# Marine mammal assessment with respect to the potential effects of proposed mussel spat catching and nursery activities off the coast of Raglan

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## Executive summary

North Western Mussels Limited (NWML) is preparing an application for four discrete green-lipped mussel (*Perna canaliculus*) spat catching and nursery sites off the coast of Raglan. The sites would be located approximately 3 km offshore, over seafloor around 20-40 m deep, and with a total aerial extent of ~700 hectares (~7 $km^2$). NWML requested a marine mammal expert assessment with respect to the effects of this application. This desk-based assessment used pre-existing information of the potential effects of spat catching and nursery activities on marine mammals.

Marine mammal species that occur around the proposed sites include: Māui dolphin (*Cephalorhynchus hectori maui*) (a sub-species of Hector's dolphin (*Cephalorhynchus hectori*)), common dolphin (*Delphinus delphis*), orca / killer whale (*Orcinus orca*), southern right whale (*Eubalaena australis*), and New Zealand fur seal (*Arctocephalus forsteri*). Humpback whale (*Megaptera novaeangliae*) occur offshore of the proposed sites. Of these, Māui dolphin, orca, and southern right whale are currently listed as 'Threatened' or 'At risk' by the New Zealand Threat Classification System.

The assessment of potential effects determined that habitat exclusion, trophic effects, entanglement, marine debris, vessel strike, and underwater noise would each have a negligible-to-minor effect on Māui dolphin when considering effects at the sub-species level, so long as: best operational practises were followed, and there was extra vigilance (including reduced vessel speed) in regions where validated sightings of juveniles have been reported. The available information for considering potential cumulative effects was extremely limited, although this was assumed to be minor at the sub-species level, based on the greatest magnitude of any single effect being minor.

For other marine mammal species, the potential effects were deemed to be negligible-to-minor so long as: best operational practises were followed, and there was increased vigilance of marine mammal monitoring during months when southern right whales (July to November) and humpback whales (June and October) are most likely to be present off the West Coast of the North Island.

Other options are given for managing the potential effects on marine mammals, including the consideration of a staged approach to developing the four sites. It is recommended that the management practices for implementing all related mitigation measures are formalised into a Marine Mammal Management Plan (MMMP).

Finally, the proposed activities would provide an opportunity to monitor the spatio-temporal distribution of Māui dolphin, as well as oocysts of *Toxoplasma gondii*—a parasite causing the disease toxoplasmosis in Māui dolphin as well as South Island Hector's dolphin. Recommendations are given for progressing the monitoring of Māui dolphin and *T. gondii*.

# 1. Contents



# 2. Introduction

## 2.1. Background

The green-lipped mussel (*Perna canaliculus*) is endemic to New Zealand and is found in a variety of coastal habitats around the country. The New Zealand mussel aquaculture industry relies on a source of spat (larvae) that are then cultivated prior to harvesting. The majority of spat comes from seaweed collected from Ninety Mile Beach, Northland. The mussel farming industry is largely dependent upon spat fall events, which can be variable in time, posing a major uncertainty and risk for the industry. An alternative to the collection of natural spat fall is to 'catch' spat on ropes suspended in the water column at times when mussel larvae are abundant, providing an alternative source of spat when natural spat fall on seaweed is scarce.

North Western Mussels Limited (NWML) is preparing an application to undertake mussel spat catching and nursery activities off the coast of Raglan. The reliability of spat catch in this region has been determined from prior sampling by NWML to be excellent and not replicable anywhere else in New Zealand (R. Clarkson, ADL, pers. comm.). The proposal is for four discrete spat catching / nursery sites, located approximately 3 km offshore over seafloor around 20-40 m deep. Three of the sites (Blocks A–C) are located approximately 20 km to the north of Raglan and the other (Block D) is located around 10 km to the south.

It is anticipated that some spat will be relocated from the proposal area on the catching ropes, while still at small size. Other spat lines will remain in place (the nursery phase) until the spat reach an average size of 70mm, when they will be harvested, then seeded and cultivated in the Hauraki Gulf. Some lines in the proposal area may also be seeded with hatchery spat for the nursery phase. The overall strategy is to spread spat collection and retention over a range of sources and locations to minimise the risk of periods with poor spat supply. Holding the spat on the west coast over the summer period is likely to provide them with sufficient resilience to survive the increasing water temperatures, snapper (*Pagrus auratus*) predation issues and land-use runoff challenges in the Hauraki Gulf.

NWML requested a draft a marine mammal expert assessment in July 2022 to support an application for the proposed aquaculture operations. Specifically, NWML required a desktop assessment, i.e., using pre-existing information, of the potential effects of the proposed spat catching/nursery application on marine mammals, and to assist with the identification of potential mitigation measures, as required.

## 2.2. Proposed mussel spat catching / nursery activities

North Western Mussels Limited have monitored spat availability through research permits in the Northland, Auckland and Waikato regions and identified that an area off the coast of Raglan is optimal for spat farming in terms of the accessibility, availability, and resilience of mussel spat, and to enable adaptation to future climate change.

Thus, the proposal is for four discrete spat catching/nursery sites (also referred to as blocks) in the locations shown in Figure 1. The proposed sites are approximately 3 kilometres from the coast, over water 20-40 metres deep. The four sites cover a combined area of ~700 hectares (or ~7 km$^2$), including the gaps between lines in each row. The three northern sites (Blocks A–C) each have an aerial extent of 180 hectares and are organised into three rows, with a 300m spacing between rows. The southern site (Block D) has an aerial extent of 160 hectares, with two rows and a 400m spacing between rows.

An indicative structural layout of a spat line is shown in Figure A-1. The spat lines would run parallel to the coastline with 50-m spacings between lines. The backbone line (on to which the spat-catching dropper lines would be attached) would be suspended approximately three metres below the sea surface using twenty 300 litre buoys, with buoy lines attached at 2–10 m intervals. The dropper lines would be approximately eight metres long and joined to the backbone at each end (rather than many dropper lines with a single vertical drop from the backbone). The dropper lines would be impregnated with a lead core to affect negative buoyancy in seawater. The catching rope will have a filamentous surface with 60–80 mm long “hairs”, which acts as a favourable settlement surface for the microscopic mussel larvae.

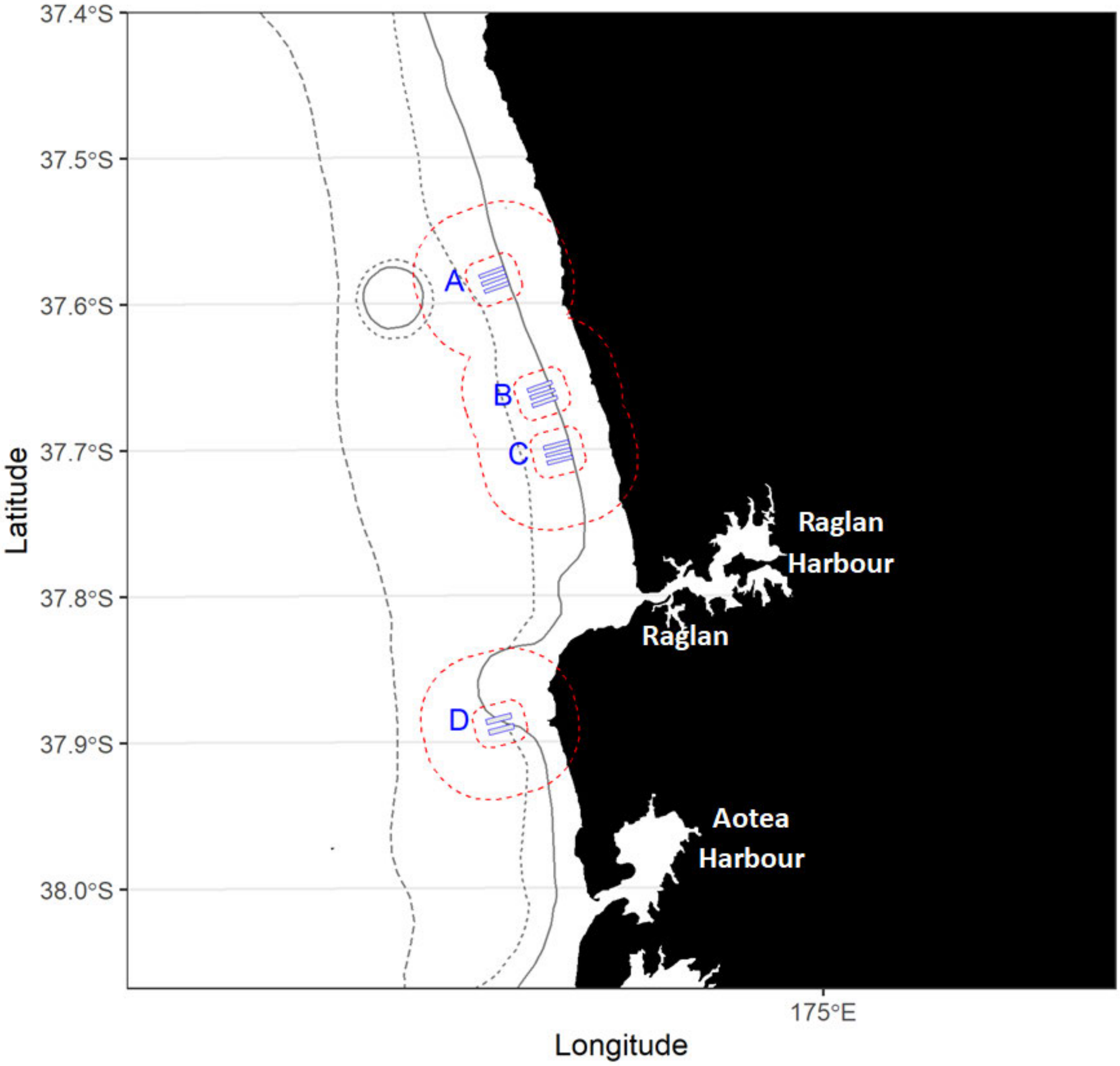


Figure 1. The proposed locations of the four discrete spat catching/nursery sites off the coast of Raglan. Sites (also known as blocks) are labelled A–D and the blue lines represent the outlines of rows of spat catching lines within each site. The dashed red concentric lines represent the outer limits of buffer zones at 1 km and 5 km from the spat catching rows (these distances are for visual reference only and do not relate to any specific regulations or recommendations with respect to mitigating marine mammal interactions). The 20 m, 30 m, and 50 m isobaths are represented using black lines.

The ends of each backbone line would be attached to the seafloor via tensioned mooring lines, which would be approximately 60 m in length depending on the depth of the seafloor. Mooring lines would be attached to the seafloor using screw anchors penetrating the seafloor by up to 6–12 m depending on substrate. Marker buoys with yellow flashing lights will be placed 200 m outside the nursery sites to aid maritime navigation, or as required by Maritime NZ and / or Waikato Regional Council (WRC). In addition, orange marker buoys would also be placed at the end of each backbone and one central marker buoy outside the longlines.

Exploratory spat sampling at the proposed locations by NWML determined that the autumn catch is 60% reliable and the winter and spring catch is 100% reliable (R. Clarkson, ADL, pers. comm.). Hence, it is anticipated that spat will mostly be captured between February and November and will be harvested and relocated to and on-grown in cultivation farms in the Hauraki Gulf at one of three life stages:

- when spat are just visible (transferred on ropes);
- when spat have an average shell length of 20 mm (transferred on ropes); or
- when spat have an average shell length of 70 mm (stripped off ropes).

The final harvest size (at the Hauraki Gulf) will around 95 to 105 mm shell length.

While it is anticipated the spat catching operations would primarily occur in winter and spring, it is anticipated that nursery activities would occur year-round. Harvesting would occur over fortnightly two-day visits, with required maintenance (i.e., to assess the structural integrity and rectify any wear and tear on lines, buoys, and lighting) carried out. If spat/seed operations are not active, maintenance would be carried during *monthly* two-day visits (R. Clarkson, ADL, pers. comm.). A specialised mussel barge and support vessels would be moored at Raglan Harbour that would be used for harvesting and maintenance.

The proposed structures would be constructed over two stages, with half of each site being built, then the remaining half built after a period of assessment.

## 2.3. Scope of assessment

By agreement with NWML, the scope of this assessment was as follows:

1. review the existing environment in relation to the known residency, migration and seasonal movement patterns of marine mammals occurring along the coastal region of the West Coast of the North Island, specifically Raglan and adjacent areas.
2. review the national/international literature to identify and describe the potential effects of open coastal mussel spat farming activities on marine mammals, with due consideration of:
    a. known versus potential effects;
    b. indirect versus direct effects; and
    c. cumulative effects.
3. summarise the overall risk of any resulting effects; and
4. where applicable, recommend appropriate mitigation and some options for monitoring marine mammals and their threats.

The scope of this review includes all species that may occur along the West Coast of the North Island, including species using migratory corridors as well as species/populations that breed there and may be present there year-round. The review gave greatest consideration to Māui dolphin (*Cephalorhynchus hectori maui*), which are known to overlap with the proposed mussel spat farm structures and are considered highly vulnerable to extinction from anthropogenic activities (Currey et al. 2012; Roberts et al. 2019).

This assessment does not consider the potential effects on marine mammals of the subsequent cultivation of the mussels in the Hauraki Gulf, which was outside of scope for this assessment.

## 2.4. Assessment approach

The assessment starts with a review of the seasonal spatial distributions of marine mammal species and populations that are most likely to overlap with the proposed mussel spat farm.

The various sources of information were then used to conduct a desk-based review of potential effects/interactions with marine mammal species/populations, including information relating to: habitat exclusion/displacement, entanglement, underwater noise disturbance, and other aspects relating to the proposed operations that were identified. This review made the distinction between known versus probable or potential effects and gave due consideration of potential indirect and cumulative effects.

The review gave due consideration to the New Zealand Coastal Policy Statement (NZCPS) 2012 guidance note 'Policy 11: Indigenous biological diversity' (DOC 2019). Of relevance to marine mammals, this policy states that coastal activities must:

- Avoid adverse effects on:
    - Indigenous taxa that are listed as Threatened or At Risk in the New Zealand Threat Classification System lists.
    - Taxa that are listed by the International Union for Conservation of Nature and Natural Resources as Threatened.
    - Habitats of indigenous species where that species are at the limit of their natural range, or are naturally rare.
    - Areas set aside for full or partial protection of indigenous biological diversity under other legislation.
- Avoid significant adverse effects and avoid, remedy or mitigate other adverse effects on:
    - Habitats in the coastal environment that are important during vulnerable life stages of indigenous species.
    - Habitats including areas and routes, important to migratory species; and ecological corridors.

A qualitative assessment of each potential effect was given, focussing on the more notable marine mammal species/populations identified. This report concludes with a summary of some options for mitigating some of the key residual effects on marine mammals identified by the review.

# 3. Marine mammals occurring off the West Coast of the North Island

This section reviews the known residency, migrations and seasonal movement patterns of marine mammals occurring along the North Island's western coastal region, focusing on the region around the proposed mussel spat farm, near Raglan. A draft review by Pavanato and Clement (2022) identified four marine mammal species commonly occurring near to Raglan: Hector's dolphin (*Cephalorhynchus hectori*), most notably the Māui dolphin sub-species, but also potentially South Islands Hector's dolphin (*Cephalorhynchus hectori hectori*); common dolphin (*Delphinus delphis*); orca / killer whale (*Orcinus orca*); and southern right whale (*Eubalaena australis*). The seasonal spatial distributions of these species along the West Coast of the North Island are described in the following paragraphs along with other aspects of relevance to the proposal by NWML. Other marine mammals were also discussed that may be relevant to the proposal, including humpback whale (*Megaptera novaeangliae*) and New Zealand fur seal (*Arctocephalus forsteri*).

In this review, summer was defined as the period from November to April and winter refers to May–October, consistent with the seasonal definitions used by the commercial fisheries risk assessment of New Zealand marine mammals (Abraham et al. 2017).

***Māui* and Hector's *dolphin***

Both Māui dolphin and South Island Hector's dolphin are known to occur along the West Coast of the North Island. The contemporary range of Māui dolphin, confirmed by the boat-based genetic sampling of live individuals (Māui dolphin are defined as those being 'Haplotype G'), is likely to be restricted year-round to the coastal strip along the West Coast of the North Island north of Cape Egmont (Baker et al. 2016; Constantine et al. 2021), although validated sightings are rare north of Kaipara Harbour and south of Raglan (Figure B-2). Based on genetic sampling, South Island Hector's dolphin are occasionally found within pods of Māui dolphin (Constantine et al. 2021), although cannot currently be differentiated based on visual appearance or acoustic monitoring. Based on genetic mark-recapture sampling, individual Māui dolphin are thought to have small home ranges, i.e., typically less than 10 km, with some ranging up to 32 km in an along-shore direction (Constantine et al. 2021).

In addition to boat-based sightings and genetic sampling, the distribution of Māui and Hector's dolphin along the West Coast of the South Island has been inferred from: aerial survey-based sightings (e.g., Slooten et al. 2005), passive acoustic studies (e.g., Nelson & Radford 2019), and habitat-based spatial distribution modelling (e.g., Derville et al. 2016; Roberts et al. 2019b).

Formal aerial surveys of Māui and Hector's dolphin were done along the West Coast of the South Island in the summers of 2000/01 and 2001/02 (Ferreira and Roberts 2003), and in summer and winter of 2004 (Slooten et al. 2005). Taken together, these surveys obtained positive sightings between Kaipara Harbour and just south of Raglan, consistent with the core range from validated public sightings (Figure B-2), and up to 4 nautical miles (~7.5 km) from the shore.

The range of Māui and Hector's dolphin has also been inferred from studies using acoustic detectors deployed at different locations along the West Coast North Island. Nelson and Radford (2019) obtained multiple detections at Hamilton's Gap to the south of Manukau Harbour, between 0.91 km and 18.2 km from shore, and obtained tentative evidence for a diurnal offshore migration during night hours. In addition, dolphin detections occurred as far south as Tapuae, off the North Coast of Cape Egmont (Nelson and Radford 2019).

The spatial distribution of Māui and Hector's dolphin has also been predicted using spatial habitat models. The two sub-species are likely to have very similar habitat requirements, i.e.: shallow, near-shore regions of high sea surface turbidity and high prey availability (Derville et al. 2016; Roberts et al. 2019b). It has been hypothesised that the historical range of both Māui and Hector's dolphins have been fragmented by the extinction of local sub-populations caused by commercial and recreational setnet fisheries (Dawson et al. 2001). Contrary to this, the spatial distributions of both sub-species predicted by habitat models of Roberts et al. (2019b) were consistent with their observed contemporary ranges, indicating that along-shore gaps in their range are primarily caused by regions of adverse habitat quality rather than extirpation by fishery entanglement mortality. However, the relative lack of beachcast Māui and Hector's dolphins in the New Plymouth region since the 1970s is consistent with a northward contraction in the range of Māui dolphin away from a region of historically high commercial setnet effort (Russell 1999).

Validated sightings of Māui and Hector's dolphins have been reported within 5 km of all four blocks (A–D) of the proposed mussel spat farm, in both the summer and winter periods (Figure 2). Both Māui and Hector's dolphin are known to have a more offshore distribution in the winter period (e.g., Rayment 2008; Slooten et al. 2005), although, based on the predictions of a habitat model produced by Roberts et al. (2019b), their relative abundance around the proposed mussel spat farm structures would be approximately the same in the summer and winter periods (see Figure 2, noting that different colour scales were used for the summer and winter plots). In the region where the proposed structures would occur, Māui and Hector's dolphins were predicted to be most abundant directly offshore of the mouth of Raglan Harbour in summer (where Māui dolphin have occasionally observed with calves) and along a coastal band north of Raglan over seafloor deeper than 20 m depth in winter (Figure 2).

Based on the spatial distribution of validated sightings of Māui and Hector's dolphins that were reported to have included juveniles (Figure 3), calves and juveniles appear more likely to be present immediately to the south of Raglan (i.e., around Block D), than to the north (around Blocks A–C). There was a total of six validated sighting events including juveniles within 5 km of Block D and one within 1 km. Notably, most sightings including juveniles were along the coastal stretch between Raglan town and Block D (Figure 3).

The diet of Māui and Hector's dolphin is dominated by small-bodied benthic and demersal fish and squid species (and juveniles of species that grow to larger sizes), including red cod (*Psuedophycis bachus*), sprat (*Sprattus* sp.), ahuru (*Auchenoceros punctatus*), *Pelthoramphus* sp., giant stargazer (*Kathetostoma giganteum*), and arrow squid (*Nototodarus* sp.) (Miller et al. 2013). There is a relative lack of the key prey species within Māui dolphin habitat, indicating that lack of food may be an issue for this sub-species (Roberts et al. 2019b). However, very few Māui dolphin have been assessed for their diet (Miller et al. 2013) and this could potentially differ to some degree from that of South Island Hector's dolphin.

The latest census of Māui dolphin estimated a total population size of only 54 individuals (95% confidence interval (CI) = 48–66 individuals) in 2020–2021 not including calves (Constantine et al. 2021). A demographic population model fitted to genetic mark recapture data found that the annual survival of female Māui dolphin was ~6% higher than that of males, and that the rate of population decline was between 0% (i.e., stable) and 4% annually when using female survival (>95% probability of decline) (Roberts et al. 2019a). Māui dolphin are currently listed as 'Threatened - Nationally Critical' under the New Zealand Threat Classification System (NZTCS) based on very low population size (Baker et al. 2019).

The main population threat to Māui and Hector's dolphins was historically considered to be entanglement mortality in commercial setnets (e.g., Currey et al. 2012; Dawson et al. 2001). However, a more recent spatial multi-threat risk assessment found that the main anthropogenic threat to both sub-species was likely to be toxoplasmosis, a disease caused by infection with *Toxoplasma gondii*, a parasite that in New Zealand is spread only by the domestic house cat (*Felis catus*) (Roberts et al. 2019b; Roe et al. 2013). Based on the relatively small sample of beachcast dolphins for which a primary cause of death was determined from formal necropsy, toxoplasmosis may be a particular problem for reproductive females (Roberts et al. 2019b; Roe et al. 2013). Other emergent threats for the species include brucellosis, and oceanic warming affecting the availability of key prey species (Roberts et al. 2019b).

The Hector's and Māui dolphin threat management plan (TMP) is a New Zealand government planning framework to manage human-caused threats to Māui and Hector's dolphins. The 2020 TMP introduced new fishing area restrictions along the West Coast of the South Island and the instigation of an action plan for better understand and managing the threat posed by toxoplasmosis (DOC/MPI 2021). In addition, the West Coast North Island Marine Mammal Sanctuary (see Figure C-6), established in 2008, imposes some restrictions on seabed mining activities and acoustic seismic surveys within the sanctuary.

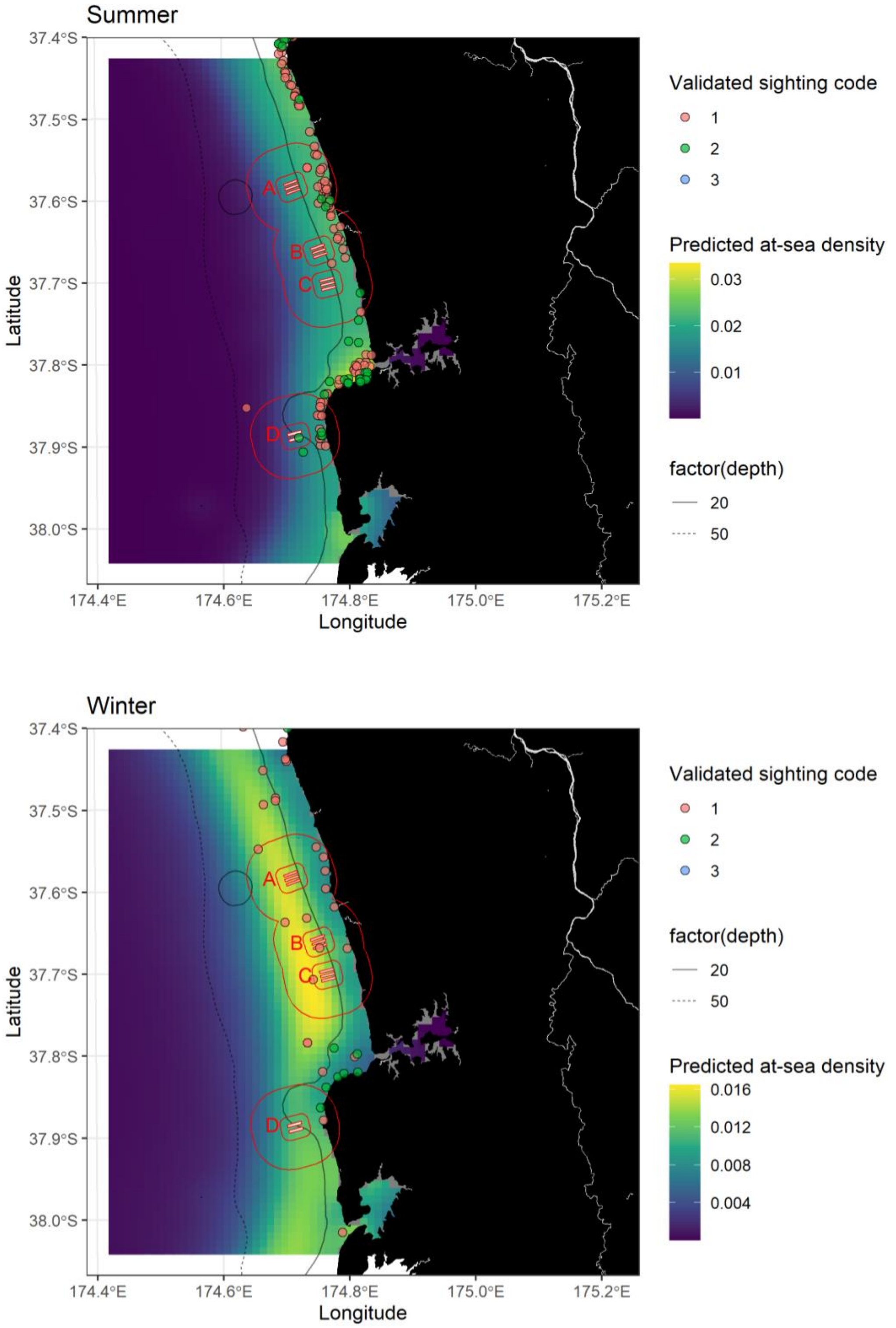


Figure 2. Predicted at-sea density of Māui and Hector's dolphins (colour scale) around the proposed mussel farm structures (outlined in red) in summer (top) and winter (bottom), and the locations of validated sightings **of all age stages**, by validation status (1 = highest confidence, 3 = lowest confidence, although description still consistent with Māui dolphin). The at-sea density was as predicted by Roberts et al. (2019b); the sightings records were from DOC (2022a). The dashed red concentric lines represent the outer limits of buffer zones at 1 km and 5 km from the spat catching rows (these distances are for visual reference only and do not relate to any specific regulations or recommendations with respect to mitigating marine mammal interactions).

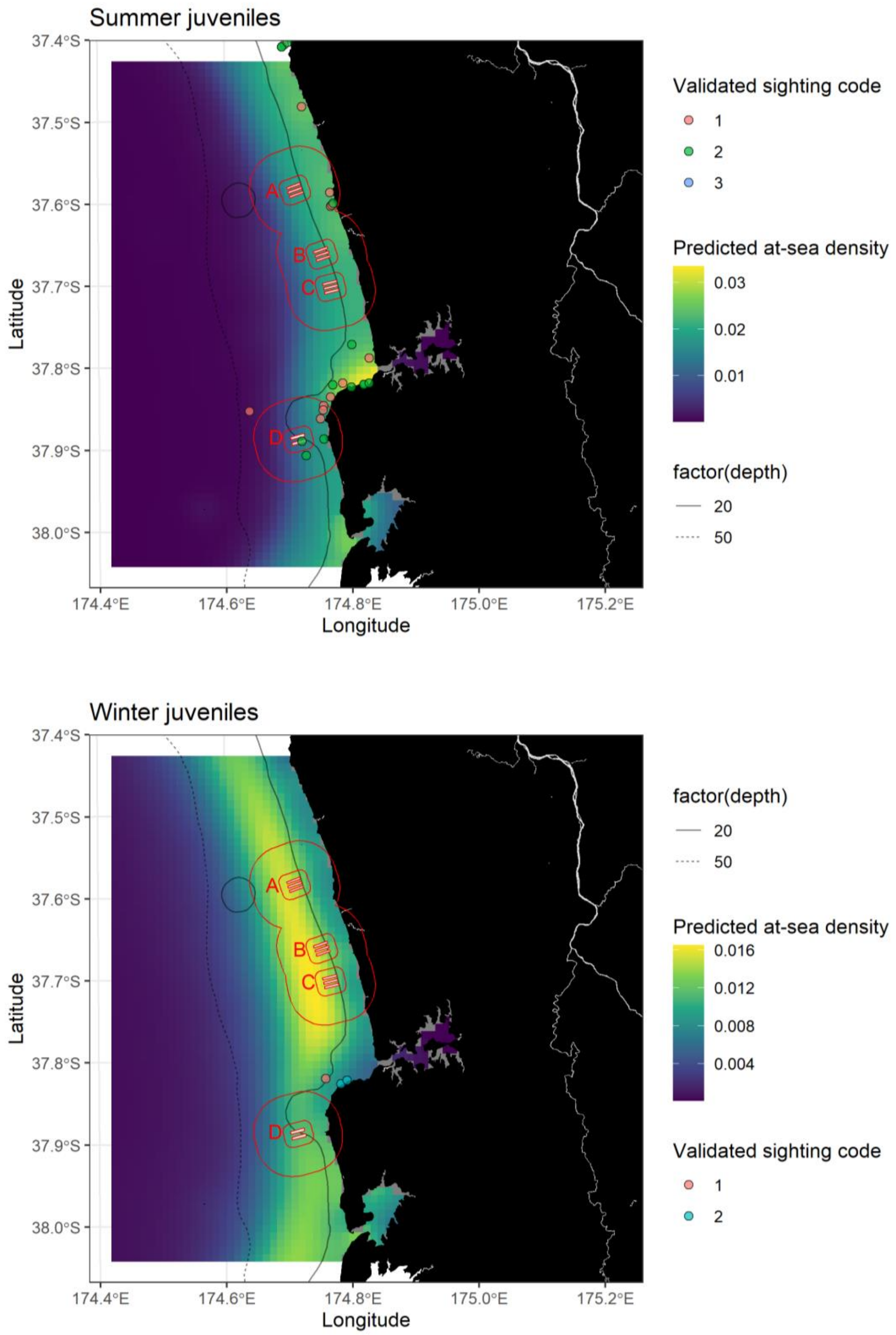


Figure 3. Predicted at-sea density of Māui and Hector's dolphins (colour scale) around the proposed mussel farm structures (outlined in red) in summer (top) and winter (bottom), and the locations of validated sightings of pods and individuals **<u>that included juveniles</u>**, by validation status (1 = highest confidence, 3 = lowest confidence, although description still consistent with Māui dolphin). The at-sea density was as predicted by Roberts et al. (2019b); the sightings records were from DOC (2022a). The dashed red concentric lines represent the outer limits of buffer zones at 1 km and 5 km from the spat catching rows (these distances are for visual reference only and do not relate to any specific regulations or recommendations with respect to mitigating marine mammal interactions).

### *Other delphinids*

The draft review by Pavanato and Clement (2022) identified two other delphinid species occurring around the proposed mussel spat farm near Raglan: common dolphin and orca. These are considered separately of baleen whales, which are: more migratory, larger, more cumbersome in their movements, and lack the ability to echolocate.

Common dolphin are abundant around the North Island of New Zealand and were also predicted to be relatively abundant off the West and North Coasts of the South Island (Stephenson et al. 2020). Individuals occurring along the West Coast North Island are known to belong to a wider-ranging population found in inshore and offshore waters around New Zealand (Stockin et al. 2014). Except for the Hauraki Gulf, where they are abundant year-round, common dolphin are considered seasonal residents and are typically found closer to shore in summer months (Stockin et al. 2008). Common dolphin predate on a variety of fish and cephalopod species, with arrow squid, jack mackerel (*Trachurus* sp.) and anchovy (*Engraulis australis*) identified as the primary prey species (Meynier et al., 2008).

A recent spatial multi-species fisheries risk assessment for New Zealand marine mammals estimated common dolphin to have the highest risk ratio from commercial fishing of all the marine mammal species (Abraham et al. 2017), although the total New Zealand population size (a key determinant of risk) was highly uncertain for common dolphin. Off the West Coast of the North Island, common dolphin were mainly captured in jack mackerel trawls (Abraham et al. 2017), which typically operate at 50-300 m depth in this region.

Orca occurring off the West Coast of the North Island are likely to comprise part of a small wider-ranging New Zealand population (Baker et al. 2019). There has only been one population size estimate for New Zealand orca (115 individuals; 95% CI = 65–167) (Visser 2000) and, hence, there is no robust information about their population trend. Orca are precautionarily listed as 'Threatened - Nationally Critical' under the NZTCS, based on small population size and tentative evidence for population decline (Baker et al. 2019). The main prey of orca around New Zealand include rays, sharks, finfish, and other cetaceans (Visser 2000).

The mainland population is believed to be made up of at least three sub-populations: a North Island only sub-population, a South Island only sub-population, and another that uses both the North and South Islands (Visser 2000). It was inferred from the available mark-recapture data that orca have large home range sizes, moving along the coastline in search of prey (Visser 2000), with some individuals travelling an average of 100–150 km per day (Visser, 2007). Based on a review of the available data up to 1997 by Visser (2000), orca are mainly seen along the West Coast of the North Island between October and February, with no sightings in late winter and early spring. Orca have been observed in most of the major harbours of the West Coast of the North Island, including Raglan Harbour, with comparable spatial patterns of sightings in the summer and winter periods (Figure B-3).

### *Baleen whales*

Two blue whale sub-species are known to occur around New Zealand: Antarctic blue whale (*Balaenoptera musculus musculus*), which is considered a seasonal migrant; and pygmy blue whale (*Balaenoptera m. brevicauda*), which is thought to be present in New Zealand waters throughout the year (Barlow et al. 2018). Pygmy blue whales are known to feed on krill aggregations in the Southern Taranaki Bight during the summer period (Barlow et al. 2020), although can range widely around New Zealand based on the preliminary outputs of a tracking study (Goetz et al. 2018). Numerous sightings of blue whales have been reported offshore the West Coast North Island, primarily in the summer period (Figure B-4). There are reported instances of ship strike and fisheries-related mortality as well as the potential impacts of noise disturbance from industrial activities in parts of their distribution (Baker et al. 2019).

Southern right whales undertake seasonal migrations from the Antarctic region to the Subantarctic islands of New Zealand and mainland coastal waters, where they occur between July to November. Sightings of southern right whales have been reported within shallow and sheltered areas of the West Coast of the North Island during the winter period, including in the mouth of Raglan Harbour, within 20 km of the proposed mussel spat farm (Figure B-4). Southern right whales use shallow coastal waters for winter calving and for nursery grounds. The main calving habitat around the New Zealand mainland is thought to be between Napier and Mount Manganui, with all sightings here of cow-calf pairs in winter and spring (Patenaude, 2003). Carroll et al. (2014) highlighted a potential increasing trend in the frequency of cow-calf pair sightings around the North Island (none were reported around the mainland for nearly four decades from 1928–1963), with recent evidence for short-term residency around the mainland. The conservation status of southern right whale improved from 'Nationally Vulnerable' to 'At Risk - Recovering' due to an apparent partial population recovery around New Zealand (Carroll et al. 2014, Baker et al. 2019). The most up-to-date abundance study estimated 2,169 individuals (95% CI = 1,836–2,563), approximately 10 % of the pre-whaling population size (Jackson et al. 2016).

Humpback whale are considered a non-resident seasonal migrant visitor to New Zealand, passing around the coast of New Zealand when migrating between summer feeding grounds around Antarctica and winter calving / breeding grounds in tropical or near-tropical waters. Northbound humpbacks predominantly migrate along the East Coast of the South Island, through the Cook Strait then up the West Coast of the North Island in winter months, and southbound humpbacks return along the West Coast in spring (Dawbin 1956; Gibbs et al. 2018). Humpback whale sightings have been reported immediately offshore of the proposed mussel spat farm in winter months (defined here as May–October), and nearshore along the north coast of Cape Egmont in summer (November–April) (Figure B-4). There appears to have been a post-whaling recovery in New Zealand of humpback whales, based on an increase in the sightings rate of individuals passing through the Cook Strait (Gibbs et al. 2018). Humpback whales were the most frequently observed cetacean species reported as entangled in commercial pot fishing gear around New Zealand (Pierre et al. 2022). Entanglements were reported year-round with peaks in June and October, coincident with the northward and southward migrations, respectively (Gibbs et al. 2018; Pierre et al. 2022).

***New Zealand fur seals***

New Zealand fur seals are generally considered to be in the process of recovering their pre-historical range around New Zealand, following the cessation of commercial sealing in the 19th Century (Smith 2002). The available sightings data were deficient for assessing their spatial distribution off the West Coast of the North Island. New Zealand fur seals are known to be generalist predators, consuming a wide range of prey of small and large body sizes, including fish, squid and octopus (reviewed by Baird 2011). Page et al. (2005) concluded that females forage more over continental shelves, whereas males tend to forage over deeper continental shelf breaks and in pelagic waters.

The locations of fur seal breeding rookeries around New Zealand were reviewed by Baird (2011) who concluded that "Few [breeding] rookeries exist on North Island offshore islands, with the most northern sites off Waikato, at Gannet Island… and off Taranaki at Sugar Loaf Islands… representing areas where pup numbers are few (but consistent pupping occurs each year) and expansion is unlikely due to the small area of available habitat" (locations plotted in Figure B-5). This was confirmed to be a good representation of the latest information (L. Boren, DOC, pers. comm.). Near to Raglan, approximately four pups are born annually at Gannet Island (approximately 15 km to the south-west of Block D) and ~1 annually at Albatross Point (~30 km to the south of Block D) (Figure B-5). These are also the main known haul out sites for New Zealand fur seals along this coast, with more than 500 seals counted at Gannet Island in a 2005 survey, and almost 100 seals at Albatross Point in 2005 and 2007, although almost 100 seals were also counted in a single survey at Tirua Point to the south of Albatross Point (Bouma et al. 2008). Taken together, these surveys are consistent with a total population of at least 500 NZ fur seals in this region, with some evidence for a seasonal oscillation in the numbers of seals using these haul outs (Bouma et al. 2008). At the time of the Bouma et al. (2008) study, there was insufficient data to assess their population trend.

Typically for an otariid species, the range of male New Zealand fur seals will be less constrained by the establishment of breeding sites, such that males may be more abundant and widespread than females along the West Coast of the North Island. This is tentatively supported by the data from fishery entanglements from the WCNI, where most of the (small) sexed sample were males (J. Roberts, unpublished data from MPI project PMM2018-11). Known threats to New Zealand fur seals include climate-induced fluctuations in prey availability (Roberts & Neale; Roberts et al. in prep.). Off the West Coast of the North Island, fur seals are mostly observed captured in jack mackerel trawls (Abraham et al. 2017).

# 4. Review of effects of coastal mussel spat farms on marine mammals

This section reviews the national/international literature to identify and describe the potential effects of open coastal mussel spat farming activities on marine mammals, with due consideration of: known versus potential effects, indirect versus direct effects, and cumulative effects. Globally, assessments of the effects of aquaculture operations on marine mammal species have focused on habitat exclusion and entanglement (Clement et al. 2013; Würsig et al. 2002). The information for these assessments can be lacking, particularly for cetacean species, and this is also true for mussel spat farms (Valdés 2021). As such, this review uses information from all mussel farming activities and included relevant international studies of proxy species.

Based on existing reviews—e.g., Clement (2013), Lloyd (2003), Keeley et al. (2009), McConnell (2019), MPI (2013), Pavanato and Clement (2022), and Price et al. (2017)—the impacts of shellfish aquaculture on marine mammals can be broadly classified into direct and indirect effects. The main examples of direct effects include: death or injury caused by entanglement in aquaculture structures, displacement from optimal habitat, and ingestion of marine debris (Watson-Capps and Mann 2005). Examples of indirect effects include: associated changes in the abundance and availability of prey species (potentially positive or negative effects), environmental contamination, and underwater noise associated with farm construction and operation (Clement 2013; Würsig 2020).

## 4.1. Entanglement

Mussel farming structures comprise three-dimensional structures that marine mammals may potentially need to actively navigate or manoeuvre around. Aquaculture gear may pose an entanglement risk for marine mammals, with increased risk when ropes are relatively thin or are not adequately tensioned (Lloyd 2003; Keeley et al. 2009; Clement 2013). In addition, MPI (2013) listed several characteristics that may cause some marine mammal species to have a greater risk of entanglement than others:

- an inability to echolocate (as is the case for baleen whales and fur seals, which rely on visual and acoustic cues to navigate) (Lloyd, 2003);

- inquisitive or playful behaviour (Clement, 2013);
- a tendency to roll (e.g., as humpback whales do when entangled in ropes);
- large pectoral fins and tail flukes (e.g., humpback whales) and large mouths (baleen whales); and
- larger, less agile species.

A small number of dead marine mammals have been reported as entangled in mussel farm structures in the 40-year history of mussel farming around New Zealand (DOC 2022b), noting that reporting rate is likely to have varied through time:

- a **Bryde's whale** reported to have become entanglement in a spat collecting line at Great Barrier Island in 1996;
- a **blue whale** that was "found dead, floated onto mussel farm" near Kataia in 2001, although was observed the previous day at another location and was "alive but appeared to have trouble swimming, not unlike a cetacean with equilibrium problems";
- another **Bryde's whale** "believed to be entangled in mussel farm buoys and ropes at Waikawau Bay, Coromandal" in 2003;
- a **humpback whale** in western Coromandel in 2015 that "was found bloated in the mussel farm. The whale is thought to have died before floating into the mussel farm.";
- an **unidentified baleen whale**, most likely a sei whale (*Balaenoptera borealis*), was found dead in a mussel farm in the Marlborough Sounds in 2018, although this was in an advance state of decomposition suggesting that it died prior to becoming entangled; and
- a **common minke whale** (*Balaenoptera acutorostrata*) that was "found tangled in the bottom of about 6 or 7 mussel droppers" at Admiralty Bay in 2021.

Globally, examples of marine mammal entanglement mortalities in shellfish farms are also limited, including a harbour porpoise (*Phocoena phocoena*) and a juvenile humpback whale that died in separate incidents after becoming entangled in dropper spat collecting lines in Iceland (Price et al., 2017). Pavanato and Clement (2022) provided a non-exhaustive list of confirmed cases of cetacean entanglements in both finfish and shellfish aquaculture gear globally. Many of these related to baleen whales and dolphins becoming entangled in anti-predator nets used for finfish aquaculture. Specifically with respect to mussel spat farms, marine mammals were entangled in single-dropper lines and spat lines and most entanglements were of baleen whales. Notably, mussel spat collecting lines are comparatively light and tend to be less tensioned than mussel cultivation ropes (MPI, 2013; Price et al., 2017). Indeed, MPI (2013) concluded that spat lines are a greater risk of entanglement for larger whales than cultivation lines, which can be mitigated to some extent by using weighted dropper lines to eliminate slack.

It is generally considered that echolocating marine mammals (including dolphins, porpoises, and toothed whales) can effectively perceive and navigate around/through mussel farms (Lloyd 2003; Markowitz et al., 2004). This is consistent with the lack of any reported odontocete (dolphin and toothed whale) entanglements in mussel farm structures in New Zealand (Clement, 2013), including the lack of any reported Hector's dolphin entanglements in farms around Banks Peninsula, despite the relatively high density of dolphins there (Lloyd 2003; Clement 2013). Entanglements in pot fishing lines have been reported for several odontocete species that may occur around the spat catching/nursery proposal (13 orca, four Hector's dolphin, two common dolphin, and one bottlenose dolphin) (Pierre et al. 2022), with nearly all the orca entanglements occurring along the North Coast of the North Island. However, pot lines may pose a greater entanglement risk than spat collecting lines because they are sparsely distributed and use thinner lines, with a length of slack line near the surface. By comparison, spat collecting lines are typically arranged into dense aggregations and can be impregnated with a lead core, which can help echolocating cetaceans to detect them.

The risk of entanglement on a per-individual basis is generally considered to be greater for baleen whales, which cannot echolocate (Lloyd, 2003). Baleen whales are the most frequently reported marine mammal entanglement in aquaculture gear, and this is likely to be exacerbated by their tendency to roll when entangled (Kemper et al. 2003, Lloyd 2003, Clement 2013). The population sizes of migratory southern right whale and humpback whale populations occurring around New Zealand are likely to be increasing, which may increase the frequency of entanglements (Kemper et al. 2003), although not on a per-individual basis (so, not affecting population risk). Humpback whale were by far the most frequent cetacean species reported entangled in New Zealand pot fishing lines (51 humpback whale, five southern right whale, one Bryde's whale, one blue whale, one pygmy right whale, and two unidentified baleen whales) (see above to compare with odontocete species), with the greatest reported entanglement rate in June and October, coincident with the northward and southward migrations of humpback whales along the coast of New Zealand (Pierre et al. 2022). A large proportion of the humpback whale entanglements in pot lines were located around the Cook Strait and along the Kaikoura Coast (Pierre et al. 2022).

New Zealand fur seals are naturally curious and are likely to be attracted to mussel farm structures. However, their small body size and agility reduces their entanglement risk relative to other marine mammals (MPI 2013; Würsig and Gailey 2002), with no reported entanglements reported in shellfish farms globally (Price et al., 2017).

## 4.2. Habitat exclusion

Habitat exclusion is often deemed a primary effect of shellfish aquaculture on marine mammals (Würsig and Gailey 2002), with some variation in the characteristics of displacement for different marine mammal species and the type of aquaculture (Clement 2013). In New Zealand, the exclusion of marine mammals from optimal habitat by mussel farms has not generally been considered a major issue (Clement 2013), although the status of this issue could be elevated with a continued expansion of mussel farming around New Zealand (Keeley et al. 2009).

Markowitz et al. (2004) studied interactions between green-lipped mussel cultivation farms and dusky dolphins (*Lagenorhynchus obscurus*) in the Marlborough Sounds. They concluded that, while the overlap of dusky dolphin habitat use with proposed marine farms is high, dolphins rarely used areas within the existing farms. Duprey (2007) also reported some avoidance of mussel farms by dusky dolphins as well as bottlenose dolphins where few groups across both species were observed inside mussel farms. Pearson et al. (2012) found that, while the foraging activity of the same population of dusky dolphins increased in waters adjacent to mussel farms, their foraging was compromised inside or near mussel farms, where it was argued that cultivation lines interfered with cooperative feeding behaviour.

With respect to South Island Hector's dolphin, which have specialised habitat requirements relative to many other New Zealand marine mammals (e.g., Roberts et al. 2019b), Lloyd (2003) concluded that large-scale mussel farms have the potential to restrict their movements and available habitat space. Valdés (2021) obtained a decreased rate of Hector's dolphin acoustic detections in bays with mussel farms than those without. Also, in the bays where farms were located, Hector's dolphins were more frequently detected over at the other side of the respective bays. Clement (2013) noted that habitat exclusion could be more of an issue for vulnerable populations comprised of few individuals (such as Māui dolphin), where this removes access to key habitat, such as nursery grounds.

McConnell (2019) concluded that the information on how other delphinid species might perceive and behave around shellfish farms is quite limited. Anecdotally, Visser (2007) noted that orca tended to avoid entering marine farms in New Zealand.

Globally, Ribeiro et al. (2007) found that the Chilean dolphin (*Cephalorhynchus eutropia*) (a close relative of Māui and Hector's dolphins) avoided high density areas of mussel farms, although were present in and around mussel farms when these were at lower densities (less than 30% coverage). Avoidance behaviour was also reported by Watson-Capps and Mann (2005) of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) around oyster farms in Shark Bay, Western Australia. Contrary to this, Díaz López and Methion (2017) found that bottlenose dolphins frequently used a mussel farm area in Spain, arguing that the dolphins were attracted to the mussel rafts, which act as fish aggregation devices (note that these are not used for mussel farming around New Zealand). Habitat exclusion may be less likely to be an issue for migratory baleen whales, for which individuals typically have very large distributional ranges, which can change through time with the spatial availability of key prey taxa (Barlow et al. 2020).

Rather than being excluded, fur seals and other pinnipeds are typically attracted to novel structures and habitat, such as those created by aquaculture structures (Clement, 2013). Given their generalist dietary habit (reviewed by Baird 2011), it follows that they should be able to exploit a wide range of habitat types and, so, would be less affected by habitat exclusion at a particular location.

## 4.3. Trophic effects

Shellfish farms can alter benthic communities in a number of ways, including: organic enrichment of the seabed underneath farms, a build-up of shell litter, smothering of benthic organisms, biofouling, and seabed shading (MPI 2013). Of these, organic enrichment is deemed to have the greatest effect on benthic communities and can potentially attract benthic and demersal predators, which may include suitable prey species of marine mammals (Würsig & Gailey, 2002).

Of the marine mammals known to occur around the spat farm proposed by NWML, Māui and Hector's dolphin, common dolphin, orca, and New Zealand fur seal are known to prey on benthic species (Baird 2011; Meynier et al. 2008; Miller et al. 2013; Visser 2007). In a study of Hector's dolphin interactions with mussel cultivation farms around Banks Peninsula, Valdés Hernández (2021) found that bays without mussel farms had a lower fish biomass compared with bays *with* mussel farms, including the key prey species of Hector's dolphin (Miller et al. 2013). However, the same study also found that, within bays with farms, sample locations within farm boundaries had a lower density of prey than those outside. The first observation would be consistent with mussel cultivation farms attracting prey, whereas the second observation is consistent with the farms excluding them in some way. However, in both cases there was no baseline information (i.e., pre-construction of the farms) with which to confirm the longitudinal effects of these farms on fish prey species.

Floating mussel farm structures provide artificial reef substrate for macroalgae, bryozoans and molluscs. Mussel farm structures can also attract fish aggregations, which may potentially draw in marine mammals looking for food or shelter (Kemper et al. 2003, Callier et al. 2018). Anecdotal evidence suggests that some dolphin species occurring around New Zealand may feed on aggregations of fish near mussel farms (Kemper et al. 2003).

Shellfish farms can cause bottom-up changes to ecosystem function (Lloyd 2003), although the magnitude of effect is typically minor relative to finfish farms (Boyd et al. 2005). While the potential for aquaculture to cause habitat degradation has been considered in the literature (e.g., Würsig & Gailey 2002; Kemper et al. 2003), there have been no studies to date to assess the extent of related indirect effects on marine mammals (Clement 2013).

## 4.4. Marine debris

Debris can affect marine mammals when it is ingested or causes entanglement (Baulch & Perry 2014). In extreme cases, ingestion of debris leading to blockage of the digestive tract can cause starvation and death. Potential sub-lethal effects of ingestion include malnutrition, disease and exposure to toxins. Entanglement in debris can lead to drowning, injury and impaired foraging efficiency. However, while plastic debris ingestion is common globally, and some New Zealand marine mammals do become entangled in marine debris (Mattlin & Cawthorn 1986; Derraik 2002), ingestion of marine debris is rare in marine mammals around New Zealand (Dr W. Roe, Massey University, pers. comm.).

Microplastics are found throughout the marine environment and are produced by the fragmentation of marine plastic debris as well from as terrestrial sources (Nelms et al., 2019). An assessment of UK marine mammals found that microplastics were present in all fifty of the assessed individuals, including whale, dolphin and pinniped species (Nelms et al. 2019). With respect to mussel farming equipment, microplastics could potentially be produced via the physical degradation of synthetic ropes, which can be mitigated to some extent by replacing worn gear.

## 4.5. Vessel strike

Vessel strike is increasingly recognised as a conservation issue for global marine mammals (IWC, 2014). Factors increasing the probability of collision with marine mammals include: large vessel size (Laist et al., 2001; Jensen & Silber, 2003); faster vessel speeds, noting that the probability of lethal collisions increases over 12 knots (Laist et al. 2001; Vanderlaan & Taggart 2007); the occurrence of large whales species, which are most commonly hit by vessels (Laist et al., 2001; Jensen & Silber, 2003; Van Waerebeek et al., 2007); and the occurrence of species that spend long periods at or near the surface or that are attracted to vessels (Constantine et al. 2012; Würsig et al., 1998). Specifically with respect to Hector's dolphin, Stone & Yoshinaga (2000) highlighted the risk of vessel strike to calves of this species.

Marine mammal species occurring around spat farms may be susceptible to collisions with vessels required for both the construction and operation of spat farms, as well as marine mammals occurring along routes regularly used by vessels between spat farms and the shore, particularly during periods when marine mammals are likely to have calves in attendance.

## 4.6. Underwater noise

Underwater noise is widespread, and yet the effects on marine mammals are generally poorly understood, particularly for larger whales (Weilgart 2007; Wright 2008). Marine mammals may produce sounds for a number of reasons including: communication, foraging, avoidance of predators, and parental care (Thomas et al., 1992; Johnson et al., 2009). Odontocetes use echolocation for foraging and navigation, whereas all marine mammals listen to underwater noises for navigational cues. Underwater noise may interrupt natural behavioural patterns (e.g., feeding, breeding, and resting behaviours). Temporary avoidance by marine mammals has been reported in the vicinity of very high intensity acoustic disturbance (Stone & Tasker, 2006), whereas attraction to low intensity acoustic disturbance has been reported in some species (e.g., Würsig et al., 1998; Simmonds et al., 2004), e.g., the temporary attraction of some dolphins to boat noise (e.g., Dawson et al, 2000). Ultimately, avoidance behaviour can cause temporary displacement from key habitat, which could become longer term displacement if this is protracted.

The underwater noises produced by mussel farming are likely to be minimal relative to other anthropogenic underwater noise sources, although this will vary according to farm size and layout, location, water depth, benthic sediments, and the shape of coastline, as well as operational requirements. It is likely that the installation of screw anchors will generate the highest noise levels during the construction of the proposed spat farm (see Figure A-1). McConnell (2019) concluded that underwater noises associated with construction phase of a mussel spat farm Whitianga could result in some short-term behavioural responses from marine mammals, including the attraction of naturally curious species (Clement, 2013) and the potential displacement of others (Morton & Symonds, 2002).

### 4.7. Cumulative effects

Cumulative effects arise where different stressors interact with each other. Globally, the cumulative effects of human activities of marine mammals are very poorly understood and difficult to predict (Wright & Khyn, 2014). However, multiple activities relating to mussel farms can potentially contribute to habitat exclusion (e.g., underwater noise and physical displacement), which could be an issue for more range-restricted and vulnerable populations. Furthermore, some mussel farm effects could potentially interact with other anthropogenic stressors, e.g., any entanglement mortalities that result from fish farming would exacerbate the population effects of wild fisheries-related mortalities and other anthropogenic stressors.

With respect to the West Coast of the North Island, the marine mammal sanctuary (Figure C-6) places restrictions on some noise-producing marine industrial activities, including seabed mining and acoustic seismic surveys. The volume of boat traffic around Raglan is not as high as some other regions of New Zealand. Extensive fishing area restrictions along the West Coast of the North Island are likely to substantially minimise the direct effects of commercial fishing on resident Māui dolphin (DOC/MPI 2021). Also, the relative lack of pot fishing along the West Coast of the North Island, particularly north of Cape Egmont and south of Northland, will minimise the direct effects of *local* fishing effort on baleen whales, although most of these will use or migrate through areas of relatively high effort (e.g., the Kaikoura Coast), such that stressors acting on marine mammals along the West Coast of the North Island can interact with *distant* activities.

For the more vulnerable populations, such as Māui dolphin, even low numbers of additional mortalities can have an appreciable population effect and would exacerbate the effects of other lethal threats. Other notable threats to Māui dolphin include toxoplasmosis mortality, brucellosis (a bacterial disease), and climate-mediated changes in prey, as well as the historical and current effects of commercial fishing (Roe et al. 2013). The potential cumulative effects of mussel farming on benthic habitat combined with other human stressors of benthic habitat (such as river management, coastal sedimentation, and bottom trawling) are poorly understood, precluding the quantitative assessment of the risk of cumulative effects. Hence only a qualitative assessment of cumulative effects is attempted below.

## 5. Assessment of effects

This section summarises the potential effects of the mussel spat catching/nursery application by NWML on marine mammals. Specific information with respect to the impacts of spat catching farms on marine mammals is scarce, although MPI (2013) concluded that, for most species, the effects were likely to be similar or lesser than for the cultivation stage and that this was likely to be true for all the different types of effect (see the previous section). However, entanglements of medium and large-sized whales may be an exception to this generalisation (MPI 2013).

Below I summarise the potential effects (defined using a qualitative scale of the relative magnitude of population effect) to marine mammals associated with each potential effect type (see Section 4) relating to the mussel spat catching/nursery application by NWML (see Section 2). Habitat exclusion/modification and entanglement are generally considered to be the greatest risks of shellfish farms to marine mammals (Clement 2013; Würsig and Gailey 2002) and, so, should be given most consideration.

For each potential effect, I conclude with my opinion of the magnitude of effect, using these categories (following the approach of McConnell 2019 and guided by the Ecological Impact Assessment guidelines of the Environment Institute of Australia and New Zealand (Roper-Lindsay et al. 2018)):

- **Negligible** – the activity may have an effect, but this is unlikely to be undetectable or of ecological significance to marine mammal populations;
- **Minor** – the activity may have a detectable effect, but this was considered to be of low ecological significance to marine mammal populations; or
- **Moderate** – the activity would have a detectable effect, and this was considered to be of moderate ecological significance to marine mammal populations.

Māui dolphin were summarised separately, given their highly threatened status. South Island Hector's dolphin were not considered given the very low proportion of individuals that would be affected by processes occurring on the West Coast North Island. The potential effects of each threat were assessed at the level of the Māui dolphin sub-species, consistent with the New Zealand government approaches to risk assessment and management, which treat Māui dolphin as a single homogenous breeding population (DOC/MPI 2021). Thus, for **Māui dolphin** it was concluded that:

- the potential effects of **habitat exclusion** are likely to be **minor**, since:
    - although the home ranges of individual Māui dolphins are likely to be small ("a conservative estimate indicates that the mean along-shore range for Maui's dolphins is at least 35.5 km") (Oremus et al. 2012) compared with the total proposal area of 700 ha (7 $km^2$), the total spatial extent of the proposal is small relative to the range of the Māui dolphin sub-species (Figure B-2), such that the effects would likely be minor at the sub-species level;
    - note that this potential effect, in particular, would need to be reviewed with any changes in aerial coverage from what was proposed, noting the location of the proposed activities at the southern end of the core range of Māui dolphin;
- the potential effects of **entanglement** are likely to be **minor**:
    - since dropper lines would be impregnated with lead cores in order to affect strong negative buoyancy and help with echolocation, and would be deployed in loops rather than spread out as individual dropper lines (see Figure A-1); and
    - so long as the structure is adequately tensioned, including the anchor and backbone lines.
- the potential **trophic effects** are likely to be **minor**, since:
    - although there is conflicting evidence about the effects of mussel *cultivation* farms on Hector's and Māui dolphin prey;
    - and the aerial extent of the proposal area is large relative to the potential home range sizes of individual Māui dolphin;
    - any benthic impacts from the proposed spat-catching/nursery activity are likely to be less than from a mussel cultivation farm; and

    - a prior baseline assessment described the benthic habitat under the proposed fish farm as a "featureless muddy sand sea floor, with no sensitive habitats, reefs or rocky outcrops, and few, if any, epifauna" (Grange 2017);
- the potential effects of **marine debris** are likely to be **negligible**, so long as:
    - ropes are made of high-quality, durable polyethylene that is 'stabilised' to prevent degradation by ultraviolet light; and
    - ropes and other gear are replaced before they degrade and structures are regularly inspected and maintained, as required;
- the potential effects of **vessel strike** and **underwater noise** are likely to be **minor**, so long as:
    - Marine Mammal Protection Regulations 1992 are complied with, specifically noting the regulation to use "best endeavours to move the vessel at a constant slow speed <u>no faster than the slowest marine mammal in the vicinity</u>, or at idle or "no wake" speed" when within 300 metres of any dolphin or other marine mammal;
    - the speeds of operational vessels do not exceed 12 knots in regions where **Māui dolphin** are most likely to occur (Figure 2), especially between Raglan town and Block D where juveniles are most frequently reported as seen, and the lesser of 10 knots and the slowest marine mammal when within 300 m of observed Māui dolphin;
    - there is extra vigilance during and immediately after the typical calving period for Māui dolphins (November–February); and
    - since noise levels of the proposed spat catching/nursery activities are likely to be less than those generated by a mussel cultivation farms (White, 2018); and
    - since underwater noise associated with the installation of the screw anchors is likely to be low relative to marine activities, e.g., pile driving and seismic surveys, and installation would occur over a finite period such that any effects would be temporary in nature;
- **Cumulative effects** are difficult to assess from the available information and may be at least **minor**, based on this being, in my opinion, the greatest magnitude for any single assessed effect.

For the **remaining marine mammal species** occurring around the mussel spat catching/nursery application, it was concluded that:

- the potential effects of **habitat exclusion** on **all other species** are likely to be **negligible**;
- the potential effects of **entanglement** on **common dolphin** and **orca** and are likely to be **minor**:
    - since dropper lines would be impregnated with a lead core to promote negative buoyancy and to help with echolocation; and
    - so long as lines are adequately tensioned;
- the potential effects of **entanglement** on **baleen whales** are likely to be **minor**:
    - so long as lines are adequately tensioned; and
    - so long as there is increased vigilance during periods when respective species migrate along the West Coast of the North Island;
- the potential effects of **entanglement** on **New Zealand fur seals** are likely to be **negligible**, so long as lines are adequately tensioned;

- the potential **trophic effects** for **all other species** are likely to be **negligible**, since:
    - the proposal area is relatively small (700 ha, or 7 km$^2$) compared with the geographic home-ranges of all other marine mammal species that occur here;
    - any other marine mammal species feeding on benthic prey (e.g., orca and some New Zealand fur seals) are also generalists;
- the potential effects of **marine debris** for **all other species** are likely to be **negligible**, so long as:
    - ropes are made of high-quality, durable polyethylene that is 'stabilised' to prevent degradation by ultraviolet light;
    - ropes and other gear are replaced before they degrade and structures are regularly inspected and maintained, as required;
- the potential effects of **vessel strike** and **underwater noise** for **all other species** are likely to be **negligible**, so long as:
    - the speeds of operational vessels do not exceed 12 knots in regions where **orca** occur;
    - Marine Mammal Protection Regulations 1992 are complied with; and
    - since noise levels of the proposed spat catching/nursery activities are likely to be less than those generated by a mussel cultivation farms (White, 2018); and
    - underwater noise associated with the installation of the screw anchors is likely to be low relative to marine activities, e.g., pile driving and seismic surveys, and installation would occur over a finite period such that any effects would be temporary in nature;
- **Cumulative effects** are difficult to assess from the available information, although are unlikely to be more than **minor**, given that none of the individual effects were rated to have more than a minor effect for any other marine mammal species.

Any effects relating to the establishment of the proposed spat farm that impact on threatened species/populations may be disproportionately felt in terms of population risk. Based on the review in Section 3, threatened species/sub-species (Baker et al. 2019) that are likely to be present in and around the proposed spat farm include Māui dolphin (classified as 'Nationally Endangered'), South Island Hector's dolphin ('Nationally Vulnerable'), and orca ('Nationally Critical'). Furthermore, southern right whale ('At risk – Recovering') may infrequently be present on a seasonal basis.

# 6. Mitigating risks to marine mammals

## 6.1. Measures proposed by NWML to mitigate risks to marine mammals

Siting mussel farms in areas to minimise or avoid the likelihood of spatial overlap with species' home ranges, critical breeding and foraging habitats or migration routes continues to be the most effective option for preventing adverse effects on marine mammals. However, some species, including vulnerable Māui dolphin *do overlap* with the proposed spat catching/nursery application (Section 3). Hence, NWML have been applying some operational approaches as precautionary measures specifically to minimise the potential impacts on Māui and Hector's dolphins. These include:

- organising the layout to include sufficient spacing between lines for dolphins to swim between them;
- the use of pingers on the corners of each site;

- adequate tensioning of warps and backbones with hydraulic barge winches;
- self-tensioning spat catching rope with added negative buoyancy;
- impregnating spat catching rope with a lead core, which acts as a sonar deflection mechanism as well as causing negative buoyancy;
- regular infrastructure inspections and maintenance to ensure structural integrity
- deployment of best practices to minimise impacts from vessel activity;
- monitoring and reporting of marine mammal interactions; and
- strict protocols to avoid marine debris.

NWML have not yet proposed any measures specifically to address potential entanglements of other marine mammal species, including large baleen whales and New Zealand fur seals, although the above measures would also be effective for other species. Some additional options are proposed below to address residual risks.

### 6.2. Additional measures for mitigating residual risks

Additional measures for mitigating residual risks are proposed, as follows:

- ropes and lines should be *monitored regularly* to ensure that they are adequately tensioned;
- ensure that anchor warps do not overlap or cross between farm blocks;
- minimise the use of artificial lighting;
- minimise underwater noise produced during the construction of farm structures and during operations;
- compliance with Marine Mammal Protection Regulations 1992, specifically to regulations relating to at-sea contact with marine mammals; and
- increasing the vigilance of marine mammal monitoring around the proposed spat catching/nursery application during months when southern right whales (July to November) and humpback whales (June and October) are most likely to be present off the West Coast of the North Island. The risk of entanglement for these species may, where possible, be further reduced by avoiding the deployment of dropper lines when these species are most likely to be present.

Specifically with respect to Māui dolphin, a staged approach to the construction of blocks A–D could be implemented, with monitoring of Māui dolphin presence at intermediate steps. For example, two of blocks A–C could be constructed in the first phase (i.e., avoiding Block D initially, which has several juvenile dolphin sightings around it). These structures could then be used for the attachment of passive acoustic monitoring devices for assessing the spatial and seasonal occurrence of Māui dolphin (also see Section 6.3, noting that this can also be used to monitor other marine mammal species). The new information could then be used to reappraise the effects of developing the remaining blocks.

I recommend that the management practices required to implement all mitigation measures are formalised into a **Marine Mammal Management Plan (MMMP)**, describing protocols that will be implemented to minimise the effects of the proposed spat catching/nursery application on marine mammals. The MMMP would be developed in consultation with DOC and must:

- include strict guidelines to reduce potential entanglement risks;
- establish reporting and response procedures in the event of marine mammal interactions with farm structures (including all entanglements, injuries and deaths);
- ensure that staff regularly monitor for the presence (and absence) of marine mammals and provide sighting records to DOC, including details of species observed, numbers of individuals (including separate counts of juveniles), and other details; and

- assess the efficacy new mitigation approaches and management modifications on an adaptive basis.

The MMMP should be prepared by the consent holder at least four months prior to the first installation of structures under this consent and should be signed-off by a suitably qualified and experienced marine scientist. An advanced draft version of the Marine Mammal Management Plan should be provided to DOC for comment and then be provided to the Waikato Regional Council, along with any comments provided by DOC.

### 6.3. Options of monitoring marine mammals and their threats

The proposed spat catching/nursery application is located at the southern end of the probable core range of Māui dolphin and will use structures that are fixed in the water column over a protracted period. Therefore, there may be an opportunity to collect additional data that can be used to describe the seasonal/diurnal alongshore and offshore distribution of this species around the four sites of the application (Figure 1). With respect to acoustic monitoring, C-PODs (also T-PODs and F-PODs) have previously been used to detect the click trains of Māui dolphin and other dolphins or toothed whales around New Zealand (e.g., Nelson & Radford 2019). However, sound recordings using hydrophones would be required for detecting baleen whales which do not echolocate, and which migrate around the West Coast of the North Island in certain months. This may also be a better, if potentially more costly, approach for the acoustic detection of Māui dolphin since there is a sound recording, rather than just the positive detections of a C-POD, which are harder if not impossible to validate retrospectively.

I recommend that NWML contact DOC and/or relevant researchers to discuss the potential for attaching the appropriate passive acoustic monitoring devices to the farm structures to monitor Māui and Hector’s dolphins and potentially other marine mammal species. Note that it is likely that appropriate measures would need to be put in place (and included in the MMMP) to ensure that any related modifications and attachments to farm structures do not compromise the management of potential effects on marine mammals. The data collected from this monitoring could then be used to identify periods when Māui dolphin are most likely to be present around the proposed activity.

Toxoplasmosis is a major anthropogenic threat for Māui dolphins (Roberts et al. 2019; Roe et al. 2013), caused by a parasite spread by cats. The prevalence of *T. gondii* oocysts in the water column can be monitored by sampling the tissues of green-lipped mussels (Coupe et al. 2018). Therefore, I recommend that NWML approach DOC and/or the relevant researchers to discuss the development and implementation of a protocol for collecting mussel samples that can be analysed be a suitable laboratory for the presence of *T. gondii* oocysts. Note that both Māui dolphins confirmed by formal necropsy to have died from toxoplasmosis were recovered in the Raglan area (one beachcast and the other found floating at-sea) (Roberts et al. 2019). Also, all confirmed fatalities of Māui and Hector’s dolphin from toxoplasmosis were recovered in the period from September to November (Roberts et al. 2019; Roe et al. 2013). Mussel sampling in the Raglan area could be useful for determining the seasonal and spatial distribution of *T. gondii* oocysts in the water column and, potentially, for the genetic identification of the likely source cat populations on the mainland.

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# 9. Appendix A – Indictive structural diagram of a spat catching line

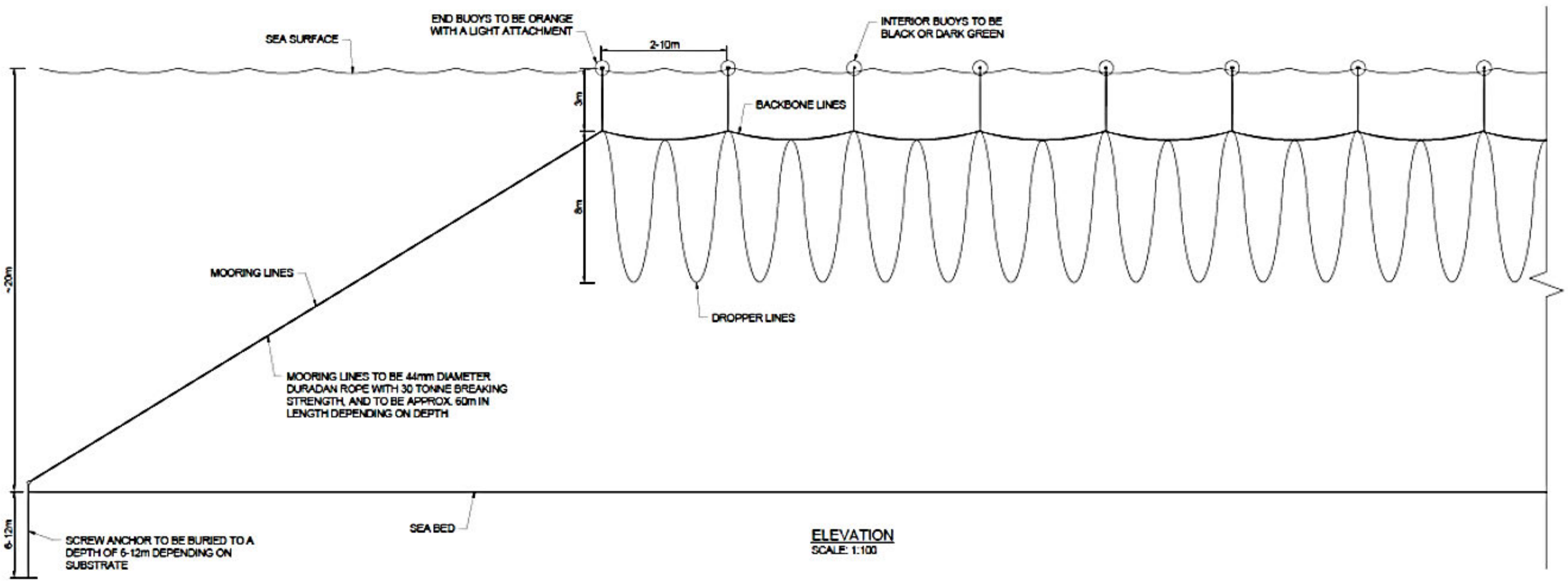


Figure A-1. Indicative structural diagram of a spat catching line. Diagram provided by ADL/NWML.

## 10. Appendix B – Supplementary data plots

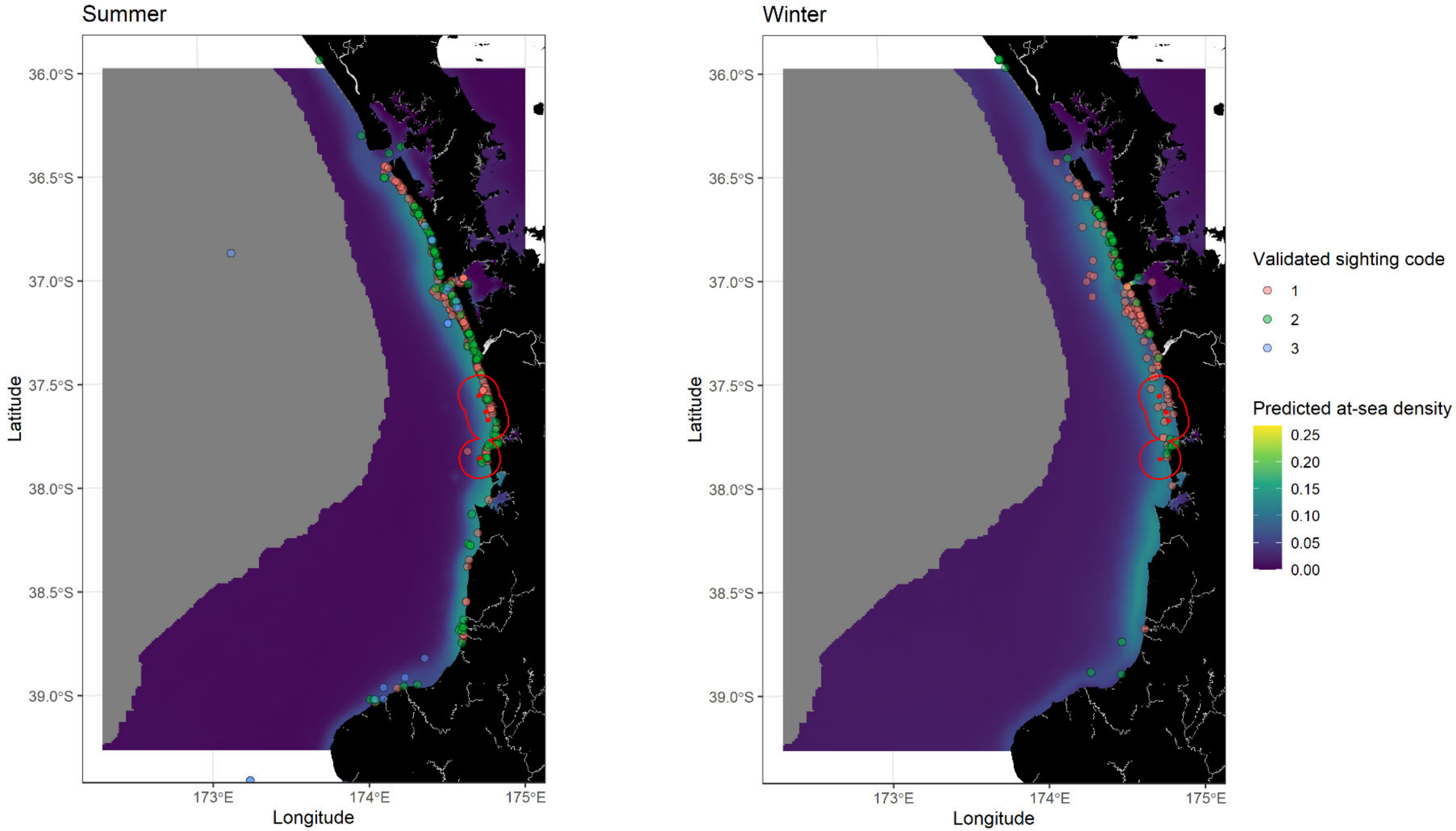


Figure B-2. Predicted at-sea density of **Māui and Hector's dolphins** along the West Coast of the North Island (colour scale), the locations of validated sightings by validation status (1 = highest confidence, 3 = lowest confidence, although description still consistent with Māui dolphin), and the locations of the proposed mussel spat farm structures (10 km buffer zone highlighted using red line). The at-sea density was as predicted by Roberts et al. (2019b); the sightings records were from DOC (2022a).

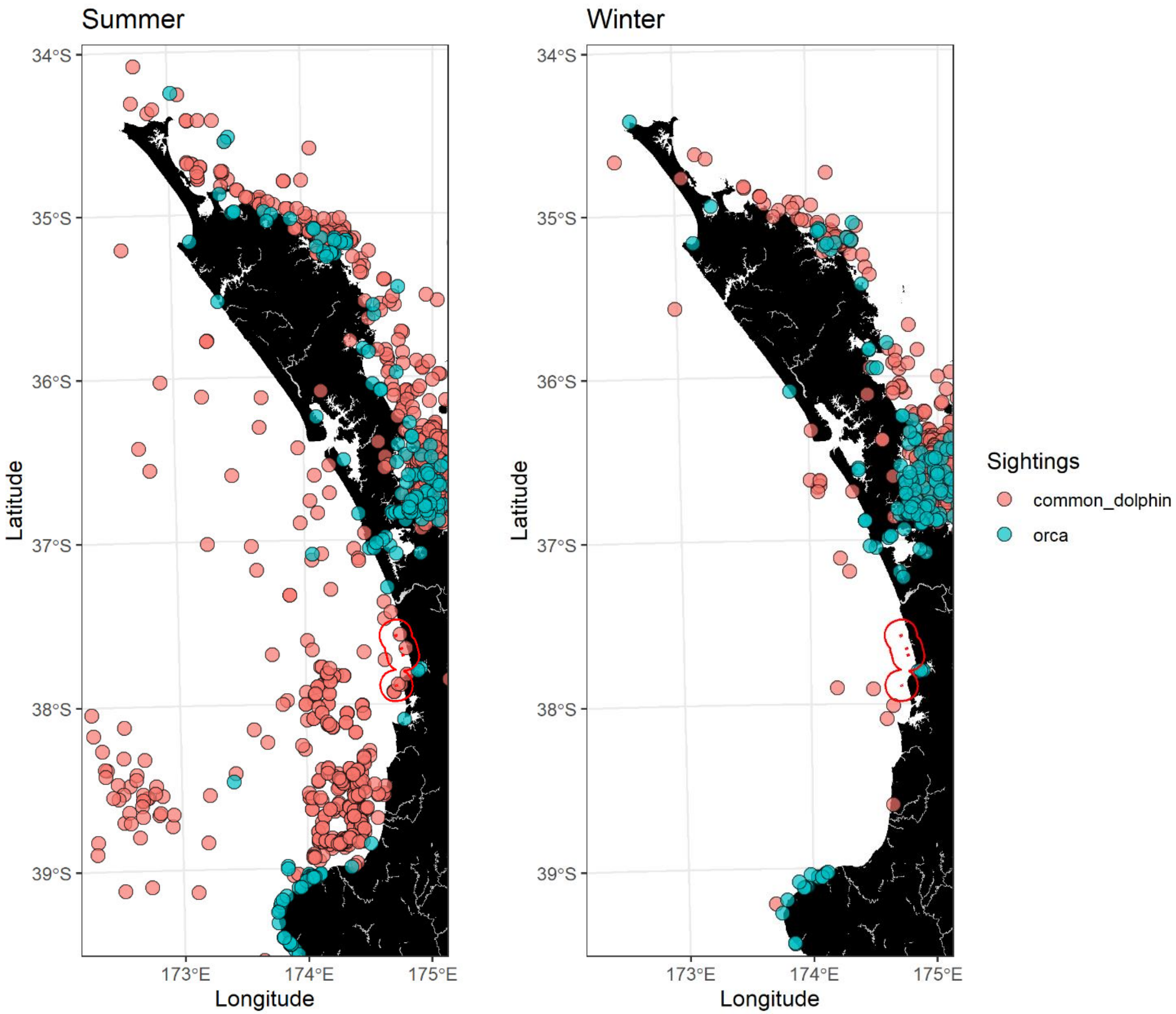


Figure B-3. The locations of sightings of **common dolphin and orca**, and the locations of the proposed mussel spat farm structures (10 km buffer zone highlighted using red line). The source of the sighting records was DOC (2022c).

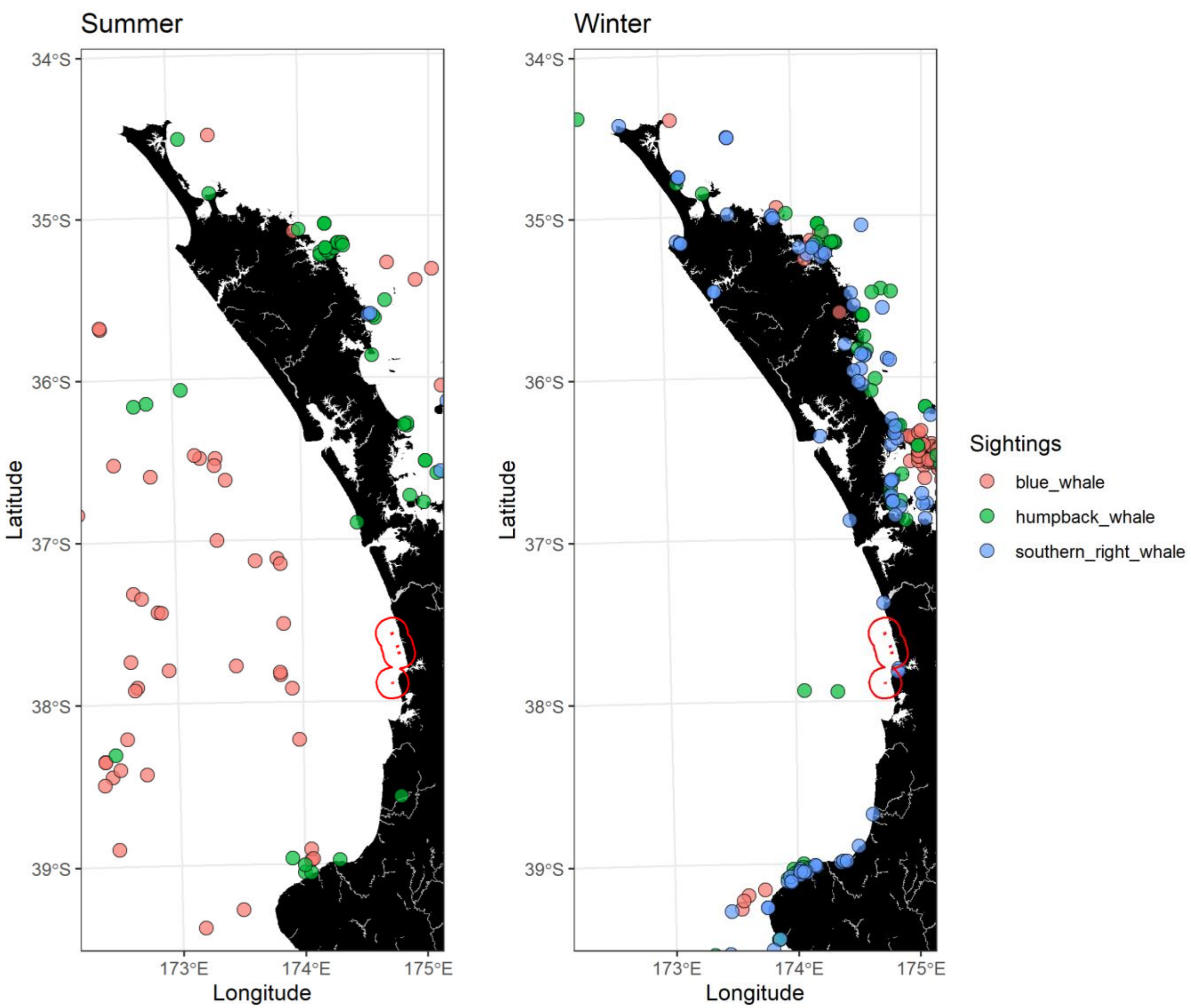


Figure B-4. The locations of sightings of **blue whale, humpback whale, and southern right whale**, and the locations of the proposed mussel spat farm structures (10 km buffer zone highlighted using red line). The source of the sighting records was DOC (2022c).

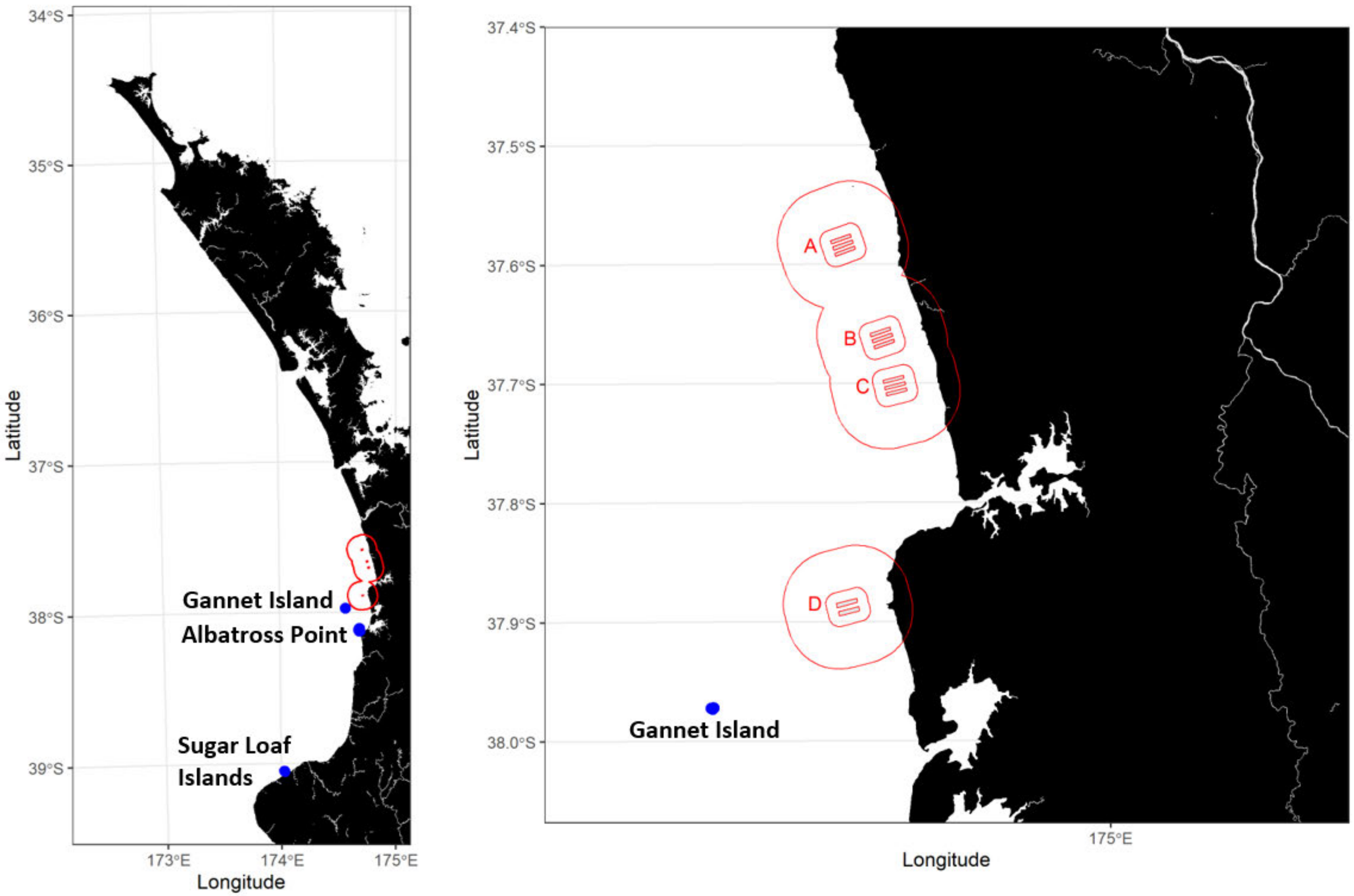


Figure B-5. The locations of known **New Zealand fur seal** breeding rookeries off the West Coast of the North Island, and the locations of the proposed mussel spat farm structures (10 km buffer zone highlighted using red line on left-hand plot, 1km and 5km buffer zone highlighted in right-hand plot). The source of the rookery locations was MPI (2012).

## 11. Appendix C – West Coast North Island Marine Mammal Sanctuary

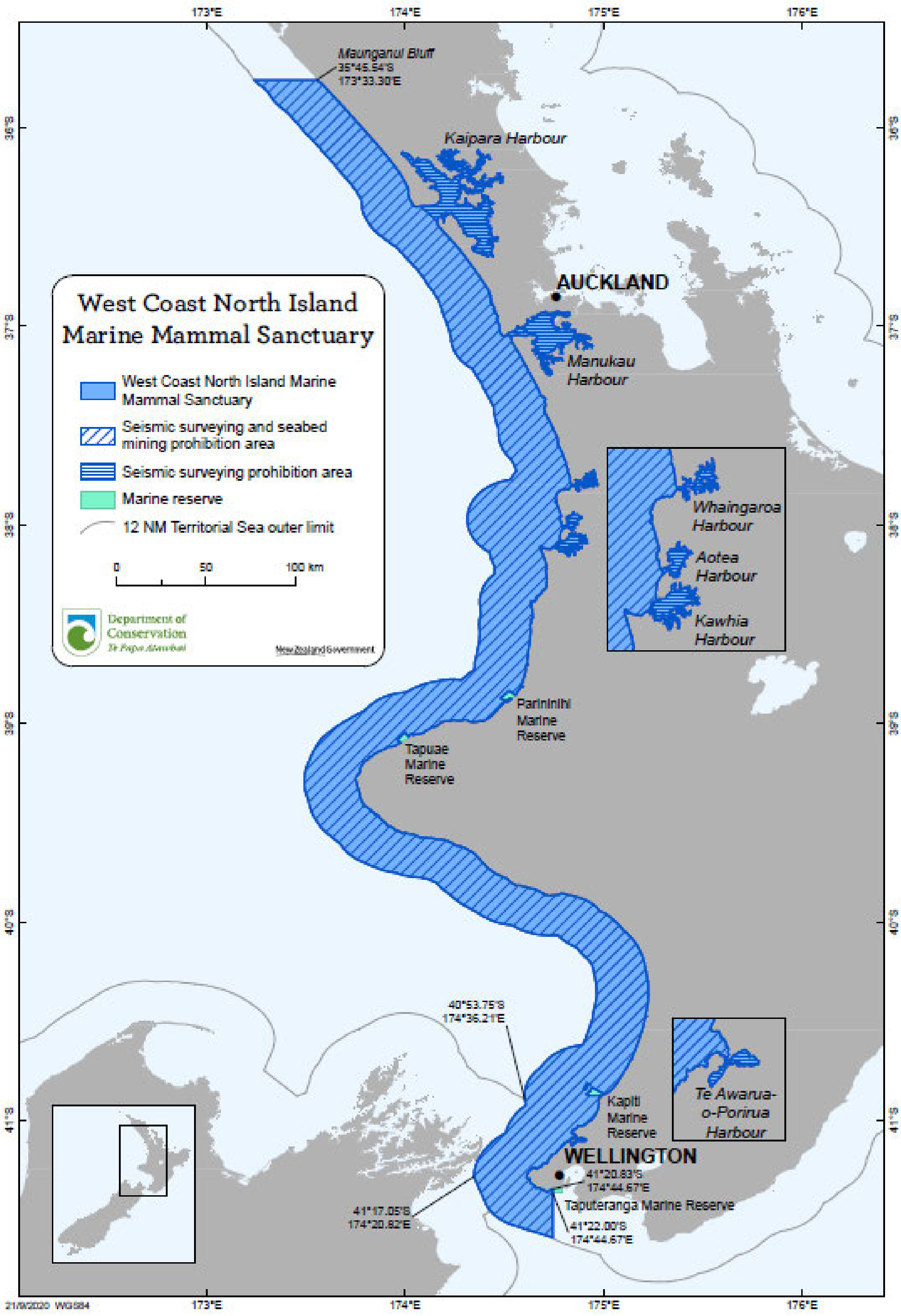


Figure C-6. The arial extent of the West Coast North Island Marine Mammal Sanctuary, imposing restrictions on seismic survey and seabed mining activities within the sanctuary (figure produced by DOC).