects on nearby marine fauna need to be managed, but the cumulative effects of multiple projects near each other will require consideration of the combined impact for effective mitigation. For example, in the Netherlands, the *Framework for assessing ecological and cumulative effects* (Heinis et al. 2019) considers sound levels and underwater sound propagation, as well as

9 'Biotic' refers to organic and living parts of an ecosystem; 'abiotic' refers to the non-living parts of an ecosystem, such as inorganic matter like rock or sediment and environmental conditions like temperature and climate.

the number of animals likely to be disturbed, the length of any disturbance and the potential population-level consequences of the disturbance.

To understand the potential cumulative impacts on populations of marine fauna, the potential impacts of individual projects need to be considered alongside existing pressures (e.g. fisheries impacts, shipping noise, vessel collision), as well as the shift in those pressures that may result from the siting of the proposed wind farming activities.

7.3 Knowledge gaps

This section summarises information gaps and future research needs to determine the impacts of various processes during the development, operation and eventual decommissioning of wind farms on marine species and benthic environments.

7.3.1 Physical impacts of turbine blades

Specific research is needed to address some of the key questions around collisions for flying birds. Developing rapid methods to measure the way different species use space when foraging or transiting through areas potentially occupied by offshore wind farms is a priority.

Unlike many Northern Hemisphere seabirds, New Zealand seabirds do not always fly low above the sea. While flight heights for many New Zealand species are unknown, many species of petrels, shearwaters, albatrosses and gannets can soar up to 100 m above the sea surface in the open ocean. At these flight heights, there is a likelihood of direct overlap with the sweep diameter of large, modern, marine turbine blades. Blade-tip speeds are expected to be high and are proportional to the length of the blade. This means that birds may encounter blade tips spinning at potentially more than 200 km/hour at the predicted 7 rotations/minute.

At such speeds, it is expected that contact with turbine blades will be a common and lethal event. Quantifying the impact rates for species where the consequences will negatively impact their population is a priority. Overseas studies show that spatial planning and avoiding areas of high overlap with wildlife is the best mitigation measure available to reduce impacts on susceptible species.

Large turbines at sea that are situated far offshore will present an especially significant risk to seabirds at night or when visibility is reduced (e.g. on dark nights with no moon above the horizon, or in foggy or rainy conditions). Nocturnally active birds travel at speeds of 60–100 km/hour and can be expected to be present and active in wind farm areas after dark and before dawn. Current observer-based methods only assess bird presence during daylight hours and will under-report these movements.

Developing methods to quantify actual bird strikes at sea during the day and night is a priority. Attempting to collect carcasses after the event will be of limited use, as fish and other sea life will consume the corpses quite quickly, making any samples collected statistically invalid. Some may wash up on nearby beaches, but most will be consumed by scavengers or lost at sea.

7.3.2 Impacts of lighting on birds

Artificial light at night from vessels may attract and disorientate fauna such as birds, marine turtles, fish and other species in the open sea. Vessel lighting will be a potential concern during site surveys, turbine installation, maintenance and decommissioning stages for offshore wind farms. Therefore, suitable and internationally recognised lighting mitigation standards will need to be applied during all these stages. Standards can be adopted that are like those agreed for use on commercial fisheries vessels. These are New Zealand guidelines that were presented at the United Nations Convention on Migratory Species Scientific Council (New Zealand Government 2023).

There is a knowledge gap around the potential impacts of lighting on wind farm structures once farms are operational, particularly in a New Zealand context, where there is a significant number of nocturnally foraging seabirds. Turbines will need lighting for safety purposes. However, the position and number of lights on each structure, their type and colour spectrum, and their pulse rate frequency will all need to be assessed to determine whether they provide attraction or avoidance stimuli for nocturnally active seabirds.

7.3.3 Vessel collision and entanglement

Species that spend significant time near the surface, such as cetaceans, diving seabirds (e.g. penguins), marine reptiles (e.g. turtles) and fishes (e.g. manta rays and basking sharks), are vulnerable to collision with vessels. This is particularly relevant where vessel movements overlap with high-use areas for species, such as areas used for foraging, resting, mating, socialising and nursing, or migration routes. Such collisions can result in injuries that may cause death (Moore et al. 2013), with potential negative consequences for populations (Schoeman et al. 2020).

Many vessel types will be used over the lifespan of an offshore wind farm, and the increased presence of vessels will introduce additional collision risks for marine animals. More research is required to understand the effects of vessel size, vessel speed and hull type on species-specific impacts.

Collision events may be detected from strandings or at-sea observations of dead or injured large marine mammals, but such observations would be an under-representation of the number of affected animals. Determining the cause of death, particularly for large whales, is difficult and costly (Moore et al. 2013). Conversely, many smaller species may not be detected, as carcasses may be scavenged before they can be observed (e.g. through washing ashore).

Understanding the habitat use of species within the locations of interest will help scientists devise mitigation measures to minimise or avoid collision risk. Such mitigation may include areas of avoidance, reduced vessel speeds, and real-time vessel-based reporting using visual observers and passive acoustic monitoring.

Entanglement of large marine species has been raised as a potential risk through direct interaction with the mooring lines of floating wind farms or through secondary entanglement with debris that has become entrapped in mooring lines (Wawrzynkowski et al. 2025). If mooring lines are held under tension, the entanglement risk will likely be low for large marine mammals. However, lines may still represent a collision risk, particularly during extreme weather conditions, through reduced visibility (e.g. from increased sediment suspension) or the impacts of human-induced noise (e.g. from vessels), which could disrupt echolocation or mask sounds, potentially impairing an animal's ability to detect such structures. Large numbers of mooring lines may also create an exclusion zone, leading to increased energy expenditure, particularly for migratory species.

Secondary entanglement, such as in debris that has become entangled in mooring lines, may be more problematic for smaller animals. The most likely mitigation for this is monitoring for and cleaning up debris within sites.

7.3.4 Underwater noise

There are no existing offshore construction industries in New Zealand that produce high-level, long-term underwater noise emissions comparable to the construction of an offshore wind farm. Noise will be produced to varying degrees during all phases of offshore wind farm development, including site assessment, construction, operation and maintenance, and decommissioning.

The impacts of underwater noise are further described in Appendix 3.

Noise can have notable effects on marine mammals and diving seabirds and may impact other vertebrates (fishes and reptiles) and invertebrates.

Natural and human-induced noise pollution affects marine animals in many ways, including through:

- auditory injury, including temporary and permanent damage to ears and hearing, known as temporary and permanent threshold shift
- behavioural responses, including stress, fright–flight and avoidance responses
- changes in other behavioural responses, such as foraging
- changes in reproductive success
- changes in vocal communication
- masking, meaning interference with the ability to hear predators and other important sounds
- potential changes in populations (Ortega 2012).

To assess the impacts of underwater noise on threatened and at-risk species during the construction and operation of any offshore wind farm, we need to understand the overlap of potential noise with species of concern. This requires an understanding of which species are known to be, or may potentially be, in the area, when they are there and what behaviours they carry out. This information can be used to assess the effects on each species or species group. Species-group information is required to identify the relevant noise thresholds for acoustic modelling. These issues are discussed in more detail in Appendix 3.

While effective mitigation options have been developed to minimise underwater noise, these have technical limitations that currently cannot be surmounted. Developers will need to investigate all means to reduce sound emissions, including considering the best-available technology and the implementation of best-practice mitigation.

Even with the best of intentions, it may not always be possible to minimise impacts to an acceptable level, regardless of the technical and management measures applied. This is partly due to the limitations of mitigation methods but also because some areas may contain particularly sensitive species.

7.3.5 Electromagnetic field impacts

During the operation of offshore wind farms, generated electricity is sent through inter-array cables that connect individual wind turbines to offshore transformer substations. Export cables transmit this electricity to substations onshore and to the electrical grid. These electrical cables produce electromagnetic fields, as the flow of electricity through them creates a magnetic field (B-field) that, in turn, induces an electric field (IE-field). Both these field types can interfere with the natural background magnetic field.

Studies suggest that electromagnetic fields from submarine cables carrying electricity may interfere with marine species that rely on natural geomagnetic fields for navigation and orientation, foraging behaviour, and predator-prey interaction behaviours (Riefolo et al. 2016; Rezaei et al. 2023).

Key groups that are likely to be directly impacted include:

- fishes that move from fresh water to salt water (diadromous fishes)
- benthic sharks, rays and skates
- sea turtles
- some invertebrate species that live in sediments where cables are laid or buried.

Secondary effects may include changes to the foraging behaviours of predator species that depend on the distribution of directly affected prey species.

As this is an emerging identified risk to these organisms, more information is needed to understand potential impacts. It is assumed that the burial of cables will mitigate most impacts, but this needs further investigation.

8. Conclusions

This report is a first attempt to describe the numbers of species in and diversity of ecological communities that could be impacted within three locations of interest proposed for offshore wind farming in New Zealand (Appendix 1).

The assessments of risks to individual species are limited in this report due to limitations in the available data, including the bias of incomplete coverage and a bias towards shore observations. Additionally, offshore surveys, where they exist, often consist of single isolated trips without seasonal coverage, or are not targeted, and frequently lack the expert tools and observers required to make suitable assessment. These biases mean there is a risk of overlooking how any given site is used by an individual species.

Many of the species listed in Tables 2 and 3 are classified as Data Deficient under the New Zealand Threat Classification System, meaning insufficient data are available to assess their vulnerability to becoming extinct. For some species, this lack of data is a major impediment to assessing the impacts of proposed wind farm developments.

Advancing our knowledge and providing information that is consistent and evidence-based requires an assessment at the national scale. International examples provide a useful starting point, but the diversity of species in the New Zealand region requires a comprehensive review. To be successful, this will require funding for baseline species distribution surveys.

The combined effect of multiple stressors will potentially impact wildlife and environmental processes beyond the footprint of a project. Stressors from individual human-induced activities or processes, and their products or by-products, may add up to population-level consequences.

The highly mobile behaviours of marine mammals, seabirds and marine turtles mean that the impacts of offshore wind energy generation will need to be assessed at a wider scale than the footprints of individual sites or projects. Relying on abundance figures from historical sighting data will likely result in an inaccurate estimate of true population numbers, as these data are strongly correlated to changes in sighting effort and do not account for variables such as climate change, which will likely drive changes in distribution patterns. Adequate baseline surveys will be needed to support site-based comprehensive environmental assessments. These should be completed before wind farm development proceeds at a site. It will also be essential to undertake comprehensive site-specific surveys to identify the benthic habitats and species present to assess potential impacts and the suitability of the site.

Offshore developments should avoid sensitive benthic habitats (notably biogenic habitats, meaning habitats created by plants and animals) and areas containing protected species that are vulnerable to disturbance (e.g. cold-water corals).

Managing the effects of noise beyond individual projects is required to ensure that the cumulative effects of multiple projects occurring near each other are managed appropriately.

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Appendix 1. Maps showing locations of interest to developers for wind farming

The areas of interest to developers for wind farming published in *Annex 1: Location of Interest maps* in MBIE (2022) were used as a baseline for this report and are shown below.

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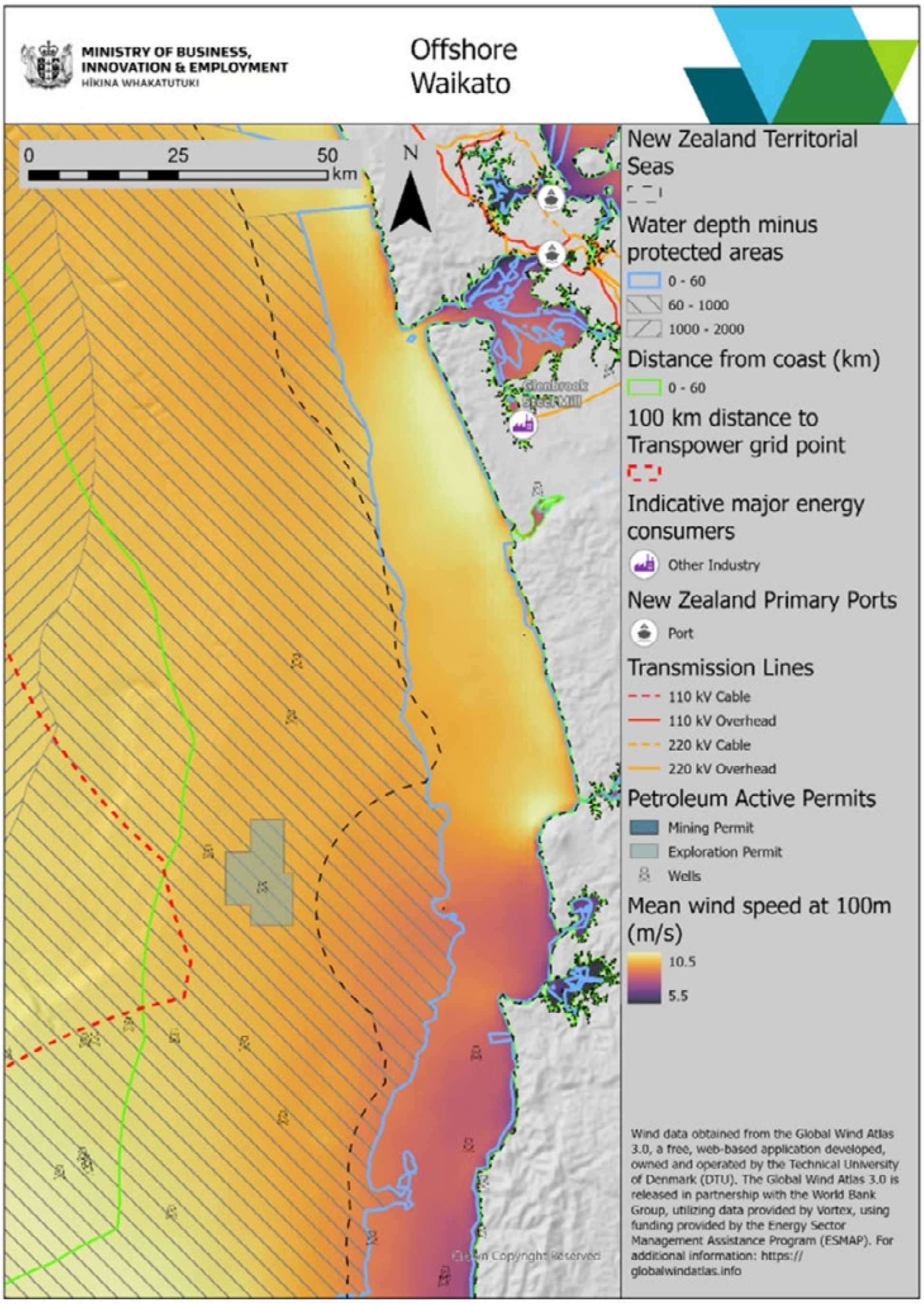
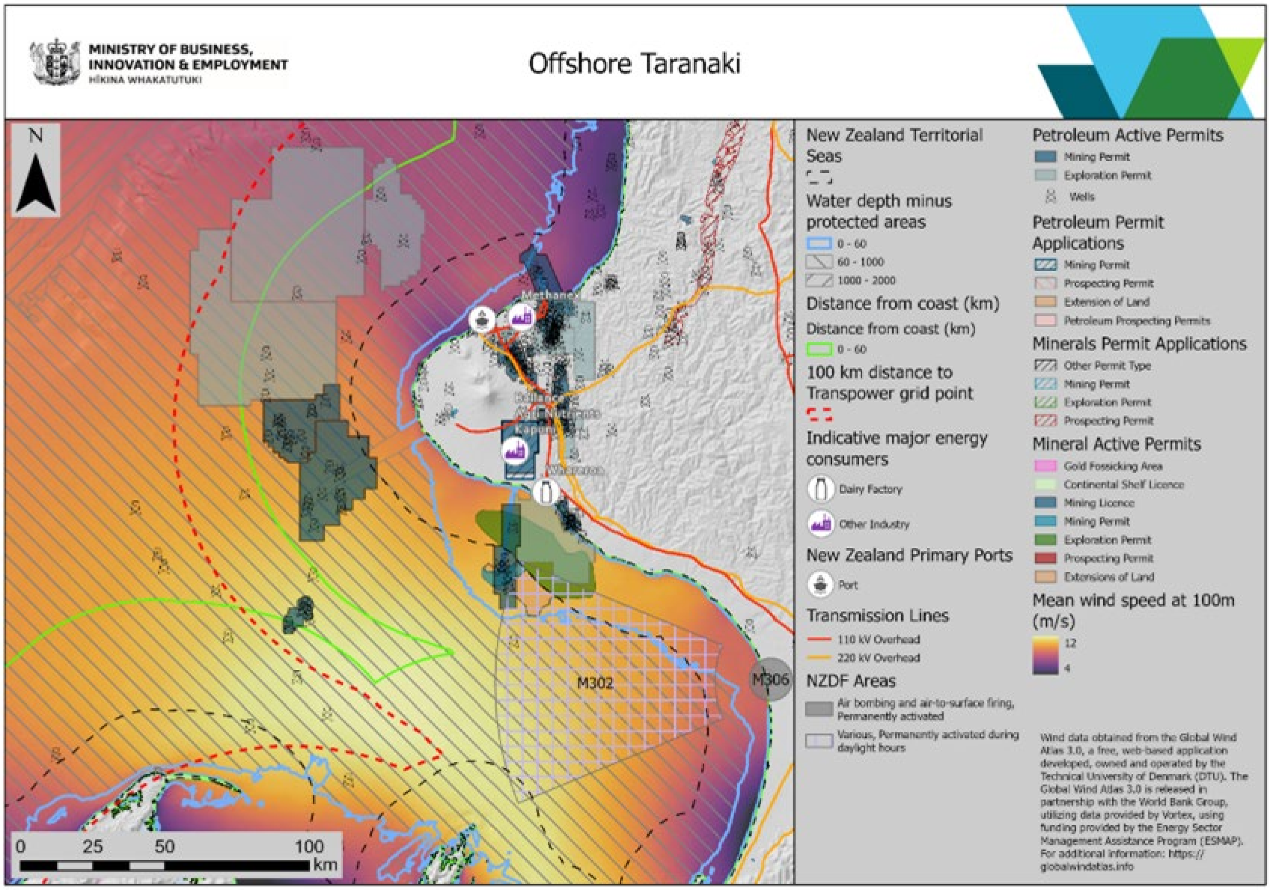
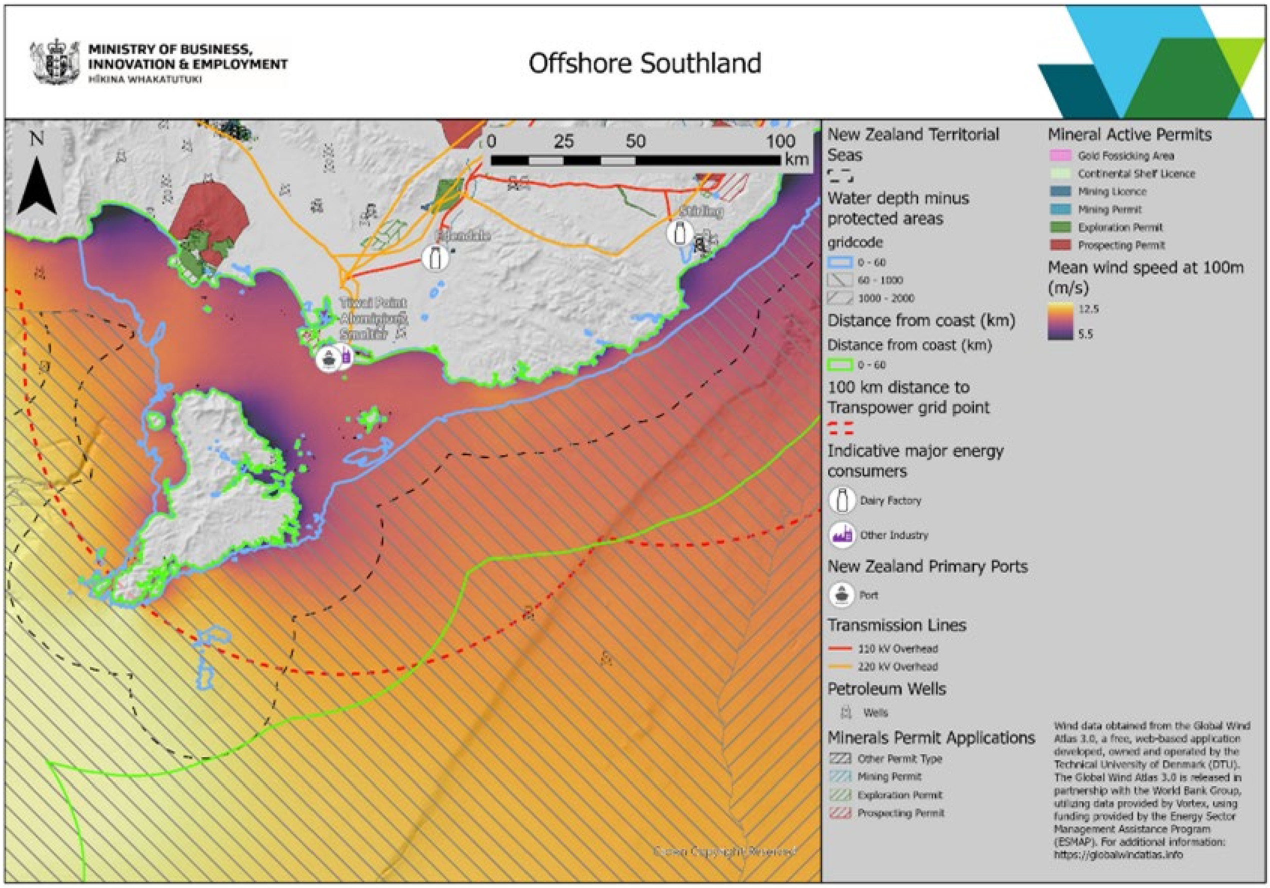



MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI
Offshore Taranaki
N
Methanex
Ballance Agri-Nutrients
Kapuni
Whareroa
M302
M306
0 25 50 100 km
New Zealand Territorial Seas
Water depth minus protected areas
0 - 60
60 - 1000
1000 - 2000
Distance from coast (km)
Distance from coast (km)
0 - 60
100 km distance to Transpower grid point
Indicative major energy consumers
Dairy Factory
Other Industry
New Zealand Primary Ports
Port
Transmission Lines
110 kV Overhead
220 kV Overhead
NZDF Areas
Air bombing and air-to-surface firing, Permanently activated
Various, Permanently activated during daylight hours
Petroleum Active Permits
Mining Permit
Exploration Permit
Wells
Petroleum Permit Applications
Mining Permit
Prospecting Permit
Extension of Land
Petroleum Prospecting Permits
Minerals Permit Applications
Other Permit Type
Mining Permit
Exploration Permit
Prospecting Permit
Mineral Active Permits
Gold Fossicking Area
Continental Shelf Licence
Mining Licence
Mining Permit
Exploration Permit
Prospecting Permit
Extensions of Land
Mean wind speed at 100m (m/s)
12
4
Wind data obtained from the Global Wind Atlas 3.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info


MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI
Offshore Southland
N
0 25 50 100 km
Edendale
Stirling
Tiwai Point Aluminium Smelter
New Zealand Territorial Seas
Water depth minus protected areas
gridcode
0 - 60
60 - 1000
1000 - 2000
Distance from coast (km)
Distance from coast (km)
0 - 60
100 km distance to Transpower grid point
Indicative major energy consumers
Dairy Factory
Other Industry
New Zealand Primary Ports
Port
Transmission Lines
110 kV Overhead
220 kV Overhead
Petroleum Wells
Wells
Minerals Permit Applications
Other Permit Type
Mining Permit
Exploration Permit
Prospecting Permit
Mineral Active Permits
Gold Fossicking Area
Continental Shelf Licence
Mining Licence
Mining Permit
Exploration Permit
Prospecting Permit
Mean wind speed at 100m (m/s)
12.5
5.5
Wind data obtained from the Global Wind Atlas 3.0, a free, web-based application developed, owned and operated by the Technical University of Denmark (DTU). The Global Wind Atlas 3.0 is released in partnership with the World Bank Group, utilizing data provided by Vortex, using funding provided by the Energy Sector Management Assistance Program (ESMAP). For additional information: https://globalwindatlas.info

Appendix 2. Potential impacts of offshore wind farms

A list of potential environmental impacts arising from the construction, use and decommissioning of offshore wind farms is presented below. The certainty about potential impacts varies across species, many of which are classified as Data Deficient under the New Zealand Threat Classification System.

There is a lack of key information on the species-specific seasonal presence and behavioural-ecological context to inform risk assessments. This is particularly important because Aotearoa New Zealand has a very different and more diverse marine fauna than areas such as the North Sea, where most impact studies about offshore wind farming have been undertaken to date. New Zealand is a world hotspot for seabirds and marine mammals.

The non-exhaustive list of potential environmental impacts provided below will be influenced by the scale, intensity and duration of impacts and their environmental context.

Standardisation in data collection and data sharing is particularly important, as interest in areas will overlap. Potential impacts will be present over different scales that are often greater than the area of the footprint of an individual wind farm project.

The likely impacts on the benthic environment and water column include:

- direct effects, including impacts resulting from piling, foundation drilling and cable laying (e.g. direct habitat loss, habitat disturbance, habitat modification caused by scour/abrasion, physical occupancy)
- changes to the physical environment (habitat changes from hard material in soft sediment areas)
- sedimentation effects during construction – localised and from sediment plumes
- near- and far-field impacts resulting from alterations in the wind, current and wave climate changing current velocities (e.g. retardation in flow causing deposition of finer sediments, wind shadowing downstream of structures, dampening of waves inshore of structures)
- impacts from antifouling usage on permanent and temporary structures
- other pollution and water quality effects.

The likely impacts at the ecosystem level include:

- habitat exclusion for fish, marine mammals, seabirds and other vertebrates (e.g. turtles), and invertebrates
- artificial reef or fish attraction device type effects resulting from hard structures becoming available
- the risks of introducing invasive marine species through increased traffic, such as during the towing of foundations from port to site
- the risk of oil spills from increased vessel traffic
- the risk of chemical spills (e.g. hydraulic fluids)
- the physical presence of offshore wind farms altering the behaviour of marine mammals, fish and seabirds through attraction or avoidance, and the indirect ecosystem effects that may result
- electromagnetic fields interfering with the navigation and foraging of animals such as sharks, other fish and turtles
- the effects arising from cable heat.

The likely impacts for seabirds include:

- bird strike from collision with rotating turbine blades and other structures
- the impacts of artificial lighting on birds
- the displacement of birds from critical migratory pathways and habitats
- underwater noise impacts on diving seabirds (also see Appendix 3).

The likely impacts for marine mammals include:

- the effects of underwater noise at different stages of development (also see Appendix 3), including the:
  - pre-construction survey and geophysical survey stages: shallow seismic, multibeam, sub-bottom profilers and other geophysical survey methods; geotechnical surveys involving drilling or core sampling; and vessel noise
  - construction stage: noise from impact pile driving (impulsive sound sources), vessel noise (including dynamic positioning thrusters), foundation drilling, and dredging or trenching and cable laying; construction in coastal areas associated with port developments may also cause noise that will require evaluation
  - operational stage: propagated noise from turbine vibration (cumulative and continuous over the lifetime of the facility) for many turbines, and noise from maintenance vessels
  - decommissioning stage: noise from mechanical cutting and from vessels
- collision risk (with increased vessel traffic and potentially with floating wind farm moorings)
- entanglement risk for floating foundations
- displacement from migratory pathways and habitats.

Impacts on other fauna include:

- noise disturbance for some fishes, turtles and invertebrates (e.g. through particle motion) (also see Appendix 3)
- displacement through changes to habitat and food webs.

Other impacts include:

- the cumulative impacts of both multiple projects and the intersection of other existing impacts on species and ecosystems
- the onshore impact where the cabling comes ashore and through linkage to the national grid (e.g. additional power lines).

Appendix 3. Impacts of underwater noise

Sound is the most efficient means of communication under water and is the primary means of communicating and assessing the environment for marine mammals, most other aquatic vertebrates and many aquatic invertebrates. Therefore, anything that interferes with the ability of animals to detect sounds has the potential to significantly impair the survival of individuals and populations. Noise (unwanted sound) produced by human-induced sources may also elicit behavioural responses and/or physiological effects that interfere with biological activities, such as feeding or spawning.

Marine mammals have been more extensively studied than other marine fauna with respect to the sensitivity of their hearing and the impacts from noise (Williams et al. 2015). Sound is particularly significant to marine mammals (whales, dolphins, seals, sea lions), as they use sound both actively and passively to communicate and sense their environment. The frequencies used differ between species, ranging from a few hertz to more than 100 kilohertz (Erbe et al. 2018). The impacts of noise are particularly relevant to marine mammals which, except for seals, spend all their lives in water and depend heavily on sound and their sense of hearing to navigate, locate prey, avoid predators and communicate in the ocean environment to fulfil important life functions. Underwater noise can interfere with these key life functions by impairing their hearing sensitivity, masking acoustic signals, eliciting behavioural responses or causing physiological stress.

Other species groups that will be impacted by underwater noise in Aotearoa New Zealand include a range of seabird species that spend time foraging under water, particularly penguins (which spend the greatest amount of time under water), sea turtles and sea snakes / kraits, as well as potentially some fishes and invertebrates.

The potential effects of noise change with distance from the source, with the received level of noise and its impact on individual animals generally decreasing with increasing distance. The zones surrounding the noise source progress from permanent reductions in the ability to hear sound (permanent threshold shift [PTS]), through to temporary impairment (temporary threshold shift [TTS]), through to behavioural responses and, lastly, auditory masking (these last two zones can be interchangeable).

At the lowest noise levels, the onset of behavioural effects can occur when noise is detected by an animal. A noise becomes detectable when the human-induced noise level exceeds both the ambient natural sound level and the animal's hearing threshold. Behavioural responses range from benign, such as turning the head towards the direction of a noise source, to more extreme, like fleeing or ceasing an important activity (e.g. foraging or breeding) that may have significant biological consequences.

A range of New Zealand seabird species spend time foraging under water, including diving petrels, tākapu / Australasian gannets (*Morus serrator*) and shags. Penguins spend the most time under water, and 19 species or subspecies of penguins are found here. Approximately a third of penguin species are occasional vagrants from Antarctica.

Birds that engage in underwater pursuits and deep diving have adaptations of the middle ear to facilitate hearing under water (Zeyl et al. 2022). The onset thresholds for auditory injury for penguins and other diving seabirds is unknown. There is evidence, however, that African penguins (*Spheniscus demersus*) avoided key foraging areas in response to a large-scale seismic survey (Pichegru et al. 2017). Methods to understand and manage the impacts of noise are needed.

Marine reptiles such as turtles, sea snakes and kraits may also be impacted by noise. An assessment of hearing sensitivity thresholds has been completed for turtles (Finneran et al. 2017). While less is known about the effects of noise on sea snakes and kraits, they are likely sensitive to low-frequency sounds, but with lower sensitivity than marine turtles (Chapuis et al. 2019).

Fishes use sound for communication, mating behaviour, the detection of prey and predators, orientation and migration, and habitat selection. Activities producing noise that can mask biologically relevant sounds can reduce survival and the fitness of individuals and populations by interfering with the ability of a fish to detect and respond to the relevant sounds (Popper and Hawkins 2019).

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Appendix 4. Useful references for further context

Note: Unpublished reports may be available from Department of Conservation staff if copyright agreements allow them to be shared.

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Appendix 5. Data sources to inform an understanding of benthic ecological values in a location

Source abbreviations: DOC = Department of Conservation, FNZ = Fisheries New Zealand, LINZ = Land Information New Zealand, MfE = Ministry for the Environment, MPI = Ministry for Primary Industries.

Information	Description	Source	Link/reference
NIWA invertebrate collection in the Ocean Biodiversity Information System (OBIS) database	Database that holds specimens from almost all invertebrate phyla	NIWA	obis.org/dataset/2c6db58f-ae91-4a17-9f0f-7db28506b94f
Vulnerable marine ecosystems (VMEs) in the South Pacific Ocean region	Dataset of a defined 10 benthic invertebrate taxa that are regarded as indicators of VMEs; records of VME taxa for the South Pacific Regional Fisheries Management Organisation (SPRFMO) area and the New Zealand Exclusive Economic Zone (EEZ) were extracted from OBIS, other online data sources, research institutes and fisheries agencies	NIWA	data-niwa.opendata.arcgis.com/datasets/NIWA::vulnerable-marine-ecosystems-vme-invertebrates-sprfmo/about
Atlas of Seabed Biodiversity	Species distribution models	DOC	doc-marine-data-deptconservation.hub.arcgis.com/search?groupIds=72e16bd0dc9c4849b908ac4ac9261892
Administrative boundaries	Multiple datasets in the DOC Marine Data Portal	DOC, MPI, LINZ, Stats NZ	doc-marine-data-deptconservation.hub.arcgis.com/search?groupIds=351fec4374a94ad19a32035db28084d9
Protected areas	Marine reserves, marine mammal sanctuaries, and submarine cables and pipelines protection	DOC, MPI	doc-marine-data-deptconservation.hub.arcgis.com/search?groupIds=726d24f6433e4f7d9ca7fbe391a98fbb
New Zealand Seafloor Community Classification	Reports and a dataset (territorial sea, EEZ)	NIWA prepared for DOC	Stephenson F et al. 2021. Development of a New Zealand Seafloor Community Classification (SCC). Prepared for the Department of Conservation. Hamilton: National Institute of Water & Atmospheric Research Ltd. NIWA Client Report 2020243WN. doc.govt.nz/seafloor-community-classification doc-marine-data-deptconservation.hub.arcgis.com/documents/98d452b3b1ba4e1193a3b8b909bb9a64/about doc-marine-data-deptconservation.hub.arcgis.com/documents/4050708cbf274e26a978448c4caf2b3d/about
New Zealand Seafloor Bioregionalisation	Dataset and published paper	NIWA prepared for DOC	doc-marine-data-deptconservation.hub.arcgis.com/datasets/093a3ed7e18a49f2a4af34275c78278d_1/explore?location=-30.965777%2C70.565324%2C3.30 Stephenson F et al. 2023. A seafloor bioregionalisation for New Zealand. Ocean & Coastal Management. 242:106688. doi.org/10.1016/j.ocecoaman.2023.106688
New Zealand Seabed Geomorphology	Characterising New Zealand seafloor habitats using the Benthic Terrain Modeller	DOC	doc-marine-data-deptconservation.hub.arcgis.com/search?tags=benthic%2520terrain%2520model

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Appendix 5 continued

Information	Description	Source	Link/reference
Review of New Zealand's key biogenic habitats	Report	NIWA prepared for MfE	Anderson T et al. 2019. Review of New Zealand's key biogenic habitats. Prepared for the Ministry for the Environment. Wellington: National Institute of Water & Atmospheric Research Ltd. NIWA Client Report 2018139WN. environment.govt.nz/assets/Publications/Files/NZ-biogenic-habitat-review.pdf
Biogenic habitats on New Zealand's continental shelf. Part I: Local ecological knowledge	Report and data layers	NIWA prepared for MPI	Jones EG, Morrison MA, Davey N, Hartill BW, Sutton C. 2016. Biogenic habitats on New Zealand's continental shelf. Part I: Local ecological knowledge. Wellington: Ministry for Primary Industries. New Zealand Aquatic Environment and Biodiversity Report No. 174. webstatic.niwa.co.nz/library/NZAEBR-174.pdf
Biogenic habitats on New Zealand's continental shelf. Part II: National field survey and analysis	Report and datasets	NIWA prepared for MPI	Jones EG et al. 2018. Biogenic habitats on New Zealand's continental shelf. Part II: National field survey and analysis. Wellington: Ministry for Primary Industries. New Zealand Aquatic Environment and Biodiversity Report No. 202. fs.fish.govt.nz/Page.aspx?pk=113&dk=24624
Identified important coastal marine areas	Data layers or text description	Regional and district councils	Held by councils
Identification of protected coral hotspots using species distribution modelling	Report	NIWA prepared for DOC	Anderson O, Schnabel K, Bowden D, Davey N, Hart A. 2023. Identification of protected coral hotspots using species distribution modelling. Prepared for the Department of Conservation. Wellington: National Institute of Water & Atmospheric Research Ltd. NIWA Client Report 202323WN. doc.govt.nz/identification-of-protected-coral-hotspots
Improved habitat suitability modelling for protected corals in New Zealand waters	Report	NIWA prepared for DOC	Anderson O, Stephenson F, Behrens E. 2020. Updated habitat suitability modelling for protected corals in New Zealand waters. Prepared for the Department of Conservation. Wellington: National Institute of Water & Atmospheric Research Ltd. NIWA Client Report 2020174WN. doc.govt.nz/habitat-modelling-for-protected-corals
Habitat suitability models for vulnerable marine ecosystem (VME) indicator taxa within the SPRFMO Convention Area and the New Zealand EEZ	Published papers	NIWA, DOC, FNZ	Stephenson F et al. 2021. Presence-only habitat suitability models for vulnerable marine ecosystem indicator taxa in the South Pacific have reached their predictive limit. ICES Journal of Marine Science. 78(8):2830-2843. doi.org/10.1093/icesjms/fsab162 Bennion M. 2024. Evaluation of the full set of habitat suitability models for vulnerable marine ecosystem indicator taxa in the South Pacific High Seas. Fisheries Management and Ecology. 31(4):e12700. doi.org/10.1111/fme.12700

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Appendix 5 continued

Information	Description	Source	Link/reference
New Zealand Seamounts Polygons	Data layer	MPI	data-mpi.opendata.arcgis.com/datasets/cc7d6940c6b14e0b84c40970a3572084_0/explore?location=-37.723156%2C10.269947%2C3.78
Hydrothermal vents and cold seeps	Locations of known submarine hydrothermal vents and cold seeps	NIWA	Held by NIWA
Marine Spatial Catalogue	Table describing the marine geospatial data holdings that are available from MPI	MPI	data-mpi.opendata.arcgis.com/datasets/14b928ae845a46c2b40bd0edf5d6f41a_0/explore
Mapping key ecological areas in the New Zealand marine environment: data collection	Report	NIWA prepared for DOC	Stephenson F et al. 2018. Mapping key ecological areas in the New Zealand marine environment: data collection. Prepared for the Department of Conservation. Hamilton: National Institute of Water & Atmospheric Research Ltd. NIWA Client Report 2018332HN. doc.govt.nz/globalassets/documents/conservation/marine-and-coastal/marine-protected-areas/mpa-publications/key-ecological-areas-report-2018.pdf