ATTACHMENT FOURTEEN

Marine Mammals Environmental Impact Assessment (SLR)

McCALLUM BROS LTD

Established 1904

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

PO Box 71 031
Rosebank
Auckland 1348

Prepared by:

SLR Consulting NZ

6/A Cambridge Street, Richmond, Nelson 7020,
New Zealand

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Revision Record

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Basis of Report

Code of Conduct Reference for Application Material

Although this is not a hearing before the Environment Court, I (Helen McConnell) record that I have read and agree to comply with the Environment Court's Code of Conduct for Expert Witnesses as specified in the Environment Court's Practice Note 2023 as relevant to preparation of a report for this Fast-track application. In particular, I confirm that this report is within my area of expertise, except where I state that I rely upon the evidence or reports of other expert witnesses lodged forming part of the project's application material. I have not omitted to consider any material facts known to me that might alter or detract from the opinions expressed.

MBL Confidentiality Statement

Executive Summary

McCallum Bros Ltd (**MBL**) is aiming to submit a resource consent application to extract sand in Te Ākau Bream Bay. The intention of this application is that sand will be extracted and collected by the purpose-built trailing suction hopper dredge (**TSHD**), the *William Fraser*. A lower annual extraction volume (of 150,000 m^3) is proposed in the first three years of the project, followed by an increase in the annual extraction volume (to 250,000 m^3) for the remainder of the proposed project term. This report assesses the potential impacts of the proposed sand extraction activities on marine mammals.

Marine mammal occurrence and habitat use was determined using Department of Conservation sighting and stranding data, published and unpublished literature, and acoustic monitoring data. Distributional data was reviewed for the coastal marine area (**CMA**) from the Bay of Islands/Pēwhairangi in the north to the Hauraki Gulf/Tikapa Moana in the south; however, sightings within Te Ākau Bream Bay were further interrogated to gain a more comprehensive understanding of how frequently species occur here. A recently released report (Brough et al., 2024) added invaluable information about fine-scale habitat use in Te Ākau Bream Bay.

Assessment findings suggest that waters of the wider region are used by c. 30 marine mammal species. Evidence suggests that Te Ākau Bream Bay supports foraging, breeding and resting behaviours, and includes important habitat for bottlenose dolphins. However, virtually all species that have been identified as having a likely or possible presence here have large home ranges, so the proposed sand extraction area would only represent a very small part of their overall distribution. The only potential exception to this is for bottlenose dolphins that have a high degree of residency to Te Ākau Bream Bay; as indicated by both acoustic monitoring data collected by Styles Group (2025) and boat-based survey data from Brough et al. (2024).

Actual and potential impacts on marine mammals from the proposed sand extraction activities were identified as underwater noise, habitat modification, ship strike, exposure to contaminants, marine debris, entanglement, artificial lighting and cumulative impacts. Each of these potential impacts has been thoroughly described and assessed in the context of the marine mammal species and habitats that could be affected, and also on the basis that the following mitigations will be implemented to minimise and manage potential adverse impacts on marine mammals from the proposed sand extraction activities. These mitigations form part of the application and associated management plans and should be reflected in consent conditions where appropriate.

<u>To minimise and manage the potential impacts of underwater noise:</u>

- While recognising the efforts to date made by MBL to reduce noise outputs, and their ongoing commitment to undertake regular maintenance of extraction equipment, any further efforts to reduce the noise source level (e.g. the consideration of additional quietening technologies as they become available) and/or to further reduce the daily exposure duration would be beneficial to minimising the potential changes to the existing Te Ākau Bream Bay soundscape; and
- Monitoring Programmes will be implemented to:
  - Validate the predictions of the underwater acoustic modelling in terms of soundscape change by demonstrating that any change in the soundscape level arising from sand extraction does not exceed 3 dB, or if it is greater than 3 dB, to stipulate additional mitigation measures to reduce/manage the soundscape change to an acceptable level (the ‘Acoustic Monitoring Programme’); and
  - Support the continuation of boat-based research surveys in Te Ākau Bream Bay.

To minimise and manage the potential impacts of ship strike:

- The *William Fraser* will be operated in compliance with the Marine Mammal Protection Regulations 1992 (**MMPR**);
- The Hauraki Gulf Transit Protocol will be implemented. Noting that for this application, this protocol will be implemented not only in the Hauraki Gulf but in all waters subject to transit and extraction activities associated with this application;
- In addition, vessel masters and crew will maintain vigilance for marine mammals and will complete a marine mammal sighting form[1] for each cetacean sighting that is made; and
- All vessel strike incidents or near incidents, regardless of outcome, will be recorded and reported.

To minimise and manage the potential impacts of marine debris:

- Appropriate waste management programmes must be adopted during all components of the proposed sand extraction activities;
- Compliance with Resource Management (Marine Pollution) Regulations 1998; and
- MBL must collect and retrieve any obvious marine debris during extraction and safely dispose of these onshore.

To minimise and manage the potential impacts of entanglement:

- The draghead and all other operational equipment in the water column must be free from loose lines, loops of tubing etc;
- Free-floating or slack lines must be avoided;
- Suction of the draghead must be restricted to within 3 m of the seafloor;
- While extracting, the *William Fraser* must be operated in a consistent manner in terms of direction and speed;
- The extraction vessel master and crew must remain vigilant for marine mammals during active extraction, and be prepared to shutdown extraction if necessary;
- A 100 m exclusion zone for large whales (killer whales and larger, including all baleen whales) must be implemented around the extraction vessel and draghead such that active extraction must cease if a large whale enters this zone; and
- Extraction must not recommence until the large whale has been resighted and has moved away from the draghead/vessel, or until there has been no further sightings for 10 minutes.

MBL has prepared a Marine Mammal Management Plan (**MMMP**) for the project which will be lodged as part of the application. The results of this assessment found that with the adoption of the proposed mitigations, the overall level of impact of the project activities on marine mammals' ranges from **negligible** to **low**.

[1] As presented in the Marine Mammal Management Plan.

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Acronyms and Abbreviations

CEA	Cultural Effects Assessment
CI	Confidence Internal
CMA	Coastal Marine Area
CVA	Cultural Values Assessment
DOC	Department of Conservation
HF	High frequency
IMMA	Important Marine Mammal Area
IUCN	International Union for Conservation of Nature
Leq	Equivalent Continuous Sound Pressure Level
LF	Low frequency
LSR	Listening Space Reduction
MBL	McCallum Bros Ltd
NMFS	National Marine Fisheries Service (United States)
NZTCS	New Zealand Threat Classification System
NZCPS	New Zealand Coastal Policy Statement
OCW	Otariid Carnivore in Water
PCW	Phocid Carnivore in Water
POAL	Port of Auckland Limited
PRPN	Proposed Regional Plan for Northland
PTS	Permanent Threshold Shift
SLR	SLR Consulting NZ
SST	Sea Surface Temperature
TSHD	Trailing Suction Hopper Dredge
TTS	Temporary Threshold Shift
VHF	Very high frequency

1.0 Introduction

McCallum Bros Ltd (**MBL**) is aiming to submit a resource consent application to extract sand in Te Ākau Bream Bay from the area indicated in **Figure 1**. The intention is for this application to be lodged in accordance with the Fast-track Approvals Act 2024.

The proposed extraction area occurs in the vicinity of existing anchorage sites that are used by commercial vessels awaiting berthage at Northport and south and west of the major shipping routes into Northport. Proposed extraction will occur beyond the outer depth of closure in Te Ākau Bream Bay (i.e. the morphodynamic boundary separating the active coastal zone, in terms of sediment transport, from the inactive seaward zone).

MBL supply coastal sand to concrete manufacturers and the proposed extraction in Te Ākau Bream Bay will represent an expansion of the existing sand extraction operations in the Mangawhai-Pākiri embayment which have been occurring since the 1940's.

The overall purpose of this report is twofold:

- To evaluate the available marine mammal data that exists in relation to Te Ākau Bream Bay and surrounds and describe what is known about marine mammal occurrence and habitat use in and around the sand extraction area; and
- To undertake a robust assessment of actual and potential environmental impacts of the planned sand extraction activities, including the proposed mitigation measures (which have been incorporated into the application).

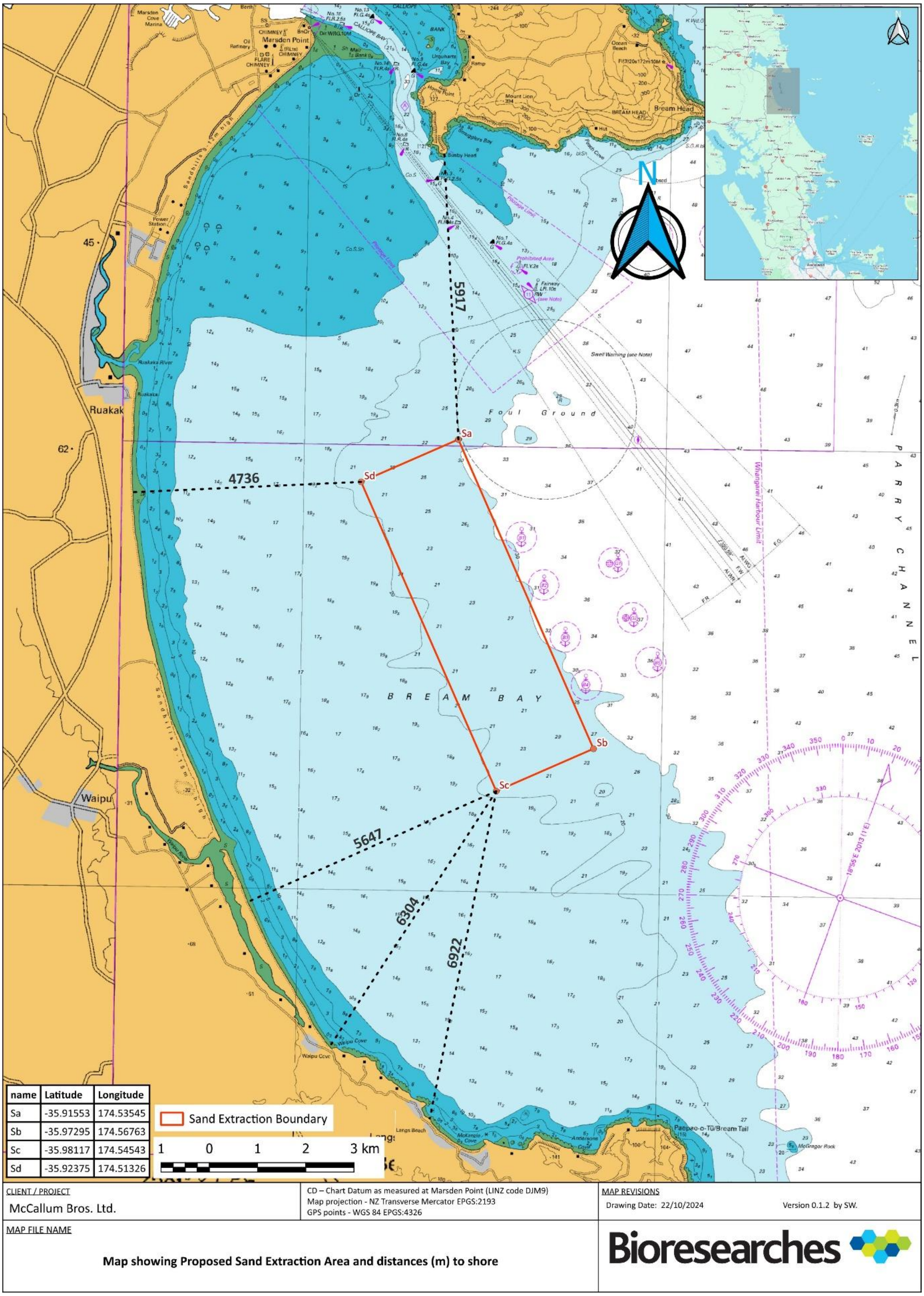

Figure 1 Proposed ‘Sand Extraction Area’ in Te Ākau Bream Bay

2.0 Project Description

For the Te Ākau Bream Bay sand extraction project, MBL are proposing that only one vessel, the *William Fraser*, will be used. The *William Fraser* is a purpose-built trailing suction hopper dredge (**TSHD**) (**Figure 2**) that was built in Malaysia in 2019 for MBL. The *William Fraser* is 68 m long with a hopper volume capacity of 923 m^3.

Figure 2 The *William Fraser* actively extracting sand at Pākiri

Features of the *William Fraser* that minimise environmental impacts are summarised in the bullet points below (McCallum, 2022):

- Euroclass, ACERT marine propulsion engines that meet both EPA Tier 4 and IMO II emission regulations to minimise fuel use and reduce emissions;
- Moon pools to deliver the over size and sediment discharge below the water line to minimise turbidity;
- A Dutch designed screening deck, rather than flume pipes, which reduces damage to live animals passing through the draghead and increases the screening efficiency;
- A draghead designed to minimise seabed disturbance and take a wider and shallower extraction furrow. This also reduces entrainment of burrowing organisms;
- An electric pump to reduce underwater noise and eliminate the possibility of hydraulic oil leaks or spills;
- Acoustically lined engine and pump rooms to reduce engine noise from the vessel; and
- Reduced lighting. As far as possible, the vessel uses subdued and downward facing lighting whilst still complying with Maritime NZ lighting and safety requirements. When the vessel is extracting it must display 'Restricted Ability to Manoeuvre' lighting and have some lighting so the crew can safely work while extracting sand (only applicable outside of daylight-saving hours).

The sand extraction process is summarised as follows:

Typically, the operational cycle would begin when the *William Fraser* leaves the Port of Auckland on the morning of an extracting day in transit to the Te Ākau Bream Bay extraction site. This transit route passes through Tiri Passage, rounds Kawau Island, Takatu Point and Cape Rodney, before travelling along Jellicoe Channel then rounding Paepae-o-tū (Bream Tail) to enter Te Ākau Bream Bay. During transit, the TSHD travels at a maximum of 9.5 knots in keeping with the requirements of the Hauraki Gulf Transit Protocol (Port of Auckland Ltd (**POAL**), 2024) which recommends a speed limit of a maximum of 10 knots to reduce the probability of vessel strike to marine mammals. The *William Fraser* will transit to and from the following alternative ports on a less frequent basis: Port of Tauranga, Kopu Wharf (in Thames), and Northport (in Whangārei).

Before the vessel reaches the extraction area it reduces its speed and begins to prepare the extraction equipment. By the time the vessel is within the extraction area it will be travelling at a speed of 1.5 – 2.5 knots which it maintains while extracting sand.

At this point, the draghead is partially lowered (to ~3 m off the seafloor) in readiness, and the pump is started, and checks are made to ensure that the equipment is functioning properly. Following this, the draghead is lowered completely to the seabed and pumping of sand slurry (a mixture of sand and seawater) commences.

Once aboard, the slurry passes through a 2.5 mm screen to remove any larger material and then into the hopper where the sand settles. The water and any finer sediments pass out of the hopper into one of the six moon pools before being discharged at the keel, and any larger material captured by the screen is also discharged below the waterline.

At the Te Ākau Bream Bay extraction site, a maximum daily extraction time of 3.5 hours will be implemented. This will limit the extraction track length from between 11 – 13 km per extraction day. Once the hopper is full, the draghead is lifted off the seabed and the equipment is flushed with seawater before it is stowed onboard, and the vessel returns to Auckland (or one of the alternative ports listed above) to unload.

Active extraction will be limited to the following operational windows:

- 12:00 pm to 6:00 pm during the months of April to September (inclusive).
- 12:00 pm to 8:00 pm during the months of October to March (inclusive).

The term of the consent sought is 35 years.

MBL are seeking a consent consisting of:

- The first three years of the proposed 35-year term. During this period, 150,000 m^3 of sand will be extracted annually, representing up to 14 trips per month; and
- The next 32 years of the proposed 35-year term. During this period, up to 250,000 m^3 of sand will be extracted annually, representing up to 23 trips per month.

3.0 Description of Existing Environment

This section provides a description of the marine mammal species that have been reported from the project area and surrounds. Marine mammals have extensive home-ranges and because of this, marine mammal distributional data across a broad spatial scale must be assessed to establish a baseline understanding of potential marine mammal presence in the project area. For the purpose of this application, distributional data across the coastal marine area (**CMA**) over a large portion of northeastern New Zealand (from the Bay of Islands in the north to the Hauraki Gulf in the south: **Figure 3**) was reviewed to investigate potential marine mammal presence[2]. In addition, and to gain a more comprehensive understanding of how frequently species occur in and around the project area itself, this assessment further interrogated the available data to identify species that are consistently observed in Te Ākau Bream Bay (which for the purpose of this assessment is defined as being from Te Whare (Bream Head) to Paepae-o-Tū (Bream Tail), and out to the Taranga-Marotere Islands (Hen and Chickens Islands).

3.1 Methodology

Knowledge of marine mammal distribution is typically amassed over long temporal periods from a combination of stranding data, opportunistic sightings data, systematic survey data, and habitat modelling. It is therefore important to analyse multiple data sources when describing marine mammal distribution.

In the absence of any long-term project specific baseline monitoring for marine mammals in Te Ākau Bream Bay, and for the purpose of this report, the following data sources were analysed to determine the likelihood of marine mammal species being present:

1. Sightings data as recorded in the Department of Conservation (**DOC**) Marine Mammals Sightings Database from 1968 to 2024 (DOC Sightings Database) (supplied by H. Hendricks, DOC, 16/05/2024)[3]. See **Appendix A**;
2. Stranding data as recorded in the DOC Marine Mammals Incident Database from 1873 to 2024 (DOC Incident Database) (supplied by H. Hendricks, DOC, 16/05/2024)[3]. See **Appendix A**;
3. Habitat modelling and distribution descriptions (Stephenson et al., 2020 and MacKenzie et al., 2022). See **Appendix A;**
4. SLR marine mammal sighting data collected during water quality monitoring trips. See **Appendix B;**
5. Project specific acoustic monitoring data collected by Styles Group. See **Section 3.2.1**;
6. Patuharakeke Te Iwi Trust Board marine mammal monitoring data. See **Section 3.2.2** and **Appendix C**;
7. Existing acoustic data for Pākiri Embayment collected by Styles Group for MBLs previous resource consent application. See **Appendix D**;

[2] Note that the extent over which the distributional data was reviewed has no bearing on the predicted zone of impacts from the proposed sand extraction but is solely used to predict species that could occur in and around Te Ākau Bream Bay.

[3] Entries in the DOC Sightings and Stranding Databases that do not identify marine mammals to species level were excluded from analysis. Only data points inside Te Ākau Bream Bay have been corrected for duplicate records; hence, sightings in the wider region may contain records of the same animal reported multiple times on the same day.

8 Existing acoustic data for Whangārei Harbour collected by Styles Group for the recent Northport resource consent application. See **Appendix E**; and

9 Knowledge of species distribution and habitat use obtained from published and unpublished scientific literature. See **Table 1**.

While these data sources represent the best available information on marine mammal distribution in and around the sand extraction area, the following data limitations should be noted:

- DOC sightings data is generally collected in a non-systematic manner by non-experts;
- Data gaps in the DOC sightings record do not necessarily reflect an absence of marine mammals; rather they typically reflect a lack of observation effort. Conversely, areas with high levels of sightings occur where marine mammal distributions overlap with well-populated areas, research programmes or regions that actively encourage public reporting of certain species; and
- While the DOC stranding data gives a broad indication of species occurrence, dead animals can wash ashore well away from where they died; and sick or diseased animals may be outside of their normal range prior to death.

After reviewing all data sources, the likelihood of each marine mammal species being present in and around Te Ākau Bream Bay was determined as:

- Likely - species that have a frequent presence in and around the embayment; hence have an increased chance of exposure to the potential impacts of the proposed sand extraction activities (noting that large home ranges mean occurrence will not be continuous in the project area);
- Possible - species that occur on a less frequent basis in and around the embayment; hence may or may not be exposed to the potential impacts of the proposed sand extraction activities; and
- Unlikely – species that are seldom reported from in and around the embayment; hence probably only occur as rare visitors and are unlikely to be exposed to the potential impacts of the proposed sand extraction activities.

3.2 Expected Marine Mammal Occurrence

Marine mammal sightings from the DOC Sightings Database that have occurred from 1968 to 2024 in the vicinity of the sand extraction area are mapped in **Figure 4** (baleen whales and seals) and **Figure 5** (dolphins and toothed whales). Marine mammal stranding locations from 1873 to 2024 are mapped in **Figure 6** and **Figure 7**. A total of 34 species are represented over c. 60 years of sightings and over 150 years stranding data from the area for which distributional data was reviewed. **Appendix A** summarises this data in tabular form, along with any published habitat modelling results.

In addition, other findings that contribute to the conclusions presented in this section with regard to the expected marine mammal occurrence are provided in more detail as follows:

- **Appendix B** – summary of the SLR marine mammal sighting data collected opportunistically during water quality monitoring trips;
- **Section 3.2.1** – Project specific acoustic data collected by Styles Group;
- **Section 3.2.2** and **Appendix C** – Patuharakeke Te Iwi Trust Board marine mammal monitoring data;

- **Appendix D** – Acoustic data collected by Styles Group in the Pākiri Embayment and presented during the recent MBL Pākiri – Mangawhai Embayment Resource Consent Application; and
- **Appendix E** – Acoustic data collected by Styles Group in Whangārei Harbour and presented during the recent Northport Resource Consent Application.

While 34 marine mammal species are known from the region, the available data suggests that only seven species – bottlenose dolphins, common dolphins, Bryde's whales, false killer whales, pilot whales, killer whales, and New Zealand fur seals – commonly visit Te Ākau Bream Bay and the immediate surrounds.

Other species that are expected to be present less frequently include leopard seals, southern right whales, humpback whales, blue whales, sei whales, sperm whales, dwarf minke whales, and Gray's beaked whales. These species are considered to have a possible occurrence in the region, noting that the presence of southern right whales and humpback whales will be seasonal primarily over the months of winter and spring, and that several others are considered offshore deep-water species, e.g. blue whales, sei whales, minke whales, beaked whales, and sperm whales. While these species are less likely to come into direct contact with the proposed sand extraction activities, they could have some exposure to those impacts that extend beyond the immediate extraction area.

The remaining species represented in the DOC sighting and stranding data probably only occur as rare visitors to the region, hence are unlikely to be present around the proposed sand extraction activities.

In general, the findings outlined above reflect the known marine mammal assemblage from the wider northeast region of the North Island and, on this basis, are applicable to all the potential transit scenarios associated with the proposed activities, including supply trips to alternative ports outside the area indicated in **Figure 3**.

Further it is recognised that marine mammals are of high cultural significance to local tangata whenua. Information on cultural significance is provided in **Appendix F**.

Table 1 provides a summary of important ecological considerations for those species which are considered to have a likely or possible presence in the region; noting that those predicted to occur in coastal waters are of primary relevance to the proposed activities.

In light of the New Zealand Coastal Policy Statement (**NZCPS**), it is important to identify:

- Indigenous taxa that are identified as 'threatened' or 'at risk' in the New Zealand Threat Classification System (**NZTCS**) (NZCPS policy 11(a)(i));
- Taxa listed by the International Union for Conservation of Nature (**IUCN**) as 'threatened' (NZCPS policy 11(a)(ii));
- Habitats of indigenous species where the species are at the limit of their natural range, or are naturally rare (NZCPS policy 11(a)(iv)); and
- Habitats in the coastal environment that are important during the vulnerable life stages of indigenous species (NZCPS policy 11(b)(ii)); or habitats, including areas and routes, important to migratory species (NZCPS policy 11(b)(v)).

For each species listed in **Table 1**, their NZCPS policy 11(a) and (b) status is included.

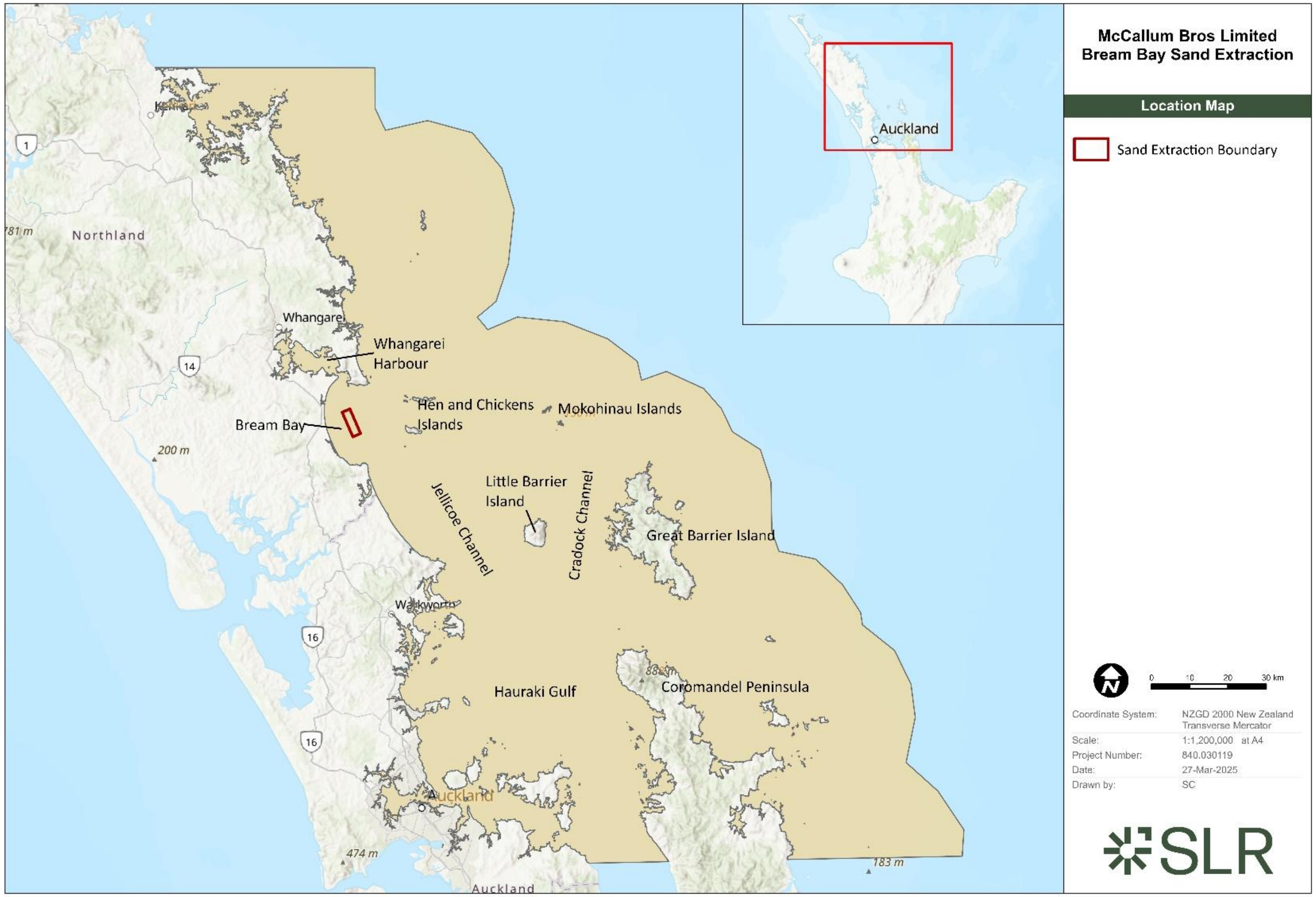

Figure 3 'Sand Extraction Area' (red) and area over which marine mammal distributional data was reviewed (tan)

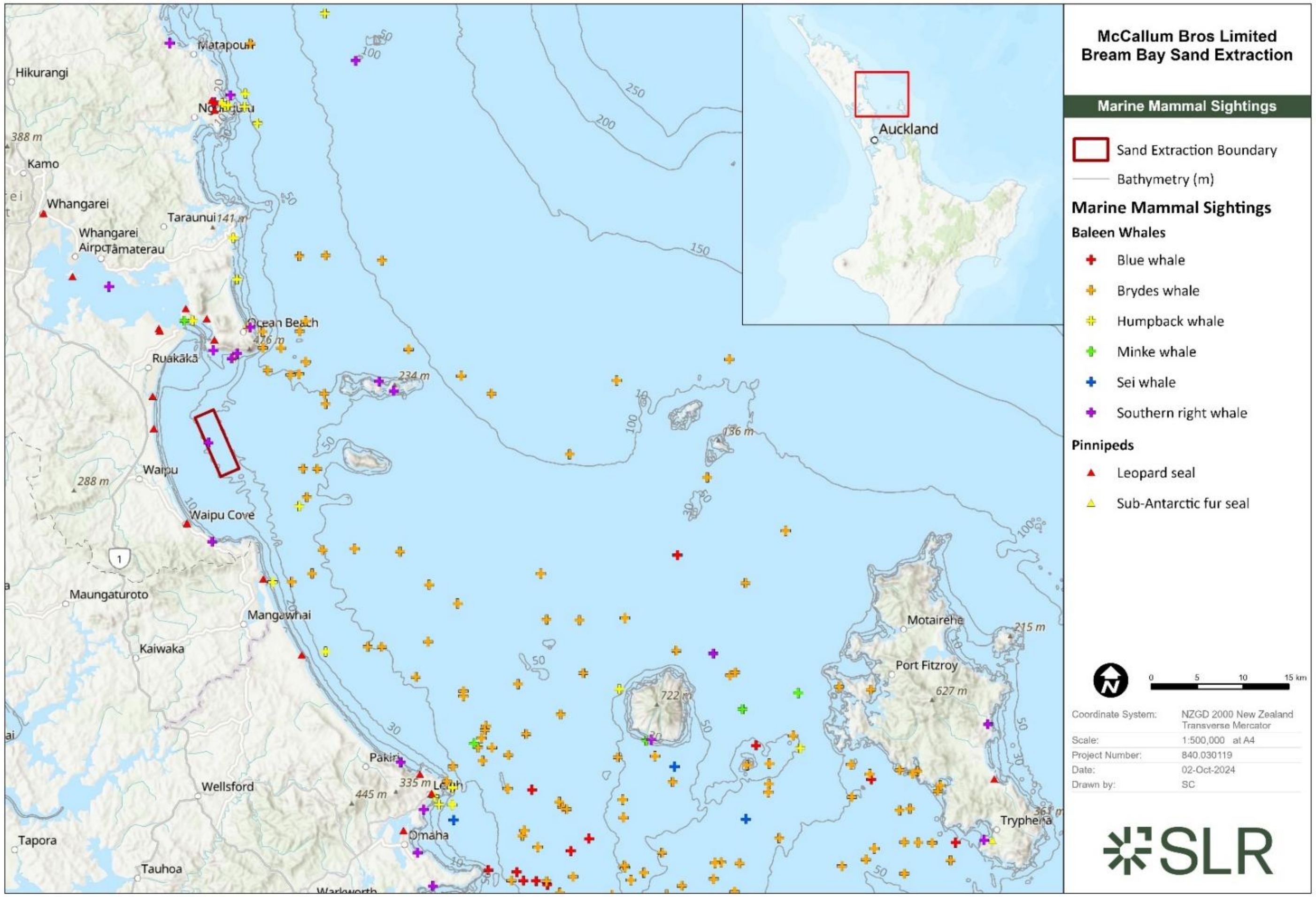

Figure 4 Baleen Whale and Pinniped (seal) Sightings Reported by DOC from 1964 to 2024 in the Vicinity of the Proposed Sand Extraction Area

Note: Each depicted point represents a sighting entry within the DOC database, where each sighting entry can be either a single animal or a group of animals.

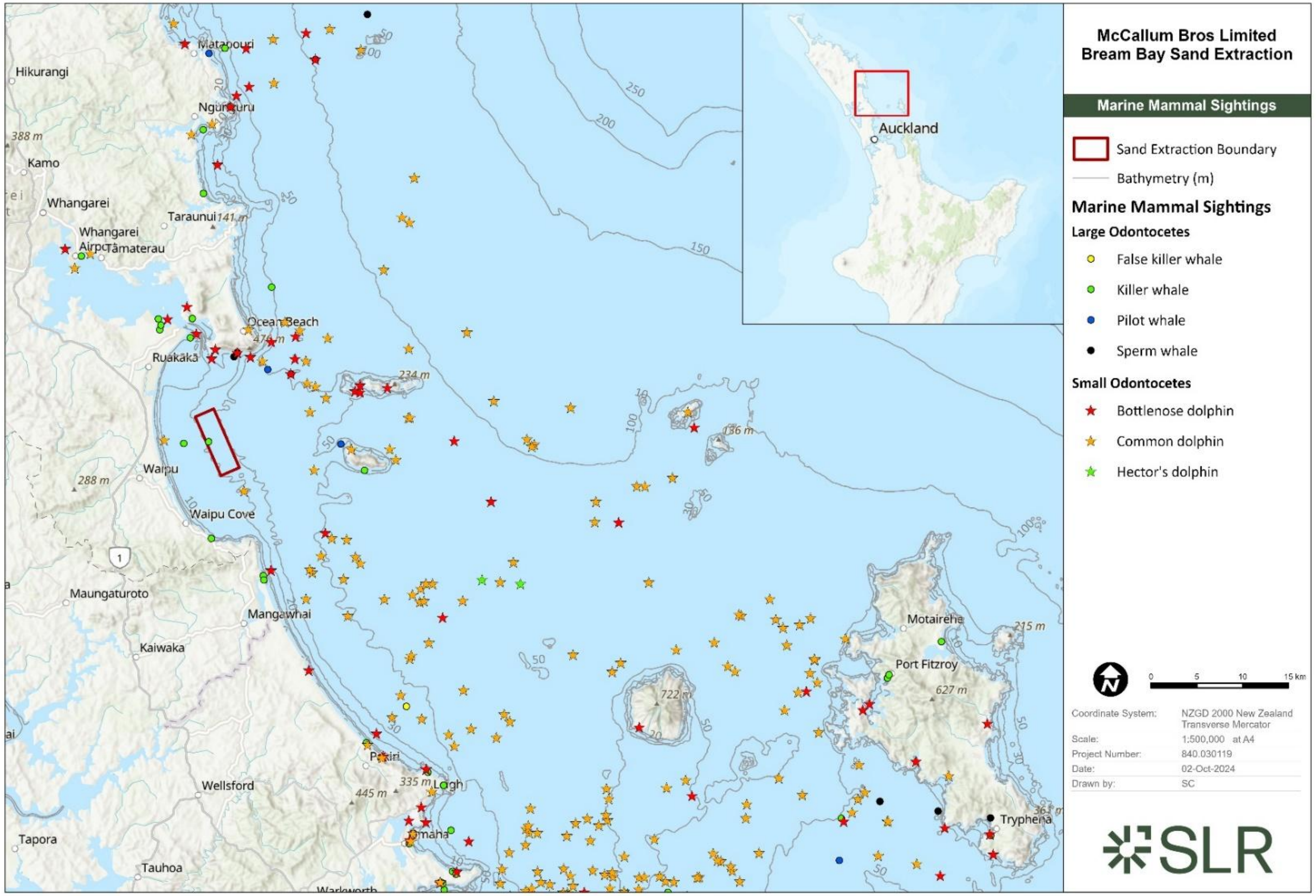

Figure 5 Odontocete (toothed whales and dolphin) Sightings Reported by DOC from 1968 to 2024 in the Vicinity of the Proposed Sand Extraction Area

Note: Each depicted point represents a sighting entry within the DOC database, where each sighting entry can be either a single animal or a group of animals.

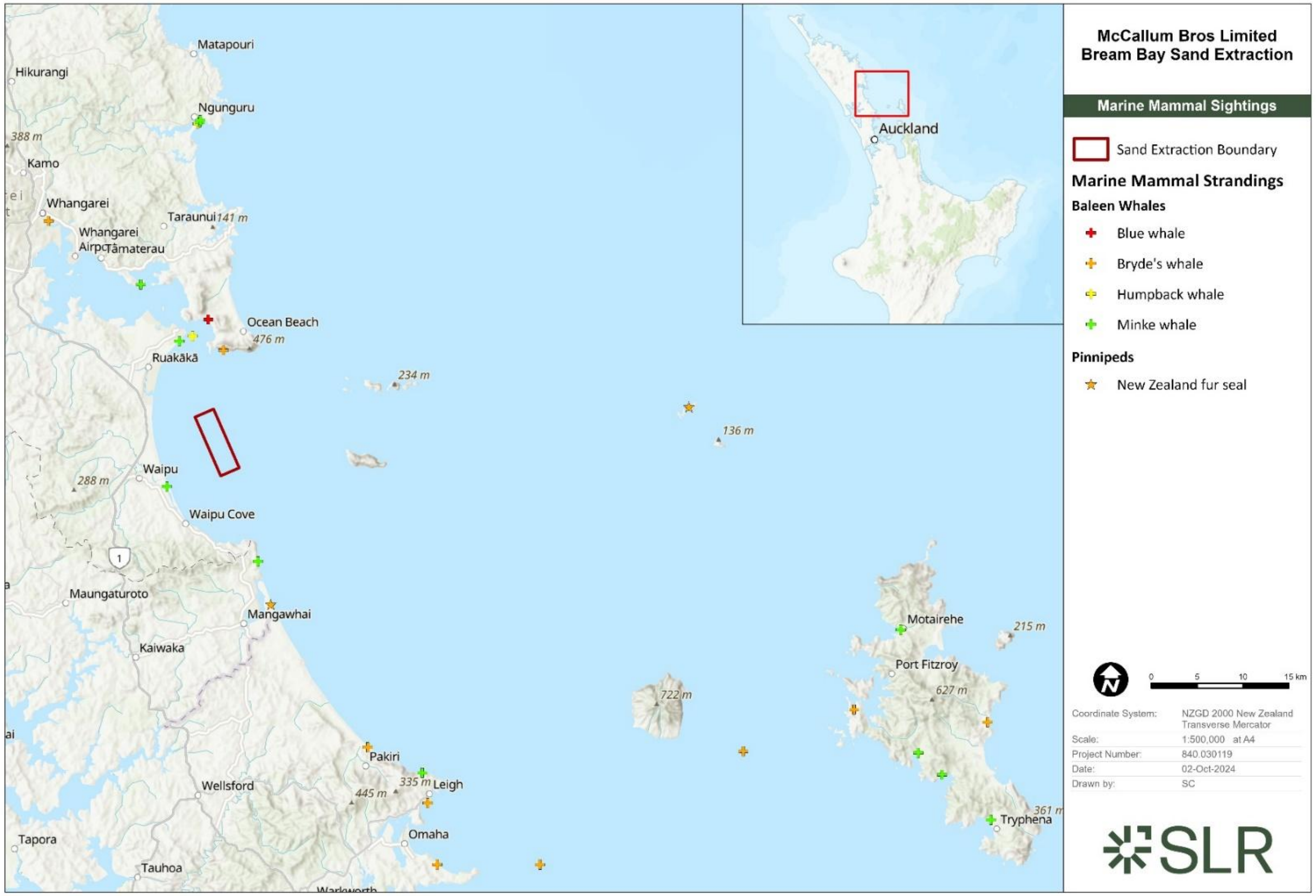

Figure 6 Baleen Whale and Pinniped (seal) Strandings Reported by DOC from 1873 to 2024 in the Vicinity of the Proposed Sand Extraction Area

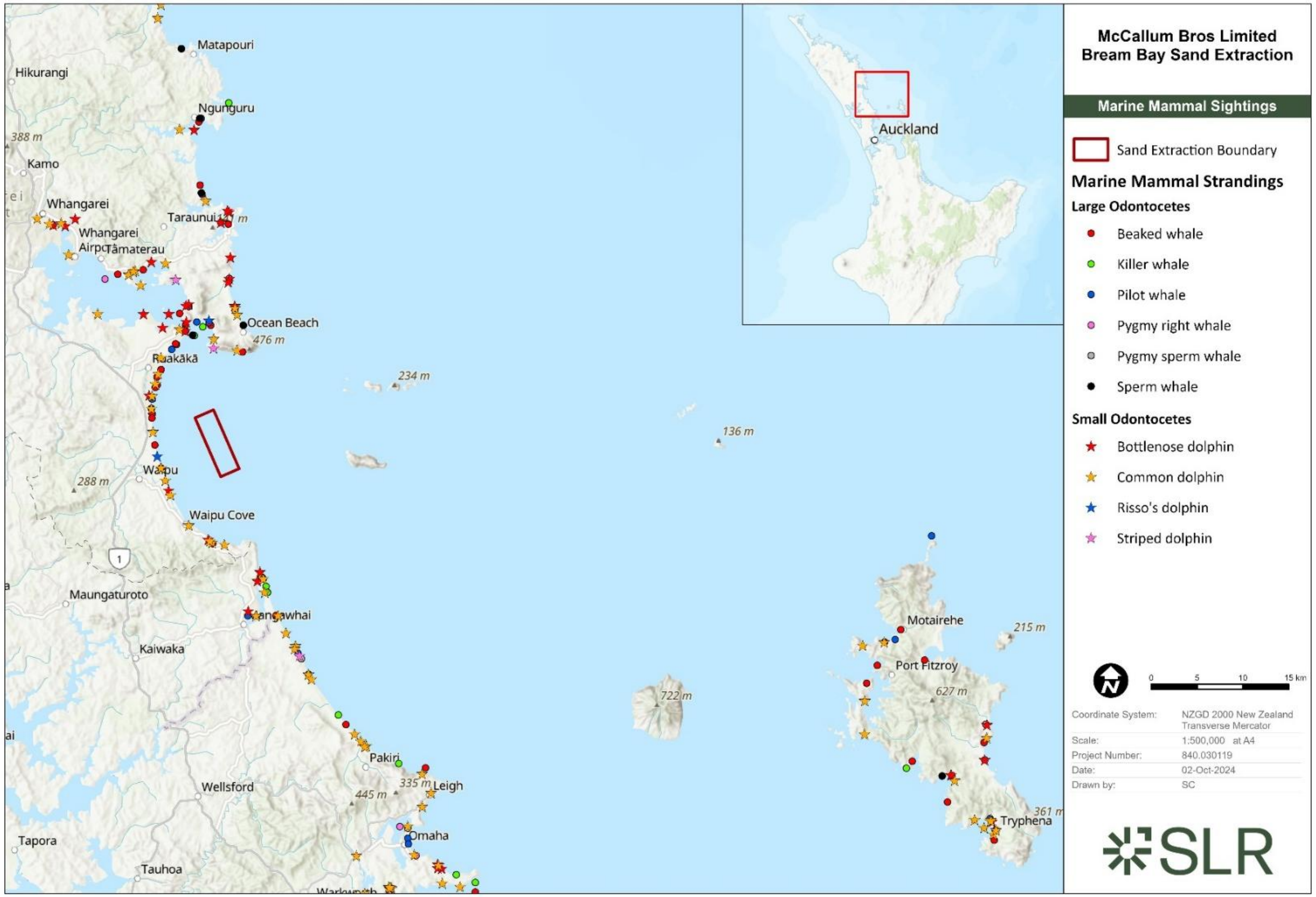

Figure 7 Odontocete (toothed whales and dolphin) Strandings Reported by DOC from 1873 to 2024 in the Vicinity of the Proposed Sand Extraction Area

Table 1 Marine Mammals that are 'likely' or could 'possibly' occur in and around Te Ākau Bream Bay.

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	Ecological considerations	Likelihood and frequency of occurrence	Seasonal trends
Common dolphins - Not threatened - Least concern - No policy 11 status	Occurs in all regions of New Zealand but the majority of sightings are from the northeastern coast of the North Island (Stockin & Orams, 2009), from the Bay of Islands to the Bay of Plenty (Constantine & Baker, 1997; Neumann et al., 2002). Recent analysis reveals two genetic subpopulations: one on the west coast (which is linked with Tasmania) and one on the east coast (Barcelo et al., 2021). While total abundance is unknown, it is likely to be substantial (Berkenbusch et al., 2013), with an estimate of c. 18,000 individuals using the North Island alone (Abraham et al., 2017). Common dolphins are highly mobile throughout a large home-range (Neumann et al., 2002). In the Bay of Islands and the Hauraki Gulf, common dolphins are typically observed in shallow coastal waters during winter and spring, moving further offshore in summer (Dwyer et al., 2020; Constantine & Baker, 1997; Stockin et al., 2008). Hauraki Gulf provides important feeding and nursing habitat (Stockin et al., 2008; Dwyer et al., 2016; Dwyer et al., 2020). Prey availability is a key driver of distribution (Dwyer et al., 2020). Stomach content analysis has revealed a diverse diet of fish and cephalopod species, with arrow squid, jack mackerel and anchovy identified as the primary prey species across all locations (Meynier et al., 2008). Common prey species from the Hauraki Gulf samples (n=16) included cardinal fish, jack mackerel, pilchard, anchovy, garfish, red cod, yellow-eyed mullet, grey mullet, blue cod, lanternfish, broad squid and arrow squid (Meynier et al., 2008). For Te Ākau Bream Bay, group sizes of 4 – 100 (DOC sighting database; 1968-2024) have been reported. One of these sightings included a calf. Most sightings in Te Ākau Bream Bay occur close to or beyond the 50 m depth contour, with very few sightings in waters shallower than 30 m. Common dolphins are one of the most frequently encountered cetaceans in the wider region with 2,971 sightings appearing in the DOC Sightings Database (from 1968-2024), 10 of which are from Te Ākau Bream Bay. Habitat modelling suggests moderate to high habitat suitability in the region (Stephenson et al. 2020; MacKenzie et al., 2022).	**Likely** frequent presence in and around Te Ākau Bream Bay. DOC data suggest that sightings within Te Ākau Bream Bay usually occur beyond 30 m depth contour, and this is supported by Brough et al. (2024) who also noted a preference for deeper open waters.	Year round – but possible increased inshore presence in winter and spring. Overall, the highest rates of occurrence occur in offshore waters in summer and autumn (Brough et al., 2024).

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	Ecological considerations	Likelihood and frequency of occurrence	Seasonal trends
	Brough (2023) states that common dolphins have a year-round presence in Te Ākau Bream Bay with high rates of feeding observed. Also see findings of Brough et al. (2024) as summarised in **Section 3.2.2.**		
Bottlenose dolphin - Nationally vulnerable - Least concern - Policy 11(a) species	Occur globally in cold temperate and tropical seas. In New Zealand there are four genetically distinct coastal populations: North Island, Marlborough Sounds, Fiordland (Tezanos-Pinto et al., 2009), and Otago/Stewart Island (Brough et al., 2015); plus, an oceanic ecotype (Zaeschmar et al., 2020). Constantine (2003) reported the range of the North Island population to be from Doubtless Bay to Tauranga; however, sightings beyond this area suggest that the overall range includes the North Island west coast (Tezanos-Pinto et al., 2013). Dolphins in the North Island population move between habitats through the year over the larger home range (Tezanos-Pinto et al., 2013). Both the Bay of Islands and Great Barrier Island have been identified as hotspots (Hartel, 2014; Dwyer et al., 2014). Abundance in the Bay of Islands has recently declined (Tezanos-Pinto et al., 2013) and this declining trend is ongoing (Brough et al., 2025). Several authors have documented movement of individual dolphins between locations; Berghan et al. (2008) reported movement between the Bay of Islands and the Hauraki Gulf (approximately 240 km) and Dwyer et al. (2014) noted that individuals moved between Great Barrier Island, the Hauraki Gulf, Bay of Plenty and the Whangarei coast. Both also found that dolphins moved to deeper, cooler, offshore waters in summer. Mean group size at Great Barrier Island is 37 (Fettermann et al., 2022) and in the Bay of Island mean group size was reported to be 15 by Peters et al. (2016), although a median group size of 4 (range 2 – 30 individuals) was reported for the Bay of Islands by Brough et al. (2025). Median group size in Te Ākau Bream Bay is 22 (range 2 – 100) (Brough et al., 2024). More recently, photo-identification studies have revealed at least 37 individual dolphins move between the Bay of Islands and Te Ākau Bream Bay (Brough et al. 2025), suggesting that Te Ākau Bream Bay supports population connectivity between locations throughout the wider region. Bottlenose dolphins have a varied diet that consists of a variety of fish and squid (Blanco et al., 2001; Gowans et al., 2008). Bottlenose dolphins have been observed carrying out foraging dives ranging from short dives in shallow habitats to depths of over 500 m (Wells & Scott, 2009). Oceanic bottlenose dolphins regularly forage with false killer whales (Zaeschmar et al., 2013; 2014).	**Likely** frequent (consistent) presence in and around Te Ākau Bream Bay. Systematic survey results report a hotspot for coastal bottlenose dolphins in the vicinity of the proposed sand extraction area during summer and autumn (Brough et al. 2024). Acoustic detections in the immediate vicinity of the sand extraction area were very common (see **Section 3.2.1**).	Year round – DOC sightings data suggests that most sightings in Te Ākau Bream Bay occur in spring, although high rates of occurrence are also noted through summer and autumn (Brough et al., 2024). Furthermore, acoustic monitoring results (see **Section 3.2.1**) confirm the presence of this species into winter months.

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	Ecological considerations	Likelihood and frequency of occurrence	Seasonal trends
	Nearly 300 reports of bottlenose dolphins are reported in the DOC Sightings Database from 1968-2024 for the wider region, ten of which are from Te Ākau Bream Bay. Habitat modelling suggests low to high habitat suitability (Stephenson et al., 2020; MacKenzie et al., 2022). Brough (2023) states that bottlenose dolphins have a year-round presence in Te Ākau Bream Bay and feeding and the nursing of young are commonly observed for this species. While home ranges extend beyond Te Ākau Bream Bay, dolphins do not use their home ranges evenly (e.g. Brough et al., 2025); hence, given the prevalence of feeding behaviours noted for this species in Te Ākau Bream Bay, the embayment likely represents core habitat for this species. The acoustic monitoring data from Styles Group (2025) as presented in **Section 3.2.1** reinforces this notion in terms of the sustained presence of dolphins in and around the sand extraction area. An abundance estimate for coastal bottlenose dolphins in Te Ākau Bream Bay was recently calculated to be 288 (95% CI = 242 – 384). Also see findings of Styles Group (2025) as summarised in **Section 3.2.1**, and Brough et al. (2024) as summarised in **Section 3.2.2.**		
Killer whales/orca - Nationally critical - Data deficient - Policy 11(a) species	New Zealand's coastal killer whale population is small (65 – 167 individuals; Visser, 2006) and is made up of at least three possible sub-populations based on geographic distribution; a North Island only subpopulation, South Island only subpopulation, and a North and South Island subpopulation (Visser, 2000). Small groups of killer whales are commonly seen around NZ where they travel an average of 100 – 150 km per day (Visser, 2000). Hupman et al. (2015) assesses the occurrence and group characteristics of killer whales in the Hauraki Gulf. Encounter rates were highest from June to November; but opportunistic sightings occurred year-round, with sightings less frequent in summer and autumn (Hupman et al., 2015). In this study, the majority of sightings (58.6%) involving smaller groups of one to five animals. Previous studies into the presence of killer whales on the North Island's east coast support the findings of Hupman et al. (2015), with sightings peaking between August and October, remaining relatively high in November, with a secondary peak in May and June (Visser, 2000; 2007). Immature animals are present on a year-round basis for this species (Visser, 2000; Hupman et al., 2015), suggesting no distinct breeding season for New Zealand killer whales.	**Likely** sporadic presence in Te Ākau Bream Bay. Given their highly transient nature, this species is not consistently present but does commonly move through the embayment. This transience most likely accounts for the lower occurrence of this species noted by Brough et al. (2024).	Year round, but more common in Te Ākau Bream Bay in winter and spring (following DOC sightings data).

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	Ecological considerations	Likelihood and frequency of occurrence	Seasonal trends
	In Te Ākau Bream Bay sightings occur mainly in winter and spring with group sizes of up to ten being reported (although most reports are of groups of less than five) (DOC sightings data). The presence of calves has been reported within Te Ākau Bream Bay. The diet of New Zealand killer whales includes 27 prey species (Visser, 2000): rays, sharks, finfish, and cetaceans. Benthic foraging for rays is common around New Zealand's coast particularly inside enclosed harbours and estuarine areas (Visser, 2000). Slightly over 300 reports of killer whales are reported in the DOC Sightings Database from 1968-2024 for the wider region, ten of which are from Te Ākau Bream Bay. Habitat modelling suggests low to high habitat suitability (Stephenson et al., 2020; MacKenzie et al., 2022); with the highest probability of occurrence (in the immediate vicinity of the sand extraction area) being inside Whangārei Harbour (Stephenson et al., 2020). Also see findings of Brough et al. (2024) as summarised in **Section 3.2.2** where few killer whale sightings were made during a recent systematic survey of Te Ākau Bream Bay and surrounds.		
Bryde's whales - Nationally critical - Least concern - Policy 11(a) species	Bryde's whales are concentrated between East Cape and North Cape (Gaskin, 1963); with the Hauraki Gulf and Northland region supporting one of the few known resident populations in the world (Constantine et al., 2012). Baker and Madon (2007) undertook aerial surveys between 1999 and 2003 and reported sightings between North Cape and the Hauraki Gulf, with concentrations of sightings occurring around headlands. Bryde's whales occur in water temperatures of 14.1 - 21.6 °C. For the Hauraki Gulf, an increase in sightings in spring and decrease in autumn corresponded with a rise and fall in sea surface temperature (**SST**) (Baker & Madon, 2007). Both Wiseman et al. (2011) and Dwyer et al. (2016) reported a year-round presence in the Hauraki Gulf, where upwelling areas are more frequent during winter, potentially explaining the higher occurrence of Bryde's whales then (Wiseman et al., 2011). Tezanos-Pinto et al. (2017) used photo-identification records to investigate Bryde's whale site fidelity within Hauraki Gulf. It is estimated that <50 Bryde's whales use the gulf at any one time, and except for a few whales, most showed low site fidelity to Hauraki Gulf (Tezanos-Pinto et al., 2017). No evidence of seasonality was observed in this study (Tezanos-Pinto et al., 2017). Hamilton et al. (2023) reported that some Bryde's whales are frequent users of the Gulf, while	**Likely** frequent presence in regional coastal and offshore waters. The DOC sighting data shows sightings within Te Ākau Bream Bay occur in the outer bay near the 50 m depth contour. Findings from Brough et al (2024) support this preference for deeper water, noting that a hotspot for Bryde's whales was identified to the northeast of the proposed sand extraction area (off Whangārei Heads) (Brough et al., 2024).	Year round, but more common in Te Ākau Bream Bay in spring, summer and autumn (following DOC sightings data & Brough et al., 2024).

Species **Threat Classification** **(NZTCS: Lundquist et al., 2025)** **(IUCN Redlist, 2024)** **NZCPS Policy 11a status**	**Ecological considerations**	**Likelihood and frequency of occurrence**	**Seasonal trends**
	others are only occasional visitors. Hamilton et al (2023) estimated that on average,15 Bryde's whales are present within the Hauraki Gulf at any one time, and that the average number present represents less than 25% of those whales that visit the gulf annually. Hence, while site fidelity to the Gulf varies with individual, even those that visit regularly are often-times absent (i.e. outside Hauraki Gulf). Carroll et al. (2019) studied prey items of Bryde's whales in the Hauraki Gulf and revealed a diet primarily of krill-like crustaceans and copepods. Changes the in the prey community are thought to drive changes in Bryde's whale habitat use (University of Auckland, 2025). Lunge feeding was frequently observed. Bryde's whales are active during the day, spending daylight hours below the sea surface engaged in foraging and travelling (Constantine et al., 2012). Activity is lower at night, with whales found closer to the sea surface and exhibiting resting behaviours (Constantine et al., 2012). This makes them particularly vulnerable to ship strike (Constantine et al., 2012). Within the wider region, Bryde's whales are the most reported whale species (1,188 sightings reported in the DOC sightings data from 1968-2024, noting that this total includes several incidences where the same whale was seen several times in one day). In Te Ākau Bream Bay most sightings (n = 11) are reported in spring and summer. With regard to Te Ākau Bream Bay, Brough (2023) states that "*Bryde's whales occur daily within the area, over all seasons, and are almost always engaged in foraging behaviour – often with juveniles/calves present*". Also see findings of Brough et al. (2024) as summarised in **Section 3.2.2.** Whales occurring in Bream Bay form part of the wider resident population that extends from North to East Cape (as described by Constantine et al. (2012). As with Hauraki Gulf, it is likely that some Bryde's whales are frequent users of Te Ākau Bream Bay and others are only occasional visitors, but that all use an area much larger than Te Ākau Bream Bay.		
Long-finned pilot whales - Not threatened - Least concern - No policy 11 status	Pilot whale sightings occur in New Zealand waters year-round (Berkenbusch et al., 2013). Long-finned pilot whales commonly strand on New Zealand coasts; with strandings peaking in spring and summer (O'Callaghan et al., 2001). Pilot whales typically forage at depth (i.e. several hundred metres; Berkenbusch et al., 2013), hence are less likely to routinely occur in shallow coastal waters.	**Likely** presence in regional waters, but mostly offshore. Acoustic detections.in the immediate vicinity of the sand extraction area	Year round but most sightings in summer and autumn (following DOC sightings data and Brough et al., 2024).

Species **Threat Classification** **(NZTCS: Lundquist et al., 2025)** **(IUCN Redlist, 2024)** **NZCPS Policy 11a status**	**Ecological considerations**	**Likelihood and frequency of occurrence**	**Seasonal trends**
	Despite this, reasonable numbers of sightings (n = 18) and strandings (n = 47) are reported from the wider region. Hence a presence in outer Te Ākau Bream Bay and in waters further offshore is expected particularly during summer and calves could be present (DOC Sighting Database; 1968-2024). Modelling results indicate a low to moderate habitat suitability (Stephenson et al., 2020; MacKenzie et al., 2022) with habitat suitability increasing with distance from shore.	have however been made (see **Section 3.2.1**), but presence will generally be further offshore.	
New Zealand fur seals - Not threatened - Least concern - No policy 11 status	Widespread around rocky coastlines, although most breeding locations occur on the South Island. This species is expanding its range northwards (Lalas & Bradshaw, 2001) and regular breeding now occurs on Gannet Island in Waikato (Bouma et al., 2008) and Motunau (Plate) Island in the Bay of Plenty (DOC, 2012). Breeding season occurs from mid-November to mid-January (Crawley & Wilson, 1976). Non-breeding distribution is large and includes the entire coastal region of Auckland and Northland. Regular sightings occur around the Hen and Chickens Islands and in the Bay of Islands (Clement, 2022). Near the entrance to Whangārei Harbour, fur seals haul-out on Motukaroro Island, with reports of up to 26 animals being present on occasion (reported by Steve Tyson, local resident, during the Northport Resource Consent Hearing, 12.10.23). Seals forage on a range of species that vary seasonally and geographically (Baird, 2011); Females forage over the continental shelf, and males use deeper pelagic waters of the shelf break (Page et al., 2005). They return to shore every few days to rest (Boren, 2005). Semi-residence of some individuals should be presumed. Reports of New Zealand fur seals to the DOC Sightings Database are generally assumed to be biased low as this species is the most regularly encountered coastal marine mammal in New Zealand and most sightings are not reported. Also see findings of Brough et al. (2024) as summarised in **Section 3.2.2.**	**Likely** in regional coastal and offshore waters; however, while small numbers of individuals are known to be present, given the lower numbers of seals in Northland compared to more southern regions of New Zealand, the density of this species is expected to be low.	Year round, but most common in winter.
False killer whales - Uncommon - Near threatened - Policy 11(a) species	Mostly found in deep, offshore waters but also occasionally over the continental shelf and shallower areas (Berkenbusch et al., 2013). Zaeschmar et al. (2014) reported on the occurrence of false killer whales off north-eastern New Zealand and found while sightings in shallow nearshore waters are relatively rare, they do predictably occur, but the low encounter rate here suggests that the species distribution is centred further offshore. Of the 47 sightings reports analysed by Zaeschmar et al. (2014) for this species, water depth ranged from 25 – 350 m, with 64% occurring in waters <100 m deep and calves were often present. Presence in nearshore waters showed a seasonal trend with all sightings	**Likely** seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters.	Summer/autumn (following Brough et al., 2024 and Zaeschmar et al., 2014)

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	Ecological considerations	Likelihood and frequency of occurrence	Seasonal trends
	occurring between Dec and May when the warm East Auckland Current occurs closer to shore (Zaeschmar et al., 2014). While this species is known to forage to depths of 500 m (Shirihai & Jarrett, 2006), foraging in shallow waters around New Zealand is not uncommon and foraging with offshore bottlenose dolphins are well documented (Zaeschmar et al., 2013; Zaeschmar et al., 2014). Group sizes in the region typically range from 20 to 150. Also see findings of Brough et al. (2024) as summarised in **Section 3.2.2.**		
Humpback whales - Migrant - Endangered - Policy 11(a) species	Humpback whales feed in the circumpolar waters of the Antarctic in summer and migrate to sub-tropical or tropical breeding grounds in winter. Around New Zealand this species migrates northwards from May to August (Gibbs & Childerhouse, 2000), and southward from September to December (Dawbin, 1956). Whales use continental shelf waters (Jefferson et al., 2008) but can approach closely to shore when passing headlands (e.g. Gibbs et al., 2017). Most sightings in the wider region occur during the southern migration (Gibbs & Childerhouse, 2000). However, the majority of humpbacks migrate south down the west coast of New Zealand (Gibbs et al., 2017). Further to this satellite tagging indicates that of those whales that do travel south down the east coast, many do not approach the coast but use an open ocean corridor south of the Kermadec Islands (Riekkola et al., 2018). During annual winter surveys of humpback whales in Cook Strait (2004 – 2015), 659 whales were observed, and the annual rate of population increase was calculated to be 13% (Gibbs et al., 2017); indicating that recovery is well underway following the cessation of historic commercial whaling. Of the 82 sightings of this species reviewed, three have been reported from Te Ākau Bream Bay. However, increasing whale presence through time cannot be dismissed as this population continues to recover.	**Possible,** seasonal presence in both coastal and offshore waters of the region.	Spring.
Southern right whales - Nationally increasing - Least concern - Policy 11(a) species	This species originally occupied bays around mainland New Zealand during their winter breeding season (Bannister, 1986; Dawbin, 1986); however, commercial whaling reduced numbers to near extinction and no whales were reported here from 1928 and 1963 (Gaskin, 1963). Evidence now suggests that the New Zealand population is recovering (Carroll et al., 2015) with a slow recolonisation of breeding range around the mainland (Patenaude, 2003; Carroll et al., 2014; Carroll et al., 2015). However, Cranswick (2022) suggests that the recolonisation process is not particularly strong around mainland New Zealand with no sustained increase in sightings between 2011 and 2021. In addition, the number of mother/calf pairs appears to have decreased over this period compared to	**Possible** seasonal presence in coastal waters of the region.	Winter/spring

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	**Ecological considerations**	**Likelihood and frequency of occurrence**	**Seasonal trends**
	earlier studies. Carroll et al. (2013) provided the first national abundance estimate for southern right whales of 2,169 (95% CI 1,836 - 2,563). Mother/calf pairs in northland can be expected from July to October (Carroll et al., 2014), utilising shallow (<20 m) coastal waters for calving and nursing (Patenaude, 2003). Northland was recognised as a hotspot for the presence of mother/calf pairs by Carroll et al. (2014); however fewer mother/calf pairs have been observed in the Northland Region since (Cranswick, 2022). Cow/calf pairs can be present in an area for several weeks at a time during the winter breeding season (Carroll et al., 2014) and given the recovering status of this population, numbers are expected to increase around mainland New Zealand over time.		
Leopard seals - Migrant - Least concern - Policy 11a(iv) status (at limit of natural range).	Leopard seals typically occur in Antarctic waters where they occur as solitary hunters that occupy pack ice habitat. However, in autumn and winter they disperse northwards where they are occasionally observed along New Zealand's coastline and recent work by Hupman et al. (2019) indicate that at least some leopard seals reside here for months at a time. A reasonable number of leopard seal reports occur in the region (n=107), 11 of which are from Te Ākau Bream Bay. An individual leopard seal (named 'Owha') regularly visited Northland (frequenting Marsden Cove Marina) from 2015 to 2019 (leopardseals.org, 2024; DOC Sightings Database 1968-2024). The available information suggests that Owha has not been seen for several years, but other identifiable leopard seals occasionally visit the Northland region and occasionally individuals will stay in and around an area for several weeks/months at a time. Hupman et al. (2019) map the density of leopard seal sightings around New Zealand and report a moderate to high density of sightings in the region.	**Possible** infrequent presence in coastal waters and ashore.	Year round, but mostly autumn and winter.
Blue whales - Nationally vulnerable (pygmy), Migrant (Antarctic) - Endangered - Policy 11(a) species	Two subspecies occur in New Zealand waters (Antarctic and pygmy blue whales), however field identification between the two species is difficult. Sightings across New Zealand are not uncommon with a concentration of spring and summer sightings being noted for NE North Island (Berkenbusch et al., 2013). Sightings in New Zealand are concentrated in the South Taranaki Bight which has been identified as an important area for blue whales (Barlow et al., 2018). The population size of pygmy blue whales in New Zealand was estimated as 718 (95% CI = 279 – 1926) by Barlow et al. (2018), although there are relatively few sightings recorded in the wider region (n = 68) with no sightings reported inside Te Ākau Bream Bay. Sightings from Jellicoe and Craddock Channels (**Figure 4**) do however suggest that this species has an occasional presence in coastal	**Possible** occasional presence in regional coastal waters.	Spring/summer.

Species Threat Classification (NZTCS: Lundquist et al., 2025) (IUCN Redlist, 2024) NZCPS Policy 11a status	**Ecological considerations**	**Likelihood and frequency of occurrence**	**Seasonal trends**
	waters, but modelling indicates relatively low habitat suitability (Stephenson et al., 2020; MacKenzie et al., 2022).		
Gray's beaked whales - Not threatened - Least concern - No policy 11 status	Has a circumpolar distribution south of 30° and occurs in deep waters beyond the shelf edge (Pitman & Taylor, 2020). Therefore, despite the reasonable number of strandings reported for the region (n = 62) and the small number of sightings (n = 2), it is unlikely that Gray's beaked whales will be present inside Te Ākau Bream Bay, but they may have a presence in offshore waters.	**Possible** unquantified presence in offshore waters.	Summer.
Sperm whales - Declining - Vulnerable - Policy 11(a) species	Have a wide geographical and latitudinal distribution but are mostly found in deep waters (> 1,000 m) in the open ocean over the continental slope (Berkenbusch et al., 2013). Despite there being 14 sightings recorded from the region (two of which occurred in Te Ākau Bream Bay), it is unlikely that this species would be regularly present in the shallow inshore waters, but occasional presence cannot be dismissed.	**Possible** occasional presence, mostly in offshore waters.	Year round.
Sei whales - Migrant - Endangered - Policy 11(a) species	Sei whales pass through New Zealand waters on their seasonal migrations between the tropics and summer feeding grounds in Antarctica/ Southern Ocean (Cook, 2018). This species is generally found in offshore, deep waters beyond the continental slope (Horwood, 2009); however coastal sightings in New Zealand waters are not uncommon and are primarily from the north-eastern coast of the North Island during spring and summer (Berkenbusch et al., 2013). Based on the relatively low number of sightings in the region (n = 28), it is unlikely that sei whales will be present in the immediate vicinity of the proposed sand extraction area, but they may pass through waters further offshore.	**Possible** occasional presence in offshore waters.	Spring/summer.
Minke whales - Migrant (Antarctic), Data deficient (dwarf) - Near threatened (Antarctic), Least concern (dwarf) - No policy 11 status	Antarctic and dwarf minke whales have an overlapping range and are difficult to distinguish; hence both are considered together here. Very abundant in Antarctic waters in summer but seen at lower latitudes in other seasons; outside of the summer months their distribution is less well-known (Reilly et al., 2008). Coastal sightings are not uncommon around New Zealand (Berkenbusch et al., 2013), but there are relatively few sightings recorded for these species in the region (n = 10). Most minke whale sightings around New Zealand occur in spring; aligning with the southern migration to feeding grounds (Berkenbusch et al., 2013).	**Possible** occasional seasonal presence.	Spring

3.2.1 Acoustic Monitoring for Marine Mammals in Te Ākau Bream Bay

Acoustic monitoring for marine mammals in Te Ākau Bream Bay was undertaken by Styles Group (refer Styles Group, 2025 for full details). For this monitoring, data was collected from a single hydrophone deployed within the proposed sand extraction area from 7 May 2024 to 26 June 2024 (a total of 51 deployment days).

Because of the large number of apparent delphinid (dolphin and small toothed whales) detections (a total of 26,129 vocalisations), the data was filtered to address the possibility of false positives (e.g. extraneous noise sources, such as sediment entrainment or mooring noise). To do this, candidate events were defined as those containing a minimum of three detections occurring within a 20-minute window from the last detection. According to Styles Group (2025), this filtering method is robust for monitoring the presence or absence of odontocetes on the basis that: '*Delphinid species are highly vocal, emitting whistles, burst pulses, and echolocation clicks at high rates. Consequently, as individuals or groups transit the monitoring area, they are highly likely to produce multiple vocalizations. The large detection radius of omnidirectional hydrophones in open-water environments further increases the probability of capturing these multiple signals. A limitation, however, is the potential for missed detection events. This can occur if an individual passes tangentially or through a narrow segment of the hydrophone's detection range, minimizing the time spent within the monitored area and thus the opportunity for multiple vocalizations to be recorded.*'

The bullet points below summarise the key findings from the acoustic monitoring:

- Delphinids were detected on an almost daily basis (on 37 of the 51 deployment days), suggesting that dolphins have a high occurrence rate in the vicinity of the sand extraction area;
- While delphinid data presented here does not attribute specific detections to species level, the raw acoustic data confirms that bottlenose dolphins were the most commonly detected species (Matt Pine, Styles Group, pers. comm.);
- **Figure 8** presents an actogram which plots delphinid detections against time of day. This data suggests that dolphin presence in Te Ākau Bream Bay is biased slightly to daylight hours, but when dolphins were present during the day it was not uncommon for them to remain in the bay well beyond sunset;
- Detection duration for delphinids ranged from 2 to 318 minutes (>5 hours) (**Figure 9**), and most longer detection events occurred during daylight hours (**Figure 8**);
- Baleen whales were also frequently detected and have been reported to species level (Styles Group, 2025). By far the majority of baleen whale detections were of Bryde's whales, which were detected on 15 of the 51 deployment days. On one deployment day a Sei whale was also detected (**Figure 10**); and
- Due to the low frequency nature of baleen whale calls which propagate a long way underwater and the inability to triangulate individual whale locations, it is important to note that the detection range for baleen whales exceeded 10 km, so individuals outside of Te Ākau Bream Bay could also be represented in this data. However, the strength of some calls detected suggest that at least in some instances, Bryde's whales occurred inside Te Ākau Bream Bay (which for the purpose of this assessment is defined as being from Te Whare (Bream Head) to Paepae-o-Tū (Bream Tail), and out to the Taranga-Marotere Islands (Hen and Chickens Islands).

Brough et al. (2024) reported a peak in bottlenose dolphin and Bryde's whale relative density and probability of occurrence in the warmer months of December to April, (see **Section 3.2.2**); hence the number of acoustic detections would be expected to vary seasonally.

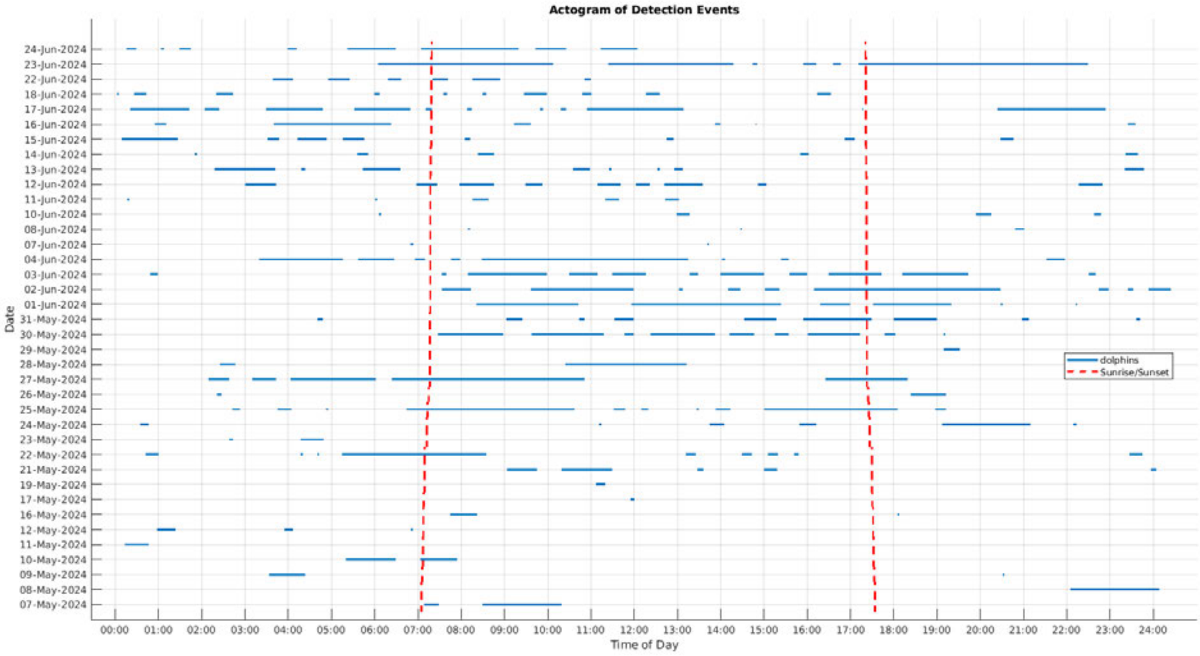

Figure 8 Delphinid detections plotted against time of day

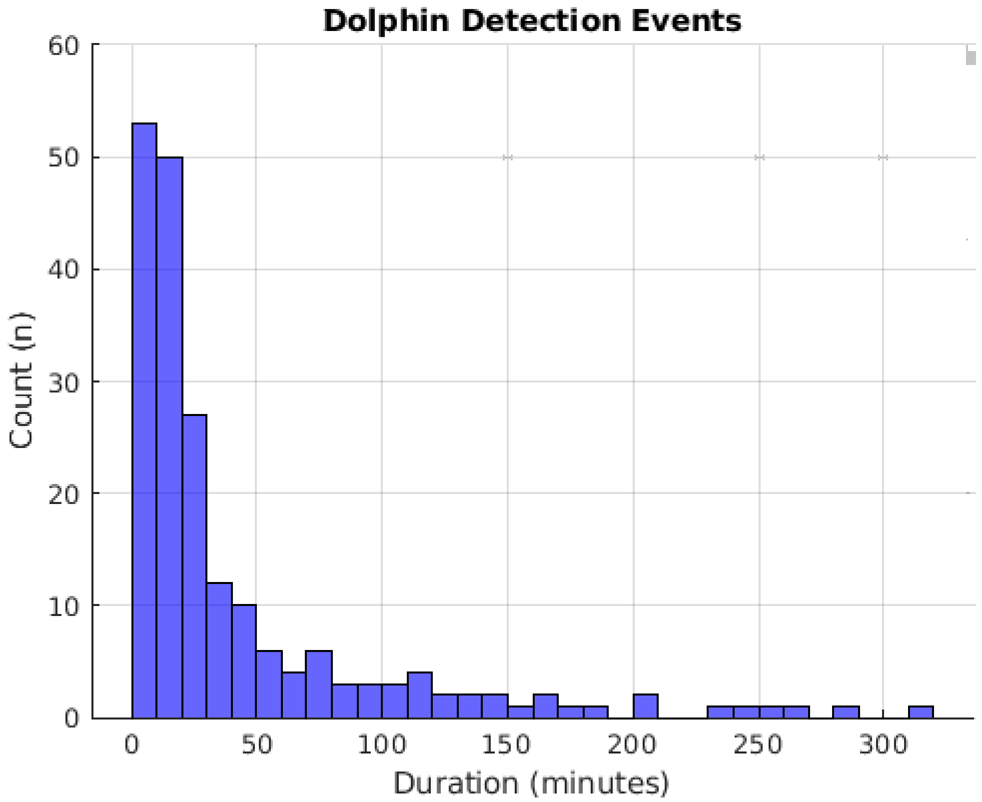

Figure 9 Duration of delphinid detection events

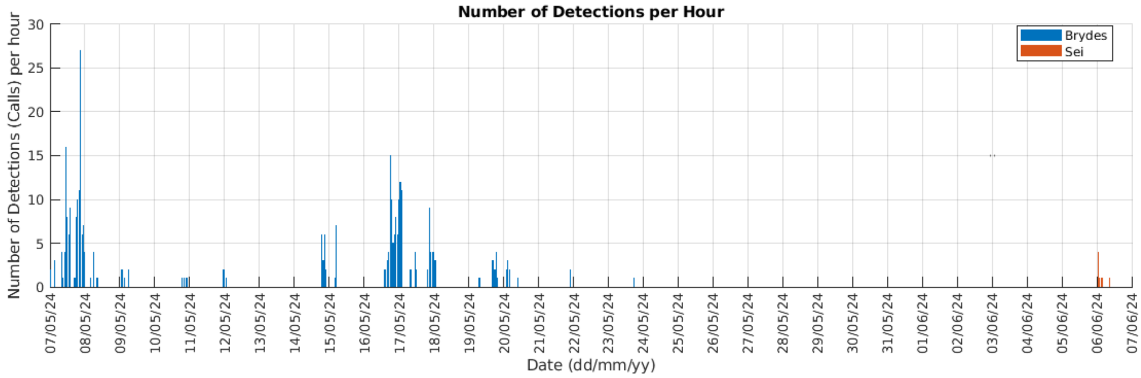

Figure 10 Acoustic detections of baleen whales

3.2.2 Tohorā research programme findings

Patuharakeke Te Iwi Trust Board have partnered with NIWA and Far Out Ocean Research Collective to conduct marine mammal surveys in Te Ākau Bream Bay and surrounds. A description of the survey methods and findings has recently been reported by Brough et al. (2024). Between December 2022 and March 2024, seven vessel-based surveys were undertaken. Each survey incorporated line transects in the area defined in **Figure 11** (which ran from nearshore to the 100 m depth contour) along which marine mammal observations and acoustic recordings (at 5 nm intervals) were made.

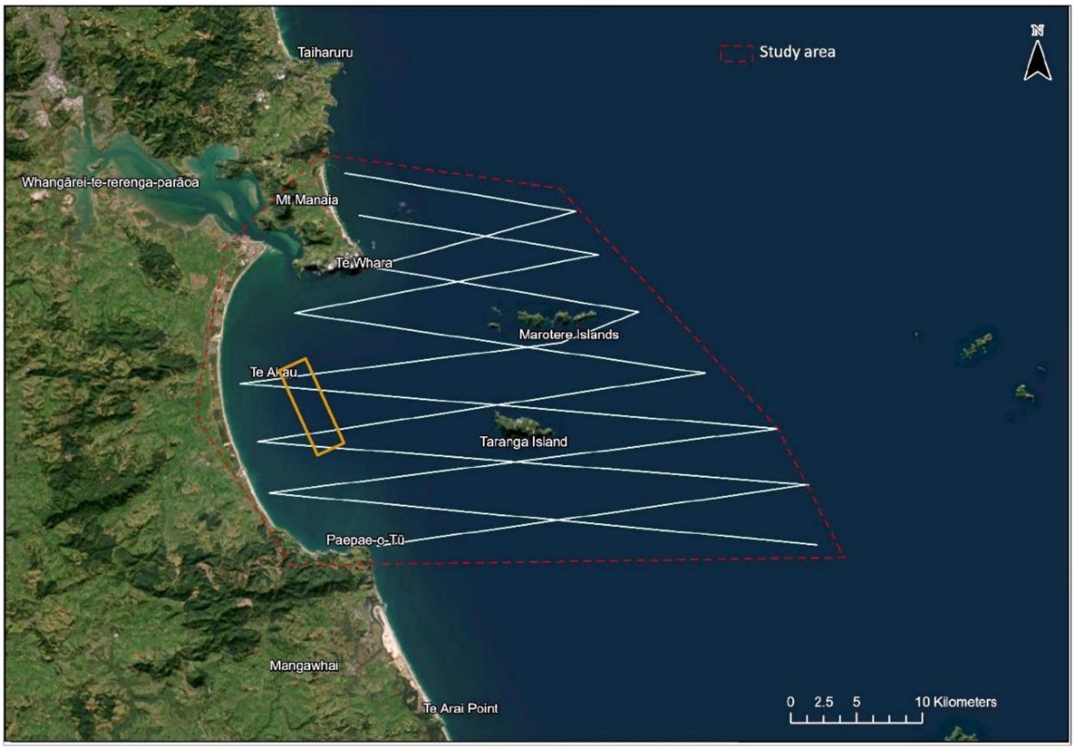

Figure 11 Study area (red polygon) and transect lines (white lines) relative to sand extraction area (yellow polygon). Adapted from Brough et al. (2024).

Along with systematic visual sightings data and acoustic detection data, photo-identification data was also collected for Bryde's whales, killer whales, coastal bottlenose dolphins and false killer whales and opportunistic sightings data from other research projects in the area was also assimilated over the same time period. The data was analysed to calculate:

- Rates of occurrence (standardised for survey effort, noting a total of 1,537.5 km of transect was covered over the entire survey period);
- Distribution and habitat use (e.g. species distribution models and relative density mapping);
- Mark-recapture demographic analysis (to generate an abundance estimate for coastal bottlenose dolphins); and
- Mātauranga Māori (or Māori knowledge systems).

The full research report associated with the Tohorā research programme is provided as **Appendix C**. This study represents the first systematic marine mammal survey to be undertaken for Te Ākau Bream Bay and the surrounding area. The relative distribution of survey effort across the study area is presented in **Figure 12**, noting that a high level of survey effort was afforded to part of the proposed sand extraction area, but the areas of highest effort occurred around Whangārei Heads and north of the Taranga-Marotere Islands (Hen and Chickens Islands).

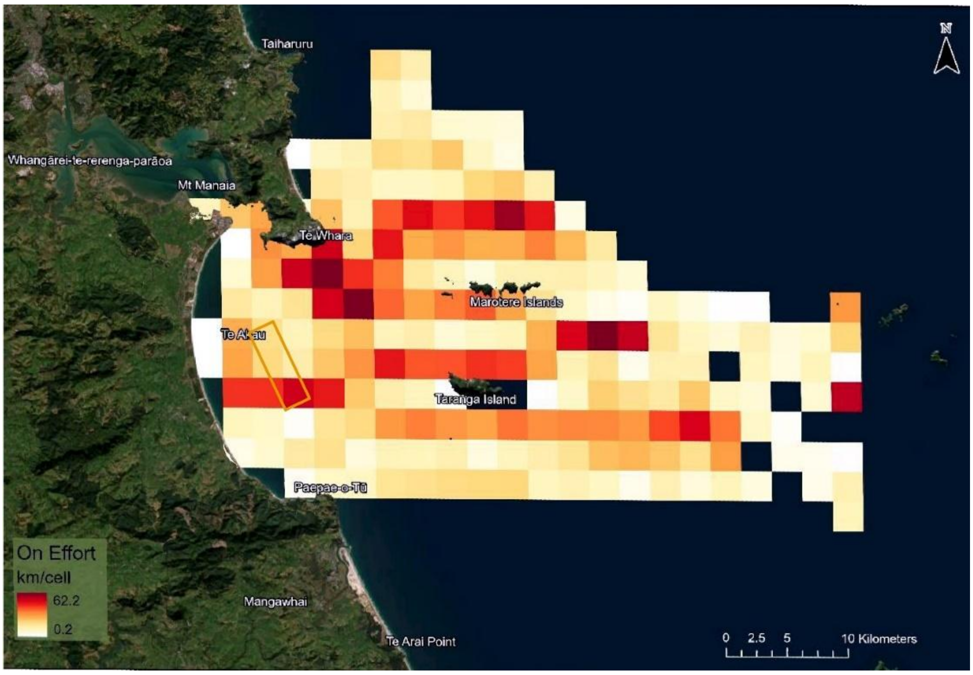

Figure 12 Distribution of survey effort relative to sand extraction area (yellow polygon). Adapted from Brough et al. (2024).

The key findings, particularly those of greatest relevance to the proposed sand extraction application, are summarised from Brough et al. (2024) below:

- Monitoring results revealed high species diversity with eight marine mammal species encountered, namely: common dolphins, Bryde's whales, bottlenose dolphins (coastal and oceanic ecotypes), false killer whales, New Zealand fur seals, killer whales, blue whales, and long-finned pilot whales (listed in order of sighting rate from highest to lowest). Sea surface temperature was consistently an important predictor of distribution for all species;

- Common dolphins had the highest rates of occurrence in the study area and were encountered in all seasons but had lower sightings rates in the cooler months. Relative density maps revealed a preference for deeper open waters (i.e. around or beyond the Hen and Chicken Island group) (Brough et al., 2024), with only one observation of common dolphins (from a total of 36 observations) made inside Te Ākau Bream Bay through the survey duration. Median group size encountered was 25 (range 5 – 250). Feeding was regularly observed confirming the importance of offshore waters of the study area (i.e. beyond the Hen and Chicken Island group) as foraging habitat, and associations with Bryde's whales were not uncommon;
- The study area[4] was identified as important foraging habitat for Byrde's whales with feeding observed in 61% of encounters. Sighting rates in the study area are comparable to those in Hauraki Gulf which is a recognised hotspot for Bryde's whales. Relative density and probability of occurrence were highest in the warmer months of December to April, but they were seen in all seasons except winter indicating that they use the area for a large part of the year. No observations of Bryde's whales were made in the shallow inner waters of Te Ākau Bream Bay (including the proposed sand extraction area); however, hotspots of relative density were identified in deeper waters both inside or around the Hen and Chicken Islands, and further offshore (**Figure 13**). Calves were often present, confirming that nursing behaviours should also be expected in the study area;
- Coastal bottlenose dolphins are present in most months of the year and high resight rates for individual dolphins suggest a high degree of residency (of 149 distinct individuals, 109 (73%) were encountered on more than one occasion, and 40% were encountered in more than one year). Sighting rates for this species in the study area are similar to those in other recognised hotspots for coastal bottlenose dolphins (e.g. Bay of Islands, inner Hauraki Gulf, and the Marlborough Sounds). An abundance estimate for coastal bottlenose dolphins in Te Ākau Bream Bay was calculated to be 288 (95% CI = 242 – 384) indicating that the study area supports one of the largest semi-resident populations in New Zealand (noting that they probably do still move between habitat patches along the north-east coast of the North Island). Relative density and probability of occurrence were highest for coastal bottlenose dolphins in the warm season (December to April, **Figure 14**) with encounters more common in summer and autumn, and less common in winter and spring. A hotspot for coastal bottlenose dolphins was identified in the vicinity of the proposed sand extraction area during the warm season (**Figure 14**). The median group size was 22 (range 2 – 100). The presence of calves was noted in 71% of encounters across all seasons and foraging behaviour was documented in 61% of encounters indicating the presence of important foraging and nursery habitat.
- Oceanic bottlenose dolphins and false killer whales were regularly encountered foraging together in the warmer months (summer and autumn), but most sightings occurred in offshore waters of the study area (i.e. around or beyond the Hen and Chicken Island group). Calves of both species were almost always present. Long-finned pilot whales were sometimes also associated with these mixed species groups;
- Other species observed during the study period were New Zealand fur seals (seen twice in inshore waters during winter) and killer whales (seen twice during the warm season in waters beyond the Hen and Chicken Islands). A single blue whale sighting was made in spring, also in offshore waters.

[4] Which is extends well beyond the area defined as Te Ākau Bream Bay in this assessment.

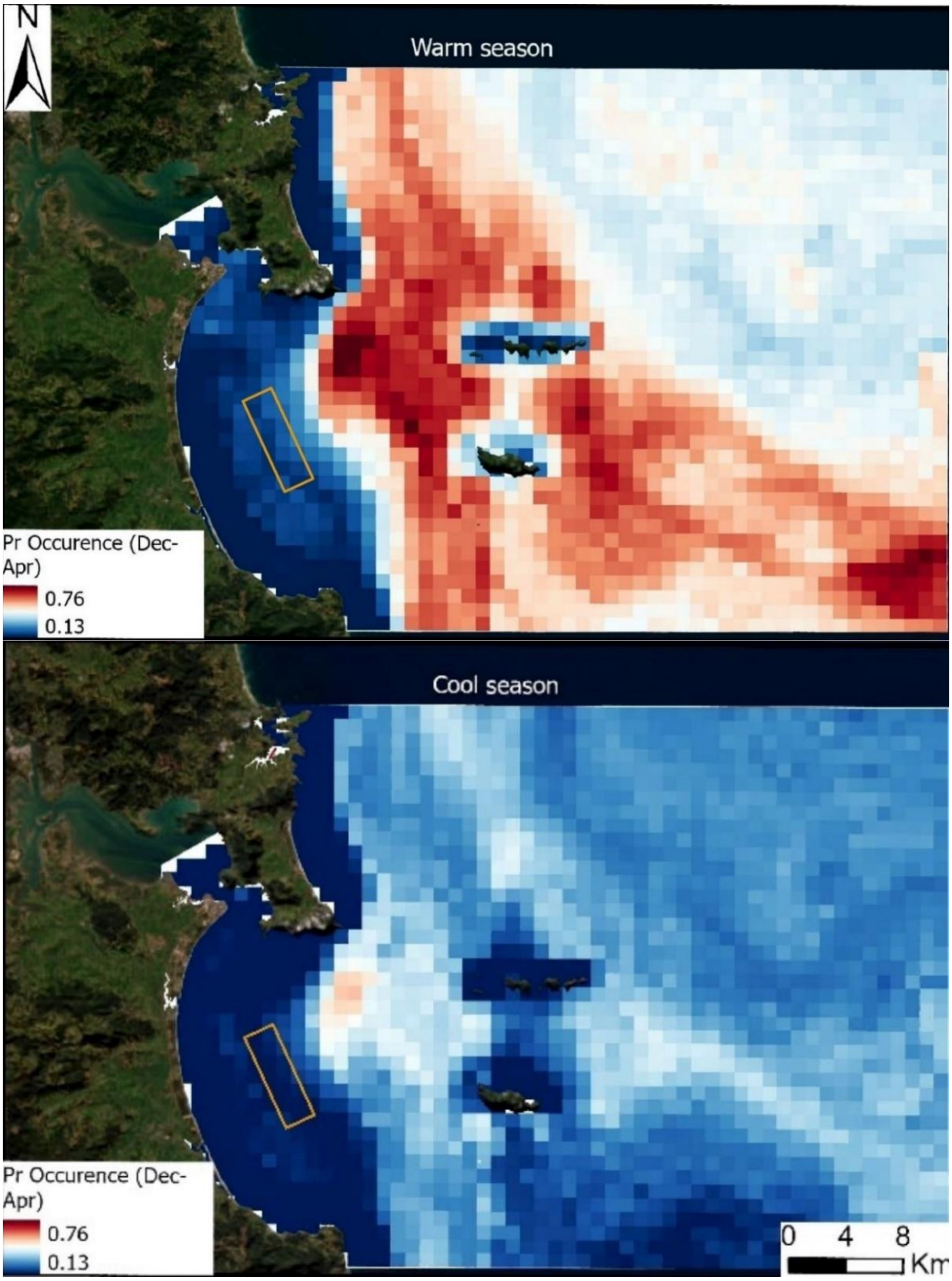

Figure 13 Bryde's whale probability of occurrence during warm (Dec – Apr) and cool (May – Sep) seasons, relative to sand extraction area (yellow polygon). Adapted from Brough et al. (2024).

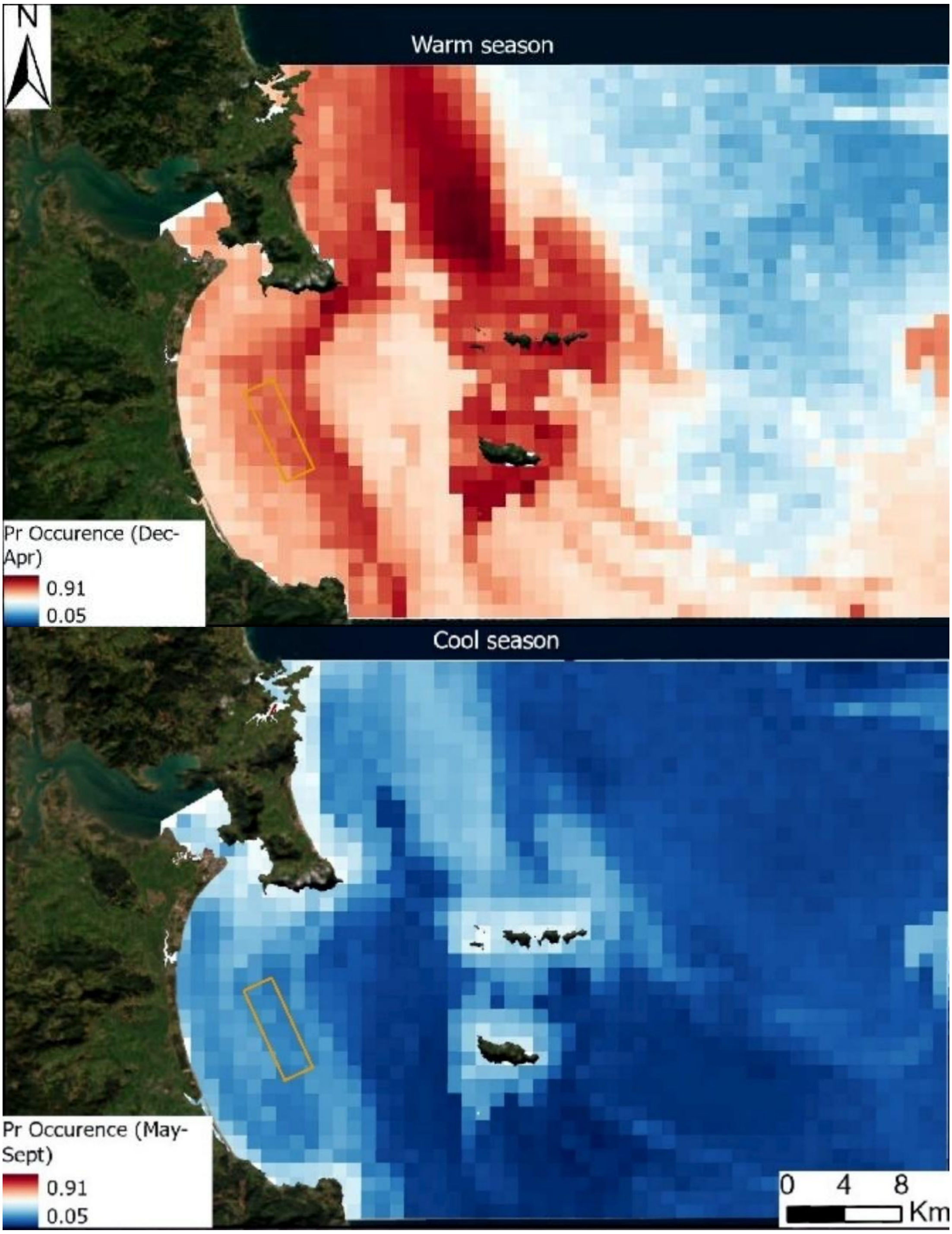

Figure 14 Coastal bottlenose dolphin probability of occurrence during warm (Dec – Apr) and cool (May – Sep) seasons, relative to sand extraction area (yellow polygon). Adapted from Brough et al. (2024).

Additional context regarding the cultural significance of marine mammals can also be found in **Appendices C** and **F.**

3.3 Marine Mammal Habitat of Importance

As described in **Section 3.2**, the wider region (over which distributional data was reviewed) supports a diverse assemblage of marine mammal species. The Proposed Regional Plan for Northland (**PRPN**) takes a very inclusive approach and identifies all of its regional CMA waters as a 'significant marine mammal and seabird area' (**Figure 15**).

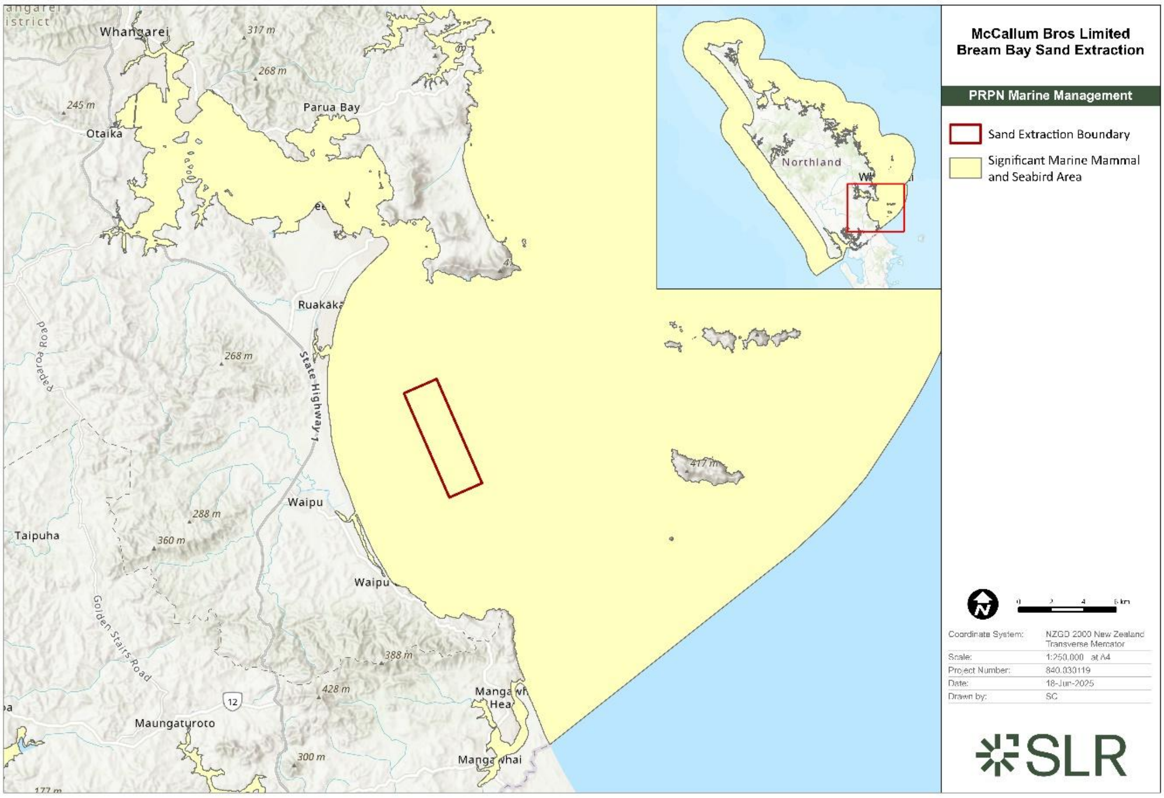

Figure 15 Areas of relevance identified in the PRPN

The Te Pēwhairangi (Bay of Islands) Marine Mammal Sanctuary (**Figure 16**) occurs in the northern portion of the wider region. This sanctuary was established in 2021 with the primary aim of reducing vessel interactions with bottlenose dolphins to address local population decline and high calf mortality. Noting that the Bay of Islands is subject to uniquely high levels of vessel activity (including permitted marine mammal watching tours) and that high levels of vessel interactions are known to disrupt normal behaviours critical for survival (such as resting and feeding) which in turn can cause stress, reduced reproductive success and increased susceptibility to illness. While vessel disturbance has not been directly linked to the ongoing decline of this local population, some evidence of dolphins changing their behaviour in the presence of vessels is emerging (Brough et al., 2025), Brough et al. (2025) also found that compliance with vessel speed restrictions in 'safe zones' that were established as part of the marine mammal sanctuary here is poor, and that these safe zones have a low level of overlap with areas of core dolphin habitat use.

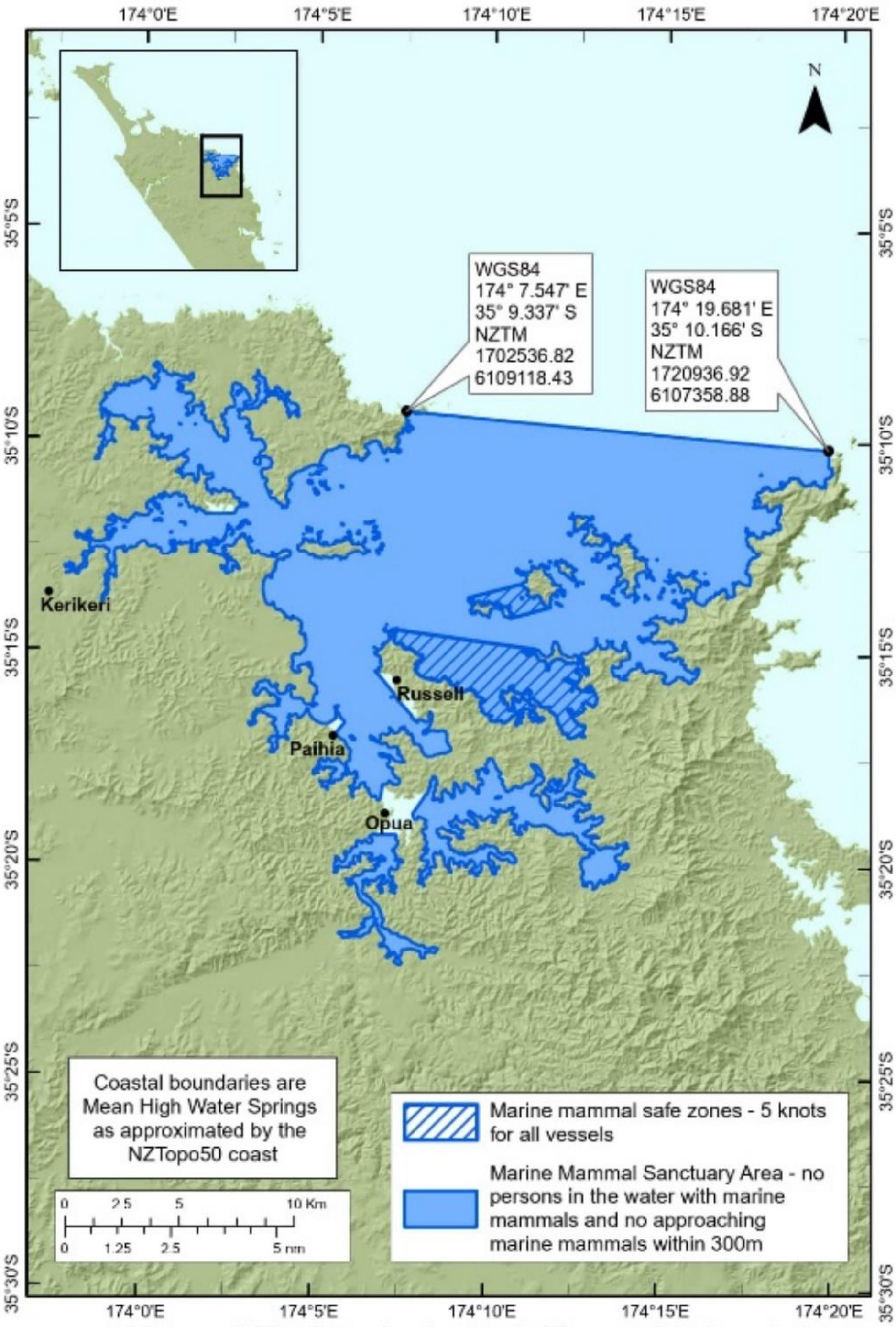

Figure 16 Te Pēwhairangi (Bay of Islands) Marine Mammal Sanctuary

Further to this, the IUCN has recently identified an Important Marine Mammal Area (**IMMA**) which overlaps part of the region but does not overlap with the proposed sand extraction area. The location of the 'Tikapa Moana Te Moananui ā Toi Hauraki IMMA is shown in **Figure 17**. While this IMMA confers no specific international or legal protection over the area, IMMAs are defined as 'discrete portions of habitat, important to marine mammal species, that have the potential to be delineated and managed for conservation' (IUCN MMPATF, 2025).

The Tikapa Moana Te Moananui ā Toi Hauraki IMMA was designated on the basis of the following criteria:

- Criterion A – Species or population vulnerability: Pygmy blue whales, listed as Endangered on the IUCN Red List, use the Hauraki Gulf for foraging in the summer months (Olson et al., 2015; Barlow et al., 2018). Whilst not listed as endangered by the IUCN, the Gulf is an important year-round habitat for a small, resident population of Bryde's whales. The Gulf is also frequently used by killer whales ranging more widely throughout New Zealand waters – both species are listed in New Zealand as nationally critical (Baker et al., 2019).
- Criterion B – Distribution and abundance (sub-criterion B2 aggregations): The Hauraki Gulf forms an integral part of the home range of Bryde's whales, even though some individuals range outside the IMMA. There is niche separation between the three main species feeding on zooplankton, fishes and squids (Kozmian-Ledward, 2015; Carroll et al., 2019). The Bryde's whales appear to shift habitat slightly offshore during warm-water events (Colbert, 2019). An estimated 135 (95% CI = 100-183) Bryde's whales use the Gulf, with some individuals' year-round residents and others transient (Tezanos-Pinto et al., 2017). Bryde's whales were threatened with unsustainable levels of ship-strike mortality, but this has been resolved with voluntary speed reductions by the shipping industry (Constantine et al., 2015; Ebdon et al., 2020). Whether this has led to an increase in population size is yet to be determined.
- Criterion C – Key life cycle activities (sub-criterion C2 feeding areas): There are increasingly regular summer-autumn aggregations of pygmy blue whales over the past decade (Olson et al., 2015; Barlow et al., 2018). These whales feed on zooplankton (Barlow et al., 2018), most likely krill which are a preferred prey of Bryde's whales in the Gulf (Carroll et al., 2019). In summer-autumn, two primary groups of false killer whales regularly use the outer Gulf waters for feeding, often in association with pelagic bottlenose dolphins (Zaeschmar et al., 2014).
- Criterion D – Special attributes (sub-criterion D2 diversity): The area is a key area for cetaceans in New Zealand (Stephenson et al., 2020) with 17 species recorded in the Gulf including *Balaenoptera musculus brevicauda, Tursiops truncatus, Orcinus orca, Pseudorca crassidens, Delphinus delphis, Globicephala melas, Ziphius cavirostris, Mesoplodon grayi, Bearadius arnuxuii, Balaenoptera borealis, Megaptera novaeangliae, Balaenoptera bonaerensis, Physeter macrocephalus, Eubalaena australis, Hydrurga leptonyx, Arctocephalus forsteri*. There are migratory species such as humpback whales and southern right whales that are infrequently sighted but likely to increase in number as populations recover from whaling (Cranswick et al., 2022). Reports of live beaked whales are infrequent, although mother-calf pairs of Gray's beaked whales may come closer inshore during the summer months to feed in the outer parts of the Gulf (Thompson et al., 2013a). There is a wide diversity of large and small cetaceans as well as native and vagrant species of pinnipeds including leopard seals. Fur seals are increasing in number, although this is not an established breeding area as it was historically (MacDiarmid et al., 2016).

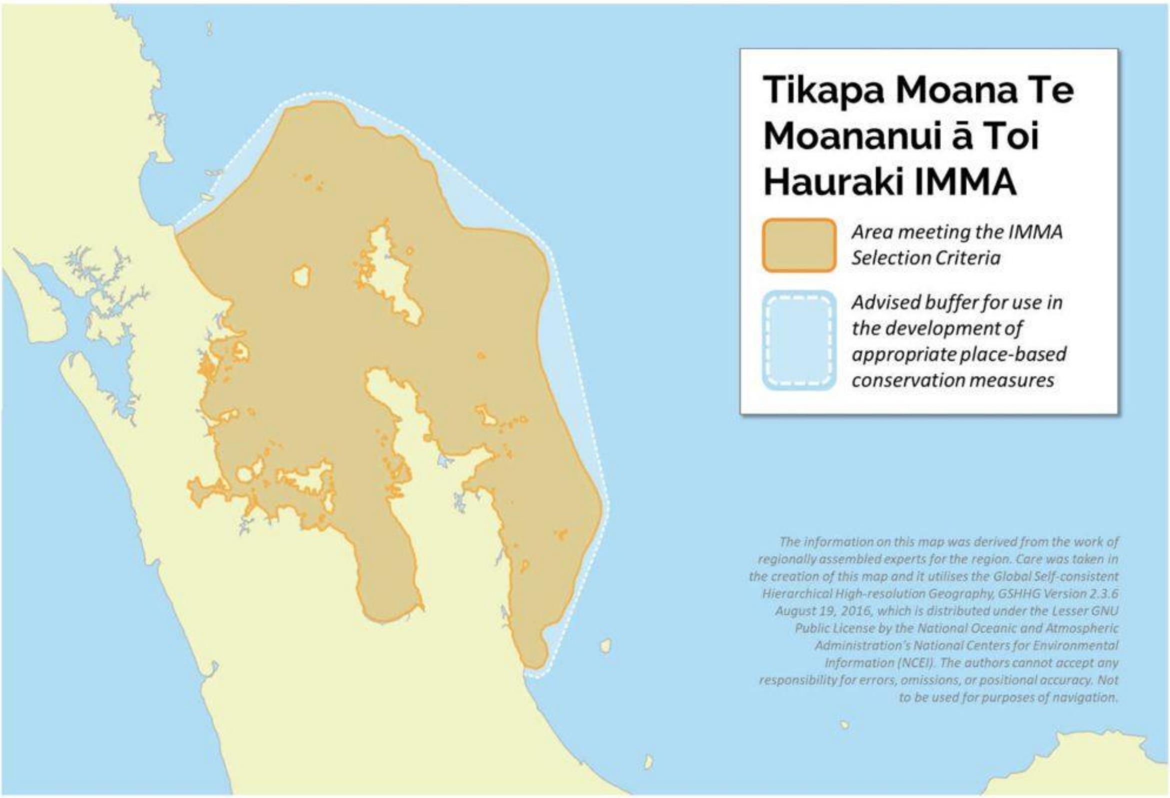

Figure 17 Central West Coast North Island Important Marine Mammal Area

Following the rationale behind IMMA Criterion C (key life cycle activities), and in keeping with the NZCPS approach, which indicates that marine mammal habitat should be assessed in terms of importance during vulnerable life stages and migration (NZCPS Policy 11(b)(ii) and NZCPS Policy 11(b)(v). Taking a broader approach to this, and accounting for international literature on this topic, it is prudent that the following additional criteria should also be considered when defining important habitat:

1. Areas that support concentrations of animals (following Clark et al., 2010);
2. Areas that are critical to the conservation of a species, particularly those areas that support a high proportion of a population/subpopulation (following the US Endangered Species Act 1973);
3. That nearby alternative habitat of equivalent quality is limited;
4. That a high proportion of sightings include calves or juveniles (following Clark et al., 2010); and/or
5. Areas that are critical for maintaining a healthy population growth rate (following Hoyt, 2011).

On this basis, important marine mammal habitats would represent areas of concentrated marine mammal presence which habitually support important ecological functions (e.g. feeding, breeding, resting) and where alternative habitat is limited. In keeping with NZCPS Policy 11(b), the regular presence of vulnerable life stages would deem an area to be important, as would habitat for migratory species.

In conclusion, the available information sources (DOC data and published and unpublished literature) have shown that regional coastal waters are used by c. 30 marine mammal species. Multiple lines of evidence suggests that Te Ākau Bream Bay supports some foraging, breeding and resting behaviours for several marine mammal species. While all species that have been identified as having a likely or possible presence here have large home ranges (i.e. the proposed sand extraction area would only represent a very small part of their overall distribution), it is highly noteworthy 1) that bottlenose dolphins do not use their home ranges evenly (Brough et al., 2025; Brough et al., 2024) and individuals will exhibit localised preferences for certain areas, 2) bottlenose dolphins have recently been reported as having high rates of residency to Te Ākau Bream Bay by Brough et al. (2024), and 3) the acoustic monitoring data collected by Styles Group (2025) from the sand extraction area indicates a near daily presence of dolphins with some detection events lasting up to five hours (**Section 3.2.1**). Hence, in terms of important habitat, and on balance of all the available information, Te Ākau Bream Bay should be considered as an important habitat for threatened bottlenose dolphins; and while the embayment comprises only part of a wider important area for this species (which, following the findings of Brough et al. (2024), extends both to the north and the east of Te Ākau Bream Bay), the sand extraction area occurs in what should be considered as 'core habitat' for this species. This finding is of particular relevance in light of the documented decline of this species in adjacent areas (Tezanos-Pinto et al., 2013; Brough et al., 2025); which infers that alternative regional habitat is possibly limited or compromised.

4.0 Environmental Impact Assessment

This section addresses both potential direct impacts (e.g., underwater extraction noise) and indirect impacts (e.g. changes in trophic interactions because of sediment plumes) of the proposed sand extraction activities on marine mammals. Where considered necessary, mitigation recommendations are made to reduce the risk to marine mammals and to manage any residual impacts.

4.1 Methodology

The Ecological Impact Assessment Guidelines for New Zealand 2nd Edition (EIANZ, 2018) broadly inform the assessment methodology that has been implemented for marine mammals in this report. In addition, and because marine mammals are typically highly mobile across large home-ranges, this assessment also considers the likelihood of adverse consequences occurring, as few marine mammals will be consistently exposed to the potential impacts from the proposed activities.

Consequently, the following spatial considerations are relevant to this assessment:

- The large home-ranges of marine mammals; that in all instances extend well beyond Te Ākau Bream Bay. For this reason, an area much larger than Te Ākau Bream Bay (see **Figure 3**) formed the basis of the distributional data review and was used to characterise expected marine mammal occurrence in and around Te Ākau Bream Bay; and
- The area over which potential impacts extend, noting that the largest 'Zones of Influence' for the proposed sand extraction activities are defined by the zones of audibility for underwater noise (ranging from 10.5 km for dolphins and toothed whales, to between 18 and 19 km for seals and baleen whales, see **Section 4.2.3**). On this basis, the zones of audibility as illustrated in **Figure 18** are used to approximate the greatest possible zone of influence from the proposed sand extraction activities[5].

[5] Noting that transit activities that occur outside this zone are permitted activities.

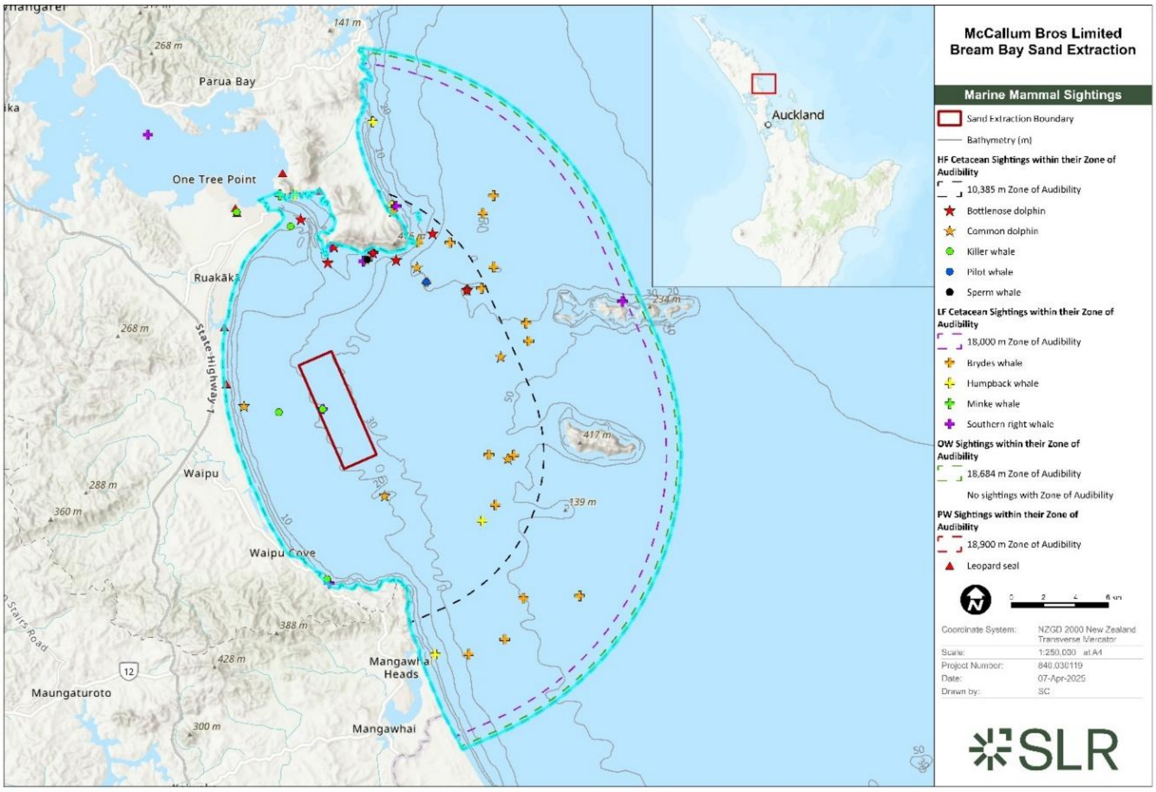

Figure 18 Zone of Influence (blue contour) as defined by the respective zones of audibility for HF cetaceans (e.g. dolphins and toothed whales), LF cetaceans (e.g. baleen whales), PW (e.g. leopard seals) and OW (e.g. New Zealand fur seals) with DOC marine mammal sightings data also shown.

Note: following the cumulative noise models presented by Styles Group (2025) the zone of audibility contours depicted above do not extend into Whangārei Harbour or Mangawhai Harbour/Estuary on account of the physical barriers provided by Mair Bank and Bream Tail respectively.

In assessing the effects of the project on marine mammals the following procedures were followed:

1. Describe and assign value to ecological features potentially impacted (see **Section 4.1.1**);
2. Identify and describe the actual and potential impacts of the project along with any mitigation measures to avoid, remedy or mitigate these impacts (**Sections 4.2 to 4.9**);
3. Determine the magnitude of any residual adverse impacts, after adoption of the proposed mitigation measures, in accordance with the definitions presented in **Table 3**;
4. Determine the likelihood of adverse consequences occurring (assuming the adoption of the proposed mitigation measures) in terms of marine mammal species distribution, individual home-ranges and occurrence (year-round vs. seasonal) and also considering the area and timescale over which each effect could occur (noting that operations will not occur daily, and for those days on which operations do occur, operations will only occur for a maximum of 3.5 hours per day). The likelihood categories used for this assessment are as follows: negligible (i.e. remote), low, moderate, high, and very high (i.e. almost certain); and

5 Consider the 'magnitude' and 'likelihood' ratings, to assign an overall level of impact in accordance with **Table 4**, which is then considered alongside ecological value.

4.1.1 Assigning Relative Ecological Value

The NZTCS is used as the criterion for assigning relative ecological value for marine mammal species as outlined in **Table 2**. While the EIANZ Guidelines do not specifically address marine mammal values, the guidelines have been adapted following Boffa Miskell (2020) to provide a suitable framework against which to provide an assessment of relative value.

Table 2 Criteria for assigning relative ecological value to marine mammal species (after EIANZ, 2018)

Relative Ecological Value	Species Classification
Very high	Nationally Threatened (Nationally Critical, Nationally Endangered, Nationally Vulnerable, or Nationally Increasing) species found in the Zone of Influence[6] either permanently or seasonally.
High	At Risk (Declining) species found in the Zone of Influence either permanently or seasonally.
Moderate	At Risk (Uncommon) species found in the Zone of Influence either permanently or seasonally.
Low	Nationally or locally common indigenous species, including those species with a Not Threatened status.

4.1.2 Assessing Magnitude of Potential Impacts

The criteria used for describing the magnitude of each potential impact are those presented in **Table 3**.

[6] The EIANZ Guidelines defines the Zone of Influence as being "*the areas/resources that may be affected by the biophysical changes caused by the proposed project and associated activities*." For the purpose of this assessment, the zone of audibility (see **Figure 18**) is used to approximate the greatest possible Zone of Influence.

Table 3 Criteria for describing magnitude of impact (adapted from EIANZ, 2018)

Magnitude	Description
Very high	Total loss of, or very major alteration, to key elements/ features of the baseline conditions such that the post development character/ composition/ attributes will be fundamentally changed and may be lost from the site altogether. Loss of a very high proportion of the known population or range of the element / feature. Habitat changes that are widespread across total habitat area (following MacDiarmid et al., 2014). In terms of underwater noise effects, Styles Group (2025) describes auditory injury as a being of 'very high' magnitude.
High	Major loss or major alteration to key elements/ features of the existing baseline conditions such that the post-development character, composition and/or attributes will be fundamentally changed. Loss of a high proportion of the known population or range of the element / feature. Habitat changes are predicted to affect >20% of total habitat area (following MacDiarmid et al., 2014). In terms of underwater noise effects, Styles Group (2025) describes a) temporary threshold shift; b) exposure of key individuals (e.g. mothers) to severe and repeated behavioural responses; and c) a soundscape change of >7 dB re 1 mPa as being of 'high' magnitude.
Moderate	Loss or alteration to one or more key elements/features of the existing baseline conditions, such that post-development character, composition and/or attributes will be partially changed. Loss of a moderate proportion of the known population or range of the element / feature. Habitat changes are predicted over 5 – 20% of total habitat area (following MacDiarmid et al., 2014). In terms of underwater noise effects, Styles Group (2025) describes a) frequent recurrence of behavioural responses of increased severity; b) infrequent exposure to 75% listening space reduction; and c) a soundscape change of 4-6 dB re 1 mPa as being of 'moderate' magnitude.
Low	Minor shift away from baseline conditions. Change arising from the loss/alteration will be discernible, but underlying character, composition and/or attributes of the existing baseline condition will be similar to pre-development circumstances/patterns. Having a minor impact on the known population or range of the element / feature. Any changes to habitat would be highly localised, <5% of total habitat area (following MacDiarmid et al., 2014). In terms of underwater noise effects, Styles Group (2025) describes a) low level behavioural response; b) short-lived and spatially limited behavioural responses of increased severity; c) discrete exposure to 75% listening space reduction; and d) exposure to 50-25% listening space reduction; and e) a soundscape change of 1-3 dB re 1 mPa as being of 'low/minor/small' magnitude.
Negligible	Very slight change from existing baseline condition. Change barely distinguishable, approximating to the "no change" situation. Having a negligible impact on the known population or range of the element / feature. In terms of underwater noise effects, Styles Group (2025) describes a) infrequent low level behavioural response; b) 0% listening space reduction; c) audibility; and d) a soundscape change of <1 dB re 1 mPa as being of 'negligible' magnitude.
Positive	Improving the existing baseline condition.

4.1.3 Overall Level of Impact

For each marine mammal species, and in respect of each identified impact, the findings for a) magnitude of impact, and b) the likelihood of an adverse consequence were evaluated in accordance with **Table 4**. While these two components form the main determinants, the overall level of impact must also be regarded alongside ecological value.

Table 4 Matrix for determining the 'Overall Level of Impact' (adapted from EIANZ, 2018)

		Likelihood of Consequence Occurring				
		Very high	High	Moderate	Low	Negligible
Magnitude of Potential Impact	Very high	Very high	Very high	High	Medium	Low
	High	Very high	Very high	Medium	Low	Very low
	Moderate	High	High	Medium	Low	Very low
	Low	Medium	Low	Low	Very low	Very low
	Negligible	Negligible	Negligible	Negligible	Negligible	Negligible
	Positive	Net gain	Net gain	Net gain	Net gain	Net gain

To gauge whether or not the overall level of impact is acceptable, the definitions in **Table 5** were applied (adapted from Wilson, 2025).

Table 5 Relationship between 'Overall Level of Impact' and acceptability

Overall Level of Impact	Acceptability Statement
Very high	Level of impact is unacceptable; refine the project and control measures to lower the environmental risk.
High	Level of impact is unacceptable; refine the project and control measures to lower the environmental risk.
Medium	Level of impact is broadly acceptable; consideration should be given to additional mitigations.
Low	Level of impact is largely acceptable
Very low	Level of impact is acceptable
Negligible	Level of impact is acceptable
Net gain	Level of impact is acceptable

The potential for interactions between marine mammals and the proposed sand extraction is largely dependent on the spatial overlap between the proposed activities and marine mammal habitat. In assessing this spatial relationship, the extent of overlap, the significance of the affected habitat, and the severity of the predicted impact (in terms of both individual and population level impacts) are considered.

It is noteworthy that Policy 11 of the NZCPS requires that effects (termed 'impacts' in this assessment) on those species identified as Policy 11(a) species in **Table 1** (bottlenose dolphins, killer whales, Bryde's whales, false killer whale, humpback whales, southern right whales, blue whales, sei whales, sperm whales, and leopard seals) to be avoided, and this requirement is replicated in the PRPN.

In addition, Policy 11 of the NZCPS requires that significant effects on important habitat during vulnerable life stages, (Policy 11(b)(ii)), and important habitat to migratory species (Policy 11(b)(v)) be avoided, and other adverse effects avoided, remedied, or mitigated.

The following potential impacts (or effects) on marine mammals have been identified from the proposed sand extraction activities:

- Underwater noise;
- Habitat modification;
- Ship strike;
- Exposure to contaminants;
- Marine debris;
- Entanglement;
- Artificial lighting; and
- Cumulative impacts.

Each of these potential impacts is thoroughly described in the relevant subsection below along with proposed mitigations and a concluding statement on the Overall Level of Impact.

4.2 Underwater noise

4.2.1 Background

The use and interpretation of sound is fundamental to marine mammal survival; being used for communication (e.g. Quick & Janik, 2012), foraging, navigation, reproduction, parental care, avoidance of predators, and maintaining an overall awareness of their environment (Thomas et al., 1992; Johnson et al., 2009). Marine mammals are therefore susceptible to impacts from anthropogenic underwater noise (e.g. shipping, seismic surveys, drilling, extraction, coastal development etc.).

Underwater noise can result in 1) physiological consequences, 2) behavioural responses, and/or 3) the masking of biologically important sounds. These potential impacts are discussed briefly below:

- *Physiological Impacts*: Marine mammals may be subject to several potential physiological impacts from underwater noise, including stress responses (Romano et al., 2004), organ damage (Cox et al., 2006) and permanent or temporary threshold shifts (**PTS** or **TTS**, i.e. permanent or temporary hearing loss) (DOC, 2013; Lucke et al., 2009). However, for most marine mammals, the sound intensity (energy levels, frequencies and duration) required to elicit physiological impacts are unknown (Richardson et al., 1995). The US National Marine Fisheries Service (NMFS, 2024) provides estimates of noise thresholds that are predictive of hearing damage. According to international best practice, these thresholds are used in this assessment to predict the range over which TTS and auditory injury (including PTS) could occur during the proposed sand extraction activities. Permanent physiological damage to date has only been associated with very high intensity underwater noise such as military sonar (Cox et al., 2006; Ketten, 2014), and most mobile species, if given the opportunity, avoid the range in which physiological impacts occur.

- *Behavioural Impacts*: Underwater anthropogenic noise most commonly results in interruption to marine mammal behaviours (e.g. feeding, breeding, migrating or resting) (e.g. Finneran et al., 2000) and/or the displacement of marine mammals from habitat (e.g. Thompson et al., 2013b). It is not unusual for high intensity acoustic disturbance to result in temporary avoidance by marine mammals (Stone & Tasker, 2006); however, some species are reportedly attracted to low/medium intensity disturbance (e.g. Wursig et al., 1998; Simmonds et al., 2004; Lalas & McConnell, 2016; Mills et al., 2024). Avoidance can be particularly significant if long-term displacement from important habitat occurs. The NMFS (2018) provides interim guidance for the noise threshold required to elicit behavioural impacts, being 120 dB_{rms} re 1 μPa for continuous noises such as sand extraction by extraction. However, best international practise has since moved towards a dose-response approach to account for differences between species and context (Faulker et al., 2018). According to international best practice, this dose response approach is used in this assessment to predict the distances for low-level and moderate-level behavioural responses during the proposed sand extraction activities.

- Masking: Masking refers to the reduced ability of individuals to receive and interpret important naturally occurring acoustic signals (e.g. marine mammal vocalisations) in the presence of anthropogenic noise (Erbe & Farmer, 2000). The likelihood of masking is determined by how much overlap occurs between the frequency of animal vocalisations and the frequency of anthropogenic sounds (Richardson et al., 1995). Marine mammals are broadly grouped into the functional hearing groups presented in **Table 6** according to the frequency range over which their vocalisations occur (following NMFS, 2024).

  Low frequency sounds travel further through water than high frequency sounds; hence, low frequency anthropogenic noise is often associated with masking the low frequency calls of baleen whales (Simmonds et al., 2004; Clark et al., 2009). While some species are known to compensate for masking by changing the frequency of vocalisations (e.g. right whales; Parks et al., 2007 and bottlenose dolphins; Sobreira et al., 2023), increasing calling rate (bottlenose dolphins; Buckstaff, 2004) and changing call durations (e.g. killer whales; Foote et al., 2004 and bottlenose dolphins; Sobreira et al., 2023), even relatively low intensity underwater noise can cause some masking. The biological significance of any masking will depend on 1) the significance of the habitat affected and 2) the duration of the impact, where widespread and ongoing masking in habitat of high importance will lead to consequences of greatest ecological significance.

The likelihood of anthropogenic underwater noise leading to an ecologically significant consequence on marine mammals, and the resultant magnitude of the impact, depends on:

- The noise characteristics (frequency, volume, intensity, duration etc.);
- The physical and acoustic characteristics of the local marine environment (water depth, seabed gradient, existing underwater soundscape etc.);
- The species present and life history stages (Simmonds et al., 2004); and
- How important the area is to these species.

Table 6 Marine Mammal Functional Hearing Groups

Group	Auditory bandwidth	Species that could occur in and around Te Ākau Bream Bay
Low frequency (**LF**) cetaceans	7 Hz to 36 kHz	Bryde's whales, southern right whales, humpback whales, blue whales, sei whales and minke whales.
High frequency (**HF**) cetaceans	150 Hz to 160 kHz (including ability to echolocate). Sensitivity of this group significantly decreases below 1-2 kHz (Southall et al., 2007).	Common dolphins, bottlenose dolphins, killer whales, long-finned pilot whales, false killer whales, sperm whales and beaked whales.
Very high frequency (**VHF**) cetaceans	200 Hz to 165 kHz	-
True seals (or Phocidae) (**PW**[7])	40 Hz - 90 kHz	Leopard seals
Sea lions and fur seals (or Otariidae) (**OW**[8])	60 Hz to 68 kHz	New Zealand fur seals

The ecological significance of any underwater noise impact will generally be greatest when:

- The frequency of the anthropogenic noise overlaps with the frequency of animal vocalisations resulting in masking (Erbe et al., 2016);
- The volume and intensity of the anthropogenic noise is high, and the duration is long or continuous (McGregor et al., 2013);
- The noise occurs in shallow or confined waters that provides important habitat to resident animal populations with small home ranges (Forney et al., 2013);
- The affected marine mammal population/s is/are already of conservation concern (Weilgart, 2007); and/or
- Animals are subject to noise during periods of critical life history (e.g., breeding, feeding, resting, migrating etc.) (Dunlop et al., 2017).

It is clear that anthropogenic noise can act as a stressor to marine mammals; however, corresponding evidence for direct impacts on survival or fitness is limited (Duarte et al., 2021). Despite this, it is generally accepted by the scientific community that pervasive underwater noise could affect the fitness of individuals and/or populations. In keeping with the points outlined above, understanding 1) the likely characteristics of the proposed extraction noise, 2) the distribution of marine mammals in the vicinity of the sand extraction area, and 3) the relative importance of this area to these animals; is fundamental to assessing the potential impacts of underwater noise from sand extraction activities on marine mammals.

As outlined in **Section 3.2**, while numerous marine mammal species could be present in the region, only seven species are commonly expected in Te Ākau Bream Bay – common dolphins, bottlenose dolphins, pilot whales, killer whales, false killer whales, Bryde's whales, and New Zealand fur seals. Several other species could have a temporary seasonal presence, in particular migrating humpback and minke whales in spring, and southern right whales during their winter/spring breeding season. It is noteworthy that most species that

[7] Referring to 'Phocid in Water'.

[8] Referring to 'Otariid in Water'.

could potentially be present have large home ranges, and none are strictly confined to Te Ākau Bream Bay (although a semi-resident population of bottlenose dolphins does occur here). On this basis, and with the exception of bottlenose dolphins, the proposed sand extraction area and the surrounding waters would only represent a small portion of an individual animal's home range.

4.2.2 Characterisation of Extraction Noise

Extraction activities, the most common example of which is dredging, generate continuous, broadband sound with most energy being low frequency (<1kHz; Todd et al., 2015), with peak levels <500 Hz (Robinson et al., 2012). In addition to the noise from active extraction (i.e. noise is generated from the active draghead, from overboard pumps, suction pipes, and water/sediment discharge systems), TSHD vessels also produce the standard noise components associated with shipping (e.g. propellor/thruster noise, and hull noise) (Robinson et al., 2012).

MBL will use a TSHD, the *William Fraser,* to undertake sand extraction under this consent application. Typical source levels (or loudness) of operational TSHDs range from 160 – 188 dB re 1µPa at 1 m distance from the source (De Jong et al., 2010; Robinson et al., 2012). The noise level of the *William Fraser* has previously been measured by Styles Group (Pine, 2020) and is reported to be lower than other large TSHD vessels that have previously been assessed in New Zealand waters. During active extraction, the average source level of the *William Fraser* was measured to be approximately 168 dB re 1 µPa @ 1m. The lower source level for this vessel results from design features that specifically increase its acoustic and vibration isolation properties and the improved engine and pump efficiency of this vessel. On this basis, the operational noise profile of the *William Fraser* falls at the quieter end of the source level range that is generally reported for TSHDs.

At frequencies below 500 Hz typical extraction source levels are comparable or lower than normal engine and propeller cavitation noise or hull noise that would be expected from ships (176 – 188 dB re 1µPa at 1 m: McKenna et al., 2012; Todd et al., 2015; Robinson et al., 2012). Indeed, compared to commercial shipping noise, the source level of the *William Fraser* is comparatively low (168 dB re 1 µPa @ 1m). Further to this, Hoffman (2012) reported that dredge noise is typically quieter than tug noise, and tugs operate frequently in and around Northport/Te Ākau Bream Bay. Dredge noise is also quieter than many other marine industrial activities such as pile driving and seismic surveys (Robinson et al., 2012).

Extraction noise of a typical port dredging project usually persists in any one location over longer time periods than that of a passing ship; hence, generically speaking, dredging noise typically persists in the coastal environment for extended periods compared to shipping noise; with many extraction operations run 24 hours/7 days a week. The proposed sand extraction operations will however be restricted to 3.5 hours per day, noting that:

- During the first three years, at 150,000 m^3 per annum, there will be ~14 trips per month, equating to a maximum time extracting of 49 hours per month, or approximately 6.5% of the total time in a year.
- During subsequent years, at 250,000 m^3 per annum, there will be ~23 trips per month, equating to a maximum time extracting of 80.5 hours per month, or less than 11% of the total time in a year (McCallum Bros Ltd, 2025).

This represents a comparatively lower duration than the c. 1,150 commercial ship movements per year that transit through Te Ākau Bream Bay (at approximately 45 minutes to 1 hour each) (Goodchild, 2025) (see **Section 4.9** for additional detail).

4.2.3 Underwater Acoustic Modelling

Modelling has been undertaken by Styles Group (2025) to predict the impact of underwater noise from the proposed sand extraction activities on marine mammals. In particular, the modelling has been tailored to specifically address the operational parameters of the project (as outlined in **Section 2.0**), and the species that are identified in **Section 3.0** as having a likely or possible presence in the project area. The model results are presented in **Table 7, Table 8,**

Table 9 and Table 10; and in **Figure 19** and **Figure 20** and are used in this assessment to interpret the ecological consequences for marine mammals in terms of:

- Physiological impacts (will the proposed sand extraction elicit TTS or auditory injury e.g. PTS);
- Behavioural impacts (will the proposed sand extraction elicit significant behavioural responses) where:
  - Low-level behavioural responses reflect minor changes in behaviour (see Styles Group (2025) for a full description of what constates a low-level behavioural response); and
  - Moderate-level behavioural responses reflect moderate to extensive changes in behaviour, and/or avoidance (see Styles Group (2025) for a full description of what constates a moderate-level behavioural response);
- Masking (how will the proposed sand extraction affect listening space); and
- Audibility (how far will the noise from sand extraction be audible).

The points below present a summary of the key findings of the modelling results, noting that as the zones of predicted impact are not generally symmetrical around the operational dredge, the results reported below are the maximum predicted zone to reflect the worst-case scenario. The ranges reported for each of the impacts listed above are not influenced by the project duration and volume amounts.

<u>Physiological Impacts (**Table 7**):</u>

- The potential for auditory injury (including PTS) and TTS is not expected beyond 0.5 m of the active extraction. Hence the likelihood of auditory injury is highly unlikely for any species during the proposed sand extraction activities.

<u>Behavioural Impacts (**Figure 19** and **Table 8**):</u>

- The predicted distances over which low level behavioural responses could occur in killer whales, bottlenose dolphins and common dolphins are presented in **Table 8**. For these species there is a 50% risk of low-level responses at a distance of 192 m, noting that the closer animals approach the TSHD the greater the risk of a response. The outer limit of response for these species is c. 600 m; meaning that beyond this distance no behavioural responses are expected;
- Predictions relating to moderate level behavioural responses in killer whales, bottlenose dolphins and common dolphins are also presented in **Table 8**. This level of response is expected from most animals that come within 130 m of the active dredge, but beyond c. 230 m, no moderate level responses are expected (but low-level responses could occur over a wider zone as noted above);
- The predicted distances over which low-level behavioural response in Bryde's whales is greater (in line with the increased sensitivity of these species to disturbance). The modelling predicts a risk gradient from 75% at 540 m to 0% at 1.1 km. Meaning that

behavioural responses for baleen whales are expected to be restricted to those individuals within 1.1 km of the vessel;

- The predicted distances over which low level and moderate level behavioural responses in seals are presented in **Table 8**; with low level responses expected to 700 m, and moderate level responses expected out to c. 200 m from the vessel.

Masking (**Figure 20** and **Table 9**):

- Masking is gauged by way of calculating 'listening space reduction' ('**LSR**'). An animal's natural listening space is the surrounding area over which animals can typically detect biologically important sounds. However, when anthropogenic noise is present, listening space is reduced because the human-made noise masks sound that is important for marine mammals;
- LSR results are presented in
- **Table 9** and show that for HF species (including dolphins and killer whales) a 50% LSR is expected at 933 m from the active TSHD, and that lesser masking impacts persist out to 8.3 km;
- For Bryde's whales (and all other baleen whale species), a 50% LSR is expected at c. 2.8 km from the active TSHD and that masking impacts persist out to c. 16 km; and
- The 50% LSR distance for fur seals and leopard seals is c. 2 km and 2.6 km respectively, with 0% LSR not being attained until a distance of 15 – 16 km from the vessel

Audibility (**Table 10**):

- The TSHD will be audible above the existing soundscape for HF cetaceans (e.g. dolphins and killer whales) to c. 10 km away, and to 18 km for all baleen whale species. Extraction operations will be audible to seals out to c. 19 km.
- When assessed against the respective zones of audibility, the DOC sightings data confirms that the following species are definite candidates for exposure to underwater noise: bottlenose dolphins, common dolphins, killer whales, pilot whales, sperm whales, Bryde's whales, humpback whales, minke whales, southern right whales, and leopard seals (**Figure 18**).

Table 7 Predicted zones of auditory injury and TTS.

Species	Predicted range for auditory injury	Predicted range for TTS (m)
HF – Dolphins: bottlenose, common; Whale: killer, pilot, false killer, sperm, & beaked.	NA	0.01
LF – Whales: Bryde's, humpback, southern right, blue, sei, & minke.	NA	0.08
OW – New Zealand fur seal.	NA	0.01
PW – leopard seal.	NA	0.06

Table 8 Predicted zones of behavioural impacts.

Species	Behavioural Response	Distances (m) at which some probability of an individual responding to the noise from the TSHD (m)			
		75%	50%	25%	0%
HF – Dolphins: bottlenose, common; Whale: killer, pilot, false killer, sperm, & beaked.	Low	173	192	241	596
	Moderate	130	141	164	227
LF – Whales: Bryde's, humpback, southern right, blue, sei, & minke	Low	540	660	774	1,115
Pinnipeds (OW and PW) – New Zealand fur seal and leopard seals	Low	700			
	Moderate	203			

Table 9 Predicted zones of listening space reduction.

Species	Distance from the *William Fraser* (m)			
	75% LSR	50% LSR	25% LSR	0% LSR
HF – Dolphins: bottlenose, common; Whale: killer, pilot, false killer, sperm, & beaked.	170	933	2,500	8,307
LF – Whales: Bryde's, humpback, southern right, blue, sei, & minke.	1,431	2,854	5,524	16,246
OW – New Zealand fur seal.	319	2,024	4,493	15,060
PW – leopard seal.	1,074	2,664	5,928	16,174

Table 10 Predicted Zones of audibility.

Species	Audibility radius (m)
HF – Dolphins: bottlenose, common; Whale: killer, pilot, false killer, sperm, & beaked.	10,385
LF – Whales: Bryde's, humpback, southern right, blue, sei, & minke.	18,000
OW – New Zealand fur seal.	18,684
PW – leopard seal.	18,900

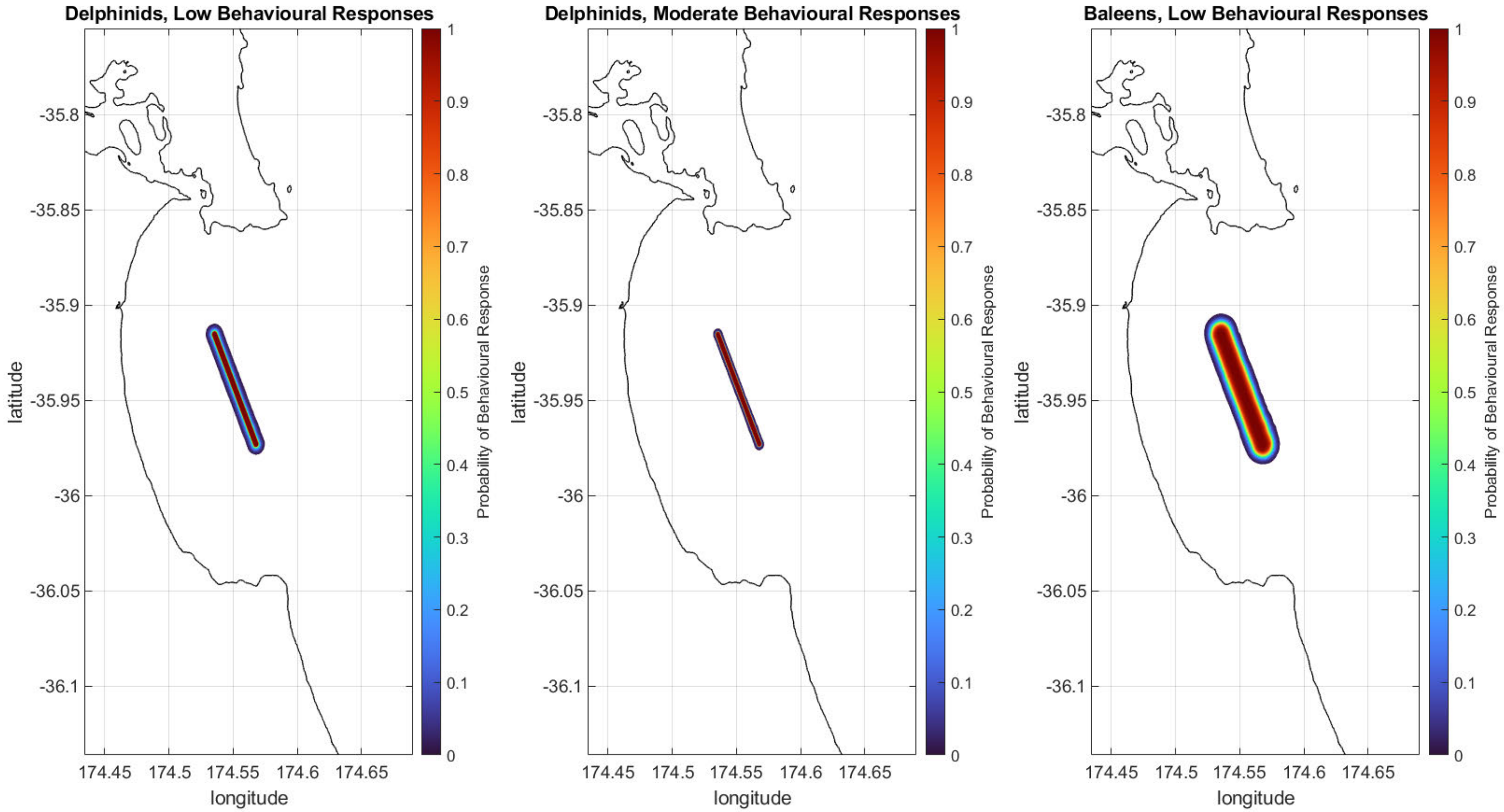

Figure 19 Extent of low (a) and moderate (b) level behavioural impacts for dolphins and killer whales, and low level behavioural impacts for baleen whales (c).

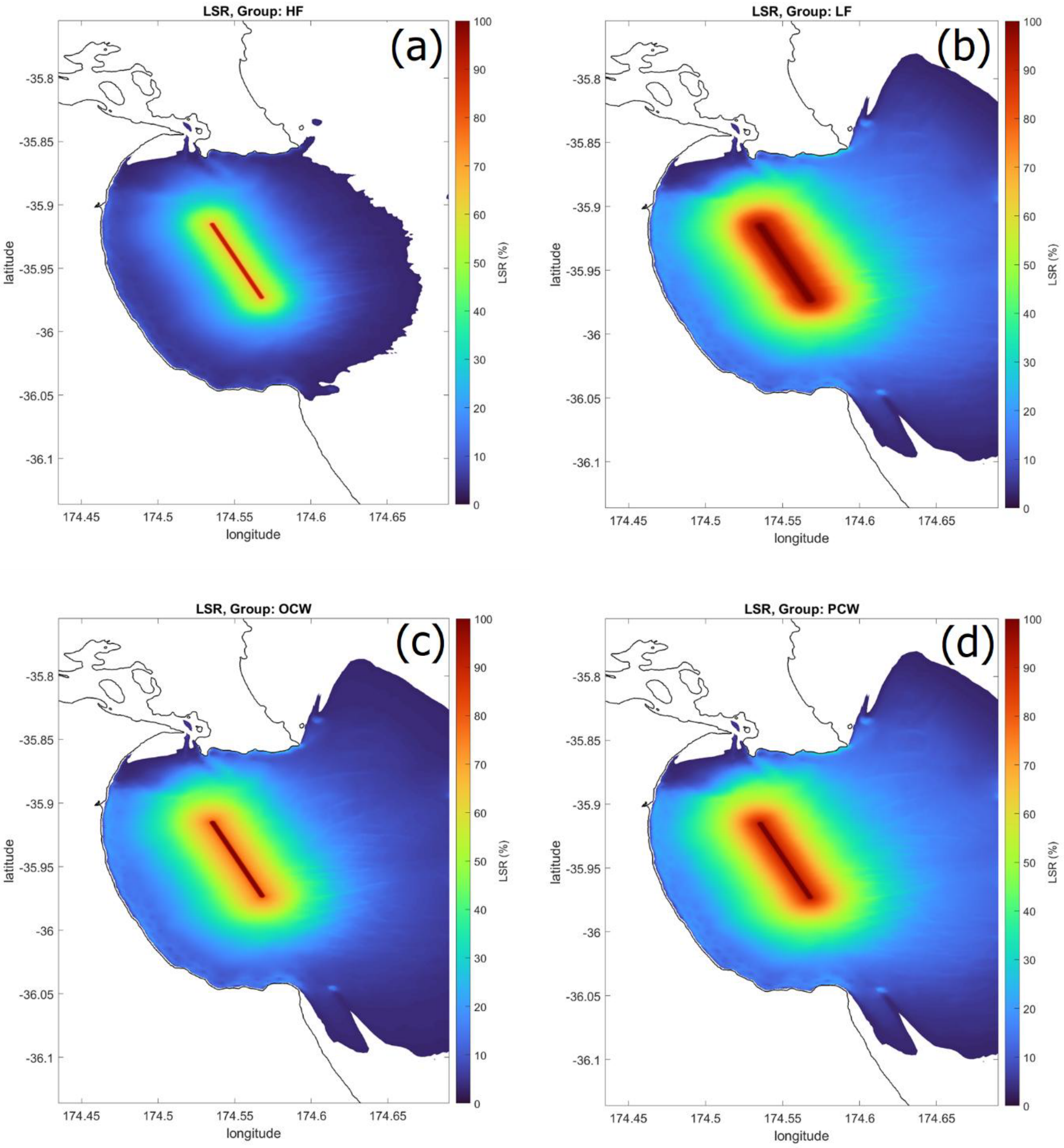

Figure 20 Predicted Listening Space Reduction for (a) HF cetaceans (i.e. dolphins and toothed whales); (b) LF cetaceans (i.e. baleen whales); (c) OW seals (i.e. fur seals); and (d) PW seals (i.e. leopard seals).

4.2.4 Modelled Changes to the Existing Soundscape

Styles Group (2025) modelled the cumulative noise impacts of the proposed sand extraction activities and the resulting soundscape changes in Te Ākau Bream Bay and surrounds. This involved the generation of underwater noise models for the *William Fraser* which were compared to conservative[9] underwater noise models of vessel traffic (generated using site specific AIS data from April – June 2024) to calculate soundscape differences and to make predictions about how the proposed extraction will alter the existing soundscape in the sand extraction area and surrounds.

It is noteworthy that the operational window with the lowest potential for soundscape change has been selected for Te Ākau Bream Bay sand extraction to minimise the cumulative underwater noise impacts on marine mammals. In contrast to Pākiri, where extraction occurs at night, modelling has confirmed that daytime operations would be preferable to minimise the cumulative noise impacts in Te Ākau Bream Bay (Dr M. Pine, pers comm, January 2025). This finding is underpinned by the fact that the existing soundscape in the project area is significantly noisier during the day (on account of other vessel traffic); hence, the soundscape difference (with the addition of extraction noise) will be of a lower magnitude during daylight hours than it would be at night. While further analysis did not identify any particular time of the day when existing noise was highest, biological understanding has been used to further refine the preferred operational window to afternoon and dusk (see **Section 2.0** for proposed hours) on account of the following considerations:

- Scientific knowledge of activity budgets and resting behaviours of bottlenose dolphins (Mann and Smuts, 1999; Gnone et al, 2001; Sekiguchi and Kohshima, 2003; and Lyamin et al, 2007) were reviewed. While there is little information on wild dolphin populations, studies on dolphins in captivity revealed a distinct 'high activity time' between midday and 4 pm, and a distinct 'low activity time' between midnight and 3 am. The low activity time was characterised by resting and sleeping behaviours in the observed dolphins, and while evidence suggests that diurnal sleep patterns do change in response to changing situations (Sekiguchi and Kohshima, 2003), the 'low activity time' correlates with the quietest nighttime soundscape for Te Ākau Bream Bay and will presumably be important for resting in this species.
- Likewise, Izadi et al. (2018) reported that Bryde's whales exhibit strong diel activity patterns, exhibiting active behaviours (consistent with travelling and foraging) during the day, and long periods of less active states (indicative of rest) that occur exclusively at night. Observations made by Izadi et al. (2022) indicated that Bryde's whales can spend days in an area targeting zooplankton aggregations; feeding by day and resting by night.
- In keeping with the bullet points above, the introduction of underwater noise at night would presumably have higher ecological costs as critical resting periods for both bottlenose dolphins and Bryde's whales occur at night (Sekiguchi & Kohshima, 2003; Izadi et al., 2018). It follows that disturbance during nighttime resting periods would lead to disproportionately greater energetic consequences (compared with disturbance impacts during the day which occur in the context of animals that are already exhibiting high levels of activity). Hence, disturbance during the hours of darkness is more likely to have negative impacts on individual and/or population health.
- The 'dusk chorus' phenomenon has also been considered; whereby biophonic activity (the noises made by animals such as urchins, shrimp and fish) on subtidal reefs shows a consistent increase at dusk (e.g. Radford et al., 2010; Radford et al., 2011; McWilliam et al., 2017; Van Hoeck et al., 2020). While the extraction area itself does not contain any reefs, the nearest reef is "Three Mile Reef" located approximately 1 km to the north-east of the northeastern corner of the sand extraction area (West & van Winkel, 2025). The dusk chorus emanating from this reef

[9] See Styles Group (2025) for further discussion on the conservative nature of the model which does not include recreational vessel noise, or noise associated with increased shipping levels or anchorage use in the future.

will increase sound pressure levels in their vicinity as night falls. Should active extraction occur at dusk, the noise from the *William Fraser* will be masked (to some extent) by the dusk chorus; and for marine mammals close to reefs at this time, the *William Fraser* will be less audible.

In terms of soundscape change, an increase in the proposed extraction volume between 150,000 m^3 to 250,000 m^3 will lead to an increase in the number of trips per month (from 14 to 23) and therefore the potential for cumulative noise exposure for marine mammals will differ between the two stages. Soundscape impacts for both stages were modelled by Styles Group (2025) over a grid of 42 measurement locations across the Te Ākau Bream Bay and surrounds.

Soundscape changes are predicted throughout Te Ākau Bream Bay for both 150,000 m^3 (**Figure 21**) and 250,000 m^3 (**Figure 22**). These figures (using the month of June as an example) illustrate the expected changes to the soundscape with the introduction of sand extraction activities using monthly '**Leq**' levels, which are defined as the Equivalent Continuous Sound Pressure Level which represents the total sound energy logged over the course of a measurement. For each measurement location, the value given represents the expected increase to the monthly Leq (above baseline, i.e. normal vessel traffic) from the addition of sand extraction activities. A complete set of results for all the other months modelled (April and May) is provided in Styles Group (2025).

While the interpretation of underwater acoustic data can be complex, a useful way of contextualising the results presented here is to understand that a 3 dB increase in sound exposure represents a 50% increase in sound intensity. Where differences of < 1 dB re 1 μPa would represent a 'negligible' soundscape change, and differences < 3 dB re 1 μPa represent a 'small' soundscape change (Styles Group, 2025).

In general, these findings indicate that the proposed activity will alter the existing soundscape of Te Ākau Bream Bay. However, with the exception of the extraction area itself, increases are predicted to be either negligible (<1 dB re 1 μPa increase to the existing soundscape) or small (<3 dB re 1 μPa). Larger increases in daily Leq are restricted solely to the extraction area and within the vicinity of the vessel while actively extracting.

Across all months modelled, the greatest soundscape change was predicted for June on account of this being the month with the lowest level of vessel traffic using Te Ākau Bream Bay. On this basis the Leq results shown in **Figure 21** and **Figure 22** represent the worst case scenario. In June, increases of up to 37 dB (unweighted) are predicted for the extraction area, but despite this, levels in surrounding waters remain small.

While the modelling does not provide Leq differences for summer months (noting that evidence suggest that both bottlenose dolphins and Bryde's whales both have higher rates of occurrence in Te Ākau Bream Bay during warmer months: see **Table 1**), and does not account for recreational vessel traffic noise; summer represents the busiest time for boating in the bay and the increase in baseline noise levels associated with higher levels of both commercial and recreational vessel traffic will serve to further reduce the Leq differences in summer. On this basis, the cumulative impact that sand extraction would have on the soundscape of Te Ākau Bream Bay is predicted to be lower in the warmer months when the highest densities of marine mammals are predicted to be present.

The Leq differences calculated by Styles Group (2025) provide a useful means of assessing how the different extraction intensities of the proposed extraction volumes between 150,000 m^3 (14 trips per month) to 250,000 m^3 (23 trips per month) affect the soundscape; noting that the greatest differences between stages are restricted to the extraction area, with surrounding waters experiencing similar soundscape impacts across both project stages.

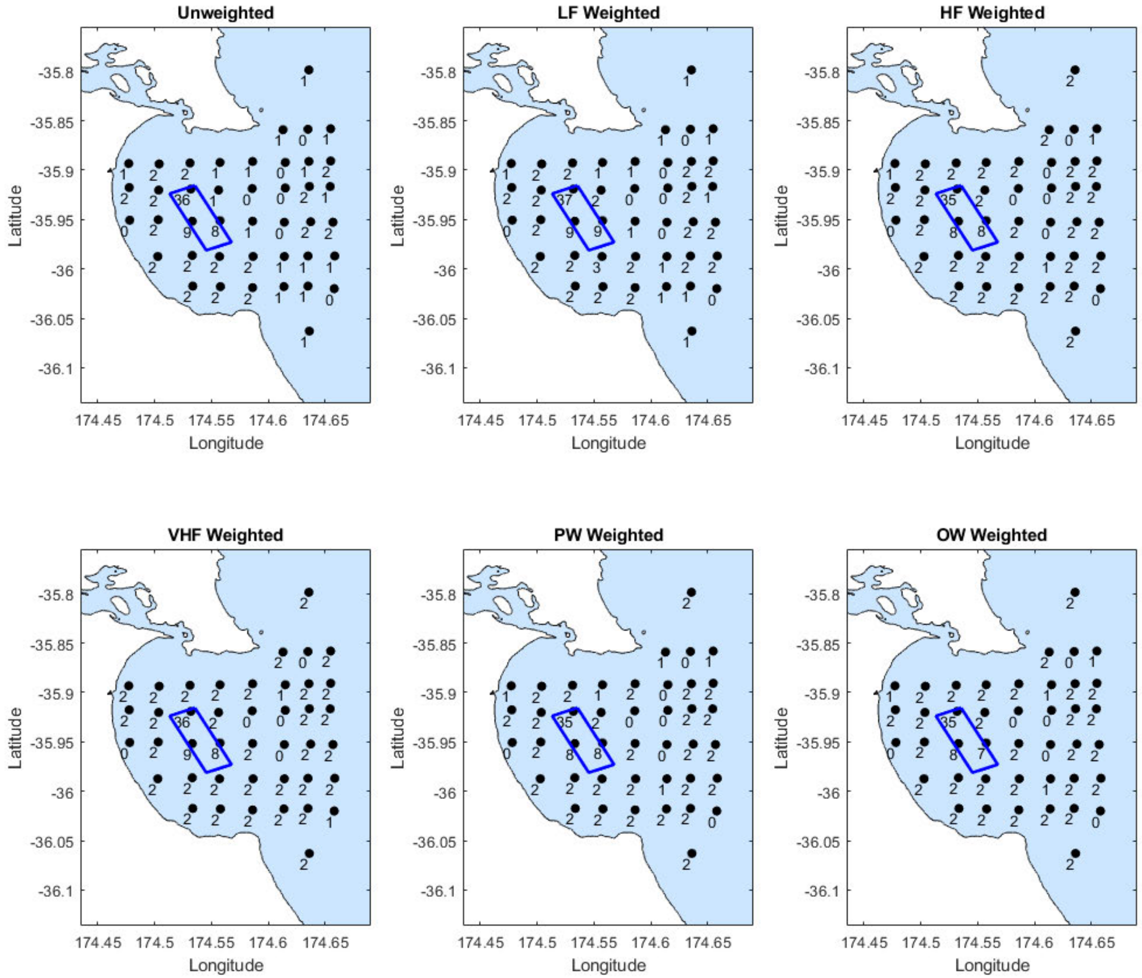

Figure 21 Stage 1 calculated differences in daily Leq between baseline conditions (i.e. normal vessel traffic) and sand extraction activity at each measurement point across Te Ākau Bream Bay, in June (using AIS data from June 2024).

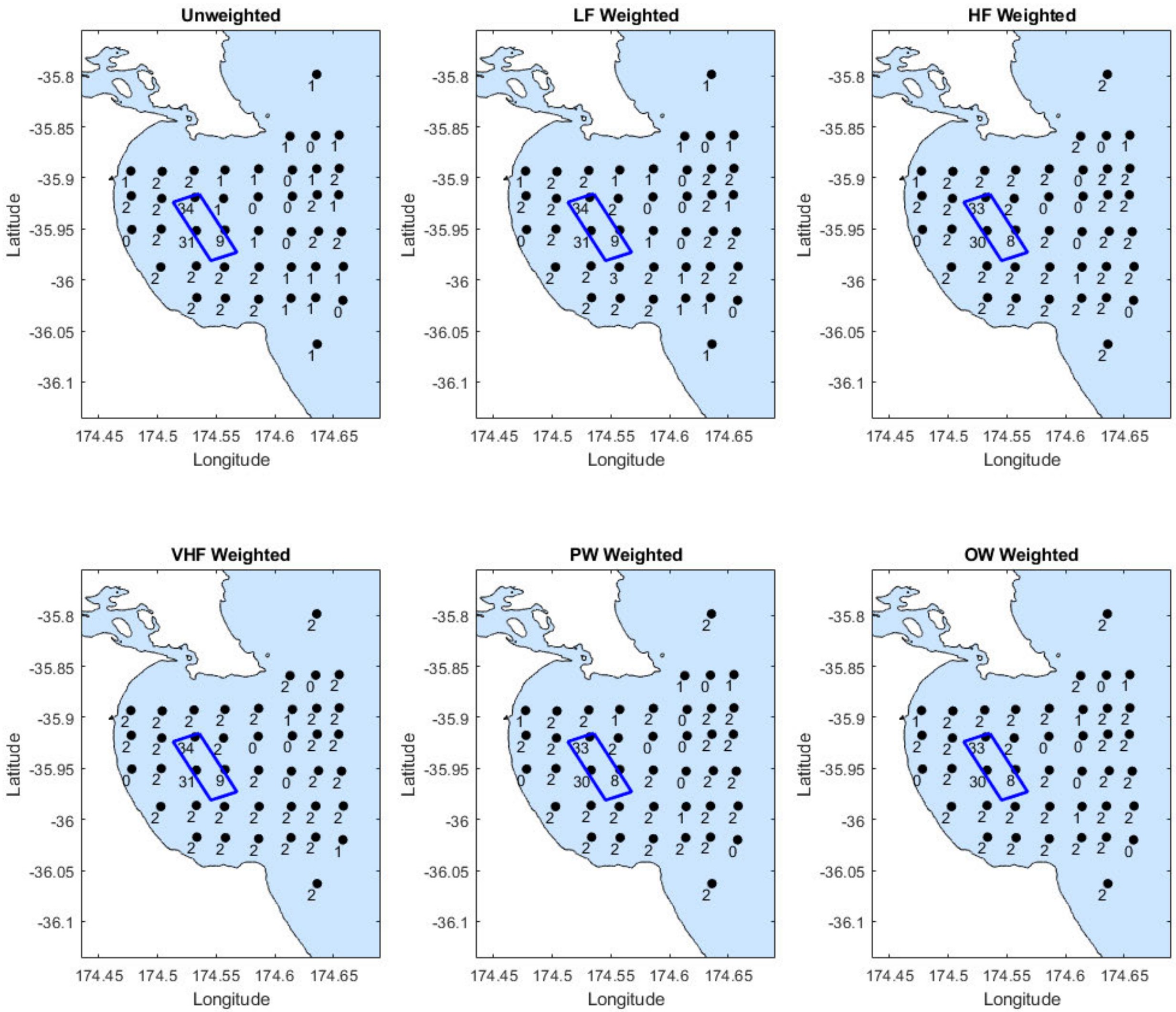

Figure 22 Stage 2 calculated differences in daily Leq between baseline conditions (i.e. normal vessel traffic) and sand extraction activity at each measurement point across Te Ākau Bream Bay, in June (using AIS data from June 2024).

An overview of soundscape change and cumulative noise impacts is depicted for each stage in **Figure 23** and **Figure 24**. These figures illustrate the expected changes to the soundscape with the introduction of sand extraction activities using two different metrics (top and bottom panels); and despite the metric used, the predictions are similar; whereby any area plotted in colour represents a predicted elevation above existing soundscape conditions.

For both stages, it is noteworthy that modelled monthly Leq levels were elevated beyond Te Ākau Bream Bay (see top panels of both **Figure 23** and **Figure 24**). But increases in Parry Channel (between Bream Head and the Hen and Chicken Islands) were found to be either negligible (<1 dB re 1 µPa increase to the existing soundscape) or small (<3 dB re 1 µPa) due to higher levels of vessel noise in the channel.

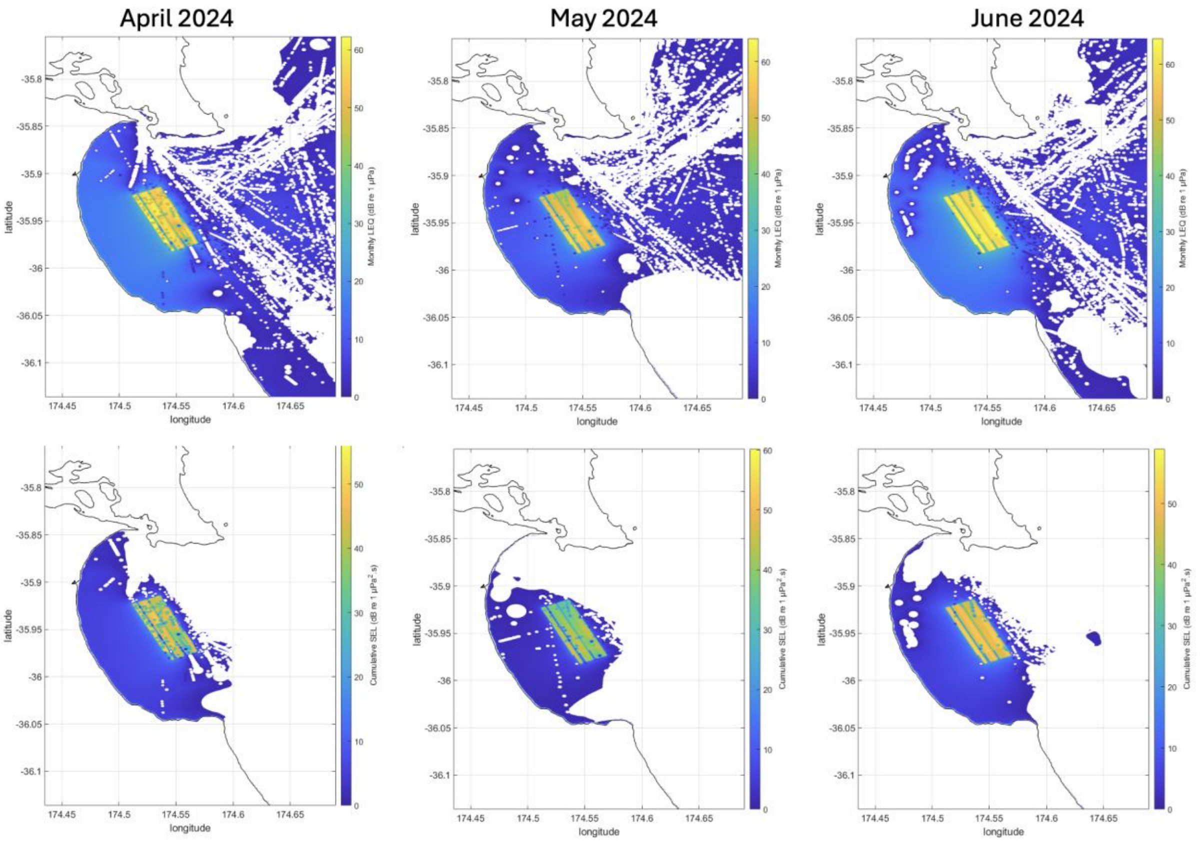

Figure 23 Predictions of Stage 1 monthly increases to the averaged Leq (top panel) and cumulative sound exposure levels (bottom panel) over three months.

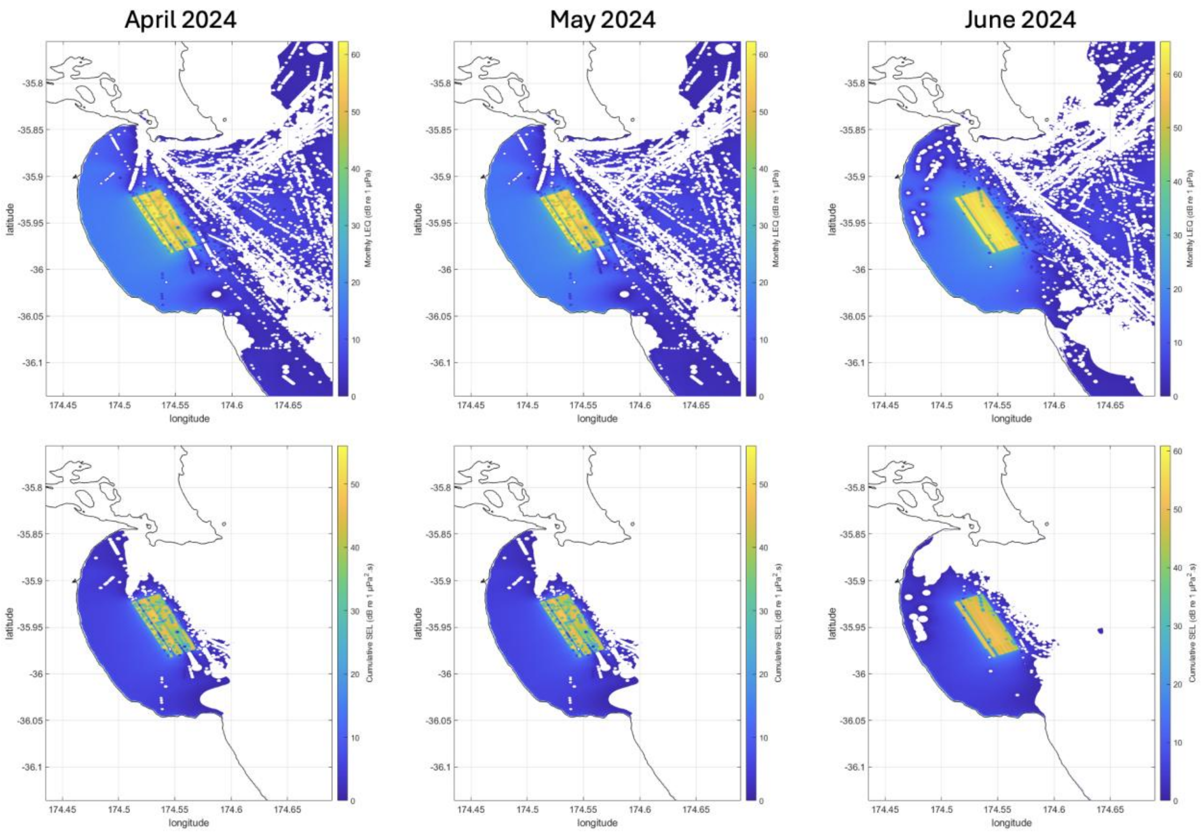

Figure 24 Predictions of Stage 2 monthly increases to the averaged Leq (top panel) and cumulative sound exposure levels (bottom panel) over three months.

4.2.5 Literature Review

Although few studies have directly quantified the impacts of extraction activities (primarily dredging) on marine mammals, the paragraphs below summarise what is available from the international literature and help to put the modelling results into context for the proposed sand extraction activities. The first three subheadings below are of particular relevance in terms of instantaneous injury, behavioural responses and masking. The last subheading addresses the potential cumulative impacts associated with chronic (i.e. long-term) exposure.

<u>Physiological Impacts</u>

The modelling results do not predict auditory injuries (i.e. physiological impacts) from the sand extraction activities. Indeed, to date hearing damage has not been reported from extraction activities (Thomsen et al., 2013) despite TTS from dredge noise being theoretically possible (i.e. if an individual marine mammal stayed in close proximity to the active dredge for a long period of time). Generally, it is reported that the risk of damage to marine mammal auditory systems from extraction noise is very low, and instead masking or temporary behavioural responses are more likely (Todd et al., 2015), the model results presented in **Section 4.2.3** align with this and confirm that no physiological impacts are predicted beyond 0.5 m of the *William Fraser*; hence ecologically significant instantaneous noise impacts are not predicted from the proposed sand extraction activities in Te Ākau Bream Bay.

Behavioural Impacts

The following temporary behavioural responses have been reported from marine mammals in the vicinity of extraction activities:

- Bossley et al. (2022) quantified the impact of dredging (TSHD and backhoe dredging) on bottlenose dolphins (*Tursiops aduncus*) and fur seals (*Arctocephalus forsteri*) around South Australia's main port in the lower reaches of Adelaide's Port River. Here surveys collecting data on the presence/absence of marine mammals occurred over 876 days for dolphins (between 1992 and 2020) and 416 days for fur seals (between 2010 and 2020). Generalised linear models were then used to analyse the relationship between dolphin and seal numbers and the following variables: dredging operations, season, rainfall, and SST. Despite fluctuations in the numbers of both species, this study concluded that dredging operations were not responsible for these fluctuations (i.e. dredging did not affect marine mammal presence); rather, SST and season were the most important predictors of presence for both species. While this study did not investigate short term behavioural changes of animals near an TSHD, it did confirm no long-term avoidance of the affected area.
- Declines in the regular occurrence of foraging bottlenose dolphins in Aberdeen Harbour, Scotland have been linked to increased dredge intensity (Pirotta et al., 2013). The authors of this study concluded that noise (which results in masking of communication between conspecifics), in combination with suspended sediment (impaired visibility) could reduce foraging efficacy which resulted in dolphin groups moving to alternative foraging patches when dredging intensity was high. While dredge type was not specified in this study, the authors refer to 'dredging boats' and the purpose of dredging here was primarily to maintain the harbour's navigation channel. On this basis, it seems likely that this study was referring to a TSHD which the effects can vary considerably dependant on the vessel size and scale of the extraction track depth and area.
- Diederichs et al. (2010) reported temporary avoidance by harbour porpoises within 600 m of a TSHD extracting sand in Sylt, off the northwestern coast of Germany, but no significant difference to long term use of the area by porpoises was detected.
- Investigations to date suggest that underwater dredging noise has little impact on pinnipeds, with several studies describing no adverse reaction or no sign of disturbance (EPA, 2007; Gilmartin, 2003, as cited in Todd et al., 2015).

Masking

In regard to the potential for masking, baleen whales are generally considered to be most susceptible, given the overlap between their low frequency vocalisations and low frequency extraction noise. Bryde's whales are resident to the region and following Brough et al. (2024), frequent presence of this species in deeper waters of Te Ākau Bream Bay and surrounds is expected. The seasonal presence of other baleen whales is also possible.

Higher frequency cetaceans (e.g. bottlenose dolphins, common dolphins, pilot whales and killer whales) also use some lower frequency sounds for communication and echolocation, but their hearing range, and the frequency range over which they produce sounds, is much higher and therefore masking is less of a concern for these species. However, Sorenson et al. (2023) recently demonstrated that anthropogenic noise can impair communication and cooperation between bottlenose dolphins despite individual dolphins increasing whistle duration and amplitude in an attempt to compensate for increased ambient noise levels. Hence, some masking (albeit spatially restricted in keeping with the model results) of dolphin vocalisations is possible.

While masking of some Bryde's whale calls is probable within Te Ākau Bream Bay, there is evidence to suggest that site fidelity of Bryde's whales to coastal northeastern New Zealand is generally low (Tezanos-Pinto et al., 2017) with an unstable mixture of individuals that are both frequently and infrequently sighted over time (Hamilton et al., 2023). This is indicative of a population that is sparsely distributed over a wide home range; hence the potential for individuals to be subject to underwater noise impacts on a repetitive basis is presumably also low.

Seals do not echolocate to forage but are known to vocalise as part of underwater social interactions, including mating (Schusterman & Van Parijs, 2003). It is not uncommon for fur seals to be attracted to moderately loud novel noises in the coastal environment, but fur seals are not as sensitive to underwater noise as cetaceans (whales and dolphins) and phocids (true seals, e.g. leopard seals) as they have small ear flaps and a cartilage valve along the external ear canal that functions to close the ear canal to water (Southall et al., 2007); hence they are expected to tolerate and habituate to underwater anthropogenic noise more readily than other species. It is, however, possible that individual leopard seals could have had an occasional presence in Te Ākau Bream Bay, and while vocalisation is thought to be important for this species during breeding (Rogers et al., 2002), Northland waters are far removed from their pack ice breeding habitat (Southwell et al., 2003).

Cumulative Underwater Noise Impacts

In addition to the potential instantaneous impacts of extraction/dredging that are discussed above, the ongoing but intermittent nature of the proposed sand extraction noise must also be considered in terms of chronic exposure to underwater noise. Kok et al. (2023) define chronic exposure as "Exposure throughout a significant part of the lifespan of an animal, at regular enough intervals to have the potential of lasting impacts from the individual- to community-scale". Marine mammals generally have long life spans, for example the life span of wild bottlenose dolphins is typically 40+ years (Karniski et al., 2018). The proposed duration of the sand extraction activities fits this definition.

In **Section 4.2.1**, several risk factors for ecologically significant impacts of underwater noise were outlined including:

1. Frequency overlap between operational noise and animal vocalisations (Erbe et al., 2016): noting that the *William Fraser* produces a broadband operational noise that does overlap with several marine mammal species predicted to be present and could lead to some masking;
2. Long duration or continuous operations (McGregor et al., 2013): noting that term sought for this application is up to 35 years with up to fourteen 3.5 hour extraction events per month during the first three years (150,000 m^3, and up to twenty three 3.5 hour extraction events per month during the subsequent years (250,000 m^3);
3. The presence of threatened species (Weilgart, 2007): noting that of the seven species considered 'likely' to be present, three are classified as threatened by the NZTCS; and
4. Exposure during periods of critical life history (Dunlop et al., 2017): noting that operations could disrupt feeding behaviours of Bryde's whales and bottlenose dolphins.

These risk factors are of direct relevance to the proposed sand extraction operations in Te Ākau Bream Bay; noting that the modelled predictions to the existing soundscape (presented in **Section 4.2.4)** are of the greatest relevance to assessing chronic underwater noise impacts.

In terms of chronic noise exposure, much of the available literature pertaining to impacts on marine mammals relate to shipping noise; where previous studies have linked vessel noise to decreases in relative abundance through time (in bottlenose dolphins: Bejder et al., 2006; Lusseau et al., 2006; and gray whales: Bryant et al., 1984), behavioural responses (in many species including killer whales: Erbe, 2002; and bottlenose dolphins: Piwetz et al., 2019), reduced foraging efficiency (in killer whales: Tennessen et al., 2024; and harbour porpoises: Wisniewska et al., 2018), decreases in the proportion of time spent resting (in humpback whales: Sprogis et al., 2020; bottlenose dolphins: Constantine et al., 2004; Constantine & Baker, 1997: and pilot whales: Arranz et al., 2021), decreases in the proportion of time spent nursing calves (in pilot whales; Arranz et al., 2021), auditory masking and vocalisation changes (in numerous species: e.g. Clark et al., 2009; Parks et al., 2011; Putland, 2018; Sorensen et al., 2023) and stress (Rolland et al., 2012). On this basis, chronic widespread exposure to underwater noise could theoretically result in reduced survival or fitness of individuals and consequent population level impacts.

Romano et al. (2004) investigated physiological stress responses in bottlenose dolphins exposed to noise and reported elevated glucocorticoid levels and altered cardiovascular function. While studies of noise-induced stress are limited, evidence is emerging to suggest that many marine taxa exhibit stress responses including oxidative stress, and changes to energy homeostasis, metabolism, immune function and respiration (El Dairi et al., 2024). These sublethal impacts could act to reduce the fitness of exposed individuals over time and chronic exposure could presumably lead to population impacts.

Erbe et al. (2019) provided a review of the reported impacts of vessel noise on marine mammals. A key observation from these authors was largely, the biological significance of elicited responses is unknown, and that further data is required to address one of what they term 'the grand unknowns': being the consequences of chronic exposures. Interestingly, New et al. (2013) modelled the potential impacts of individual bottlenose dolphins exposed to chronic vessel disturbance and while displacement from important habitat and disruption of key behaviours could theoretically lead to reduced individual fitness, reproductive success and survival, these consequences do not always manifest; hence detrimental impacts on individual health and population dynamics are not a guaranteed outcome of disturbance. Further to this, Owens et al. (2024) recently reported no detectable change in the annual occurrence or foraging patterns of harbour porpoises following rerouting of a major shipping lane through important habitat. These results are surprising considering harbour porpoises are considered to be one of the most sensitive species to underwater noise disturbance (Southall et al., 2007).

The collection of long-term data on a range of potential noise impacts (including behavioural responses, and changes in vocalisation patterns) will assist with assessing the significance of underwater noise. Generally speaking, marine mammals either avoid areas of intense underwater noise or habituate to it (Kok et al., 2023; Duarte et al., 2021), and while research into the impacts of chronic noise exposure on wildlife populations is limited, it is recognised that chronic noise may lead to changes in habitat use that can potentially have community or population level consequences (Kok et al., 2023). Unfortunately, however, there are as yet no established thresholds against which to assess the impacts of chronic noise.

As noted previously, declines in the regular occurrence of foraging bottlenose dolphins were linked to increased dredging intensity in Aberdeen Harbour, Scotland (Pirotta et al., 2013). This study documented a five-week period during which dolphins abandoned their stable foraging patch in the harbour while extraction operations occurred on a near daily basis and for the greater part of most days (unfortunately data is not available to clearly indicate the actual duration of extraction operations per day for this period, or the source level of the dredge). Dolphins did however return towards the end of the dredging campaign when the intensity of operations was lower (i.e. the frequency and duration of extraction had decreased), but overall, there was a lower probability of dolphins being present when dredge vessels were active. While the character and intensity of this example exceed what is proposed in Te Ākau Bream Bay, it demonstrates the potential for habitat use changes.

In another example, gray whales reportedly abandoned Guerrero Negro Lagoon (Baja, Mexico) for c. ten years (in the 1960s) on account of disturbance from shipping and dredging associated with the construction of a large salt works operation (Bryant et al., 1984). Little detail is available, but it is understood that near continuous dredging occurred there between 1957 and 1967, whale numbers declined dramatically in the late 1950s, and whales were completely absent from 1964 to 1970. From 1973 onwards whales returned to the lagoon, but numbers have continued to fluctuate (Urban et al., 2002). Again, the character and intensity of this example far exceed what is proposed in Te Ākau Bream Bay but is useful for understanding the range of different consequences that have historically been ascribed to dredging.

Findings of the behaviour of bottlenose dolphins in the vicinity of a five-year bridge removal and replacement project in Florida are also of interest here. This study (Weaver, 2021) demonstrated that despite this location representing prime habitat (a key area for dolphin transit between two major water bodies and a rich feeding ground), dolphins adapted to around-the-clock noise pollution (from underwater demolition activities, dredging, and pile driving) by establishing feeding areas beyond the immediate zone of disturbance, and shifting temporal patterns of activity to avoid times when the level of disturbance was high. While at the outset of the project a period of initial displacement was reported, the probability of dolphin presence returned to pre-disturbance levels in the latter part of the project, suggesting an adaptation to project-related disturbance. This study provides an example of how bottlenose dolphins have in other circumstances adapted to anthropogenic disturbance (at levels much higher than those potentially associated with what is proposed in Te Ākau Bream Bay).

While the examples presented here demonstrate that the potential for behavioural disruption (particularly avoidance) and the possible consequent temporary displacement of threatened species from the proposed sand extraction activities in Te Ākau Bream Bay cannot be dismissed, neither can they be assumed a guaranteed outcome. Furthermore, while compensatory strategies will likely be employed to combat masking[10], impacts on individuals and populations will likely be dependant on the energetic trade-offs between remaining in the face of disturbance or leaving for alternative habitat.

4.2.6 Discussion

On the basis of the modelling results, the instantaneous impacts on marine mammals of underwater noise from the proposed sand extraction activities will be spatially restricted, where:

- Auditory injury is not expected during sand extraction, and TTS is not predicted beyond 0.5 m; hence physiological impacts are highly unlikely for any species during the proposed sand extraction activities;
- Low-level behavioural impacts are limited to 600 m for dolphins and killer whales, and 1.1 km for baleen whales, and medium level behavioural responses (including avoidance behaviours) are only predicted out to c. 230 m from extraction operations. On this basis, individual marine mammals are not expected to avoid Te Ākau Bream Bay on account of the instantaneous behavioural impacts of the proposed extraction, but some avoidance of the area in the immediate vicinity of the *William Fraser* can be

[10] Examples of such strategies include changes to vocalisation rate, duration, amplitude and frequency/bandwidth (e.g. Parks et al 2007; 2009; 2011; Lusseau et al., 2009; Dahlheim & Castellote, 2016; Heiler et al., 2016; Guera et al., 2014; Fournet et al 2018) across a wide range of marine mammal species.

expected. Furthermore, as sand extraction will not occur daily, and on the days that it does occur, will be limited to 3.5 hours, there is infrequent potential for behavioural impacts. This coupled with the wide-ranging nature of marine mammals across large home-ranges further reduces the potential for project-related behavioural impacts. In particular, no Bryde’s whales have been reported from inside of in the immediate vicinity of the sand extraction area, and while their occasional presence here cannot be dismissed, the sightings information available suggests that in most instances Bryde’s whales will occur further offshore in deeper waters of outer Te Ākau Bream Bay;

- While the predicted extent of masking is substantially larger than that associated with behavioural impacts, the degree of LSR for all species decreases to 25% at 3 km from the *William Fraser*. However, masking will continue to persist at low levels (<25% LSR) out to c. 7.5 – 12 km (depending on species). Masking will therefore be the most widespread instantaneous impact associated with underwater noise from sand extraction. Because of this, further discussion on this impact is provided in the paragraphs below; and
- The *William Fraser* will be audible through most of Te Ākau Bream Bay for all marine mammal species.

In keeping with the requirement of NZCPS Policy 11(a) that effects on threatened marine mammal taxa (populations) are avoided, these model results confirm that no population level effects/ impacts are predicted from the instantaneous consequences of underwater noise (e.g. injury, behavioural response and masking), as no injury or mortality will occur as a result of extraction noise.

The ongoing (albeit intermittent) nature of the proposed sand extraction activities introduces a long-term change to the soundscape of Te Ākau Bream Bay. However, high level changes are confined to the immediate extraction area, and the remainder of the embayment will only be subject to negligible or small soundscape changes. While sand extraction noise therefore has the potential to elevate sub-lethal risks to marine mammals above those already present from existing extraction and/or commercial shipping, large cumulative impacts will be spatially restricted to the extraction area. It is expected that individual marine mammals will either avoid the immediate extraction area or habituate to the increased noise levels. The noise level required to elicit long-term avoidance is unknown for marine mammals; however, because predicted soundscape changes are small or negligible for most of Te Ākau Bream Bay, widespread displacement and long-term habitat use changes are considered to be unlikely.

In terms of NZCPS policy 11(b), significant effects on habitats that are important during ‘vulnerable life stages’ must be avoided and DOC (2010) states that indigenous species can be vulnerable when breeding, as juveniles and during migration. It is important therefore to recognise that:

- Brough (2023) and Brough et al. (2024) reports the presence of juveniles and calves of Bryde’s whales and bottlenose dolphins in Te Ākau Bream Bay; and
- The project area occurs in the inshore portion of a migratory corridor that is seasonally used by migrating humpback, minke and southern right whales.

While some baleen whale species use coastal waters of the region as a seasonal migratory corridor, most individual whales typically pass by any given point on the coast quite quickly (e.g., migrating humpback whales travel at average speeds of 3.2 – 5.8 km/hr; Riekkola et al., 2020; Modest et al., 2021). On this basis, masking and audibility associated with the proposed activities (which are predicted to extend to 16 km and 18 km respectively for baleen whales) would be low level and temporary for migrating whales (limited to several hours of exposure as they migrate past Te Ākau Bream Bay). The likelihood of exposure of migrating whales to project-related underwater noise reduces even further when considering that sand extraction will only occur for 3.5 hours at a time and only on extraction days.

Although southern right whales have the potential for a more sustained presence in coastal locations during their seasonal breeding migrations, it is probable that exposed individuals would avoid the zone of audibility and take advantage of plentiful nearby unaffected coastal habitat. For these reasons, the magnitude of underwater noise effects/impacts on migratory habitat will be negligible and significant effects can be avoided as required by NZCPS Policy 11(b).

Little quantitative data is available on the use of Te Ākau Bream Bay by marine mammals for breeding or rearing calves and juveniles. However, the near daily use of the bay by delphinids (in accordance with acoustic monitoring results) and the frequent presence of Bryde's whale and bottlenose dolphin calves and juveniles, including observations of nursing (Brough, 2023; Brough et al., 2024) suggest that Te Ākau Bream Bay is used for some breeding behaviours at least by these two species. While underwater extraction noise could theoretically mask contact calls between mother/calf pairs (particularly for Bryde's whales), result in behavioural changes that could compromise individual health (e.g. reduced foraging) or maternal investment (reduced time nursing), or lead to habitat avoidance, these impacts are considered unlikely for the reasons outlined in the paragraphs below.

Bryde's whales have large home ranges of which Te Ākau Bream Bay is only a small part; hence, individual whales would presumably only be subject to masking temporarily and on an intermittent basis. Consequently, significant underwater noise impacts on Bryde's whale breeding, calves or juveniles are unlikely.

Conversely, although the overall distribution of bottlenose dolphins is broad along the northeastern coast of New Zealand, individuals that use Te Ākau Bream Bay have a high degree of residency (Brough et al., 2024), therefore underwater noise impacts on bottlenose dolphin breeding and calf rearing behaviours cannot be completely dismissed. However, given that large soundscape changes will only occur inside the extraction area and, on a daily basis, instantaneous behavioural impacts and masking will be spatially restricted and temporally limited to the 3.5 hour window of operations, ecologically significant impacts on breeding behaviours for this species seem unlikely.

To summarise, significant underwater noise effects on marine mammal migratory habitat and breeding habitat are not anticipated; therefore, and in terms of underwater noise, the requirements of NZCPS Policy 11(b) can be met. Furthermore, **Section 3.2** found that bottlenose dolphins, common dolphins, pilot whales, killer whales, Bryde's whales, false killer whales and New Zealand fur seals occur in Te Ākau Bream Bay and surrounds (with varying levels of frequency as stated in **Table 1**). This suggests that despite the existing level of port related activities at Northport (and their associated underwater noise), marine mammals still frequently utilise coastal habitat in the vicinity. Hence, at least some species are tolerant of, or already appear to be habituated to, some underwater noise and vessel activity. In particular, the highest calculated probabilities of occurrence for bottlenose dolphins and Bryde's whales in and around Te Ākau Bream Bay (as mapped by Brough et al., 2024 and reproduced in **Figure 13** and **Figure 14** of this report) appear to have a strong positive correlation (i.e. a large overlap) with the transit routes used by commercial vessels into and out of Te Ākau Bream Bay at Parry Channel (also see **Figure 23** and **Figure 24** which indicate shipping routes; and Styles Group, 2025 for mapped AIS data). This specifically suggests that at least some bottlenose dolphins and Bryde's whales tolerate underwater noise from commercial vessels and have potentially habituated to coexist in its presence. However, Bejder et al. (2009) cautions that habituation should not automatically be interpreted to imply a complete absence of detrimental consequences. Furthermore, individual variation in sensitivity to underwater noise probably exists, and it is unknown whether any individuals have already been displaced from this habitat (i.e. those that are more sensitive to disturbance). Habituation is however commonly reported in marine mammals and is commonly inferred to represent a level of resilience to disturbance, for example:

- Habituation of bottlenose dolphins to high levels of shipping activity has recently been reported by Mills et al. (2023; 2024) where dolphins frequently foraged in the presence of multiple vessels in the Corpus Christi Shipping Cannel, in Texas (the largest port in the USA that typically sees >20 vessels pass through per hour). Mills et al. (2024) suggested that prey availability may be higher in these areas and therefore the costs of tolerating anthropogenic disturbances may be lower than the energetic cost to relocate.
- The Hauraki Gulf is primary habitat for a year-round population of Bryde's whales (Wiseman et al., 2011; Carroll et al., 2019). High occurrence of Bryde's whales in the Hauraki Gulf occurs despite the region being subject to high levels of transiting vessels (both commercial and recreational vessels), suggesting a level of habituation to vessel movement and noise within the Bryde's whale population that utilise the Hauraki Gulf.

4.2.7 Mitigations

As no auditory injury (including PTS) is predicted and the potential for TTS in marine mammals will be limited to within 1 m of the operational dredge, an exclusion zone is not specifically required to protect marine mammals from hearing damage. However, an exclusion zone will be implemented as a strategy to minimise the risk of entanglement for large whales (see **Section 4.6**) and this will provide a high level of protection to these species from the potential instantaneous impacts of underwater noise.

The following additional mitigations will be implemented to minimise any adverse impacts arising from underwater noise on marine mammals during Te Ākau Bream Bay sand extraction activities:

- While recognising the efforts to date made by MBL to reduce noise outputs, and their ongoing commitment to undertake regular maintenance of extraction equipment (see McCallum Bros Ltd, 2025) ,any further efforts to reduce the noise source level (e.g. the consideration of additional quietening technologies as they become available) and/or to further reduce the daily exposure duration would be beneficial to minimising the potential changes to the existing Te Ākau Bream Bay soundscape;
- Monitoring Programmes (as described in the MMMP) will be implemented to:
  - Validate the predictions of the underwater acoustic modelling in terms of soundscape change by demonstrating that any change in the soundscape level arising from sand extraction does not exceed 3 dB, or if it is greater than 3 dB, to stipulate additional mitigation measures to reduce/manage the soundscape change to an acceptable level (the 'Acoustic Monitoring Programme'); and
  - To support the continuation of boat-based marine mammal research surveys in Te Ākau Bream Bay.

These mitigations form part of the application and associated management plans and should be reflected in consent conditions where appropriate.

4.2.8 Assessment Results

Potential adverse effects associated with underwater noise have been identified as the masking of biologically important sounds, behavioural responses or physiological consequences. While Styles Group (2025) assigned a magnitude of effect for each of these consequences, it is important to recognise that the measures ascribed by Styles Group (2025) relate specifically to individual fitness in terms of acoustic ecology only. In comparison, this assessment applies the findings of the acoustic modelling in the wider context of 1) the broader species ecology to which the model findings are relevant, and 2) the ecological setting of Te Ākau Bream Bay.

On this basis, acoustic modelling has been used in this assessment to determine that these instantaneous underwater noise impacts from the proposed sand extraction activities are unlikely to be of ecological significance to marine mammals in accordance with the assessment findings below:

- Underwater noise produced by sand extraction activities is not expected to result in auditory injury. On this basis, the likelihood of auditory injury occurring is **negligible**;
- Exceedance of TTS thresholds is not predicted beyond 0.5 m for any marine mammal species. On this basis, the likelihood of TTS occurring is negligible (i.e. remote) for all marine mammal species, and in accordance with the criteria defined in **Table 3** and **Table 4**, the overall level of impact is **very low;**
- Other impacts of underwater noise on marine mammals from the proposed sand extraction activities will be spatially restricted, with all but low-level masking being limited to within 3 km of the *William Fraser* actively extracting. No marine mammal species are expected to be consistently present within this radius, rather, animals will sporadically enter this effects range and will most likely pass beyond it within a relatively short time frame;
- On this basis, while HF cetaceans (e.g. dolphins) and pinnipeds could occasionally be exposed to moderate behavioural effects when they are present within c. 200 m of the *William Fraser*, frequent recurrence of such effects for individuals is unlikely and these effects will be short-lived; hence in accordance with **Table 3** behavioural responses are considered to be of low magnitude for HF cetaceans and pinnipeds, and despite a moderate to high likelihood of such impacts occurring over the lifetime of the project, the overall level of impact is **low**;
- The sightings records suggests that LF cetaceans (e.g. Bryde's whale and other baleen whale species) are even less likely to be present in the immediate vicinity of extraction activities. In particular, most Bryde's whale sightings are offshore from the sand extraction area and other baleen whale species are only seasonally present during migrations. Hence while some low-level behavioural responses could occur when baleen whales are present within c. 1 km, the likelihood of this occurring is reasonably low; hence the overall level of impact is **very low**;
- Infrequent exposure to 75% LSR is considered by Styles Group (2025) to represent a moderate magnitude impact. LSR of this magnitude is expected to 1.4 km for LF cetaceans, 170 m for HF cetaceans, 1.1 km for leopard seals and 300 m for fur seals (**Table 9**);
- All species which could have a likely presence in Te Ākau Bream Bay could on occasion experience such impacts. However, as no marine mammal species are

expected to be consistently present within the relevant ranges. The likelihood is low; hence the overall level of impact of 75% LSR masking is **low**; and

- More typically animals will be exposed to negligible to low magnitude LSR impacts (0 – 50%) as they move through wider Te Ākau Bream Bay, as these impacts extend 8-16 km from the *William Fraser* (depending on species, see **Table 9**);
- While such effects are expected across all species that use the embayment, these effects will be intermittent and limited to the 3.5-hour extraction period on extraction days. On this basis a moderate likelihood has been assigned, and the overall level of impact will be **negligible** to **low**.

The following considerations are also of relevance to the assessment of underwater noise impacts on marine mammals:

- The model results relating to the instantaneous impacts of underwater noise confirm that no population level impacts on threatened taxa are predicted, as no injury or mortality will occur as a result of underwater noise from the proposed sand extraction activities and the potential impacts associated with masking and behavioural changes will be temporary, and spatially limited;
- Despite the identification of important marine mammal habitat in Te Ākau Bream Bay for bottlenose dolphins, habitat use associated with vulnerable life stages (breeding and migrating) and other essential biological functions (feeding, resting, socialising) is not solely constrained to central Te Ākau Bream Bay (i.e. the vicinity of the sand extraction area). Therefore, while localised temporary displacement could occur in the immediate vicinity of the sand extraction area, alternative adjoining habitat is available within Te Ākau Bream Bay. In particular, and in recognition of the hot spot of dolphin occurrence that extends across the entire length of the central embayment (on the outer boundary of the proposed sand extraction area) from December to April (see **Figure 14**; Brough et al., 2024), the proposed operations will not preclude animals from using this hot spot on a daily basis;
- Regional coastal waters are frequented by commercial and recreational vessels, therefore the marine mammal species predicted to be present in Te Ākau Bream Bay and surrounding waters are frequently exposed to underwater noise throughout their distribution and most individuals are probably already somewhat habituated to this;
- With the exception of bottlenose dolphins, the proposed sand extraction area and the associated zone of audibility represents only a small percentage of each species overall distribution. Hence, individuals would only be subject to masking or behavioural impacts from sand extraction activities temporarily and on an intermittent basis. For example:
  - While the total distribution for the North Island population of Bryde's whales is largely undefined, they are known to occur at least from North Cape to East Cape and are thought to maintain offshore links with a wider regional population (i.e. occur out to and beyond the CMA boundary; following Baker et al., 2010). On this basis, the proposed sand extraction area, and the associated zone of audibility (18 km radius from the *William Fraser*) would therefore represent no more than approximately 4% of the total habitat area for this species. Furthermore, while site fidelity of Bryde's whales to coastal northeastern New Zealand varies, it is generally low (Tezanos-Pinto et al., 2017; Hamilton et al., 2023); and
  - With specific regard to migrating baleen whales, potential audibility and masking impacts on migrating humpback and minke whales are predicted to be low level and temporary (several hours duration as individual whales pass by), and southern right whales are likely to avoid the zone of audibility and take advantage of plentiful nearby unaffected coastal habitat for winter breeding migrations.

In addition to the instantaneous impacts discussed above, this assessment also investigates how the proposed sand extraction activities in Te Ākau Bream Bay will introduce ongoing acoustic disturbance to the area (albeit intermittent). Given the high rates of residency recently reported for bottlenose dolphins in Te Ākau Bream Bay (Brough et al., 2024), it is probable that this species is most likely to be affected by ongoing underwater noise from the proposed sand extraction activities. This has been carefully considered, particularly in the context of the documented decline of this species in adjacent areas (Tezanos-Pinto et al., 2013; Brough et al. 2025).

In particular, and on the basis of the soundscape modelling results (**Section 4.2.4**), it is possible that ≥5% of the home range of those semi-resident individuals could be impacted (noting that 5% is used as a threshold for defining the level of magnitude of an impact, see **Table 3**). However, in this instance the magnitude of impact is considered to be low as:

- While the full distributional range of these semi-resident dolphins is unknown, Brough et al. (2024) states that “It is highly likely individuals from the study area migrate between adjacent areas along the north-east coast including the Bay of Islands, Aotea/Great Barrier Island and the Hauraki Gulf”.
- Furthermore, while the proposed activity will alter the existing soundscape of Te Ākau Bream Bay, soundscape increases outside the extraction area are predicted to be either negligible or small (Styles Group, 2025);
- Even though extraction operations will be audible out to 10.4 km for dolphins (**Table 10**), this zone should not automatically be regarded as ‘habitat loss’ as it is probable that dolphins will continue to utilise habitat throughout Te Ākau Bream Bay, although some displacement within 600 m of the extraction operation is expected (**Table 8**); and
- Any reduction in habitat availability would only be intermittent while actively extracting[11].

Because of the declining population trend for threatened bottlenose dolphins in the Bay of Islands, a cautious approach is warranted, and a monitoring programme will be implemented if consent is granted.

The assessment results in terms of soundscape change, which is the most persistent predicted underwater noise impact expected from the proposed sand extraction, are summarised in **Table 11.** In accordance with the criteria outlined in **Table 3**, the predicted soundscape change will be of high magnitude inside the sand extraction area, but throughout the remainder of Te Ākau Bream Bay, the soundscape change will be of a negligible or low magnitude (depending on the specific location). However, as no marine mammal species are restricted solely to habitat in Te Ākau Bream Bay, a broader perspective is required to approximate the overall effect this might have on any individual marine mammal throughout its wider home-range. Noting that all marine mammals will move freely both inside and outside the embayment (including the sand extraction area) and that home range size varies with species from humpback whales that cover thousands on kilometres to bottlenose dolphins that are semi-resident to Te Ākau Bream Bay. On this basis, the proportion of affected habitat approach (following MacDiarmid et al., 2014, see **Table 3**) has been taken to assess the overall level of impact from soundscape change.

With the proposed mitigations in place, the overall level of predicted impacts from soundscape change will be **low** or **negligible**.

[11] Which equates to a maximum of 49 hours per month (14 trips at 3.5 hours each) in the first three years and a maximum of 80.5 hours per month (23 trips at 3.5 hours each) in subsequent years.

Table 11 Soundscape change impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible impact on population or range	Low	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment which represents core habitat.	Low - minor impact on population or range	Moderate	**Low**
Killer whales	**Very High**	Likely sporadic presence in regional coastal and offshore waters. Large home ranges.	Negligible impact on population or range	Low	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible impact on population or range	Low	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible impact on population or range	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Low - minor impact on population or range	Moderate	**Low**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible impact on population or range	Low	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible impact on population or range	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Low - minor impact on population or range	Moderate	**Low**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Low - minor impact on population or range	Moderate	**Low**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible impact on population or range	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible impact on population or range	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible impact on population or range	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible impact on population or range	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible impact on population or range	Negligible	**Negligible**

4.3 Habitat modification

Extraction activities involve the removal of sediments from the seabed which inevitably leads to changes in the marine environment and modification of habitats utilised by marine mammals. Potential impacts can be either direct, such as the generation of sediment plumes which may be encountered by marine mammals, or indirect, such as alteration of the habitat (i.e. topography, depth, waves, tidal currents, sediment particle size, and suspended sediment concentration) of a marine mammal's prey species and associated food-web interactions (Todd et al., 2015). In particular, temporary elevations of turbidity in the water column during sand extraction can reduce light penetration for phytoplankton and associated zooplankton assemblages; noting that small pelagic planktivorous fish are important contributors to the diet of some marine mammals.

Potential direct impacts (presence of sediment plumes)

Sediment plumes, and a corresponding increase in turbidity, may occur via several pathways during the proposed sand extraction activities: during extraction, rejection of screened material, or with discharge of sediment-laden overflow water. Generally speaking, extraction-related plumes (from dredging for example) are generally confined to within a few hundred meters of the point of disturbance or discharge, and are temporary (Hitchcock and Bell, 2004) but result in a localised reduction in visibility for marine mammals. Notwithstanding this, any plume generated by proposed sand extraction in Te Ākau Bream Bay will be highly localised in terms of the temporal and spatial extent. Given the high assimilative capacity of the wider Te Ākau Bream Bay environment, and the natural fluctuations and prevalent metocean conditions experienced in the bay, it is highly unlikely coastal water quality standards set out in NRC's Policy H.3.3 will be breached (Wilson, 2025). On this basis, the overall level of effects of the proposed sand extraction to water quality in Te Ākau Bream Bay was considered to be negligible by Wilson (2025).

Marine mammals often inhabit naturally turbid (such as coastal waters influenced by riverine inputs and natural wave resuspension) or dark environments and are highly tolerant of turbidity plumes (Todd et al., 2015) and therefore often do not rely solely on vision for either navigation or foraging (Todd et al., 2015). For example, toothed whales and dolphins use echolocation for navigation and prey detection, while baleen whales and pinnipeds use their sensitive whiskers to 'feel' for prey (Peyensen et al., 2012; Dehnhardt et al., 1998). Furthermore, the feeding methods employed by some species result in the generation of sediment plumes, indicating some level of tolerance to turbidity and the ability to feed in turbid conditions. Examples include mud ring feeding in bottlenose dolphins (see Kiszka et al., 2022); and killer whales hunting for rays in shallow waters (see DOC, 2014).

Marine mammals are highly mobile and have ample opportunity to avoid areas of increased turbidity. Water quality parameters of the discharge plume associated with the *William Fraser* during extraction operations in Pākiri were assessed by Jacobs (2020) and indicated that elevations in turbidity above the baseline range expected from the coastal marine environment were limited to within 250 m of the *William Fraser*. This area is insignificant in comparison to the large home ranges of marine mammals potentially present within the sand extraction area and wider region. Further to this, Wilson (2025) concluded that temporary increases in total suspended solids will be temporary and will return to ambient levels within hours of the activity ceasing.

<u>Potential indirect impacts (food web interactions)</u>

In addition to direct contact with sediment plumes, extraction activities 1) remove sections of the seabed and 2) increase turbidity in the water column; hence, can theoretically affect the quality and availability of demersal or pelagic fish that are either preyed upon directly by some marine mammals or form part of the food chain of which could have flow-on effects for marine mammals.

In terms of demersal prey species of marine mammals, MBL have undertaken extraction activities similar to those proposed under this consent application in an area south of Te Ākau Bream Bay between Mangawhai and Pākiri for more than 75 years and monitoring results confirm that significant effects on benthic fauna are not expected. For instance, Bioresearches (2019) undertook sampling at sand extraction and control stations to investigate potential impacts on benthic fauna following extraction operations. The authors found there to be no statistically significant differences in benthic fauna between sand extraction and control stations, with depth being the main determining factor in faunal communities. Due to the depth of sediment removal, large burrowing polychaetes were not removed by extraction activities. In keeping with this, Bioresearches (2020) found no difference in communities between control and extracted stations, and a 93% survival rate of fauna passing through the pumping and screening system onboard the *William Fraser*. Furthermore, given the non-contiguous distribution of the proposed extraction tracks, the result will be a 'patchwork' of benthic disturbance with a large proportion (78%) of the seabed within the extraction area undisturbed (having had a t least one year of recovery) at any one time (West & van Winkel, 2025).

While benthic fauna forms the basis of the diet of many demersal fish species, which in turn, may be prey species for marine mammals, West and van Winkel (2025) concluded that the proposed sand extraction would result in a negligible magnitude of effects on benthic fish, and that fish would not be adversely affected through loss of benthic prey; indeed, the discharge of large biota following extraction and screening could act as an additional food source for fish or scavenging benthic fauna.

In terms of small pelagic planktivorous fish (and as stated in relation to the potential direct effects presented earlier in this section), the magnitude of effects of the proposed activity on water quality has been assessed as negligible (Wilson, 2025), it follows that turbidity effects on primary production will also be negligible, and therefore impacts of the project on small pelagic planktivorous fish populations (which are important contributors to the diet of some marine mammals) are expected to be minimal (Boyd, 2025).

Additional information about the foraging ecology (including prey species where known) of those marine mammal species likely to be present, or those that could possibly be present in Te Ākau Bream Bay, are presented in **Table 12**. With the exception of baleen whales, the diets of cetacean species that utilise Te Ākau Bream Bay typically include both benthic and pelagic prey. Given that effects on fish from the proposed activities are predicted to be of low magnitude, impacts associated with prey quality and availability are not expected to be of ecological significance to marine mammals which can readily move away from poor quality foraging habitat to undisturbed alternative foraging habitat nearby. Furthermore, the scale of direct extraction disturbance is miniscule compared to marine mammal home ranges (i.e. foraging ranges), and prey species of marine mammals are most likely to be mobile enough to also move away from heavily disturbed areas.

Table 12 Foraging ecology of marine mammals that could occur in and around Te Ākau Bream Bay.

	Species	Foraging Ecology	Demersal or Pelagic Prey?
Likely Presence in Te Ākau Bream Bay	Common dolphin	Diet is diverse, with primary prey being pelagic arrow squid, jack mackerel and anchovy. However, full diet does include some benthic prey (Meynier et al., 2008). Diet changes with body size, sex and season (Peters et al., 2020). Diet includes both benthic and pelagic prey.	Both
	Bottlenose dolphin	Varied diet of fish and squid (Blanco et al., 2001; Gowans et al., 2008; Constantine & Baker, 1997; Wells & Scott, 2009; Fisheries New Zealand, 2025). Foraging ecology in this species is characterised by its significant plasticity in prey species and foraging strategies (Berkenbusch et al., 2013). Foraging dives in both shallow and deep habitats (to depths of over 500 m) (Wells & Scott, 2009). Diet includes both benthic and pelagic prey.	Both
	Killer whale	North Island killer whales are generalist foragers that opportunistically take advantage of prey (Visser, 2007). Benthic foraging for rays is known to be common around New Zealand's coast (Visser, 1999). Diet includes both benthic and pelagic prey.	Both
	Bryde's whale	Feed on schooling fish (e.g., anchovies, herring, pilchards and mackerel) (Omura, 1962), krill & plankton (Constantine et al., 2012). Diet does not include benthic prey.	Pelagic only
	Long-finned pilot whale	Information is limited for this species in New Zealand, but stomach content analysis of five stranded individuals suggests a cephalopod diet of both pelagic squid and benthic octopus (Beatson et al., 2007). Diet includes both benthic and pelagic prey.	Both

	Species	Foraging Ecology	Demersal or Pelagic Prey?
Possible Presence in Te Ākau Bream Bay	New Zealand fur seal	Forage on a range of species. Relative importance of each prey item is seasonal: arrow squid are important in summer and autumn, lanternfish are taken year-round, barracouta and jack mackerel are major contributors to the summer diet, while red cod, ahuru, and octopus are important in winter (Harcourt et al., 2002). Diet includes both benthic and pelagic prey.	Both
	Humpback whale	Feed on krill and small pelagic schooling fish by lunge feeding in mid- or surface waters (Murase et al., 2002). Diet does not include benthic prey.	Pelagic only
	Southern right whale	Do not typically feed during coastal winter presence in New Zealand (Carroll et al., 2011). Utilise offshore summer feeding grounds in Antarctic waters to feed on krill by lunge feeding in mid- or surface waters. Diet does not include benthic prey.	Pelagic only
	Leopard seal	Diet includes birds, mammals, benthic and pelagic fish and invertebrates (Hall-Apsland & Rogers, 2004). Diet includes both benthic and pelagic prey.	Both
	Blue whale	Feed on krill and other zooplankton by lunge feeding in mid- or surface waters (Acevedo-Gutierrez et al., 2002). Diet does not include benthic prey.	Pelagic only
	False killer whale	Feed on a variety of oceanic squid and fish. Diet occasionally supplemented with marine mammals (Baird, 2009). Diet does not include benthic prey.	Pelagic only
	Gray's beaked whale	Diet appears to vary with location but includes meso-pelagic fish and squid (Pitman et al., 2020). Diet does not include benthic prey.	Pelagic only
	Sperm whale	In New Zealand sperm whale diet mostly consists of cephalopods (particularly mesopelagic squid), with limited quantities of fish, salp and crustaceans (Gomez-Villota, 2007). Benthic foraging dives are reported (Delgado et al., 2022). Diet includes both benthic and pelagic prey.	Both
	Sei whale	Feed on zooplankton, pelagic schooling fish and squid (Cooke, 2018). Diet does not include benthic prey.	Pelagic only
	Minke whale	Feed on krill and a variety of other small schooling fish by lunge feeding in mid- or surface waters (Cooke et al., 2018a). Diet does not include benthic prey.	Pelagic only

4.3.1 Mitigations

There are no specific mitigations required in relation to reducing potential habitat modification impacts on marine mammals during Te Ākau Bream Bay extraction activities.

4.3.2 Assessment Results

While marine mammals could theoretically be affected through low magnitude, small scale changes to habitat quality and prey availability in response to sand extraction activities, these changes are unlikely to be of ecological significance to marine mammals due to the following:

- Extraction activities, namely dredging, already occur in and around Northport, with marine mammals continuing to utilise coastal habitats in the vicinity;
- Sediment plumes created during extraction activities will be spatially and temporally restricted. Marine mammals are highly mobile and have ample opportunity to avoid areas of turbidity. Marine mammals are well adapted to forage and navigate in areas of restricted visibility (e.g. at depth where natural light is limited, or in turbid coastal waters);
- Although the diet of some marine mammal species present within the region includes demersal components, any area of reduced prey abundance or quality will be highly localised, and no species with a potential presence in and around Te Ākau Bream Bay is entirely dependent on demersal prey;
- Potential impacts of the project on small pelagic planktivorous fish populations (which are important contributors to the diet of some marine mammals, particularly dolphins) are expected to be minimal. On this basis, detectable flow-on effects to apex predators that target pelagic fish are highly unlikely;
- Previous extraction activities in the vicinity of Te Ākau Bream Bay found there to be no statistically significant differences in benthic fauna between sand extraction and control stations and concluded that fish would not be adversely affected through loss of prey. On this basis, detectable flow-on effects to apex predators that target demersal fish are highly unlikely; and
- All marine mammal species expected in and around Te Ākau Bream Bay have home-ranges that are very large compared to the area that will be subject to disturbance and therefore have alternative habitat readily available.

In the context of the vast home ranges of most marine mammals, the magnitude of impact is **negligible** for all but semi-resident bottlenose dolphins, for which a **low** magnitude has been assigned on the basis that the extraction area probably accounts for a higher proportion of their home range and likely occurs within their core habitat. The likelihood of adverse consequences occurring varies with species, depending on 1) the probability that each species will occur in the immediate vicinity of the sand extraction area and 2) the probability that foraging (the behaviour that is most likely to be affected by habitat modification) actively occurs here. The overall level of impact of potential habitat modification arising during the proposed Te Ākau Bream Bay extraction activities on marine mammals' ranges from **negligible** to **low** (**Table 13**).

Table 13 Habitat modification impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible – very slight change from baseline conditions	Low	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Low - minor impact on population or range	Moderate	**Low**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Killer whales	**Very High**	Likely sporadic presence in regional coastal and offshore waters. Large home ranges.	Negligible – very slight change from baseline conditions	Low	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible – very slight change from baseline conditions	Low	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible – very slight change from baseline conditions	Low	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible – very slight change from baseline conditions	Low	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible – very slight change from baseline conditions	Low	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible – very slight change from baseline conditions	Low	**Negligible**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible – very slight change from baseline conditions	Negligible	**Negligible**

4.4 Ship Strike

A vessel collision or ship strike is any impact between any part of a watercraft and a live marine mammal. Ship strike incidents usually involve a vessel's bow or propeller (Peel et al., 2018) and typically result in physical trauma (with a potential decrease in animal fitness over time) or death (immediately or subsequent to the incident) in the impacted animal (Moore et al., 2013). Such collisions are of conservation concern on a global scale (Nisi, 2024).

The probability of a ship strike incident occurring is influenced by the following vessel- and animal-related factors:

- Vessel-related factors:
  - Vessel size – larger vessels (> 80 m) are more frequently involved in collisions with marine mammals than smaller vessels (Laist et al., 2001; Jensen & Silber, 2003). This is influenced by the fact that large vessels typically have deeper drafts (i.e. a larger strike zone), less manoeuvrability (i.e. greater response time to initiate and adjust an avoidance manoeuvre), and larger distances to avoid an animal (Schoeman et al., 2020);
  - Vessel speed – A vessel poses a higher risk when travelling at speed due to the higher speeds resulting in a stronger impact/force (Schoeman et al., 2020), increasing the risk of blunt force trauma (Wang et al., 2007). Higher vessel speeds also decrease the probability of detection of marine mammals (and vice versa), increasing the probability of collision (Gende et al., 2011). Most lethal marine mammal collisions involve vessels travelling at faster speeds (> 12 knots; Laist et al., 2001; Vanderlaan & Taggart, 2007);
- Animal-related factors:
  - Species – Although large whales are the most common victims of ship strike (e.g. fin whales, right whales, humpback whales, minke whales and sperm whales) (Laist et al., 2001; Jensen & Silber, 2003; Van Waerebeek et al., 2007), a recent global review of ship strike incidents by Schoeman et al. (2020) found a total of 61 marine mammal species have been involved in a ship strike incident, including several smaller species; and
  - Behaviour – i.e. behaviour at the surface, behavioural response to vessels, and hearing capability. Behaviours such as resting, foraging, nursing, and socialising

likely distract animals from detecting risks (e.g. an approaching vessel) (Dukas, 2002). Species that remain at or near the sea surface for extended periods are particularly vulnerable to collisions (Laist et al., 2001; Constantine et al. 2012), as are species that are attracted to vessels (Bejder et al. 1999; Wursig et al., 1998).

As evidenced within the scientific literature, all marine mammal species, including all species with a potential presence in the region, are at risk of being involved in a ship strike incident. However, the size and agility of dolphins and seals mean that these groups are more adept at avoiding potential collisions (Schoeman et al., 2020). Available evidence (i.e. Jensen & Silber, 2003) suggests that the risk is greatest for the large whales potentially present within the region, these being Bryde's whales (resident), humpback whales, southern right whales, sei whales and minke whales (seasonal migrants).

Vessel speed is the most influential factor in determining the severity of a ship-strike incident (Jensen & Silber, 2003), with faster vessel speed resulting in a higher probability of mortality in the event of a collision (Jensen & Silber, 2003; Schoeman et al., 2020). Jensen & Silber (2003) reported that the mean vessel speed resulting in ship strike mortality was 18.6 knots. Similarly, Laist et al. (2001) reported that most lethal ship-strikes involved vessels travelling at speeds ≥14 knots, while Vanderlaan and Taggart (2007) reported that the probability of a lethal injury dropped below 0.5 when vessels travelled at a speed of 11.8 knots or less.

In an analysis of the type of vessel involved in a ship strike incident with a marine mammal, Jensen and Silber (2004) identified 134 collisions globally between 1975 and 2002. Of these incidents, only one was attributed to a dredging vessel; a southern right whale cow/calf pair surfaced in the immediate proximity of an underway TSHD (110 m length) resulting in the calf being struck and subsequently dying from injuries. The speed the vessel was travelling at the time of the collision was not recorded, and it is unclear whether the collision occurred during active dredging or transit. The findings of this study indicate however that ship strikes involving dredge vessels are very uncommon, and the slow operational speed of TSHD vessels significantly contributes to the rarity of collisions between these types of vessels and marine mammals.

As described in **Section 2.0**, the THSD *William Fraser* will be travelling at a speed of 1.5 - 2.5 knots during extraction activities. Travel speed between the extraction site and the Port of Auckland (or alternative port) will be a maximum of 9.5 knots, indeed the *William Fraser* is not mechanically able to go faster than 9.5 knots (unloaded), and its maximum loaded speed is 8 - 8.5 knots. In keeping with the findings of Vanderlaan and Taggart (2007), these operational speeds (which are less than the threshold of 12 knots) will significantly reduce the probability of a lethal ship strike during the proposed sand extraction activities.

Todd et al. (2015) noted that ship strike incidents are more likely when TSHD's are in transit to/from the extraction site. However, Tillin et al. (2011) stated that extraction activities in areas of high shipping traffic are unlikely to increase the overall collision risk present in an area as the overall frequency (i.e. hours at sea) of vessels involved in extraction activities is a minor proportion of overall shipping activity and unlikely to add significantly to vessel movements.

The Hauraki Gulf is the transit route for approximately 1,400 ships per annum entering the Port of Auckland and is also an area of high recreational use (Constantine et al., 2015). As described in **Section 3.2**, Bryde's whales are likely to occur in Te Ākau Bream Bay; particularly in deeper water of the outer bay. The behaviour of Bryde's whales makes this species susceptible to ship strike; Bryde's whales tend to remain just below the surface. While only one marine mammal mortality incident from Te Ākau Bream Bay has been noted as a possible ship strike (DOC Stranding Database), Constantine et al. (2015) reported 17 Bryde's whale deaths in the Hauraki Gulf between 1996 and 2014 that were able to be attributed to vessel strike (based on examination of stranded whales). MBL has been undertaking extraction activities within the Mangawhai-Pākiri embayment (south of Te Ākau

Bream Bay) for 75 years and has not had a collision incident between any marine mammal and the extraction vessel/s (Clement & Johnston, 2020), despite the presence of Bryde's whales being well documented along the entire northeast coast of the North Island (Gaskin, 1963; Baker & Madon, 2007). It is noteworthy that many of the reported Bryde's whale ship strike incidents have involved large commercial ocean-going vessels with a bulbous bow. The *William Fraser* does not have this bow configuration and does not draw the same amount of water as large commercial vessels (draft 4.2 m loaded vs over 10 m for large commercial vessels).

The year-round presence of Bryde's whales in the region, the increased potential for ship strike in this species, and the high use of the Hauraki Gulf by commercial and recreational vessels led to the development of the Hauraki Gulf Transit Protocol in 2013. This protocol was last updated in September 2024. Development and voluntary adoption of the Hauraki Gulf Transit Protocol has resulted in a significant reduction in ship strike threat to Bryde's whales in the Hauraki Gulf, with the probability of lethal ship strike nearly halving since the protocol's implementation in 2013 (Ebdon et al., 2020). While this protocol has been developed specifically in response to the presence of Bryde's whales in the Hauraki Gulf, it will serve to protect all species of marine mammal in the area. Mitigations associated with the Hauraki Gulf Transit Protocol are provided in **Section 4.4.1** and will be adopted for the project both in Hauraki Gulf and all other waters associated with the proposed sand extraction including supply trips to alternative ports. A key component of the protocol is the POAL recommendation of a transit speed of 10 knots or less, noting that the *William Fraser* is not mechanically able to go faster than 9.5 knots.

Although the information presented above suggests that the proposed extraction activity will not materially increase the risk of ship strike in Te Ākau Bream Bay waters or surrounding waters, the potential for collision with seasonally present humpback whales, southern right whales, minke whales and sei whales, and resident Bryde's whales needs to be considered when assessing the potential impacts of extraction activities on marine mammals. The mitigations below outline legal obligations and additional measures that will be implemented. These mitigations will serve to further minimise the already **low** operational risk of ship strike from the proposed sand extraction activities on marine mammals.

4.4.1 Mitigations

The Master of the *William Fraser* will ensure that at all times the vessel is operated consistently with:

- The Marine Mammal Protection Regulations 1992 (**MMPR**);
- The Hauraki Gulf Transit Protocol (POAL, 2024);
- Vessel Masters and crew will maintain vigilance for marine mammals and complete a marine mammal sighting form[12] for each cetacean sighting that is made; and
- All vessel strike incidents or near incidents, regardless of outcome, will be recorded and reported.

In particular, the following considerations should be noted -

The Hauraki Gulf Transit Protocol is a measure agreed between the Port of Auckland and the shipping industry. It outlines the following steps for vessels to take while transiting the Hauraki Gulf and planning passage to and from Auckland:

[12] As presented in the Marine Mammal Management Plan.

- Transit the Hauraki Gulf at 10 knots (or less) (noting as per above, this speed restriction will be implemented not only in the Hauraki Gulf but in all waters subject to transit and extraction activities associated with this application);
- Post a whale lookout during daylight hours when transiting;
- Slow down and/or change course in the event a whale is sighted forward of the vessel beam to keep as far from the whale as possible. Whenever safe to do so, no vessel should pass closer than 1,000 m from a whale; and
- Report all whale sightings that are made inside the Hauraki Gulf immediately to the Port of Auckland Harbour Control (this acts as a reporting and warning system for vessels transiting the Hauraki Gulf).

For the purpose of this application, this protocol will be implemented not only in the Hauraki Gulf but in all waters subject to transit and extraction activities associated with the proposed activities (including transit to and from the alternative ports). The only exception to this protocol will be in relation to the POAL recommendation that vessels “approach and depart from the Port of Auckland using the recommended route as outlined in the New Zealand Annual Notices to Mariners, Section 10: Shipping routes around the New Zealand coast”. For operational efficiency and during transit from the Port of Auckland to Te Ākau Bream Bay the William Fraser will travel inshore of the recommended route (**Figure 25**). The slower than recommended transit speed will more than compensate for this deviation from the protocol recommendations and is anticipated to have no material consequence on the risk of ship strike. It is also noteworthy that MBL requires no consent for the transit part of their proposed operations. All alternative transit routes (to Northport, Port of Tauranga and Kopu) will follow the relevant recommended route as prescribed by the protocol.

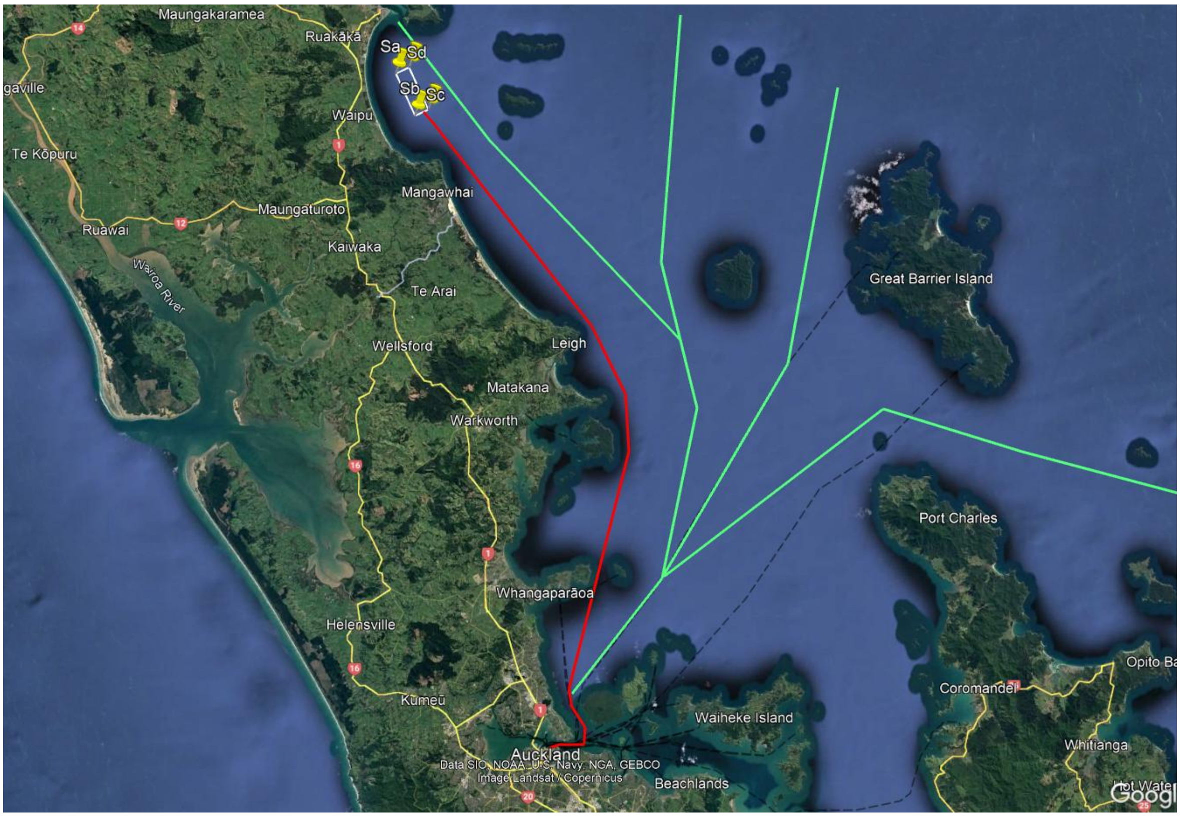

Figure 25 Comparison between the proposed primary transit route of the William Fraser (red) and the recommended route for large commercial vessels (green)

The MMPR stipulate the requirements for operating vessels around marine mammals including:

- Vessel operators shall endeavour not to disrupt the normal movement or behaviour of marine mammals;
- Care should be taken not to separate any individuals from, or scatter any groups of marine mammals and no vessel shall proceed through a pod of dolphins;
- No sudden or repeated change in the speed or direction of any vessel shall occur in the vicinity of marine mammals (except in emergency circumstances);
- No vessel shall cut off the path of a marine mammal;
- Vessels less than 300 m from a marine mammal shall move at a constant slow (no wake) speed. In the case of dolphins, vessels may exceed this speed in order to out-distance the dolphins but must increase speed gradually, and shall not exceed 10 knots within 300 metres of any dolphin;
- No vessel shall approach within 50 m of a whale, and if a whale approaches a vessel, the vessel shall make every attempt to keep out of the path of the whale and to maintain a minimum distance of 50 m; and
- No vessel shall approach within 200 m of a baleen whale or sperm whale with a calf.

Compliance with the Hauraki Gulf Transit Protocol, and the MMPR regulations during the proposed sand extraction activities will serve to reduce the likelihood of marine mammal ship strike. Other factors that will be of benefit to minimising the risk of ship strike are 1) the slow operational speed of the *William Fraser* and 2) that the extraction activities will occur during daylight hours which will assist with early visual detection of marine mammals. While the return trip from the extraction site to the Port of Auckland (or alternative port) will at times occur after dusk, the transit speed of the *William Fraser* when loaded is well below the POAL (2024) recommended speed of 10 knots.

The mitigations outlined in this subsection form part of the application and associated management plans and should be reflected in consent conditions where appropriate.

4.4.2 Assessment Results

Marine mammals are susceptible to ship strike on a global basis, with resident Bryde's whales, and other baleen whales that may have a seasonal presence being the most likely species to be involved in a ship strike incident within the project area. Assuming compliance with the recommendations outlined above, the likelihood of ship strike will be **low** (at most). The following considerations are also of relevance:

- The coastal region is regularly frequented by commercial and recreational vessels;
- The majority of migrating baleen whale species typically pass offshore of Te Ākau Bream Bay in deeper waters; however, Bryde's whale habitat is known to overlap with the general transit route that will be taken by the *William Fraser* and this species has been specifically identified as being at risk of vessel strike as it spends much of its time just below the seas surface;
- There is a **negligible** likelihood of a vessel strike incident occurring during extraction due to the operational window for extraction being limited to afternoon and dusk (i.e. daylight hours) and the very low speed of the vessel during active extraction (1.5 – 2.5 knots). The transit speed will also be less than 9.5 knots which manages the risk of vessel strike during all potential transit scenarios to **low**;
- MLB have undertaken extraction operations off the Mangawhai-Pākiri coast for 75 years and has never recorded a collision incident between the *William Fraser* and any marine mammal; and
- Vessel movements between Te Ākau Bream Bay and the Port of Auckland (or alternative ports) are the activities most likely to result in a vessel strike; however, these activities do not require consent. Compliance with the Hauraki Gulf Transit Protocol, MMPR regulations and best practice boating behaviours during the proposed extraction activities (including all potential transit routes) will serve to reduce the likelihood of marine mammal ship strike.

The magnitude of impact varies with species (on the basis that baleen whales are more prone to ship strike incidents); however, with the implementation of the proposed mitigations, no ship strikes are anticipated. The overall level of impact of ship strike from the proposed Te Ākau Bream Bay extraction activities (including transit) is **negligible** or **very low** (**Table 14**).

Table 14 Ship strike impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Negligible	Negligible	**Negligible**
Killer whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Low	Low	**Very low**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Low	Low	**Very low**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Low	Low	**Very low**
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Low	Negligible	**Very low**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Low	Negligible	**Very low**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Overall level of impact
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Low	Negligible	**Very low**

4.5 Exposure to contaminants

Extraction operations result in the resuspension of sediment at the draghead (i.e. on the seabed) and in the water column during overflow (see **Section 2.0**). If the extracted sediments contain contaminants, the resultant plumes have the potential to have a toxicological impact on marine mammals.

Suspended contaminants immediately become more bioavailable to pelagic fauna (e.g. marine mammals and fish). Marine mammals present in the vicinity of these suspended contaminants are at risk of coming into direct contact with the contaminant (i.e. via skin and mucous membranes) when swimming through a sediment plume or can be indirectly exposed through the consumption of contaminated prey (i.e. via trophic pathways) or via gestation and lactation where contaminants are transferred from mother to offspring (Reckendorf et al., 2023; Schaap et al., 2023). Bioaccumulation[13] and the impact of contaminants is most acute in long-lived, top predators, such as marine mammals (Weijs & Zaccaroni, 2016; Schaap et al., 2023; Williams et al., 2023).

Persistent organic pollutants (i.e., organochlorines such as PCBs, DDT etc. used in pesticides, industrial chemicals, solvents, and pharmaceuticals), hydrocarbons (namely PAHs), and toxic trace elements/heavy metals (such as mercury, cadmium, and lead) are the contaminants of primary concern to marine mammals due to their abundance and/or known toxicity (De Guise et al., 2003). Known impacts of contaminant exposure include immunosuppression, reproductive and developmental consequences, and endocrine disruption (Vos et al., 2003).

There are several sources of contaminants into coastal zones and, given the persistence of many chemical contaminants through time, some can remain in water or sediment over years or decades. Contaminants are easily spread throughout the coastal marine environment primarily due to the proximity of human populations that facilitate the transfer of contaminants from land to water (Green & Larson, 2016). In areas of historical contamination, extraction has the potential to resuspend sediments and expose marine mammals to legacy pollutants (Todd et al., 2015).

Contaminant concentrations in marine mammal tissue vary with contaminant bioavailability and exposure dynamics, marine mammal habitat preferences, distribution, trophic level, and foraging ecology (Méndez-Fernandez et al., 2017; Pinzone et al., 2015); as well as biological factors such as species, gender, and age (Remili et al., 2021; Schwacke et al., 2002). Individual marine mammals that utilise habitat around industrialised areas are generally the most heavily contaminated (Williams et al., 2023; Delgado-Suarez et al., 2023). However, contaminant concentrations detected in marine mammals in New Zealand are generally considerably lower than those detected in northern hemisphere species (Jones, 1998).

Different contaminants behave differently in the marine environment; metals typically bioaccumulate in molluscs and crustaceans (Zeng et al. 2013) and hydrocarbons show greater bioaccumulation concentrations in bivalves (Hoffman et al., 2003). Benthic foraging marine mammals could therefore be subject to some secondary contamination through the

[13] Bioaccumulation is the ingestion of contaminants which are then stored in fatty body tissues and increase in concentration inside the organism.

consumption of contaminated invertebrate prey. Marine mammals can metabolise and excrete hydrocarbon contaminants over time (see Ruberg et al., 2021), however, this is not the case with metals which are well recognised to bioaccumulate and biomagnify[14] (see Delgado-Suarez et al., 2023).

While there is potential for marine mammals to be exposed to contaminated sediment as a result of the proposed sand extraction activities, Todd et al. (2015) notes that exposure potential from extraction activities will be spatially restricted and based on the size of the sediment plume, which as discussed in **Section 4.3** is expected to be restricted to a 250 m radius around the point of discharge (following Jacobs, 2020). As identified by Todd et al. (2015), the quality of the sediment to be extracted also affects the likelihood of marine mammals being exposed to contaminants during extraction activities. West and Beetham (2024) conducted sediment analysis for a suite of potential contaminants at the proposed extraction site (including metals/metalloids, and hydrocarbons) and reported that all contaminants assessed were well below the Australia and New Zealand Guidelines for Fresh and Marine Water Quality (default guideline values). Sediments at the proposed extraction site are also described as 'sandy' (West & Beetham, 2024), with generally low mud content, and low organic content. These sediment characteristics contribute to their being a poor 'sink' for contaminant accumulation.

On the basis of sediment contaminant concentrations at the sand extraction area being very low, and the levels of dissolved copper and zinc concentrations being within the 95th percentile level of species protection, Wilson (2025) concluded that the magnitude of effects on water quality from the sand extraction activity on dissolved contaminant concentrations would be negligible after reasonable mixing.

There are several species of marine mammal that are expected to or could occur in and around the proposed extraction area (see **Section 3.2**); however, all species identified as potentially present have home ranges substantially larger than the area over which the sediment plumes are predicted to extend and therefore, on the basis of distribution alone, direct exposure to suspended contaminants is unlikely.

Furthermore, even if marine mammals are present in and around the extraction area during operations, they are not expected to spend extended periods in contact with any sediment plume (and associated contaminants) as 1) marine mammals move freely over large distances on a daily basis and 2) sediment plumes generated during extraction activities will be spatially and temporally restricted. For example, Constantine et al. (2015) tracked tagged Bryde's whales and reported that Bryde's whales range widely across the Hauraki Gulf based on prey shifts and prey distribution, with the uniform environment of the Gulf meaning that potential prey may be found throughout. Similar behaviour is likely for Te Ākau Bream Bay where fine scale Bryde's whale distribution is linked to that of their prey.

With regard to marine mammal contaminant exposure, Williams et al. (2023) concluded that the impact of exposure will be greatest in areas where high contaminant burdens overlap with areas defined as important marine mammal habitat. In regard to this, the sediment testing by West and Beetham (2024) confirms that the contaminant burden of the proposed extraction area is low, and despite the bay providing important habitat for bottlenose dolphins, no marine mammal (including bottlenose dolphins) is constrained solely to Te Ākau Bream Bay, but rather the bay constitutes a small part of a larger overall home range.

[14] Biomagnification causes toxic compounds to be found at higher concentrations in tissues of predators higher in the food chain. The concentration of pollutants increases with each step upwards in the food chain where they accumulate within tissues. The amount of increase/magnification depends on the biological half-life of the contaminant, and how easily it is assimilated, metabolized, or excreted by the organism.

4.5.1 Mitigations

There are no specific mitigations required in relation to potential impacts from contaminant exposure during extraction operations. However, it is noteworthy that the extraction methodology which utilises screens and moonpools to regulate the discharge of suspended sediment and oversized material will serve to reduce the extent and duration of the sediment plume and hence reduce the potential for marine mammals to become exposed to any contaminants that could be resuspended.

4.5.2 Assessment Results

The likelihood of adverse consequences (from direct and indirect exposure) on marine mammals from chemical contamination during the proposed Te Ākau Bream Bay sand extraction activities will be **negligible**. Additional assessment considerations are as follows:

- Te Ākau Bream Bay sediments do not contain concerning levels of contaminants;
- The extraction techniques that will be utilised for sand extraction (see **Section 2.0**) will minimise contaminant resuspension;
- Marine mammals are highly mobile with ample opportunity to avoid sediment plumes. The likelihood of marine mammals spending extended periods in contact with suspended contaminants is therefore **negligible**;
- Uptake of contaminants within the water column by marine mammals is limited, and restricted to trophic pathways (e.g. via the food chain) or direct contact with skin and mucous membranes (i.e. marine mammals do not assimilate oxygen directly through gills such as in fish and shellfish); and
- Bioaccumulation of contaminants via trophic pathways is unlikely as the potential affected area (i.e. the area in which the sediment plume could occur) is small compared to the total foraging habitat of marine mammals potentially present in the area.

On this basis, ascribed magnitude of impact for all species is **negligible**, and the overall level of impact of contaminant exposure from the proposed Te Ākau Bream Bay extraction is **negligible** (**Table 15**).

Table 15 Contaminant impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible – no/very slight change from baseline.	Negligible	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Negligible	Negligible	**Negligible**
Killer whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible	Negligible	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Negligible	Negligible	**Negligible**
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible	Negligible	**Negligible**

4.6 Marine debris

The term marine debris covers "*any persistent, manufactured or processed solid material discarded, disposed of or abandoned in the marine environment*" (Kruse et al., 2023). Marine litter, particularly plastics, can have negative impacts on marine mammals primarily due to ingestion and entanglement (Panti et al., 2019). Any maritime vessel (including TSHD's) is a potential source of marine debris, noting that the pathway for debris to enter the marine environment, relates to deliberate littering as well as accidental loss (e.g. plastic litter blowing overboard) or equipment failure (e.g. extraction equipment breaking and being lost to the environment).

When marine mammals encounter debris in their habitat, they are at risk of 1) becoming entangled (especially in thin loose ropes, fishing line, nets etc) which can lead to injury or drowning; or 2) of ingesting foreign objects which in extreme cases can result in blockage of the digestive tract leading to death by starvation. Sublethal impacts of ingestion may also present as malnutrition, disease and exposure to toxins (as summarised by Baulch & Perry, 2014).

Marine debris poses a significant threat to marine mammals on a global scale. While the rate of interactions between marine mammals and marine debris in New Zealand has not been quantified; Baulch and Perry (2014) reported approximately 500 marine litter interactions with cetaceans globally since the 1960s and concluded that the number of reported cases had steadily increased over this time. These authors reported that ingestion of debris had been reported for 48 cetacean species and entanglement in debris for 14 species.

Source reduction and debris removal are the primary methods of mitigation of potential impacts of marine debris on marine mammals. It is noteworthy that in many cases extraction programmes can effectively support debris removal as they can collect and retrieve man-made objects during extraction operations for safe disposal ashore. New Zealand legislation requires that all vessels in the CMA (both commercial and recreational) comply with the Resource Management (Marine Pollution) Regulations 1998. These regulations give effect to Annex V of the MARPOL Convention which aims to eliminate and reduce the amount of debris being lost to sea from ships.

4.6.1 Mitigations

To minimise any adverse impacts on marine mammals from marine debris the following strategies will be implemented:

- Adoption of appropriate waste management programmes during all components of the proposed sand extraction activities;
- Compliance with Resource Management (Marine Pollution) Regulations 1998; and
- A commitment to collect and retrieve obvious debris objects of marine debris during the course of extraction and to safely dispose of these onshore.

These mitigations form part of the application and associated management plans and should be reflected in consent conditions where appropriate.

4.6.2 Assessment Results

With the adoption of the mitigations above, the likelihood of adverse consequences of marine debris on marine mammals from the proposed sand extraction activities are **negligible**. Indeed, the magnitude of impact would at worst be **negligible**, but could be **positive** as any marine debris objects encountered during operations will be retrieved and removed from the marine environment. This applies to both debris arising from the *William Fraser* and to any other existing debris encountered. On this basis, the overall level of impact will be one of **negligible** (**Table 16**).

Table 16 Marine debris impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible	Negligible	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Negligible	Negligible	**Negligible**
Killer whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible	Negligible	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Negligible	Negligible	**Negligible**
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible	Negligible	**Negligible**

4.7 Entanglement

In addition to entanglement in marine debris (**Section 4.6**), entanglement of marine mammals in the extraction equipment itself (draghead and associated equipment) should also be considered.

Globally marine mammal entanglement is a conservation issue but is nearly exclusively limited to entanglement in fishing gear (Price et al., 2017). Entanglement in extraction equipment has to date not been reported (see Todd et al., 2015). On this basis, the risk of entanglement of marine mammals in extraction equipment is extremely low on account of 1) the intrinsic nature of the equipment (no loose lines, ropes or nets); 2) the slow operational speed of the *William Fraser* allows marine mammals to avoid direct contact with any submerged equipment, and 3) extraction does not typically act as an attractant to marine mammals.

4.7.1 Mitigations

As a precautionary measure and given the possible presence of Bryde's whales in the extraction area on occasion, the following strategies will be implemented to minimise the risk of entanglement:

- The draghead and all other operational equipment in the water column must be free from loose lines, loops of tubing etc. which could pose an entanglement risk to marine mammals;
- Free floating or slack lines at the water surface and in the water-column must be avoided;
- Suction of the draghead must be restricted to within 3 m of the seafloor;
- While extracting, the *William Fraser* must be operated in a consistent manner in terms of direction and speed;
- The extraction vessel master and crew must remain vigilant for marine mammals during active extraction, and be prepared to shutdown extraction if necessary;
- A 100 m exclusion zone for large whales (killer whales and larger, including all baleen whales) must be implemented around the extraction vessel and draghead such that active extraction must cease if a large whale enters this zone; and
- Extraction must not recommence until the large whale has been resighted and has moved away from the draghead/vessel, or until there has been no further sightings for 10 minutes.

These mitigations form part of the application and associated management plans and should be reflected in consent conditions where appropriate.

4.7.2 Assessment Results

With the adoption of the proposed mitigations, both the likelihood and magnitude of entanglement of marine mammals during sand extraction activities will be **negligible**. On this basis, the overall level of impact for all species is **negligible** (**Table 16**).

Table 17 Entanglement impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible – very slight change from baseline	Negligible	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Negligible	Negligible	**Negligible**
Killer whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible	Negligible	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Negligible	Negligible	**Negligible**
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible	Negligible	**Negligible**

4.8 Artificial lighting

As outlined in **Section 2.0,** active extraction inside the extraction area will be restricted to the afternoon and dusk. No nighttime extraction will occur; however, at the completion of the extraction component of each extraction day, the *William Fraser* will at times return to the Port of Auckland after dark. At all times the *William Fraser* will comply with standard Maritime NZ navigation and safety lighting requirements and therefore will (at times) introduce some artificial lighting to the marine environment. Although submerged underwater lighting is not required for any component of the Te Ākau Bream Bay sand extraction activities, vessel lighting (e.g. navigation and deck lighting) may generate some spill-over to sea which could potentially attract prey species (e.g. plankton and fish), which in turn may attract marine mammals. In the most-part impacts of artificial lighting are not predicted for Te Ākau Bream Bay, but only for transit back to Auckland. Research into the consequences of artificial lighting on marine mammals at sea is relatively limited compared to other potential impacts, but attraction and associated risks (e.g. ship strike) have been recognised (MPI, 2013). However, during transit, the *William Fraser* will confer no greater risk to the marine environment, in terms of artificial lighting, than any other vessel moving through the region at night.

Underwater noise generated by extraction activities (**Section 4.2**) will likely counter any potential attraction of marine mammals to the *William Fraser* at dusk, however, some individuals may be more inquisitive, or more sensitive than others. When considering the potential species that could occur in and around Te Ākau Bream Bay, fur seals and dolphins are considered most likely to be attracted to extraction activities as they are generally more inquisitive and are likely to be more tolerant of anthropogenic activities than baleen whales.

Any potential ship strike risk that could culminate from attraction to artificial lighting is offset by the slow operational speed of the *William Fraser*, and the agility of fur seals and dolphins which are the species most likely to be attracted to any artificial lighting used.

4.8.1 Mitigations

Although there are no specific mitigations required in relation to minimising potential impacts on marine mammals from artificial lighting, **Section 2.0** notes that as far as possible, lighting on the *William Fraser* will be subdued and downward facing whilst still complying with

Maritime NZ lighting and safety requirements. This measure will be of benefit to marine mammals as they are designed to reduce the amount of light spill-over to sea.

4.8.2 Assessment Results

Based on the information presented above, both the likelihood of adverse consequences and the predicted magnitude of artificial lighting impacts on marine mammals is **negligible**; therefore, the overall level of impact is **negligible** (**Table 18**).

Table 18 Artificial lighting impacts on marine mammals – assessment findings.

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Common dolphins	**Low**	Likely frequent presence in and around Te Ākau Bream Bay, with preference for deeper open waters. Large home ranges.	Negligible – no/very slight change from baseline	Negligible	**Negligible**
Bottlenose dolphins	**Very High**	Likely frequent (consistent) presence in and around Te Ākau Bream Bay, including a hotspot in the vicinity of the sand extraction area in summer and autumn. Semi-resident to the embayment.	Negligible	Negligible	**Negligible**
Killer whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Bryde's whales	**Very High**	Likely frequent presence in regional coastal and offshore waters. Preference for deep water, noting a hotspot to the northeast of the sand extraction area in Te Ākau Bream Bay. Large home ranges.	Negligible	Negligible	**Negligible**
Long-finned pilot whales	**Low**	Likely presence in regional waters, but mostly offshore. Large home ranges.	Negligible	Negligible	**Negligible**
New Zealand fur seals	**Low**	Likely in regional coastal and offshore waters. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
False killer whales	**Moderate**	Likely seasonal presence in and around Te Ākau Bream Bay, but mostly in offshore waters. Large home ranges.	Negligible	Negligible	**Negligible**
Humpback whales	**Low**	Possible, seasonal presence in regional coastal & offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Southern right whales	**Very High**	Possible seasonal presence in regional coastal waters. Could stay for several weeks at a time during breeding season.	Negligible	Negligible	**Negligible**

Species	Ecological value	Likelihood of presence	Magnitude of impact	Likelihood of adverse consequences	Level of impact
Leopard seals	**Low**	Possible infrequent presence in coastal waters and ashore. Some semi-residence of individuals is possible in embayment.	Negligible	Negligible	**Negligible**
Blue whales	**Very High**	Possible occasional presence in regional coastal waters. Large home ranges.	Negligible	Negligible	**Negligible**
Gray's beaked whales	**Low**	Possible in offshore waters. Presume large home ranges.	Negligible	Negligible	**Negligible**
Sperm whales	**High**	Possible occasional presence, mostly in offshore waters. Large home ranges outside of Kaikoura.	Negligible	Negligible	**Negligible**
Sei whales	**Low**	Possible occasional presence in offshore waters. Very large home ranges.	Negligible	Negligible	**Negligible**
Minke whales	**Low**	Possible occasional seasonal presence. Very large home ranges.	Negligible	Negligible	**Negligible**

4.9 Cumulative Impacts

Stressors on marine mammals are often not experienced in isolation (spatially or temporally), and as a result, an individual/group may be simultaneously exposed to a number of stressors from one activity with multiple stresses, and/or from multiple activities occurring simultaneously or consecutively (Hague et al., 2022). Cumulative impacts are a result of incremental, sustained, and combined consequences of human actions and natural variations over time. When the consequences of a single activity (e.g. extracting marine sands) interact with consequences from other activities in space and time, then cumulative impacts can arise. Cumulative impacts are of greatest relevance to threatened species, and species that are less abundant now than they were historically e.g. southern right whales and humpback whales (see **Table 1**). Also of relevance here is that coastal communities (particularly manawhenua) strive to restore coastal habitats such that species may again thrive in Te Ākau Bream Bay (see **Appendix F**).

Evaluation of the potential for cumulative impacts on marine mammals is challenging given the wide range of variables that can influence how wildlife populations are affected, e.g. other threats that a population may be facing, unquantified long-term pervasive impacts from habitat degradation, undescribed anthropogenic or natural impacts, etc. Tools to effectively quantify cumulative impacts are not widely available (Hague et al., 2022), and cumulative impacts on marine mammals from multiple stressors are largely unknown due to a paucity of data. Therefore, the following discussion forms the basis of a qualitative assessment which is currently regarded as the best approach on which to assess potential cumulative impacts.

With regard to the Te Ākau Bream Bay sand extraction proposal, the most significant potential single impact that has been identified is that of the addition of underwater noise from extraction operations (see **Section 4.2**). The ongoing nature of the proposed activity and consequent ongoing noise exposure represents a type of cumulative impact and has already been discussed in **Sections 4.2.4** to **4.2.8**.

The existing soundscape of the region is already heavily affected by anthropogenic noise; including commercial shipping, periodic maintenance dredging at Northport (the closest port to the proposed sand extraction area), the existing sand extraction operation by MBL along the nearby Mangawhai-Pākiri coast, and high levels of recreational boating activities along the northeastern coast of New Zealand. Despite these regionally elevated background noise levels and the intermittent nature of the proposed extraction, the modelled results presented in **Section 4.2.4** predict that the underwater noise inputs from the proposed sand extraction activities will be substantial inside the extraction area, but in the wider embayment cumulative noise levels will be low.

In terms of commercial ship movements through Te Ākau Bream Bay, **Table 19** summarises shipping movements in the last decade (2014-2024). During this period an average of 576 ship calls were made per year, equating to an average of 1152 ship movements (i.e. transit both in and out of the embayment) annually. Considering both available shipping routes in Te Ākau Bream Bay (i.e. Parry Channel and Jellicoe Channel) and a travel speed of 10 knots, commercial ships would take approximately 1 hour to transit through Te Ākau Bream Bay.

Table 19 does not include recreational vessel movements or ship anchorages which represent additional underwater noise inputs to the embayment. In particular, and based on the shipping data tabled, anchorages are expected to be occupied nearly continuously, with a total of 72 ships using the anchorages over a six-month period and staying on anchor for 2-3 days at a time (with ships predominantly using the southern anchorage area). The highest number of anchorage uses per month in 2024 was 14 with total calls to anchorages being 139 (pers. comm. Deputy Harbourmaster, Northland Regional Council). Furthermore, the Harbourmaster estimates that the frequency of shipping movements could increase by 10-15% on average over the next two decades.

Table 19 Commercial ship calls to Te Ākau Bream Bay from 2014 to 2024

	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Northport Ltd	265	271	257	303	283	309	298	262	237	211	226
Refinery NZ	223	221	192	202	198	220	159	146	122	123	104
Portland	189	185	134	62	94	60	116	114	124	105	91
Upper harbour	27	23	56	19	12	12	23	12	23	15	13
Total ship calls	704	700	639	586	587	601	596	534	506	454	433
Total movements (in & out)	1408	1400	1278	1172	1174	1202	1192	1068	1012	908	866

Furthermore, while numbers of recreational boats in Te Ākau Bream Bay varies with weather and season. On weekends in summer, it is possible to have 50+ recreational boats in Te Ākau Bream Bay (pers. comm. Deputy Harbourmaster, Northland Regional Council).

Because of the existing sources of anthropogenic noise in the region, it is likely that some marine mammal vocalisations are already being masked, and the proposed sand extraction activities could add to this. While no marine mammals are confined to the zone within which the extraction noise will be audible (i.e. all species with an expected presence have home-ranges that extend well beyond the predicted zone of audibility). Ellison et al. (2016) noted that cumulative impacts from chronic exposures can be of relevance at a population level, while temporary impacts are more likely to affect individuals. The ongoing change to the soundscape from the proposed sand extraction activities needs to be viewed in this context, whereby cumulative impacts on threatened species are of specific relevance and in this regard cumulative impacts on bottlenose dolphins, killer whales, and Bryde's whales are specifically discussed later in this section.

Further to the potential for cumulative acoustic threats, multiple other threats to marine mammals are present in the coastal waters of the region, yet despite this, a diverse marine mammal assemblage is still present, for example:

- Potential entanglement in fishing gear;
- Potential disturbance from commercial and recreational vessel traffic;
- Potential trophic impacts from habitat degradation through time (e.g. Climate change, over-fishing, changes to benthic communities from trawling etc.); and
- Potential exposure to contaminants (primarily from terrestrial runoff).

While the issue of climate change is becoming more prevalent with time, the impacts of climate change are difficult to predict (Roberts and Hendricks, 2022). Predictions on the impacts of climate change on marine mammals suggest alterations to marine mammal distribution and productivity (Albouy et al., 2020), with climate variability and shifts within New Zealand already being implicated in productivity (e.g. Roberts and Hendricks, 2022) and distribution (e.g. Hartel et al., 2015; Barlow et al., 2020). Roberts and Hendricks (2022) summarise the following climate change hazards that have the potential to influence marine mammals:

- Increasing sea temperature – may directly impact marine mammals through changes in ambient temperature (which may be problematic for species already close to a thermal tolerance threshold), or indirectly such as through changes in mixed layer depth and other oceanographic features that impact on prey productivity/distribution (Sydeman et al., 2015);
- Changes in ocean circulation – projected climate change is expected to alter global patterns, with some changes, such as the strength of surface mixing or coastal upwelling events, predicted to impact marine mammals by changing the availability of prey species (Boyd & Law, 2011; Peters et al., 2022);
- Changes in atmospheric climate – includes changes in climate patterns such as rainfall intensity, storm frequency, and wave conditions. Small-bodied marine mammals (i.e. pinnipeds and dolphins) may be more affected than larger taxa, and offspring may be most vulnerable (Roberts and Hendricks, 2022). More intense precipitation can increase the nutrient loading of coastal waters (via increased terrestrial run-off), and is expected to increase the frequency of harmful algal blooms (Doney et al., 2012), risk of exposure to infectious diseases (Schumann et al., 2013; Sanderson & Alexander, 2020), and flow of pollutants/pathogens into coastal waters (Lawler et al., 2007);
- Ocean acidification – direct impacts are mostly unknown but considered to be minimal (Schumann et al., 2013), although marine mammals may be indirectly affected through impacts on prey (e.g. krill) (Rosa et al., 2014);
- Rising sea level – may reduce the extent of suitable breeding and haul-out habitat for pinnipeds, or affect coastal bays/lagoons utilised by marine mammals for breeding activities (Roberts & Hendricks, 2022); and
- Change in ecosystem structure – mostly involves changes in prey availability driven by changes in ocean productivity and food web structure (Sydeman et al., 2015). This is considered to be the greatest climate change threat for marine mammals (Schumann et al., 2013; Simmonds, 2016).

The above climate change associated hazards may impact marine mammals by changing spatial distribution, migration patterns, the timing of breeding, ecosystem processes affecting prey availability or predation pressure, and/or changes in demographic rates driving population change (Roberts & Hendricks, 2022). Threats already faced by marine mammals may be exacerbated by these changes (Macinnis-Ng et al., 2021). Potential positive impacts of climate change are limited but include the colonisation of new areas for some species (Roberts & Hendricks, 2022).

As alluded to above, cumulative impacts will be of most relevance to threatened species, i.e. those whose populations may already be limited by anthropogenic impacts. The threatened species that are most likely to be present in the project area are bottlenose dolphins (Nationally Vulnerable), Bryde's whales (Nationally Critical), and killer whales (Nationally Critical). The potential for cumulative impacts on these species is specifically discussed below:

- Bottlenose dolphins: bottlenose dolphins in the northern North Island routinely occur along the coastline from Doubtless Bay to Tauranga (Constantine, 2003) and beyond into parts of the eastern Bay of Plenty (Zaeschmar et al., 2020) and the west coast of the North Island (Tezanos-Pinto, 2013). Dolphins inhabiting this stretch of coastline show varying degrees of site fidelity but generally exhibit high levels of movement (Constantine, 2003; Tezanos-Pinto, 2009), with animals seldom stable within an area for more than a few days (Mourão, 2006). However, relatively high rates of residency (as inferred from photo-identification data) have recently been described for bottlenose dolphins in Te Ākau Bream Bay, indicating a semi-resident[15] population here (Brough et al., 2024), and the acoustic monitoring results (refer **Section 3.2.1**) align with this finding, indicating that dolphins have a near daily presence in Te Ākau Bream Bay. Along with the Bay of Islands and Hauraki Gulf, bottlenose dolphins may indeed utilise Te Ākau Bream Bay disproportionally more often than general coastal habitat along the northeastern coast of New Zealand (Brough et al., 2025) and that individuals with the highest rates of occurrence in Te Ākau Bream Bay will be subject to the highest levels of cumulative risk from project-related disturbance.

  Bottlenose dolphin abundance in the Bay of Islands (88 km north of the proposed sand extraction area) has recently declined (Tezanos-Pinto et al., 2013; Brough et al., 2025). On the basis that 1) declining numbers of identifiable bottlenose dolphins are using the Bay of Islands (from 278 in 1997 to 96 in 2015) and 2) a concurrent high rate of calf mortality (75% between 2012 and 2015), the Te Pēwhairangi (Bay of Islands) Marine Mammal Sanctuary (see **Figure 16**) was established in 2021 with the primary aim of addressing the high levels of vessel interactions here (DOC, 2021). To date, the causative factor that is driving the reduced presence of bottlenose dolphins in the Bay of Islands is unknown (Brough et al., 2025) with displacement to other areas on account of vessel disturbance and high mortality coupled with low birth rates both being identified as potential causes (DOC, 2021). Recent survey results confirm that the decline is ongoing with the local population estimate for the Bay of Islands in May 2024 being 39 individuals (CI = 29 - 99), and future research is recommended to elucidate the specific drivers of decline (Brough et al., 2025). Noting that vessel disturbance has not been definitively identified as a causative factor, but evidence is emerging to suggest that dolphins exhibit behavioural changes in the presence of vessels (Brough et al., 2025).

  Studies on bottlenose dolphins in other regions of New Zealand (i.e. Doubtful Sound) have attributed decreases in dolphin abundance to human disturbance (environmental and behavioural), with dolphin-related boat tourism activities a main

[15] Demonstrating a high level of site fidelity, where individual dolphins are repeatedly seen in the area.

stressor (Currey et al., 2009). The restrictions on dolphin-based tourism that have been implemented in the Bay of Islands since the establishment of the Te Pēwhairangi (Bay of Islands) Marine Mammal Sanctuary reflect this. While it is possible that bottlenose dolphins displaced from the Bay of Islands could be attracted to nearby alternative habitat such as Te Ākau Bream Bay, photo-identification data does not strongly support this possibility; with only a small proportion (37 individuals or 6%) of the total number of recognisable individual dolphins (540) being observed in both locations (Brough et al., 2025).

Bottlenose dolphins have a year-round presence in Te Ākau Bream Bay and feeding and the nursing of young are commonly observed for this species (Brough, 2023; Brough et al., 2024). If dolphins are present in Te Ākau Bream Bay at the time of active sand extraction, they could be subject to some temporary impacts from underwater extraction noise (i.e. behavioural response or masking) depending on how close to the *William Fraser* they approach (see **Section 4.2.3**); noting that sensitive behaviours such as resting and nursing calves may be particularly susceptible to disturbance.

Interestingly, Bossley et al. (2022) concluded that fluctuations in bottlenose dolphin presence in Adelaide's Port River did not coincide with TSHD activity. Instead, dolphin presence was strongly linked to sea surface temperature and seasons. In this long-term study (1992 to 2020), the number of dolphin sightings increased from 1992 to 2012, after which the rate of increase declined. The authors noted that this reduction in the rate of increase occurred c. 6 years after completion of the first dredging campaign and therefore was unlikely to be a direct function of dredging. Further to this, the habituation of bottlenose dolphins to high levels of shipping activity has recently been reported by Mills et al. (2023; 2024) where dolphins frequently foraged in the presence of multiple vessels at the largest port in the USA.

In summary, while the North Island population of bottlenose dolphins is facing existing pressures and the proposed sand extraction will represent additional temporary disturbance, there is evidence that this species can and does coexist with shipping and extraction activities in other parts of the world. Indeed, the highest probabilities of occurrence for bottlenose dolphins in Te Ākau Bream Bay (see **Figure 14**) overlap with Parry Channel. This suggests that at least some bottlenose dolphins that occur in and around Te Ākau Bream Bay are tolerant of underwater noise and that habituation to sand extraction activities in Te Ākau Bream Bay is probable. However, given the individual variability in sensitivity to disturbance, it is possible (but unlikely) that some individuals could be displaced on account of cumulative underwater noise. Due to a) the threat status of this species in New Zealand and b) that the potential for changes to habitat use (including avoidance of the extraction area and immediate surrounds) cannot be entirely dismissed, a cautious approach is warranted and an Acoustic Monitoring Programme will be implemented to ensure that any soundscape change resulting from the proposed sand extraction activities is no greater than 3 dB; hence cumulative effects from project-related underwater noise will be restricted.

- Bryde's whales: Bryde's whales are concentrated between East Cape and North Cape (Gaskin, 1963); with the Hauraki Gulf and Northland region supporting one of the few known resident populations in the world (Constantine et al., 2012). Bryde's whales are active during the day, spending daylight hours below the sea surface engaged in foraging and travelling (Constantine et al., 2012). Activity is lower at night, with whales found closer to the sea surface and exhibiting resting behaviours which makes them particularly vulnerable to ship strike (Constantine et al., 2012). With regard to Te Ākau Bream Bay, Bryde's whales have been reported within the bay, often with juveniles/calves present (Brough, 2023; Brough et al., 2024);

however, the DOC sighting data shows sightings within Te Ākau Bream Bay occur in the outer bay near the 50 m depth contour, and findings from Brough et al (2024) support this preference for deeper water, noting that a hotspot for Bryde's whales was identified approximately 5 km to the northeast of the proposed sand extraction area (off Whangārei Heads) (see **Figure 13**).

It is noteworthy that between 2011 and 2020 the diet of Bryde's whales appears to have shifted from being fish dominated to primarily feeding on zooplankton (Gostischa, 2020). This may reflect changes in prey availability, due to possible epizootic events, fisheries, and climate-induced ecosystem changes and therefore could reflect that this species is already facing environmental pressures. Changes in prey community are likely to have consequences for habitat use, as reported recently by University of Auckland (2025) whereby Bryde's whales appear to be spending proportionally less time in the inner Hauraki Gulf (their traditional hot spot) and more time in the outer gulf. On account of this distributional shift, it is possible that Bryde's whales may have an increased presence in the offshore waters of Te Ākau Bream Bay through time.

Given the increased susceptibility of baleen whales to masking from underwater noise, care must be taken in assessing the cumulative impacts on Bryde's whales. As previously stated, this species may already be under some pressure relating to prey availability and has until recently also been subject to high levels of ship strike. Further, while site fidelity of Bryde's whales to coastal northeastern New Zealand varies, it is generally low (Tezanos-Pinto et al., 2017; Hamilton et al., 2023) suggesting that individual whales will not be routinely subject to ongoing impacts associated with the proposed sand extraction activity.

- <u>Killer whales</u>: threats to New Zealand killer whales and their habitat are listed by Visser (2007) as habitat degradation, noise pollution, chemical pollution, and interactions with fisheries. Killer whales in New Zealand have extensive home-ranges (circumnavigating the entire North Island as a minimum), covering large distances (average 100 – 150 km) daily (Visser, 2000). While these ecological characteristics have some advantages (i.e. the ability to readily move to avoid disturbance), they also expose animals to a wide range of threats over a wide range of habitats. Individual killer whales and family groups visit Te Ākau Bream Bay on a sporadic basis. If killer whales are present at the same time as active extraction operations, they could be exposed to underwater noise. However, the home range of killer whales is vast, and the proposed sand extraction area is small in comparison; hence this species is less likely to be subject to ongoing impacts from repetitive exposure to sand extraction activities. Furthermore, there is no specific evidence to suggest that Te Ākau Bream Bay provides habitat of high relative importance to killer whales, although calves have been reported within Te Ākau Bream Bay (see **Table 1**).

4.9.1 Mitigations

The mitigation measures outlined previously within **Section 4.2.7**, **Section 4.4.1**, and **Section 4.6.1** will serve to reduce the potential individual impacts associated with the proposed sand extraction activities on marine mammals; hence will also serve to minimise the risk of additional cumulative impacts.

4.9.2 Assessment Results

The greatest contributor to cumulative impacts from the project is the ongoing exposure to underwater noise associated with the proposed sand extraction activities. On this basis, the assessment results presented in **Section □** are also of relevance here.

5.0 Summary of Findings

The table below provides a summary of findings, in terms of the assigned overall level of predicted impact on marine mammal species posed by each actual or potential impact identified.

Table 20 Summary of assessment findings – potential impacts on marine mammals.

Potential Impact	Summary of Proposed Mitigations	Magnitude of Impact	Likelihood of Adverse Consequence	Overall level of impact
Underwater noise – Auditory injury	Regularly maintained extraction equipment. Compliance with Marine Mammal Management Plan, including adoption of future quietening technologies as appropriate. Implementation of an Acoustic Monitoring Programme. Support boat-based research surveys in Te Ākau Bream Bay.	Very high	Negligible	Low
Underwater noise – TTS		High	Negligible	Very low
Underwater noise – Behavioural response for HF cetaceans and pinnipeds		Low	High	Low
Underwater noise – Behavioural response for LF cetaceans		Low	Low	Very low
Underwater noise – Masking (75% LSR)		Moderate	Low	Low
Underwater noise – Masking (0 - 50% LSR)		Negligible to Low	Moderate	Negligible to Low
Underwater noise – soundscape change		Negligible to Low	Negligible to Moderate	Negligible to Low
Habitat modification	None.	Negligible to Low	Negligible to Moderate	Negligible to Low
Ship strike	Compliance with the MMPR. Compliance with the Hauraki Gulf Transit Protocol in all waters subject to transit and extraction activities associated with this application. Vigilance for marine mammals maintained. Records of marine mammal sightings kept. All vessel strikes and near misses will be recorded and reported.	Negligible to Low	Negligible to Low	Negligible to Very low
Exposure to contaminants	None.	Negligible	Negligible	Negligible

Potential Impact	Summary of Proposed Mitigations	Magnitude of Impact	Likelihood of Adverse Consequence	Overall level of impact
Marine debris	Adoption of appropriate waste management programmes Comply with Resource Management (Marine Pollution) Regulations 1998. Collect and retrieve any obvious marine debris during extraction and safely dispose of this onshore.	Negligible	Negligible	Negligible
Entanglement	In-water equipment must be free from loose lines, loops of tubing etc. No free floating or slack lines. Suction of draghead restricted to ≤ 3 m of seafloor. Consistent direction and speed of vessel. Vigilance for marine mammals maintained. 100 m exclusion zone for large whales.	Negligible	Negligible	Negligible
Artificial lighting	None.	Negligible	Negligible	Negligible
Cumulative Effects	None.	Negligible to Low	Negligible to Moderate	Negligible to Low

6.0 Conclusion

This report describes the marine mammal populations in and around Te Ākau Bream Bay and assesses the potential impacts on marine mammals from the proposed sand extraction activities. Data from a range of different sources (including opportunistic observations, systematic visual and acoustic surveys, stranding data, and habitat modelling) was assessed to determine the marine mammal species that use the waters in and around the project area and to assess the likelihood of each species being present here.

While at least 30 marine mammal species are reported for the wider region, the available data suggests that only seven species – bottlenose dolphins, common dolphins, Bryde's whales, false killer whales, pilot whales, killer whales, and New Zealand fur seals – commonly visit Te Ākau Bream Bay and the immediate surrounds. Bottlenose dolphins are of particular interest as Te Ākau Bream Bay has been identified as important habitat for this semi-resident species.

Several potential impacts of extraction have been identified and assessed in this report, including underwater noise, habitat modification, ship strike, exposure to contaminants, marine debris, entanglement, artificial lighting, and cumulative impacts.

In particular, underwater noise modelling was undertaken by Styles Group (2025) to determine the potential impacts that the proposed sand extraction activities could have on marine mammals. While these modelling results conclude that no auditory injury or TTS is expected beyond 0.5 m, and the instantaneous impacts of sand extraction noise will be spatially restricted (to within c. 1 km for behavioural responses and c. 16 km for masking), the operational noise from the intermittent presence of the *William Fraser* is predicted to change the soundscape of parts of Te Ākau Bream Bay. While widescale displacement of marine mammals is considered unlikely, underwater noise from sand extraction activities may affect the fine scale distribution of marine mammals in Te Ākau Bream Bay. For this reason, an Acoustic Monitoring Programme (soundscape change validation) (as described in the MMMP) will be implemented.

The results of this assessment found that with the adoption of the proposed mitigations, the overall level of impact from the proposed sand extraction ranges from **negligible** to **low.**

Overall, no population level effects on marine mammals are expected as a result of the proposed sand extraction. Further, there are no predicted adverse effects that exceed the thresholds set by the NZCPS.

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Appendix A Marine Mammals and their Likelihood of Occurrence in the Region

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

Common Name	Scientific Name	NZ Conservation Status (Lundquist et al., 2025)	IUCN Conservation Status www.redlist.org	DOC Sightings database (No. within Te Ākau Bream Bay/ Total in region)	DOC Incident database (No. within Te Ākau Bream Bay/ Total No. in region)	Modelled habitat suitability of region (Stephenson et al., 2020/ MacKenzie et al., 2022)	Likelihood of Presence in and around Te Ākau Bream Bay
Andrew's beaked whale	*Mesoplodon bowdoini*	Data deficient	Data deficient	0/0	1/1	Low/Low	Unlikely
Antarctic fur seal	*Arctocephalus gazella*	Vagrant	Least Concern	0/0	0/0	NA/Low	Unlikely
Arnoux's beaked whale	*Berardius arnuxii*	Data deficient	Least concern	0/1	0/5	Low/Low	Unlikely
Blue whales	*Antarctic blue whales Balaenoptera musculus intermedia* *Pygmy blue whales B. m. brevicauda*	Migrant Nationally vulnerable	Critically endangered Endangered	0/68	1/4	Low-Moderate/ Moderate	Possible
Bottlenose dolphin	*Tursiops truncatus*	Nationally vulnerable	Least concern	10/298	17/81	Low-High/Moderate	Likely
Bryde's whale	*Balaenoptera edeni*	Nationally critical	Least concern	11/1188	2/28	Low-High/Moderate-High	Likely
Common dolphin	*Delphinus delphis*	Not threatened	Least concern	10/2971	32/243	High/Moderate	Likely
Crab eater seal	*Lobodon carcinophaga*	Vagrant	Least concern	0/0	0/0	NA/Low	Unlikely
Cuvier's beaked whale	*Ziphius cavirostris*	Uncommon	Least concern	0/1	0/3	Low/Low	Unlikely
Dense beaked whale	*Mesoplodon densirostris*	Data deficient	Least concern	0/0	0/0	Low/Low	Unlikely
Dusky dolphin	*Lagenorhynchus obscurus*	Not threatened	Least concern	0/3	0/1	Low/Low	Unlikely
Dwarf sperm whale	*Kogia sima*	Data deficient	Least concern	0/0	0/1	NA/Moderate-High	Unlikely
False killer whale	*Pseudorca crassidens*	Uncommon	Near Threatened	0/10	0/0	Low/Low-Moderate	Likely
Fin whale	*Balaenoptera physalus*	Migrant	Vulnerable	0/0	0/0	Low-High/High	Unlikely
Fraser's dolphin	*Lagenodelphis hosei*	Data deficient	Least concern	0/0	0/0	NA/Low-Moderate	Unlikely
Ginkgo-toothed whale	*Mesoplodon ginkgodens*	Data deficient	Data deficient	0/0	0/0	NA/Moderate-High	Unlikely
Gray's beaked whale	*Mesoplodon grayi*	Not threatened	Least concern	0/2	17/62	Low-Moderate/Low-Moderate	Possible
Hector's beaked whale	*Mesoplodon hectori*	Data deficient	Data deficient	0/0	0/4	NA/Moderate-High	Unlikely
Hourglass dolphin	*Lagenorhynchus cruciger*	Data deficient	Least concern	0/0	0/0	Low/Low	Unlikely
Humpback whale	*Megaptera novaeangliae*	Migrant	Endangered	3/82	1/7	Low–Moderate/Moderate	Possible
Killer whale	*Orcinus orca*	Nationally critical	Data deficient	10/314	2/19	Low-High/Moderate	Likely
Leopard seal	*Hydrurga leptonyx*	Migrant	Least concern	11/107	0/2	NA/Moderate-High	Possible
Lesser/pygmy beaked whale	*Mesoplodon peruvianus*	Data deficient	Least concern	0/0	0/0	NA/Low	Unlikely
Long-finned pilot whale	*Globicephala melas*	Not threatened	Least concern	3/18*	13/47	Low-Moderate/Low-High	Likely
Maui's dolphin or Hector's dolphin	*Cephalorhynchus hectori spp.*	Nationally critical Nationally vulnerable	Critically En Endangered	0/13	0/2	Low-High/Low	Unlikely
Melon-headed whale	*Peponocephala electra*	Vagrant	Least concern	0/0	0/1	NA/Moderate	Unlikely
Minke whales - Antarctic	*Antarctic minke whale Balaenoptera bonaerensis*	Migrant	Near Threatened	0/0	1/4	NA/Moderate-High	Unlikely

Common Name	Scientific Name	NZ Conservation Status (Lundquist et al., 2025)	IUCN Conservation Status www.redlist.org	DOC Sightings database (No. within Te Ākau Bream Bay/ Total in region)	DOC Incident database (No. within Te Ākau Bream Bay/ Total No. in region)	Modelled habitat suitability of region (Stephenson et al., 2020/ MacKenzie et al., 2022)	Likelihood of Presence in and around Te Ākau Bream Bay
Minke whales - Dwarf	*Dwarf minke whale Balaenoptera acutorostrata*	Data deficient	Least concern	1/10	2/17	Moderate/Moderate-High	Possible
New Zealand sea lion	*Phocarctos hookeri*	Nationally endangered	Endangered	0/0	0/0	NA/Low	Unlikely
New Zealand fur seal	*Arctocephalus forsteri*	Not threatened	Least Concern	0/32**	0/7	NA/High	Likely
Pantropical spotted dolphin	*Stenella attenuata*	Vagrant	Least concern	0/0	0/0	NA/Low-Moderate	Unlikely
Pygmy killer whale	*Feresa attenuata*	Vagrant	Least concern	0/0	0/0	NA/Low-Moderate	Unlikely
Pygmy right whale	*Caperea marginata*	Data deficient	Least concern	0/1	1/9	NA/High	Unlikely
Pygmy sperm whale	*Kogia breviceps*	Uncommon	Least concern	0/0	0/15	Low/Low-Moderate	Unlikely
Risso's dolphin	*Grampus griseus*	Data deficient	Least concern	0/0	2/2	Low/Low-Moderate	Unlikely
Ross seal	*Ommatophoca rossii*	Vagrant	Least concern	0/0	0/0	NA/Low	Unlikely
Rough-toothed dolphin	*Steno bredanensis*	Data deficient	Least concern	0/0	0/0	NA/Moderate	Unlikely
Sei whale	*Balaenoptera borealis*	Migrant	Endangered	0/28	0/5	Low–Moderate/ Moderate-High	Possible
Shepherd's beaked whale	*Tasmacetus shepherdi*	Data deficient	Data deficient	0/0	0/2	Low/Low	Unlikely
Short-finned pilot whale	*Globicephala macrorhynchus*	Data deficient	Least concern	0/2	0/1	Low-Moderate/Low	Unlikely
Southern bottlenose whale	*Hyperoodon planifrons*	Data deficient	Least concern	0/2	1/9	Low/Low	Unlikely
Southern elephant seal	*Mirounga leonina*	Nationally critical	Least concern	0/0	0/0	NA/Low	Unlikely
Southern right whale	*Eubalaena australis*	Nationally increasing	Least concern	6/64	0/0	Low–Moderate/Low	Possible
Southern right whale dolphin	*Lissodelphis peronii*	Uncommon	Least concern	0/0	0/1	Low/Low	Unlikely
Spade-toothed whale	*Mesoplodon traversii*	Data deficient	Data deficient	0/0	0/0	NA/Low-Moderate	Unlikely
Spectacled porpoise	*Phocoena dioptrica*	Data deficient	Least concern	0/0	0/0	Low/Low	Unlikely
Sperm whale	*Physeter macrocephalus*	Declining	Vulnerable	2/14	2/17	Low/Low	Possible
Strap-toothed whale	*Mesoplodon layardii*	Data deficient	Least concern	0/0	3/18	NA/Low-Moderate	Unlikely
Striped dolphin	*Stenella coeruleoalba*	Data deficient	Least concern	0/0	2/6	Low/Low-Moderate	Unlikely
Subantarctic fur seal	*Arctocephalus tropicalis*	Vagrant	Least concern	0/2	0/0	NA/Low	Unlikely
True's beaked whale	*Mesoplodon mirus*	Data deficient	Least concern	0/0	0/0	NA/High	Unlikely
Weddell seal	*Leptonychotes weddelli*	Vagrant	Least concern	0/0	0/0	NA/Low	Unlikely

Appendix B SLR Marine Mammal Sighting Data

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

Methodology

SLR was engaged to undertake water quality monitoring at the proposed Te Ākau Bream Bay Sand Extraction Area on a weekly basis from 6 May 2024 to 24 June 2024. During these filed trips, SLR field staff were instructed to collect information on the presence and absence of marine mammals.

On each day that monitoring was undertaken, the research vessel departed Northland Port and travelled to the proposed sand extraction area where samples were collected before returning to Northland Port.

Marine mammal sightings data collected during these trips is summarised in the table below.

Results

Marine mammals were detected on only two of the eight monitoring trips. On both occasions the detections were of bottlenose dolphins.

Date	Marine mammal detections made?	Species and sightings details
6 May 2024	No	-
13 May 2024	Yes	**Bottlenose dolphins**. Group of 3 animals. 12:04 pm. Seen north of sand extraction area on transit back to port. The dolphins were travelling and appeared to be moving westward towards shore.
22 May 2024	No	-
27 May 2024	No	-
4 June 2024	Yes	**Probably Bottlenose dolphins**. Group of 5 – 7 animals. 10:52 am. Seen inside the proposed sand extraction area. The dolphins were only seen at a distance in choppy conditions. Milling.
12 June 2024	No	-
17 June 2024	No	-
24 June 2024	No	-

Appendix C Marine Mammal Survey Report, Te Ākau Bream Bay (Brough et al., 2024)

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

SLR

Baseline surveys of marine megafauna in Te Ākau/Bream Bay to support kaitiakitanga

Tere Tohorā, Karanga Tangata

A collaboration between Patuharakeke, Far Out Ocean Research and the National Institute of Water and Atmospheric Research

April 2024

Prepared by:
Tom Brough
Hollie Kereopa
Jochen Zaeschmar
Eva Leunissen
Taryn Shirkey

For any information regarding this report please contact:

Tom Brough
Marine Ecologist
Marine Ecology
[redacted]

National Institute of Water & Atmospheric Research Ltd
PO Box 6414
Dunedin 9059

Phone +64 3 477 8615

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[redacted]	Reviewed by:	Carolyn Lundquist
	Formatting checked by:	Jo Downey
	Approved for release by:	Michael Bruce

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Executive summary

Marine mammals/tohorā/Nga tamaraki o Tinirau and manu moana/seabirds are critically important components of Aotearoa New Zealand's marine ecosystem and are of major cultural significance in te aō Māori. Despite Aotearoa New Zealand being recognised as a biodiversity hotspot of international importance for both marine mammals and seabirds, most locations within our waters do not have adequate information on these species to manage populations against anthropogenic impacts. Patuharakeke te iwi are mana whenua/mana moana of the southern reaches of Te Rerenga Parāoa/Whangarei Harbour and Te Ākau/Bream Bay. The rohe moana of Patuharakeke is faced with numerous, cumulative stressors that may impact populations of taonga species. Further, there is no reliable information on marine megafauna that can be used to understand the occurrence, distribution, habitat use, population status and key behaviours for any species within this area. Thus, Patuharakeke do not have the necessary information to management threats to species that hold significant importance to their people.

This project, Tere Tohorā Karanga Tangata, forms a hononga/partnership between marine scientists and tangata tiaki to address the gaps on marine mammals, seabirds and other megafauna within the wider rohe moana of Patuharakeke. The project aims to synthesise an accurate baseline of species that are found in Te Ākau/Bream Bay and Te Rerenga Parāoa by weaving conventional scientific surveys and analysis with a mātauranga Māori approach.

Wānanga were held to co-design the systematic surveys and integrate local knowledge into the design. Seven, multi-day vessel-based surveys/wānanga were carried out over the full study area over 15 months and included science team members, members of the Patuharakeke Taiao unit and the wider Patuharakeke whānau. Visual and acoustic data on marine mammals were collected using a line-transect survey design with acoustic recording stations positioned along the survey track. Ten-minute seabird counts were taken alongside visual observations of marine mammals (and other megafauna). Photo-identification was used to document individuals for commonly occurring species. Mātauranga Māori and kōrero toku ihu on the study area was pooled from Patuharakeke members, the wider whanaunga and from distinguished tohunga tohorā who took part as guests in our wānanga.

A suite of analyses on the visual and acoustic dataset were used to determine species occurrence, distribution, habitat use and population status. These include: calculation of indexes of relative density, dynamic species distribution modelling, kernel density analysis, mark-recapture modelling of population demographics, and fitting detection algorithms to acoustic datasets.

The key findings of this study include:

- The area has high diversity of marine mammal species and the relative density of key species (including several threatened species) is comparable or higher than documented areas of importance for marine mammals elsewhere in Aotearoa.
- Documentation of the largest population of semi-resident coastal bottlenose dolphins in Aotearoa with an abundance of 288 individuals with high residency in Te Ākau/Bream Bay.
- Determination of the spatial and temporal distribution patterns of five commonly occurring marine mammal and eight seabird species, and the identification of key hotspots for each species.

- Regular foraging behaviour observed by all commonly occurring marine mammals confirms this area is likely an important foraging area for multiple species.
- The confirmation of a diverse seabird community with at least 24 species, and a high proportion of threatened and at-risk species.
- The alignment of key findings across dual knowledge systems to confirm the importance of this area for marine megafauna.

In this baseline report we document the key approaches and findings of Tere Tohorā Karanga Tangata. We discuss the results within the context of recognising Te Ākau/Bream Bay as a location of significant importance for marine megafauna. We identify key threats to the taonga species including vessel traffic, coastal development and land-use impacts, sand mining and commercial fishing. Through our hononga, this report generates the information required by Patuharakeke and their wider whanaunga to undertake evidence-based kaitiakitanga of this area of special significance.

1 Introduction/background

Marine megafauna (marine mammals, seabirds, reptiles, large fish and sharks) are a key component of Aotearoa New Zealand's (hereafter Aotearoa) marine ecosystems and are of substantial importance to iwi/hapū and other coastal communities. Aotearoa is considered a hotspot of international importance for marine mammals and seabirds, with over half of the world's species of both groups found in our waters (Chown et al. 1998; Gordon et al. 2010; Kaschner et al. 2011). No other country has such high diversity in marine megafauna. In recognition of the importance of these species, marine megafauna are protected under various statutory legislation including the Marine Mammal Protection Act (1978), the Wildlife Act (1953), the Resource Management Act (1991) and the Fisheries Act (1996). Despite this high level of protection, in many locations throughout Aotearoa there are limited data with which to understand the fundamental aspects of megafaunal populations' ecology and status. Without this information it is difficult to make informed decisions on the risks to populations from the range of threats that exist within our waters. As a minimum, accurate information on the spatial and temporal variability in species occurrence, distribution, habitat use and population status (i.e., abundance, survival, reproductive rate) are considered critical information for species' management (Avila et al. 2018; Bestley et al. 2020). In addition, due to the likelihood of the disruption of critical behaviours (e.g., foraging, resting, nursing/provisioning young) and the impact this can have on populations (Bejder et al. 2006; Baker et al. 2007), knowledge on the incidence and distribution of these behaviours is also important for management.

Within Aotearoa, the north-east of the North Island is a recognised area of importance due to the high abundance of a range of threatened species (IUCN 2020). However, there have been no systematic surveys to generate the types of information required for evidence-based management throughout the region, with prior surveys focussing on the Hauraki Gulf (Wiseman et al. 2011; Constantine et al. 2015; Dwyer et al. 2016), the Bay of Islands (Constantine et al. 2004; Tezanos-Pinto et al. 2013), and off North Cape (Far Out Ocean Research, unpublished data.). Ecologically, there are no reasons to expect that other areas within the north-east region are less important that than those where surveys have occurred, with similar oceanographic features, habitat types and distribution of primary productivity found throughout the region. Further, mātauranga Māori in the form of place names, whakapapa relationships and kōrero tukuiho supports the idea that many discrete locations throughout the north-east are important for these taonga species.

Whangārei Terenga Parāoa/Whangārei Harbour and Te Ākau/Bream Bay to the north of the Hauraki Gulf are key areas on the Northland coast that have received no formal surveys for marine megafauna. Opportunistically collected data (largely from the general public) confirms the presence of a range of marine mammal species, including several threatened species including bottlenose dolphin, Bryde's whale and killer whale (DOC 2023). However, these data are inadequate for providing appropriate information for the management of these species. Te Ākau/Bream Bay is facing significant pressure from coastal development and resource use that may result in stressors on populations of local megafauna (Clement 2020; Clement 2022). These include planned extensions of the local port and corresponding increases in commercial shipping traffic and mining of sand from the sea floor which may impact local marine mammal populations (Nairn et al. 2004; Constantine et al. 2015; Forney et al. 2017).

Coupled with the broad scale anthropogenic impacts associated with climate change (Simmonds & Isaac 2007) and potential impacts associated with existing local stressors (e.g., commercial fishing, habitat degradation from land-use practices), local megafauna may face considerable cumulative impacts which increases the need for detailed information on population ecology.

1.1 Patuharakeke te iwi

Ko Manaia te maunga
Ko Whangārei Terenga Parāoa te moana
Ko Takahiwai te awa
Ko Takahiwai te whenua
Ko Patuharakeke te iwi

Whangārei Terenga Parāoa and Te Ākau are culturally, ecologically, spiritually and economically significant places to the people of Patuharakeke. Patuharakeke has strong ties to the waters of Whangārei Terenga Parāoa and Te Ākau/Bream Bay with these areas considered a taonga handed down with reverence from our tūpuna. Patuharakeke's whakapapa and local history is weaved throughout the rohe, from the highest ranges of the native ngahere in Pukekauri and the Piroa/Brynderwyn Hills, it flows through our freshwater awa in Pukekauri, Takahiwai, Ruakākā, Uretiti, and Waipū, connecting us to our Moana in Te Ākau. There are various tikanga and mātauranga relating to the meaning of the harbour's name that are shared and valued amongst harbour tribes, including Patuharakeke. A Ngāpuhi interpretation of Whangārei Terenga Parāoa is that historically, it was a significant gathering place for esteemed chiefs from surrounding hapū and iwi to strategise battle plans before embarking on a voyage to engage in battle. Another essential kōrero from Ngāti Wai is the naming of the harbour, "Whangarei-terenga-parāoa", which directly translates to "the gathering place of whales". It is said that Parāoa used to visit our waters to feed during summer when the waters are warmer. This highlights the connection between Parāoa and the abundant coastal waters of Whangārei, furthermore affirming the deep-rooted connection and relation of Parāoa and Patuharakeke.

Patuharakeke Te Iwi Trust Board (PTB) gazetted the Rohe Moana boundaries (under the Kaimoana Customary Fishery Regulations 1998) on behalf of the hapū in 2009 (Figure 2-1). Since then, PTB have been actively involved in customary fisheries management, providing opportunities for the hapū to better manage the customary mahinga mātaitai fisheries and undertaking large-scale research projects within the rohe moana.

1.2 Aims and objectives

This project follows Patuharakeke's longstanding tradition to uphold kaitiakitanga of their rohe using the best available information. Given the importance of marine megafauna to the hapū, and the presence of existing and proposed additional threats to these taonga, this project will provide the necessary information for Patuharakeke to actively manage populations of marine mammals, sea birds and other megafauna. At the same time, it will enable the hapū to continue to collect information on these taonga to monitor the effectiveness of any customary management and the impact of threats.

Specifically, this project aims to:

1. Hold wānanga to design and implement a monitoring programme for marine megafauna while considering mātauranga Māori and Patuharakeke's requirements for information on their rohe.

2. Access mātauranga Māori on marine megafauna within the rohe moana of Patuharakeke that can be woven with information gathered using conventional scientific surveys.

3. Undertake systematic surveys to develop a comprehensive baseline of marine mammal, seabird and other megafauna species and address the key information gaps for these taonga species.

4. Implement a capacity building programme for Patuharakeke to ensure the skills and experience is available to continue to gather information for the customary management of these taonga[1].

Together, the delivery of these aims will provide Patuharakeke and their wider partners with the information (across dual knowledge systems), relationships, skills and experience to care for a critical component of their rohe moana.

[1] Note this aim is mentioned as a key component of the wider project, but is not reported on in this baseline report.

2 Approach

2.1 Wānanga

"Tere Tohorā, Karanga Tāngata": "The whales' journey is the calling of the people"

The Patuharakeke kaimahi that were involved in this Tohorā kaupapa hosted a series of wānanga throughout the project to relay research findings to the whānau of Patuharakeke and the respective surrounding hapū and iwi. The purpose of holding wānanga was to create a space for whānau to engage in tohorā kōrero, to provide updates of the marine mammal species that are utilising Te Ākau and to gain a deeper understanding of our connection to Tohorā from a te ao Māori perspective within our hapū. Using the mātauranga from our elders and whānau, we were able to wānanga and determine a name for this rangahau. The name comes from the ancestral mātauranga passed down through generations of Patuharakeke whānau. Understanding our historical connection to Tohorā, from observing them in Te Ākau, to caring for them when they have stranded, to giving them appropriate respect and dignity during the hauhake process, it is evident that we are consistently present throughout different stages of the Tohorā's journey. Kaitiakitanga is our innate calling, and the name of this kaupapa reflects the ongoing relationship between Patuharakeke and Tohorā.

Throughout the project's wānanga, but particularly during the first project initialisation wānanga, we synthesised information that could be used to guide the design of the scientific survey. This included information on likely species presence, potential distribution and times of the year particular species may occur and be abundant.

2.2 Study area

The study area encompasses the wider Whangārei Terenga Parāoa/Whangārei Harbour and Te Ākau/Bream Bay area off the north-eastern coast of Aotearoa's North Island (Figure 2-1) from the shore to the 100-meter depth contour. It is bounded to the north by Te Whara/Bream Head (approx. 35°49'25"S/174°35'7 "E to 35°49'48"S/174°49'1"E to the east) and by Paepae-o-tui/ Bream Tail to the south (approx. 36° 3'16"S/174°36'58"E and 36°2'24"S/174°55'24"E to the east. This wider study area captures a broad area of interest for Patuharakeke and their wider whānau and was used to pool opportunistic data from aligned research programmes. A subset of the area was used to undertaken systematic line transect surveys (see below).

The area is characterised by several physical features; a large estuarine harbour (Te Rerenga Parāoa /Whangārei Harbour) a prominent headland (Te Whara/Bream Head), and a group of islands (Taranga-Marotere Islands/Hen and Chicken Islands). The seafloor is generally subdued, with various knolls and reefs distributed throughout the area (Manighetti & Carter 1999). The gradient is low, gradually sloping to a depth of ~100 meters approximately 35 km from shore. The continental shelf is approximately 80 km wide in the area. Sediment is mostly fine consisting of sandy mud. The area is influenced by tidal and non-tidal currents as well as the East Auckland Current, carrying subtropical waters south-east ward into the study area, in particular during summer and autumn. Sea surface temperature ranges from 13^{o}C in winter to 22^{o}C in summer.

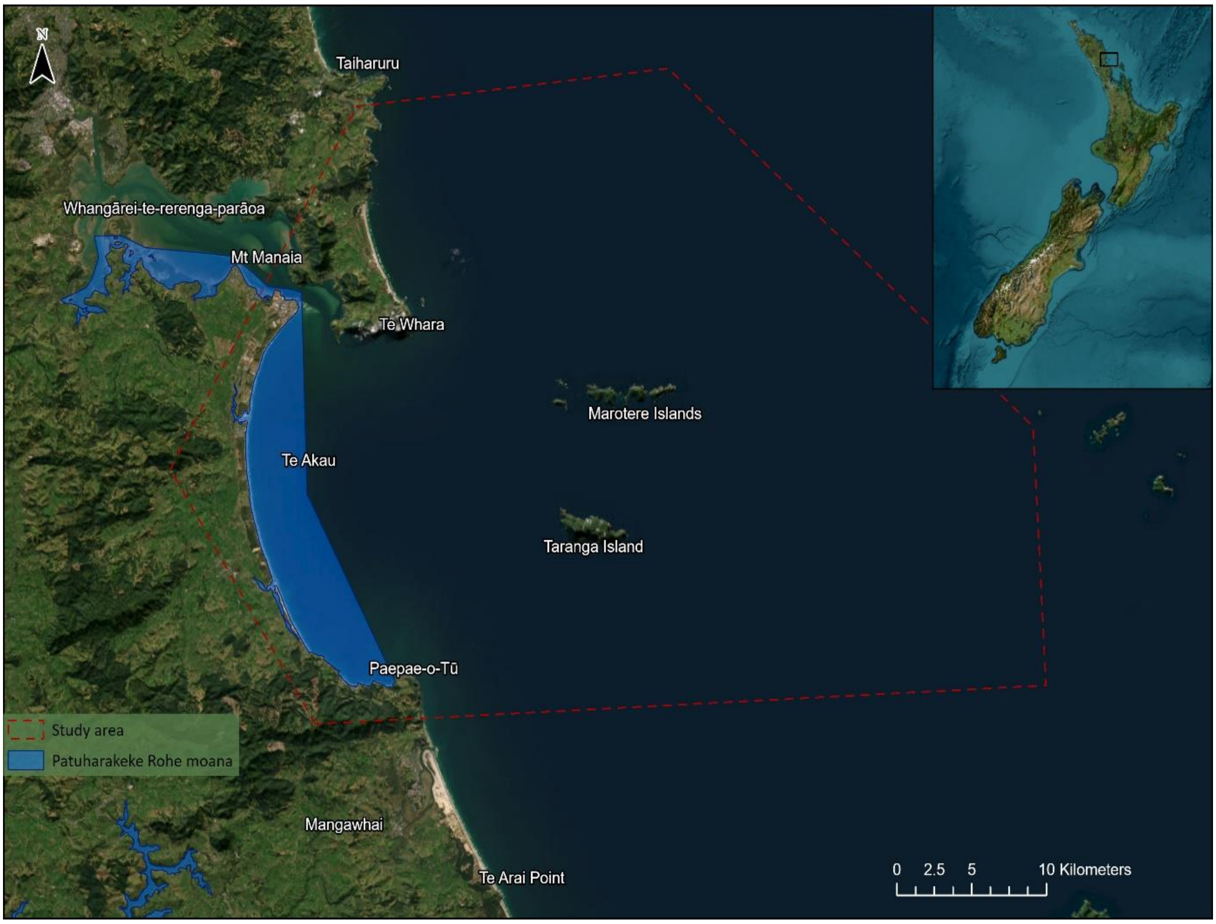

Figure 2-1: Study area and Patuharakeke rohe moana.

2.3 Vessel based surveys

Following our project initialisation wānanga with project partners, it was decided that vessel-based surveys would be the most appropriate platform for generating baseline datasets on marine megafauna within the rohe. Seven vessel-based line transect surveys were conducted between December 2022 and March 2024. Mātauranga (e.g., presence of whales in summer) and local knowledge suggested there would be seasonal patterns in marine mammal occurrence within the rohe. Thus, to incorporate seasonality while ensuring a high level of effort at times where key species are present we stratified our survey effort seasonally, with at least one survey being undertaken in each season, with multiple surveys during the warmer months of the year. Each survey covered the full study area and were 3-5 days in duration. Surveys were conducted aboard S.V. Manawanui, a 22-meter sailing vessel with a cruising speed of 6 knots and observer height of 2.5 meters.

The study area was divided into 12 transect lines running perpendicular to the coastline in a zigzag pattern to ensure even coverage (Figure 2-2). Transect lines ran from close to shore to the 100-meter depth contour and ranged in length from 16.3 to 32.2 km. Surveys were conducted during daylight hours and in sea conditions of Beaufort wind scale <4, swell of ≤1 meter and good visibility. All effort (survey track) data were continuously saved in the CyberTracker app on an Android tablet.

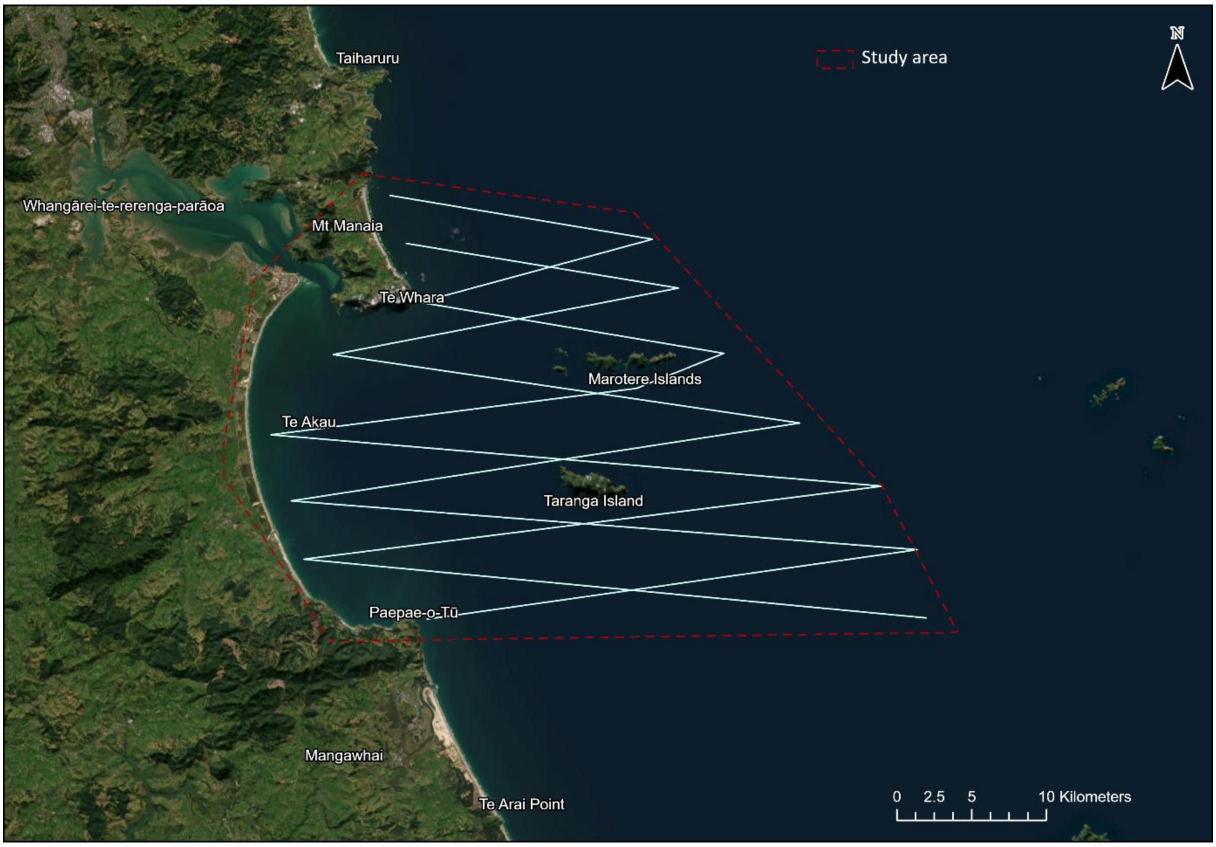

Figure 2-2: Systematic line transects. Survey effort was aportioned following two set zig-zag survey routes to spread effort throughout the study area. The offshore extent is bound by the 100m depth contour.

2.4 Marine mammal observations

For marine mammal observations, a continuous scanning method (Mann 1999) was applied, using both the naked eye and binoculars containing rangefinder reticles and a compass. Two observers were placed on the vessel's bow, with each scanning the area from the bow to 90 degrees to the port or starboard side of the vessel respectively. Marine mammal observers were rotated in 40-minute intervals.

Observers scanned the area for megafauna cues, including blows, splashes, fins or seabird activity. Upon detection, the species name, group size, compass bearing and distance from the observation platform were recorded. For high priority species, sighting effort was paused, and the species was approached for Photo-identification (photo-id) of individuals (see details below). Upon completion of Photo-identification, the vessel returned to the position where sighting effort had been paused and resumed the transect and sighting effort. All sightings data on marine mammals and other megafauna (sharks, mobulid rays) was entered into a purpose built programme within the CyberTracker app on an Android tablet.

2.5 Seabird counts

Additionally, two seabird observers were placed on the bow of the vessel to undertake seabird counts. A strip-transect method (Tasker et al. 1984) was applied, with an effective strip of 200 m (100 m each side of the vessel) to reliably identify all seabird species. Strip width was estimated using Heinemann's (1981) method.

Seabird observers counted all seabird species that occurred within the strip width during 10-minute intervals, followed by a 10-minute break and were also rotated in 40-minute intervals. In most cases, seabirds were able to be assigned to species level, however there are considerable similarities between some species that may co-occur in the study area and in these cases, seabirds were identified to shared species group (e.g., prion spp.). Data on the start, end and seabirds observed during each seabird count were entered directly into the Cybertracker app on the android tablet along with observer ID and survey conditions (sea state, swell etc).

2.6 Acoustic recordings

To further document species present within the study area we made 10-minute acoustic recordings, using a custom-made hydrophone array deployed from the stationary (with engine shut down) research vessel. The array was suspended between 10 and 20 metres below the hull of the vessel in order to minimise masking from the vessel's presence. An Edirol R4 digital acoustic recorder sampling at 48 kHz was used to make the 10-minute acoustic recordings which were saved on an internal memory card. Recordings were made at approximately 5 nautical mile intervals along the transect lines and when sea conditions were at Beaufort wind scale <4 and no rain was present. Observers made a constant lookout for marine mammal groups while recording was underway, and recorded the presence of commercial shipping, recreational vessel traffic and any other noise source (e.g., dredge operations) that may influence the detectability of marine mammals. The recording was monitored in situ using headphones and any vocalising marine mammals noted, along with any obvious anthropogenic/natural noise (e.g., swell breaking ashore). The details of each recording including time, date, geographic coordinates and any of the above-mentioned notes were saved in the Cybertracker app on the android tablet. The *.wav file for each recording was downloaded from the recording at the end of each survey day for subsequent analysis (see below).

2.7 Photo-identification

To assess site-fidelity, residency patterns and population demographics for common species of marine mammals, certain species were prioritised for the identification of individuals. To be included, the species had to be readily identifiable to the individual level using above water Photo-identification (photo-ID) methods and the species had to have a conservation status of At Risk or greater (Baker et al. 2019). The following species were selected as high-priority species:

- Bryde's whale (*Balaenoptera edeni brydei*, Threatened – Nationally critical).
- Killer whale/orca/maki (*Orcinus orca*, Threatened – Nationally critical).
- Coastal bottlenose dolphin/terehu (*Tursiops truncatus*, Threatened – Nationally Endangered).
- False killer whale/mautai (*Pseudorca crassidens*, At risk – Naturally uncommon).

Standard photo-ID methods (e.g., Würsig and Jefferson 1990) were applied. Primary identification features included notches on or adjacent to the leading or trailing edge of the dorsal fin (Figure 2-3). Dorsal fin images were graded according to the likelihood of successful recapture and matching. The quality of each image was assessed by its focus, contrast and the angle of the fin relative to the frame and graded on a scale of 1 to 4, with 1 being excellent, 2 being good, 3 being fair and 4 being poor. The best photograph obtained of an individual during an encounter was used for matching.

The distinctiveness of each dorsal fin was graded on a similar scale of 1 to 4, with 1 being very distinctive, 2 being distinctive, 3 being slightly distinctive and 4 being not distinctive. Only very distinctive and distinctive individuals and images of excellent or good quality were included in the analysis.

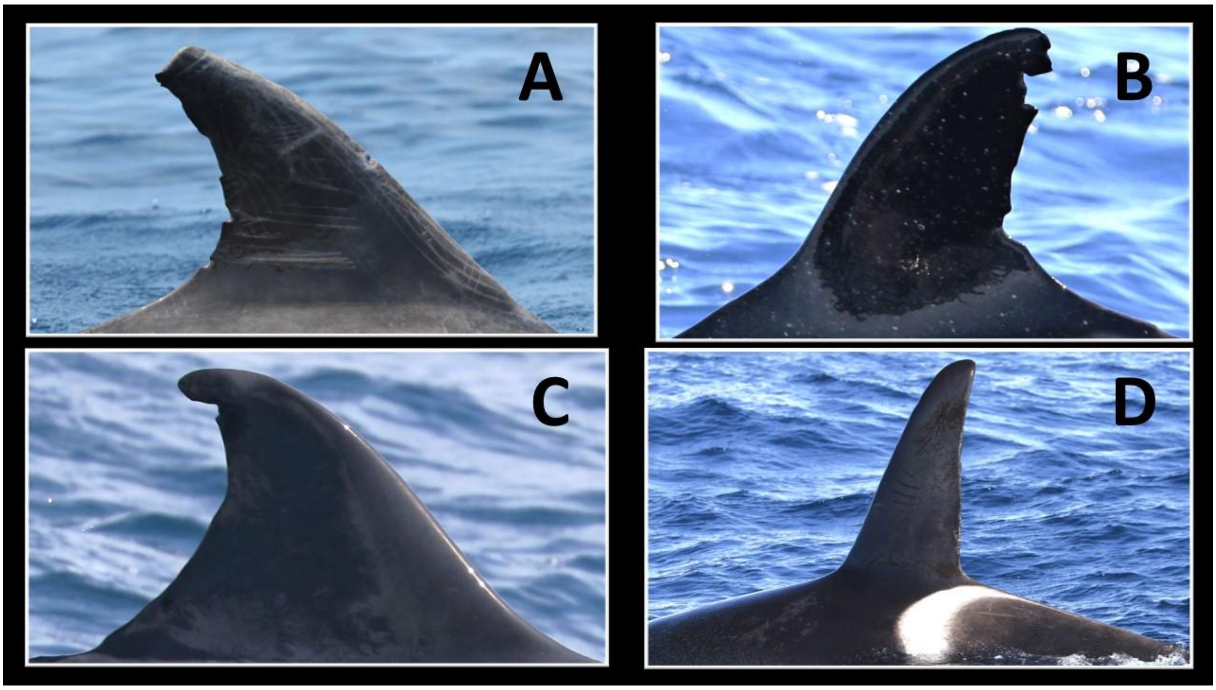

Figure 2-3: Dorsal fin photo-ID. Examples of distinctive dorsal fins used for the Photo-identification of individual terehu/bottlenose dolphin (A), mautai/false killer whale (B), Bryde's whale (C) and maki/orca (D)..

2.8 Opportunistic sightings

In addition to the data collection described above, opportunistic marine mammal sightings were obtained from other research projects operating in the area to provide further insights on occurrence, site fidelity and residency patterns of megafauna in the study area. These sighting records encompassed the same sighting information and Photo-id methods as described above but did not occur during the windows prescribed for the surveys under these project (though they largely occurred over the same time period). Opportunistic data were integrated with systematically collected data from several of the analyses as discussed below.

2.9 Analysis

2.9.1 Occurrence

Rates of occurrence of marine mammals and other megafauna (except seabirds) were calculated using information on the number of sightings obtained during each survey, standardised by the recorded kilometres of survey effort. Such simple indices of relative abundance provide useful insights on the spatial and temporal occurrence patterns of mobile marine species. Sightings per kilometre of effort were calculated for each species encountered and for each of the seven surveys.

2.9.2 Distribution and habitat use

Species distribution modelling

Analyses of distribution and habitat use for the most commonly occurring (more than 20 occurrences) marine mammal and seabird species were undertaken using a species distribution modelling (SDMs) approach (Guisan & Thuiller 2005; Elith & Leathwick 2009). For marine mammals, we fit SDMs using occurrence and pseudo-absence data obtained during both systematic surveys and from opportunistic encounters. A database of pseudo-absences was created using recorded survey tracks from our systematic surveys. For each survey day, absences were randomly generated in a 2000 m buffer around our daily survey track (the average distance at which we can make reliable detections across all species encountered in this study). Pseudo-absence points were pooled into a database for the full study period, and environmental data extracted for each pseudo-absence point (see below).

Species occurrence and pseudo-absence data were matched with spatially and temporally co-located environmental data using the *extract* function of the *terra* package (Hijmans 2023) in R 4.3.2 (2023). Environmental datasets consisted of static spatial layers representing sea floor characteristics (e.g., depth, slope, terrain characteristics) and average tidal current speed. Dynamic (e.g., temporally variable) environmental data included sea surface temperature (SST), primary productivity (chlorophyll *a* concentration, CHLA), and measures of turbidity – particulate backscatter (BBP) and light irradiance at the seafloor (EBED). A dynamic variable for horizontal gradient in SST was also calculated based on mean monthly SST variables. Dynamic variables were sourced at monthly resolution from the Seas Coasts Estuaries New Zealand (NIWA-SCENZ) data repository (Pinkerton et al. 2022) hosted by NIWA. All environmental datasets were represented as gridded raster layers with 500 m x 500 m resolution. See Table 2-1 for a full list and description of the available environmental data.

Species distribution models are used to predict the distribution and habitat use of a species according to the environmental characteristics of locations where they are observed. When the relationships between species occurrence and environmental gradients are well characterised, this allows the prediction of species distribution patterns throughout a full study area with known environmental characteristics. In this study we model species probability of occurrence using random forests (Breiman 2001), a commonly used statistical framework for robustly predicting the distribution of an occurrence of a species (Oppel et al. 2012; Hattab et al. 2014; Stephenson et al. 2023a). Random forests were fit using the tuneRF function of package RandomForest in R, with a binomial response variable (presence/absence) and with 1500 trees. The performance and inference from random forest models have limited susceptibility to correlation among predictor variables (Breiman 2001). However, high correlated variables (correlation coefficient >0.85) variables were removed to prevent overfitting (Elith et al. 2006). A list of non-correlated environmental variables was supplied as predictor variables for the SDMs.

For each marine mammal and seabird species, SDMs were trained using a randomly selected training dataset consisting of two thirds of the occurrence data, and a randomly selected equal number of absences. An equal number of absences were randomly selected from cooler months and warmer months to minimise any influence from unequal sampling between seasons. The remaining third of occurrence and an equal number of randomly selected absences were retained as withheld evaluation data.

Model validation was undertaken by comparing predictions from models tuned using the training dataset with observations from the withheld evaluation data set using the Area Under the Receiver Operating Curve (AUC) and the True Skills Statistic (TSS) metrics (Allouche et al. 2006). The model tuning and evaluation process was repeated 100 times in a bootstrapping process with randomly selected training and evaluation datasets at each iteration and for each species. The mean and standard deviation of the AUC and TSS values were calculated across each bootstrap and were used to determine the performance of each model.

Spatial predictions of species' probability of occurrence throughout the study area were generated using gridded environmental data at 500 m cell resolution. To capture any seasonal patterns in occurrence, predictions were made for two broad seasons: a warm season including the months December through to March, and a cold season including months from May through to September. The temporary dynamic variables (SST, BBP, CHL, EBED) were averaged across these months to generate seasonally averaged prediction data frames that were merged with the additional static environmental data sets. Seasonal predictions of probability of occurrence for each species were exported as GeoTiff raster layers.

Species distribution models were generated for all marine mammal and seabird species with more than 20 individual occurrences. For seabirds, individual seabird counts we used to generate species distribution models with occurrences being characterised by the presence of a particular species during a 10-minute count. Counts where the given species was not recorded were used as absences for the seabird models and thus representative of true absences. Model fitting and evaluation for seabirds followed the same process as for marine mammals detailed above.

An evaluation of the importance of the environmental predictor variables to each species' SDM can provide insights into the habitat preferences of each species (Brough et al. 2023). Thus, the relative importances of each environmental predictor were calculated from the Random Forest models using a standardised calculation of the variable importance measure. The importance of each environmental variable predictor *p* in a RF model, R_p^2, is given by (Ellis et al. 2012):

$$R_p^2 = \frac{R^2 I_p}{\sum_{p'} I_{p'}}$$

where I_p is the accuracy importance of each predictor in a forest, and R^2 is the proportion of variance explained by the forest. The goodness of fit, R^2, is partitioned among the predictors in proportion to their accuracy importance, I_p. The accuracy importance (I_p) is standardised by the densities across the raw importance from each split in each tree (for each variable p) and normalised such that they sum to R_p^2 (Ellis et al. 2012).

Table 2-1: Environmental variables. The environmental variables used for species distribution modelling of marine mammals and seabirds in this study.

Variable	Name	Description	Spatial resolution (m)	Temporal resolution	Reference
Bathy	Bathymetry	Depth of the seafloor	500	Static	National scale dataset; NIWA unpublished, updated in 2020
BBP	Particulate backscatter	The particulate backscatter coefficient at 555 nm (m^{-1}), which is highly correlated	500	Monthly	NIWA-SCENZ; Pinkerton et al. 2022

Variable	Name	Description	Spatial resolution (m)	Temporal resolution	Reference
		with turbidity measurements by optical backscatter sensors.			
BPI_fine	Bathymetric position index (fine-scale)	Bathymetric position index (BPI) is a measure of where a referenced location is relative to the locations surrounding it. Terrain metrics were calculated using an inner annulus of 12 km and a radius of 62 km.	500	Static	National scale dataset; NIWA unpublished, updated in 2020
CHL	Chlorophyll-a concentration	A proxy for the biomass of phytoplankton present in the surface ocean (to ~30 m depth)	500	Monthly	NIWA-SCENZ; Pinkerton et al. 2022
EBED	Seabed incident irradiance	Broadband (400–700 nm) incident irradiance (E m-2 d $^{-1}$) at the seabed, averaged over a whole year	500	Monthly	NIWA-SCENZ; Pinkerton et al. 2022
MLD	Mixed layer depth	The depth that separates the homogenised mixed water above from the denser stratified water below	500	Static	National scale dataset; NIWA unpublished, updated in 2020
Slope	Slope	Bathymetric slope was calculated from water depth and is the degree change from one depth value to the next	500	Static	National scale dataset; NIWA unpublished, updated in 2020
SST	Sea surface temperature	Blended from OI-SST (Reynolds et al. 2002) ocean product and MODISAqua SST coastal product. Long term (2002 – 2021) average values at 250 m resolution	500	Monthly	NIWA-SCENZ; Pinkerton et al. 2022

Variable	Name	Description	Spatial resolution (m)	Temporal resolution	Reference
SSTGrad	Sea surface temperature gradient	Smoothed magnitude of the spatial gradient of annual mean SST. This indicates locations in which frontal mixing of different water bodies is occurring (Leathwick et al. 2006).	500	Monthly	This study
TC	Tidal Current speed	Maximum depth-averaged (New Zealand bathymetry) flows from tidal currents calculated from a tidal model for New Zealand waters (Walters et al. 2001)	500	Static	National scale dataset; NIWA unpublished, updated in 2020

Kernel density estimation

For any species for which robust species distribution models could not be generated (indicated by model validation scores AUC < 0.7), we used kernel density estimation (Worton 1989) to investigate the species' seasonal distribution patterns. Species sightings were extracted from the database and partitioned into sightings from the cold or warm season. Survey effort was similarly partitioned into the two seasons and was used to weight the relative abundance of species observed during seabird counts following Brough et al. (2019). Point estimates of weighted relative abundance for each species were used to fit the fixed the kernel density surface using the SpatailEco package (Evans et al. 2023) in R. The optimum smoothing bandwidth was adapted from Seaman and Powell (1996) and is based on the standard deviation of the X and Y coordinates of the species-specific seabird counts and the total number of counts using the following equation.

$$Bw = SD_{XY} * \left(\left(\frac{2}{3 * N} \right)^{1/6} \right)$$

Where Bw is the species-specific bandwidth, SD_{XY} is the average of the standard deviation of the X and Y coordinates of species-specific occurrences and N is the total number of species-specific occurrences.

The spatial kernel density surface was output as a gridded raster layer at 100 m x 100 m cell resolution, covering the full study area. Analysis was undertaken separately for each species and for each season.

Acoustic analyses

A total of 128 recordings were made, with approximately 4 per transect. The acoustic recordings were clipped to 10-minute duration using the package tuneR (Ligges & Krey 2024) in Rstudio (v4.3.2 R Development Core Team 2024).

The open-source software for passive acoustic monitoring, PAMGuard (v2.02.09 CORE) (Macaulay & Gillespie 2022), was used to automatically detect cetacean calls and can be configured to detect clicks, whistles and moans (Yack et al. 2009; Gillespie et al. 2013; Rankin et al. 2017; Bailey et al. 2021; Jones et al. 2021; Griffiths et al. 2023; Sharpe 2023). Initial inspection of the spectrograms showed clear whistle contours, while no obvious clicks were seen, likely due to the high level of background noise (e.g., vessel noise, snapping shrimp). PAMGuard's Whistle and Moan detector (Gillespie et al. 2013) was configured to detect odontocete whistle contours. The settings used were the similar to Rankin et al. (2017) and Jones et al. (2021) (Minimum frequency: 3kHz; Maximum frequency: 37kHz; Connection type: 8 sides/diagonals; Minimum length: 10 slices; Minimum total size: 50 pixels; Crossing/joining: Relink; Maximum cross length: 5 slices; Median filter length: 61; Subtraction constant: 0.02; Smoothing: ON; Threshold: 5 dB), but with a lower detection threshold of 5 dB to reduce missed detections. The output from this detector was then passed to PAMGuard's ROCCA classifier to identify potential species (Oswald et al. 2007). The classifier was configured with the 'Temperate Pacific' classifier model (Oswald et al. 2015).

This process produced an output table of ROCCA statistics for all contours detected (n = 1,144,481). To reduce the amount of false positive detections, any detections classified as "Ambiguous" were excluded (69%). Contours with a duration less than 0.2 s were also excluded (a further 27%). This duration threshold was based on manual inspection of false positive contours. The data were then summarised per recording to generate number of detections per recording and matched to recording location and time.

To verify the accuracy of this detection process, 15 recordings (12% of full set) were randomly selected for manual checking, with a random selection from each season. Each of these 15 recording was checked by listening to the entire 10-minute recording, noting whether any whistles or moans were heard. If vocalisations were detected, the recording was considered a positive detection. This was compared to the automatic detection using PAMGuard for those recordings to assess rates of false positive and false negative detections generated by the automatic classifier.

2.9.3 Photo-identification matching

For commonly occurring marine mammal species with highly characteristic identifiable features, high quality Photo-identification images were retained for the identification of individuals. Dorsal fin photographs of coastal and oceanic bottlenose dolphins were collated and matched against available photo-ID catalogues for these populations. For coastal bottlenose, we matched against the Bay of Island's bottlenose Photo-identification catalogue and for oceanic bottlenose we matched images with the New Zealand oceanic bottlenose dolphin catalogue. False killer whales were matched against the New Zealand false killer whale Photo-identification catalogue. Photo-identification images of Bryde's whales were retained and provided to the University of Auckland to incorporate into ongoing population research on this species including updating population abundance estimates. Photo-identification of maki/orca/killer whales were retained to be incorporated into ongoing research by the Orca Research Trust.

Given the frequent encounters with coastal bottlenose dolphins and lack of matches with neighbouring catalogues, a new catalogue was generated for the Bream Bay bottlenose population using high quality left and right images. Matches against the catalogue were used to create capture histories of all individuals encountered throughout the study.

2.9.4 Mark-recapture demographic analysis

For coastal bottlenose dolphins, there were sufficient photo-ID and resighting rates to enable analysis of population abundance and survival using mark recapture (MR) approaches. MR is the most widely used method for estimating population demographics for populations of marine mammals, and has been used extensively in Aotearoa, including with bottlenose dolphins (Currey et al. 2007; Tezanos-Pinto et al. 2013; Brough et al. 2015). The core input data for MR analysis are encounter histories of individual dolphins across multiple encounters, coded as presence and absence (ones and zeros), for all individuals photographed over the study. These binomial encounter histories are used to fit a range of MR models that estimate population parameters under a range of different assumptions and formulated for different survey types and population dynamics (Cooch and White 2011).

In this study we used Photo-identification data from encounters of coastal bottlenose dolphins generated during both systematic and opportunistic surveys. Following detailed photo-ID matching (see above), the histories of a total of 149 individuals available. MR models were fit using a version of the Jolly-Seber open-population model, POPAN (Schwarz and Arnason 1996) in the RMARK package (Laake 2013) in R. An open MR model is necessary given the lack of existing information on birth/deaths and immigration/emigration in this population (Schwarz & Arnason 2009). Monthly encounter histories were generated from encounter-specific histories to represent the temporal spread of photo-ID effort across the study. Thus, multiple encounters from an individual systematic survey were merged to represent an encounter specific for that survey. The key parameters of the POPAN model are:

φ = Probability of survival between recapture periods

p = Capture probability

β = Probability of entry into the population between recapture periods

$\check{N}$ = Super population abundance

The key parameter of interest for this study is $\check{N}$ (super population abundance) which is defined as the total number of marked individuals in the population available for photographic capture during the study period (Schwarz and Arnason 2009). A range of model formulations were created to test for the evidence of static or time varying input parameters. Additionally, given unequal survey effort across encounter periods and the inclusion of opportunistic sightings, we included a covariate that accounted for any potential effect of unequal survey efforts on the probability of recapture. The survey effect covariate is represented by the number of survey days undertaken during each of the monthly encounter periods. Monthly encounter periods that included opportunistic encounters were attributed with an additional survey day of effort. Each of the different POPAN model formulations were fit in R, using maximum likelihood. Model selection was undertaken using AICc (Hurvich & Tsai 1989) values and model averaging of parameters was undertaken across all models that had values of delta AICc <6 (Burnham et al. 2011). Model estimates for the probability of survival (φ), capture probability (p), probability of entry (β) and population abundance ($\check{N}$) with associated 95% confidence intervals were extracted from the model averaged outputs.

Estimates of population abundance are indicative for marked individuals only (i.e., those with identifying dorsal fin features). To account for unmarked individuals, we calculated mark rate following commonly used methods (Williams et al. 1993; Bejder & Dawson 2001). Mark rate estimation is based on the proportion of marked and unmarked individuals within photo-ID encounters during which we were confident every individual within an encounter had been photographed using random photographic techniques (i.e., no preference for photographing individuals based on the extent of natural marking on the dorsal fin). Mark rate (MRa) is given as:

$$MRa = \frac{N}{nN}$$

where N is the total number of photographs of 'nicked' individuals and nN is the total number of photographs of both 'nicked' and 'non-nicked' individuals (Williams et al. 1993; Bejder & Dawson 2001).

The mark right was applied to the derived population abundance to scale the estimate to account for both marked and unmarked individuals in the population.

The assumptions that underpin the POPAN MR model used in this study were tested using well established methods (Cooch & White 2011; Oremus et al. (2012) and Tezanos-Pinto et al. (2013). The assumptions include equal probability of capture among individuals, and the absence of any trap happy or trip shy individual responses (e.g., individual dolphins that are more/less available for photography). The assumptions were tested in package R2ucare (Gimenez 2022) in *R* using the functions *test1*, *test2* and *test3*. The extent to which any over or under-dispersion in the binomial input data influenced our model results was investigated by calculating the variance inflation factor ($\hat{C}$). $\hat{C}$ is an estimate of model fit to the observed data, where values close to 1 indicate no evidence of overdispersion (Cooch and White 2011).

2.10 Mātauranga Māori, kōrero toku iho and pūrākau

Along with conventional scientific approaches, this project brought together mātauranga Māori and Kōrero Toku iho to help build a holistic picture on the importance of the Te Rerenga Parāoa and Te Ākau study area to tohorā in particular. Mātauranga Māori can be subject to a myriad of definitions and varies amongst tribes and institutions, however the term broadly refers to Māori knowledge systems. It encompasses traditional and contemporary knowledge, wisdom, and understanding of human-environment relationships. In this project, we aim to pool together mātauranga relating to the hapū of Patuharakeke, to build a holistic understanding of tohorā and their relationship with Patuharakeke. Information was accessed in several ways including:

- <u>Recording of Kōrero Toku iho</u> during conversations with Patuharakeke iwi members throughout the project. Such conversations were informal and typically took place during wānanga/fieldwork or presentations on the project to the wider whānau at Takahiwai marae.
- <u>Vessel-based wānanga</u> were established throughout the project where Patuharakeke and science team members would discuss particular aspects of the species assemblage/habitat of the study area which facilitated sharing of information across knowledge systems.

- Guest tohunga tohorā were invited to attend our wānanga and vessel-based field programmes. These distinguished guests took an active part in our wānanga and mātauranga they shared was woven into our understanding of the species and the study area.
- Review of existing documentation from Patuharakeke and the wider whānui (e.g., Ngātiwai) that has been prepared to explain the ecological significance of the area. Such documents included submission on various applications under the Resource Management Act (1991) and submission under the Marine and Coastal Area (Takutai Moana) Act 2011.

3 Results

3.1 Survey results

There were 7 surveys between December 2022 and March 2024, resulting in 27 discrete survey days, with a total of 1537.5 km of line transects covered (Table 3-1). The majority of systematic survey effort occurred during the summer season (13 days and 686.9 km of effort), with the lowest effort in winter (3 days and 195.5 km of effort) (Table 3-1). While seasonal effort was skewed towards the warmer season, a good representation of cool season conditions were also sampled (combined 427.4 km of effort).

Table 3-1: Systematic survey effort. The distribution of systematic survey effort from line transect surveys across seasons.

Season	Spring	Summer	Autumn	Winter	Total
Survey days	3	13	8	3	27
Kilometres on effort	231.9	686.9	423.1	195.5	1537.4

Survey effort was distributed throughout the study area, with all areas receiving some systematic effort (Figure 3-1). However, systematic survey effort was not equally distributed (Figure 3-1). The lowest survey effort was in cells adjacent to the coast that were too shallow to reliably survey given the draft of the vessel, while the highest effort occurred in areas around Whangārei Heads, north of the Marotere and around Taranga Island (Figure 3-1).

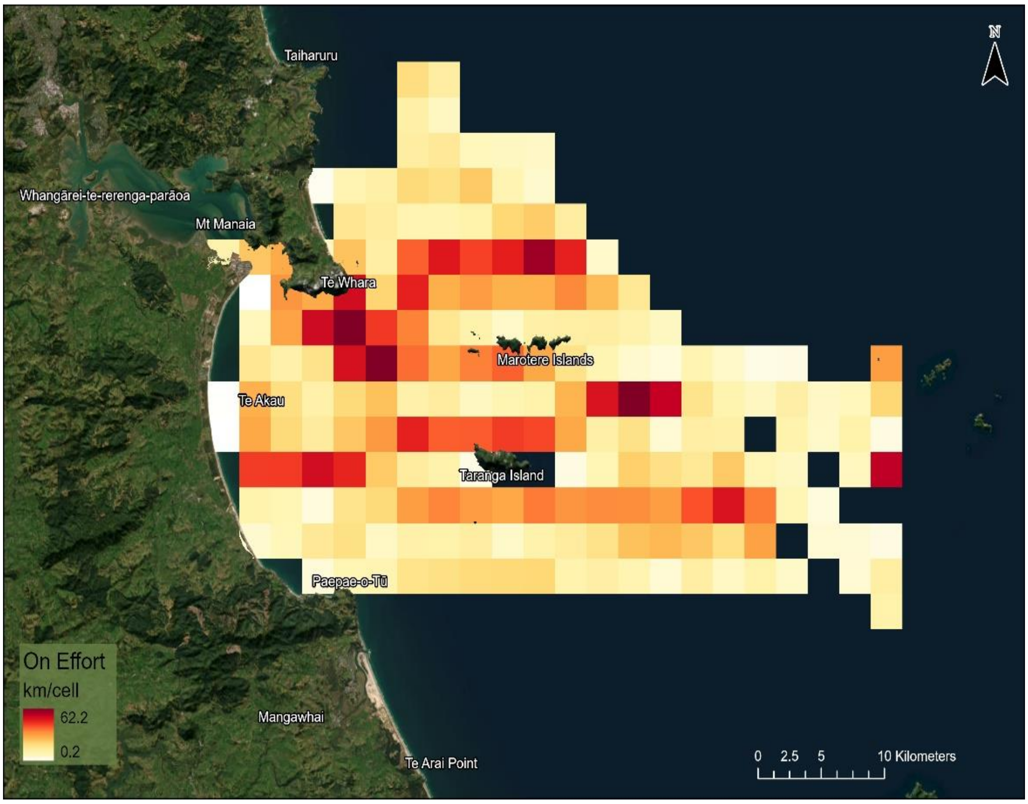

Figure 3-1: Systematic survey effort. The distribution of systematic survey effort from line transect surveys throughout the study area.

Eight species of marine mammal were encountered throughout our surveys (Table 3-2).

Each species was recorded both during systematic surveys and opportunistic encounters except for maki/orca and blue whale that were seen only during systematic surveys and upokohue/pilot whale that were seen during opportunistic encounters only. Sightings were recorded of both the coastal and oceanic ecotypes of bottlenose dolphins, with the overlap of the two ecotypes indicating the importance of the area for this threatened species (Table 3-2).

Aihe/common dolphin were the most commonly occurring species and were encountered over all seasons. Other commonly occurring species included Bryde's whale that was seen in all seasons except winter, and both ecotypes of bottlenose dolphins that were encountered more regularly during the summer and autumn (Table 3-2).

There were 33 sightings of false killer whale which were made in the summer and autumn months only. NZ fur seals were sighted twice during winter, there were two sightings of Maki/killer whale in Autumn and Summer and a single blue whale sighting during Spring.

Table 3-2: Marine megafauna sightings. Seasonal sightings of marine megafauna made during systematic surveys (S) and opportunistic encounters (O). The total number of sightings and the total number of individuals sighted are provided along with the species' sighting rate (n sightings/km effort) calculated using systematic sightings only. Penguins are reported under megafauna as they were surveyed using the same methods.

Season Species	Spring		Summer		Autumn		Winter		Total sightings		Total individuals		sightings/km
	S	O	S	O	S	O	S	O	S	O	S	O	S
Marine mammals								-					
Aihe/ common dolphin	2	-	14	5	4	5	5	0	25	9	1177	315	0.016
Terehu / coastal bottlenose dolphin	-	-	4	8	3	7	-	1	7	16	79	534	0.005
Terehu / oceanic bottlenose dolphin	-	-	2	12	3	20	-	-	5	32	375	4550	0.003
Maki / orca / killer whale	-	-	1	-	-	1	-	-	1	1	5	8	0.001
Mautai / false killer whale	-	-	1	12	3	20	-	-	3	32	240	2560	0.002
Upokohue / long-finned pilot whale	-	-	-	6	-	4	-	-	-	10	-	255	-
Bryde's whale	3	-	9	3	4	6	-	-	16	9	26	14	0.013
Blue whale	1	-	-	-	-	-	-	-	1	-	1	-	0.001
Kekeno / New Zealand fur seal	-	-	-	-	-	-	2	-	2	-	2	-	0.001
Elasmobranchs													
Mangopare / hammerhead shark	-	-	11	-	-	-	-	-	11	-	11	-	0.007
Mako	-	-	1	-	-	-	-	-	1	-	1	-	0.001
Blue shark	-	-	-	-	-	-	1	-	1	-	1	-	0.001
Manta ray	-	-	7	7	1	-	-	-	8	7	14	9	0.009
Penguins													
Kororā / little penguin	4	-	41	-	52	-	-	-	104	-	209	-	0.136

Four species of elasmobranch (sharks and rays) were seen throughout the study. Manta rays were the most frequently encountered elasmobranch with fifteen sightings occurring mostly in the summer (.

Table 3-2).

Similarly, the eleven Mangopare/Hammerhead shark sightings all occurred during summer surveys. There were single sightings of Mako and blue shark in summer and winter respectively (.

Table 3-2).

Kororā / little penguin were the most commonly encountered non-mammal species recorded during line-transect surveys with 104 sightings (.

Table 3-2).

Sightings of Kororā were more frequent in summer (n = 52) and autumn (n = 41), with 4 sightings made in spring and none in winter (.

Table 3-2).

3.2 Marine mammals

The following tables provide specific information on the occurrence (Table 3-3), the results of the species distribution models (Table 3-4) and the relative importance of environmental variables for informing the marine mammal species distribution models (Table 3-5). The findings within each table are discussed in each species-specific section below.

Table 3-3: Monthly sighting rates of marine mammals. Monthly sighting rates of the most frequently occurring marine mammals generated from systematic line transect surveys.

		Sightings per km (Number of sightings)				
	Effort (km)	Terehu / Coastal bottlenose dolphin	Terehu / Oceanic bottlenose dolphin	Aihe / Common dolphin	Mautai / False killer whale	Tohorā / Bryde's whale
December	461.3	0.004 (n = 2)	0.004 (n = 2)	0.017 (n = 8)	0.002 (n = 1)	0.011 (n = 5)
January	225.6	0.009 (n = 2)	0	0.009 (n = 2)	0	0.018 (n = 4)
March	423.1	0.007 (n = 3)	0.007 (n = 3)	0.019 (n =8)	0.005 (n = 2)	0.019 (n =8)
June	195.5	0	0	0.03 (n = 5)	0	0
September	231.9	0	0	0.009 (n = 2)	0	0.013 (n = 3)
Total	1537.4	0.005 (n = 7)	0.003 (n = 5)	0.016 (n = 25)	0.002 (n = 3)	0.013 (n = 20)

Table 3-4: Species distribution model evaluation - marine mammals. Model evaluation for species distribution models for the five most commonly occurring marine mammals. Models are evaluated by area under the received operating curve (AUC) and true skill statistic (TSS). Values represent mean scores (and associated standard deviation) across 100 model runs evaluated with withheld data.

Species	AUC	AUC SD	TSS	TSS SD
Terehu / Coastal bottlenose dolphin	0.89	0.05	0.73	0.10
Terehu / Oceanic bottlenose dolphin	0.89	0.04	0.72	0.09
Tohorā / Bryde's whale	0.75	0.10	0.51	0.16
Aihe / Common dolphin	0.74	0.07	0.47	0.11
Mautai / False killer whale	0.89	0.05	0.71	0.10

Table 3-5: Relative importance of environmental variables. The standardised relative importance (% contribution) of environmental variables to the species distribution models for each marine mammal species. Colour shading indicates a gradient from the most important variable (yellow) to least important (blue).

Species	Bathy	BBP	BPI_fine	CHL	EBED	MLD	Season	Slope	SST	SSTGrad	TC
Terehu / Coastal bottlenose dolphin	5.01	8.14	4.71	11.87	6.07	5.36	4.09	13.68	30.55	5.72	4.79
Terehu / Oceanic bottlenose dolphin	6.51	6.36	5.21	4.74	6.89	6.72	6.50	4.96	24.53	21.31	6.26
Tohorā / Bryde's whale	8.36	8.17	8.46	7.08	10.68	12.92	2.48	6.96	19.85	9.02	6.03

Species	Bathy	BBP	BPI_fine	CHL	EBED	MLD	Season	Slope	SST	SSTGrad	TC
Aihe / Common dolphin	9.85	8.24	8.56	9.02	7.01	15.24	1.22	7.45	15.05	11.86	6.49
Mautai / False killer whale	6.34	6.02	5.56	4.74	7.00	6.94	6.61	5.65	24.23	20.60	6.30

3.2.1 Bottlenose dolphin (coastal)

Occurrence

There were 23 encounters with coastal bottlenose dolphins. Of these, 30.4% (n=7) were recorded during the dedicated line-transect surveys with the remainder (n = 16) collected opportunistically between April 2019 and March 2024. Coastal bottlenose dolphins were sighted in all survey months except September. Monthly sighting rates ranged from 0 km^{-1} in June and September to 0.009 km^{-1} in March (mean = 0.005 km^{-1}, Table 3-3). Group size ranged from 2 to approximately 100 (median = 22.5). Sightings were distributed throughout the northern and western extent of the study area, with hotspots north of the Marotere Islands (the Chicks), and within Te Ākau/Bream Bay. A single sighting was made within Whangārei Harbour, adjacent to NorthPort (Figure 3-2).

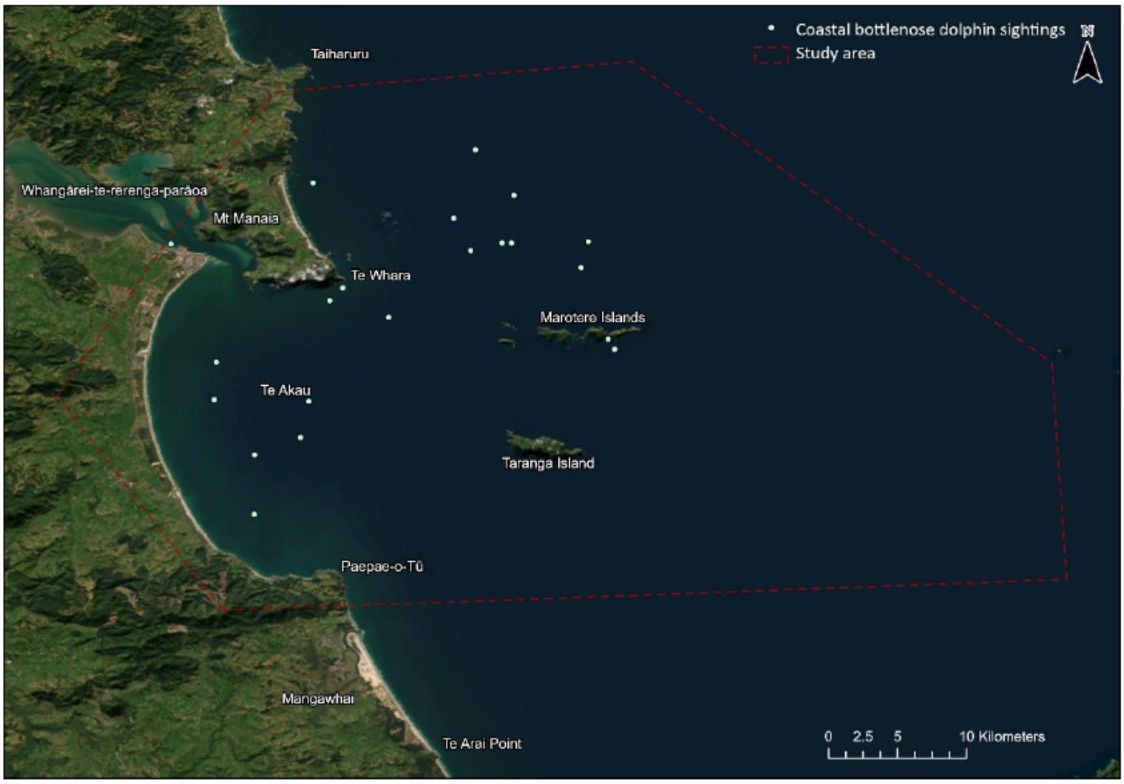

Figure 3-2: Coastal bottlenose dolphin sightings. Sighting locations for coastal bottlenose dolphins throughout the study area. Sightings made both 'on effort' and opportunistically are shown.

Distribution

Species distribution models for coastal bottlenose dolphins generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.89 (SD = 0.05) and 0.73 (SD = 0.10) for AUC and TSS respectively (Table 3-4). Predictions from the SDMs revealed distinct seasonal differences in the probability of occurrence of the species within the study area (Figure 3-3). During the warm season, high probability of occurrence was predicted throughout the northern and eastern components of the study area, with hotspots located in the north of the study area, around the Marotere and Taranga Islands, off Whangārei Heads and within Te Ākau/Bream Bay. There was moderate probability of occurrence within Whangārei Harbour during the warm season. Areas with low probability of occurrence included the offshore, eastern components of the study area, and between the Mokohinau and Taranga/Marotere Island groups (Figure 3-3).

Probability of occurrence of coastal bottlenose dolphins was considerably lower during the cooler months of the year (May – September), with a maximum value of approximately 0.4, suggesting the species is less common in Te Ākau/Bream Bay during this time of the year. Areas of relative importance (e.g., the locations with highest probability of occurrence) for the species within the cooler months remained broadly similar to warmer months with the exception of increased relative importance of nearshore habitat around Whangārei Heads and northwards to Taiharururu. The relative importance of Whangārei Harbour was also higher during the cooler months of the year area (Figure 3-3).

Sea surface temperature (SST) was ranked as the most important variables for predicting the distribution of coastal bottlenose dolphins, contributing of 30% to the predictive performance of the model. Slope (13.68%), Chlorophyll a concentration (11.87%) and turbidity (BBP, 8.14%) also made importance contributions to the species distribution model for coastal bottlenose (Table 3-5).

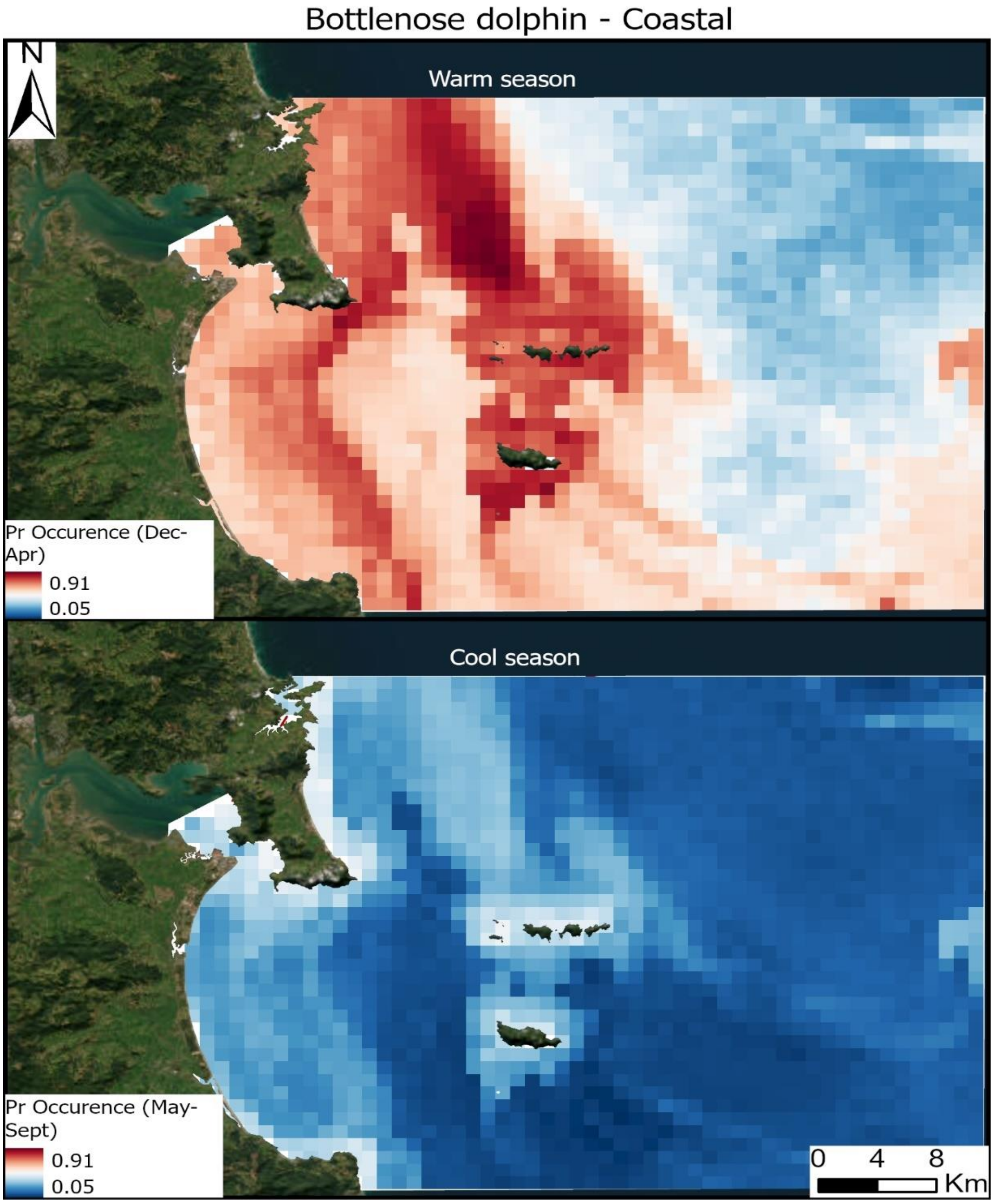

Figure 3-3: Distribution of coastal bottlenose dolphin. Predictions of the distribution of coastal bottlenose dolphin from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

Population demographics

Successful photo-ID was carried out during 84% of encounters (n=21). A total of 149 distinct individuals were identified. Of these, 73.1% (n = 109) were recorded on more than one occasion (range 1-7, median = 2) and 39.6%, (n = 59) were identified in more than one year (range 1-3). Calves and neonates were recorded during 71.4% of encounters (n = 15). There were 41 sightings of 27 individual calves and a single sighting of a neonate. Repeat close associations of the same adult with a calf were observed in 28 cases (range 1-4, median = 1). Calves were observed in all encounter months. The neonate was observed in January.

The best POPAN model used to calculate demographic parameters for coastal bottlenose dolphins in Bream Bay had static parameters or survival rate (φ), probability of entry (β), and super population abundance (Ň), along with time-varying probability of capture (t) (Table 3-6). The second-ranked model had an identical formulation except for an additive term for effort and temporal variability for capture probability (Table 3-6). Model weight for first and second-ranked models were 0.74 and 0.25, suggesting these two formulations have high likelihood for their parameter estimates.

Table 3-6: Model selection for POPAN mark recapture. Model selection table used to identify the top performing model formulation among competing POPAN mark recapture models for coastal bottlenose dolphins. The rank of each model formulation (formula) is provided along with the model's degrees of freedom (df), Akaike's information criterion (AICc), delta AICc and model weight (weight). The top performing model is the formulation with the lowest AICc value and highest weight. POPAN parameters are probability of survival (φ), capture probability (t), probability of entry into the population (β) and super population size (Ň). The top five models are provided for comparison.

Rank	Formula	df	AICc	DeltaAICc	Weight
1	φ(.) + p(t) + β(.) + Ň(.)	11	518.38	0.00	0.74
2	φ(.) + p(t + eff) + β(.) + Ň(.)	12	520.56	2.18	0.25
3	φ(.) + p(t) + β(t) + Ň(.)	17	528.96	10.58	0.00
4	φ(.) + p(t + eff) + β(t) + Ň(.)	18	531.24	12.86	0.00
5	φ(t) + p(t + eff) + β(.) + Ň(.)	18	531.92	13.54	0.00

Model averaging of parameter estimates was carried out across the first and second-ranked models only (AICC < 6). Probability of survival between encounter periods was high (0.99; 95%CI = 0.98 – 0.99), as expected given the relatively short time periods between captures. Probability of capture varied significantly among encounter periods from a low of 0.09 (95%CI = 0.06 – 0.14) at the first encounter period (p1) to a high of 0.66 (95%CI = 0.56 – 0.74) at the 7th encounter period. There was a generally increasing trend in p over time. Estimated probability of entry into the population between recapture periods was low (<0.00), with wide confidence bands suggesting accurate parameter estimation for β was not well-supported by the data. This is unsurprising given the relatively short duration of our study in comparison with bottlenose dolphin life history, and thus our inability to be able to measure recruitment into the marked population (see Discussion). The estimated parameter for super population size was 223 (95%CI = 187 – 295) individual marked dolphins.

Mark rate from coastal bottlenose dolphins in Te Ākau/Bream Bay was estimated as 0.774 (range = 0.545 - 0.935). Thus, a derived population abundance estimate for coastal bottlenose dolphins was calculated as 288 (95%CI = 242 – 384) total (i.e., marked and unmarked) individuals.

Table 3-7: Model averaged POPAN parameters. Model averaged POPAN parameters across the first and second ranked models used to investigate population demographics of coastal bottlenose dolphins in Bream Bay. Parameter estimates, standard error (SE) and the lower and upper 95% confidence intervals for the estimates are provided.

Parameter	Definition	Estimate	SE	Lower	Upper
φ	Probability of survival	0.99	0.00	0.98	0.99
p	Capture probability (p1)	0.09	0.02	0.06	0.14
p	Capture probability (p2)	0.14	0.03	0.09	0.20
p	Capture probability (p3)	0.03	0.01	0.02	0.07
p	Capture probability (p4)	0.11	0.02	0.07	0.17
p	Capture probability (p5)	0.14	0.03	0.09	0.20
p	Capture probability (p6)	0.12	0.03	0.08	0.19
p	Capture probability (p7)	0.66	0.05	0.56	0.74
p	Capture probability (p8)	0.56	0.05	0.46	0.65
β	Probability of entry into the population	0.00*	0.00	0.00	1.00
Ň	Population abundance (super)	223	25	187	295

Behaviour

Foraging behaviour by coastal bottlenose dolphins was documented during 65.2% of encounters (n = 15) and included individual prey capture events (Figure 3-4) and group-foraging tactics including the formation of 'work-ups' (i.e., with foraging seabirds) and co-ordinated prey chase.

The high proportion of groups with calves and neonatal individuals (71.4% of groups), and identification of calf identity (inferred via coastal close association with an adult) suggests this area is important nursery habitat for this species.

Figure 3-4: Prey capture - coastal bottlenose dolphin. An example of an individual prey capture event used to confirm foraging behaviour of coastal bottlenose dolphins in Bream Bay.

3.2.2 Bottlenose dolphin (oceanic)

Occurrence

There were 41 sightings of oceanic bottlenose dolphins. Oceanic bottlenose were differentiated from coastal bottlenose by their larger size, darker colour and presence of cookie cutter shark scars (Zaeschmar et al. 2020). Of these, 12.2% (n = 5) were made during line-transect surveys, with the remainder (n = 36) collected opportunistically between March 2019 and April 2024. Monthly sighting rates ranged from 0 km^{-1} in January, June and September to 0.007 km^{-1} in March (mean = 0.003 km^{-1}, Table 3-3). Group sizes ranged from 20 to ~ 250 (median = 150). Sightings were distributed throughout the eastern and northern extent of the study area, with hotspots north of the Marotere Islands (the Chicks), and east of Taranga (the Hen) and the Marotere Islands (Figure 3-5).

All encounters were recorded between December and April. Oceanic bottlenose dolphins were predominantly sighted in association with false killer whales (92.7%, n = 38), with only 7.3% of encounters (n = 3) comprising of single-species groups.

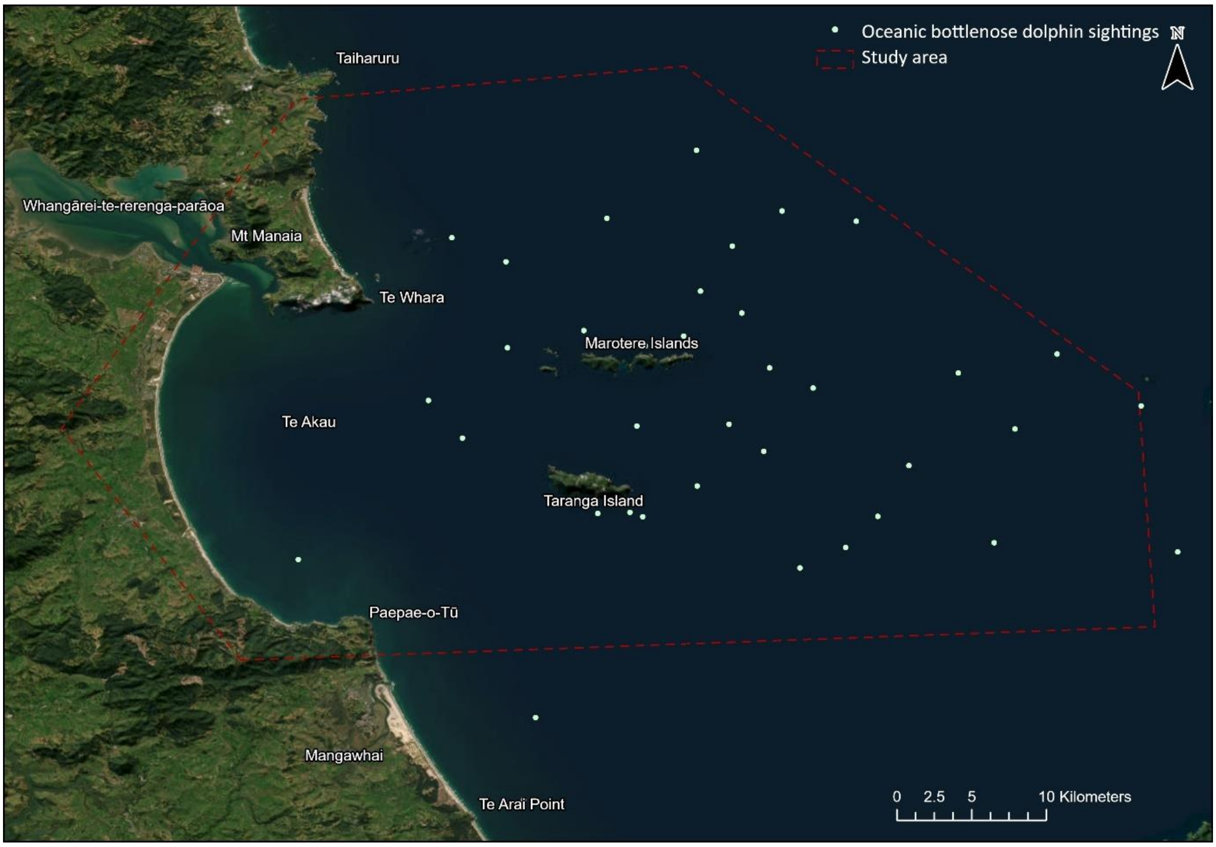

Figure 3-5: Sightings of oceanic bottlenose dolphins. Sighting locations for oceanic bottlenose dolphins throughout the study area. Sightings made both 'on effort' and opportunistically are shown.

Distribution

Species distribution models for oceanic bottlenose dolphins generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.89 (SD = 0.04) and 0.72 (SD = 0.09) for AUC and TSS respectively (Table 3-4). Predictions from the SDMs revealed distinct, seasonal differences in the probability of occurrence of the species within the study area (Figure 3-6). During the warm season, high probability of occurrence was predicted throughout the northern and eastern components of the study area, between the Mokohinau and Taranga/Marotere Island groups, with particular hotspots to the east of the Marotere and Taranga Islands and to the north of the Marotere Islands. There was moderate probability of occurrence in the mid-water Bream Bay area. Areas with low probability of occurrence included the inshore western region of the study area, and the waters close to the Marotere and Taranga Islands (Figure 3-6).

Probability of occurrence of oceanic bottlenose dolphins was considerably lower during the cooler months of the year (May – September), suggesting the species is less common in Bream Bay during this time. Areas of relative importance (e.g., the locations with highest probability of occurrence) for the species within the cooler months remained broadly similar to warmer months.

Similar to coastal bottlenose dolphins, the most importance predictor of oceanic bottlenose dolphins was sea surface temperature, contributing 24.5% to the predictive performance of the SDM.

The gradient in sea surface temperature was similarly important (21.3%), with lesser contributions from tidal current velocity (TC), mixed layer depth (MLD), season, light at the seafloor (EBED), turbidity (BBP) and bathymetry, which each contributed approximately 6% to the model (Table 3-5).

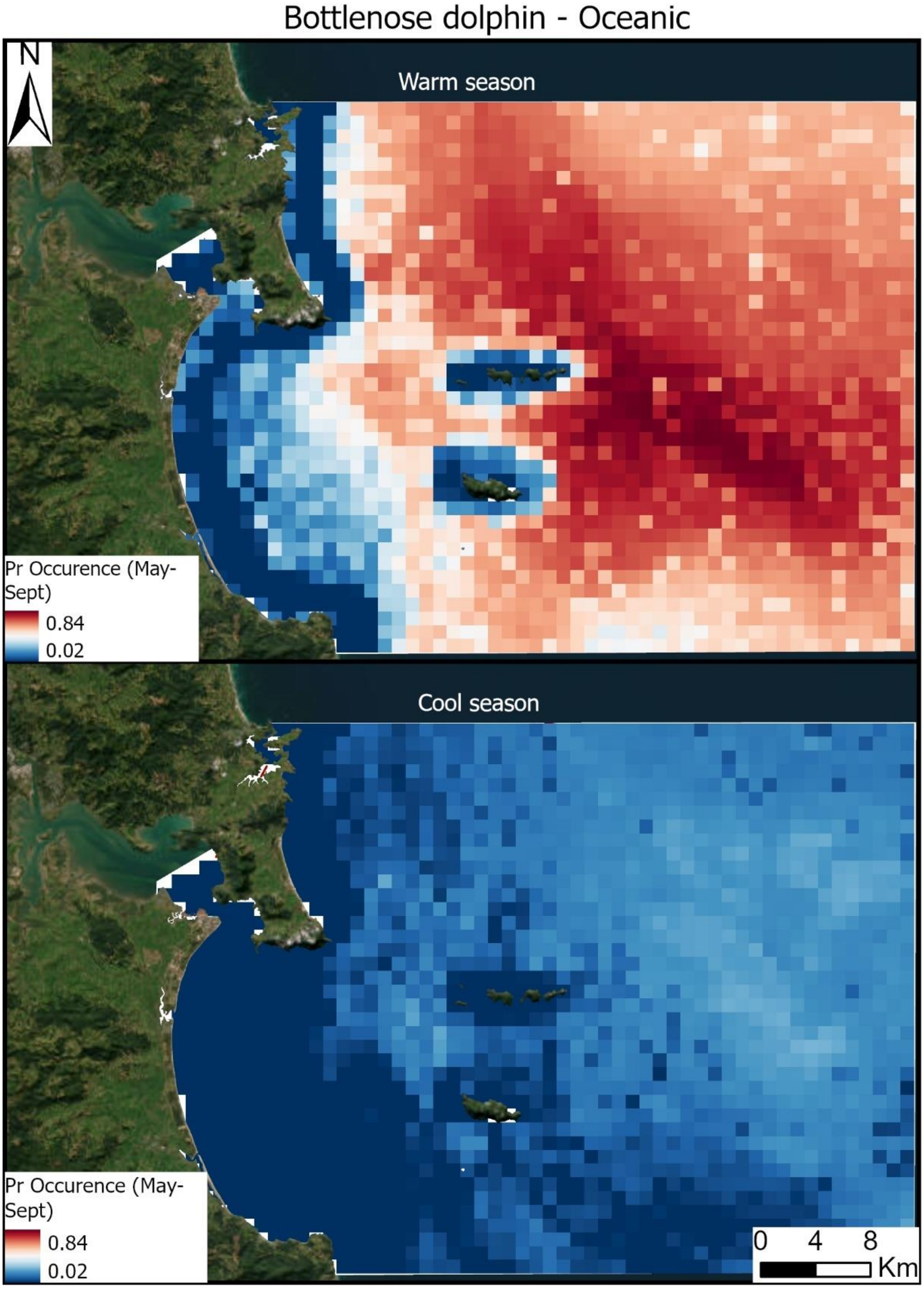

Figure 3-6: Distribution of oceanic bottlenose dolphins. Predictions of the distribution of oceanic bottlenose dolphin from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

Population demographics

All identified individuals were added to the New Zealand Oceanic Bottlenose Dolphin Catalogue.

Behaviour

Foraging was observed during the majority (85.4%) of encounters (n = 35) indicating the area is regularly used as a foraging ground for oceanic bottlenose dolphins.

Calves were present during 95.1% of encounters (n = 39), which suggests that the area could also be considered important for these vulnerable life history stage of this endangered species.

3.2.3 Common dolphin

Occurrence

There were 36 sightings of common dolphins, of which 69.4% (n = 25) were recorded during dedicated line-transect surveys, with the remainder collected opportunistically between December 2022 and March 2024. Common dolphins were sighted in all survey months. Monthly sighting rates ranged from 0.009 km^{-1} in January and September to 0.017 km^{-1} in March (mean = 0.019 km^{-1},Table 3-3). Overall, common dolphins were the most frequently detected species and were sighted during all survey months. Group size ranged from 5 to ~250 (median = 25). The species used the study area widely with a preference for deeper and open waters (Figure 3-7).

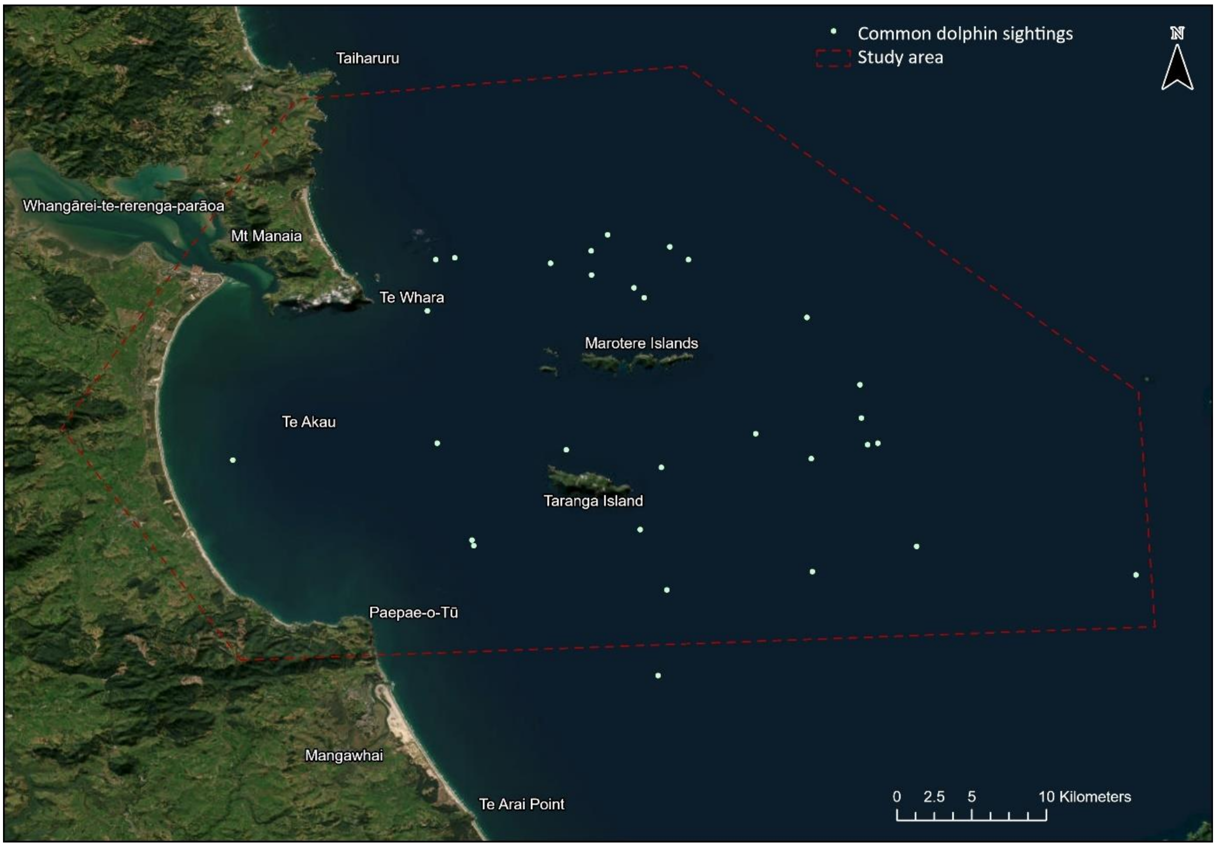

Figure 3-7: Sightings of common dolphin. Sighting locations for common dolphins throughout the study area. Sightings made both 'on effort' and opportunistically are shown...

Distribution

Species distribution models for common dolphins generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.74 (SD = 0.07) and 0.47 (SD = 0.11) for AUC and TSS respectively (Table 3-4).Predictions from the SDMs revealed distinct, seasonal differences in the probability of occurrence of common dolphins within the study area (Figure 3-8). During the warm season, high probability of occurrence was predicted for the northern and eastern components of the study area. Hotpots were notable north and east of the Marotere Islands and east of Taranga Island (Figure 3-8). There was moderate probability of occurrence in the outer Bream Bay area. Areas with low probability of occurrence included the inshore western region of the study area and Whangārei Harbour (Figure 3-8).

While probability of occurrence of common dolphins was lower during the cooler months of the year (May – September), an area of moderate to high probability of occurrence was predicted for deeper waters beyond the Island groups (Figure 3-8). This prediction indicates that, although the species is less common in Bream Bay during cooler months of the year, they are present in the area year-round. Areas of relative importance (e.g., the locations with highest probability of occurrence within a season) for the species in the cooler months was similar to that observed during warmer months except for a decrease in the relative importance of the area to the east of Taranga Island (Figure 3-8).

Several environmental variables were similarly important at predicting the distribution of common dolphins (Table 3-5). The most important variables were mixed layer depth (MLD, 15.24%), sea surface temperature (SST, 15.05%) and gradient in sea surface temperature (SSTGrad, 11.86%). Chlorophyll a concentration and bathymetry also made meaningful contribution to the common dolphin model with 9.02 and 9.85% contribution respectively (Table 3-5).

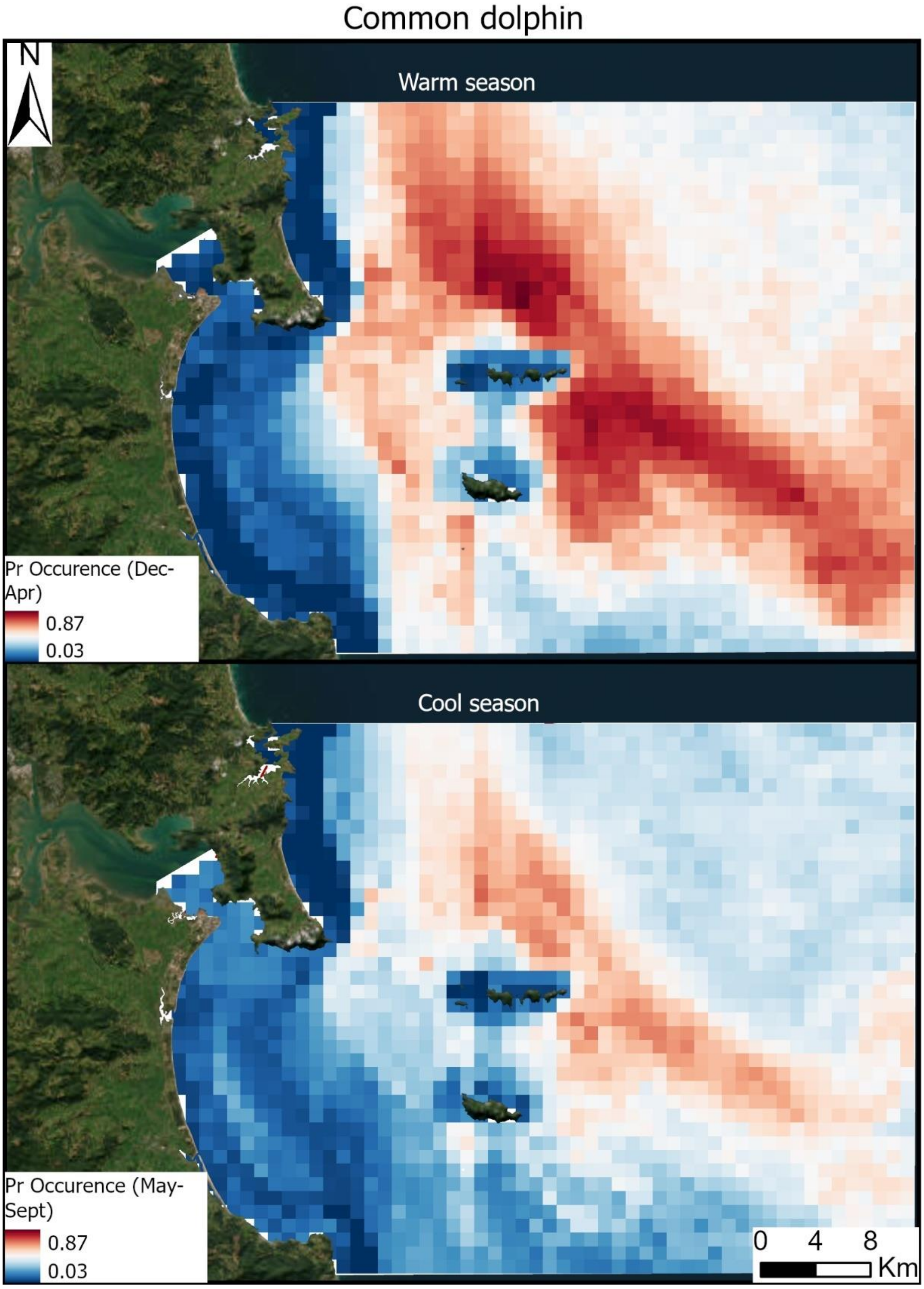

Figure 3-8: Distribution of common dolphins. Predictions of the distribution common dolphins from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

Population demographics

Photo-identification of common dolphins was not carried out due to the very low mark rate for individually recognisable dolphins.

Calves were noted in the occurrence of 20% of groups. However, due to the large size (>100), the wide spread of many groups and the lack of dedicated within-group searching, the proportion of groups with calves is likely to be underestimated.

Behaviour

Common dolphin encounters frequently involved large 'work-ups' – foraging association with Takapu/Australasian Gannets, other seabirds and often several Bryde's whales. The high frequency of occurrence of such workups suggests the study area is an important foraging ground for common dolphins.

3.2.4 Bryde's whale

Occurrence

There were 25 sightings of Bryde's whales, including 37 individuals. Of these, 80% (n = 20) of encounters were recorded during dedicated line-transect surveys, with the remainder collected opportunistically between December 2022 and March 2024 (Table 3-3). Monthly sighting rates ranged from 0 km-1 in June to 0.019 km-1 in March (mean = 0.013 km-1, Table 3-3).

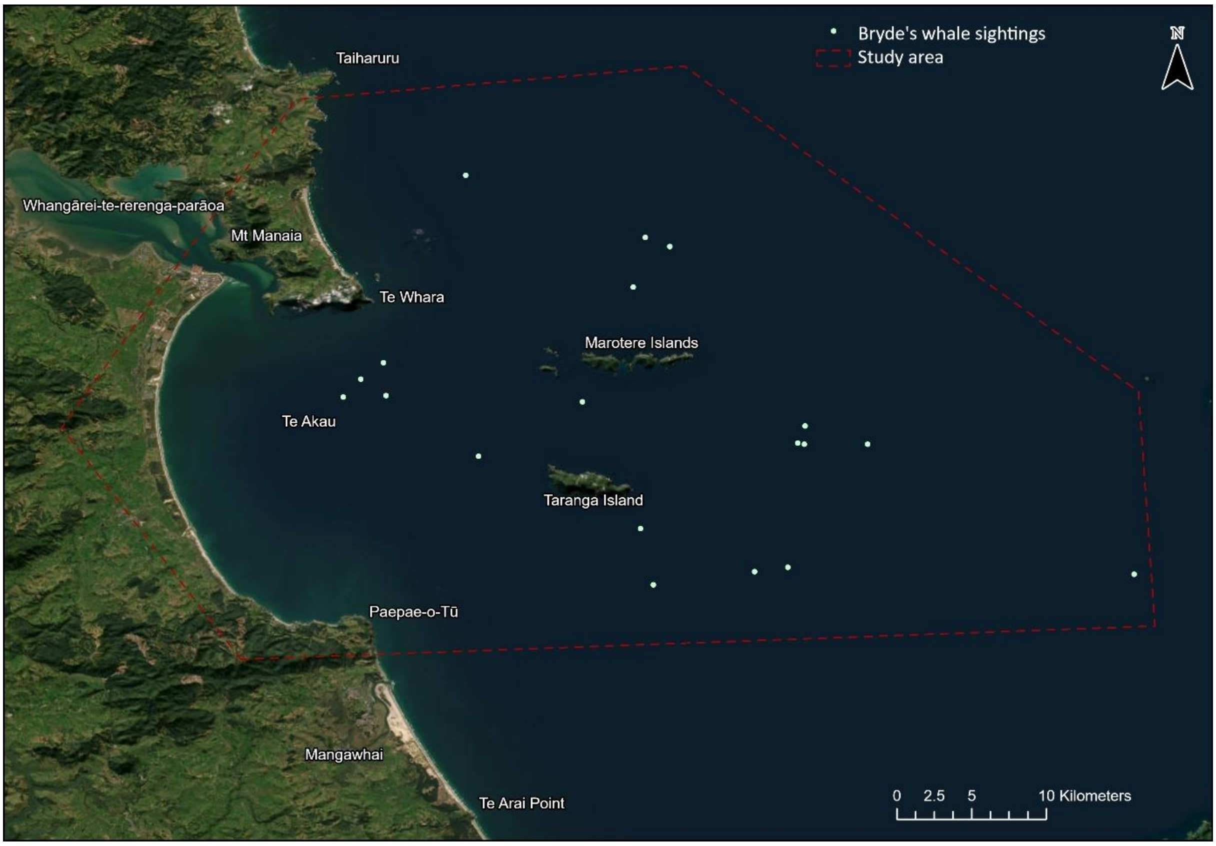

Figure 3-9: Sightings of Bryde's whale. Sighting locations for Bryde's whales throughout the study area. Sightings made both 'on effort' and opportunistically are shown...

Distribution and habitat use

Bryde's whales used the area extensively but were less likely to occur in shallow waters of inner Bream Bay (Figure 3-9). Species distribution models for Bryde's whales generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.75 (SD = 0.10) and 0.51 (SD = 0.16) for AUC and TSS respectively (Table 3-4). Similar to other marine mammal species, predicted distribution from the SDMs revealed probability of occurrence of the Bryde's whales was considerably lower in the cooler months (Figure 3-10). During the warm season, high probability of occurrence was predicted throughout the central and eastern components of the study area, with particular hotspots between Whangārei Heads and the Marotere Islands and in the south-eastern part of the study area towards Hauturu (Figure 3-10). There was also high predicted probability of occurrence within Bream Bay, inshore of the Island groups. Areas with low predicted probability of occurrence included the inshore, western components of the study area and Whangārei Harbour (Figure 3-10). Although the species is predicted to be less common in Bream Bay during the cool season, the cool-season predictions reveal some moderate probability of occurrence in the outer Bream Bay area, south of Whangārei Heads. This prediction, along with 3 sightings in September suggest Bryde's whales likely use the area for the majority of the year.

The key drivers of distribution for Bryde's whales according the SDMs included sea surface temperature (SST) (contributing 19.85% to the model) and mixed layer depth (MLD, 12.92%). Other important environmental variables were light at the seafloor (EBED, 10.68%) and gradient in SST (9.02%) (Table 3-5).

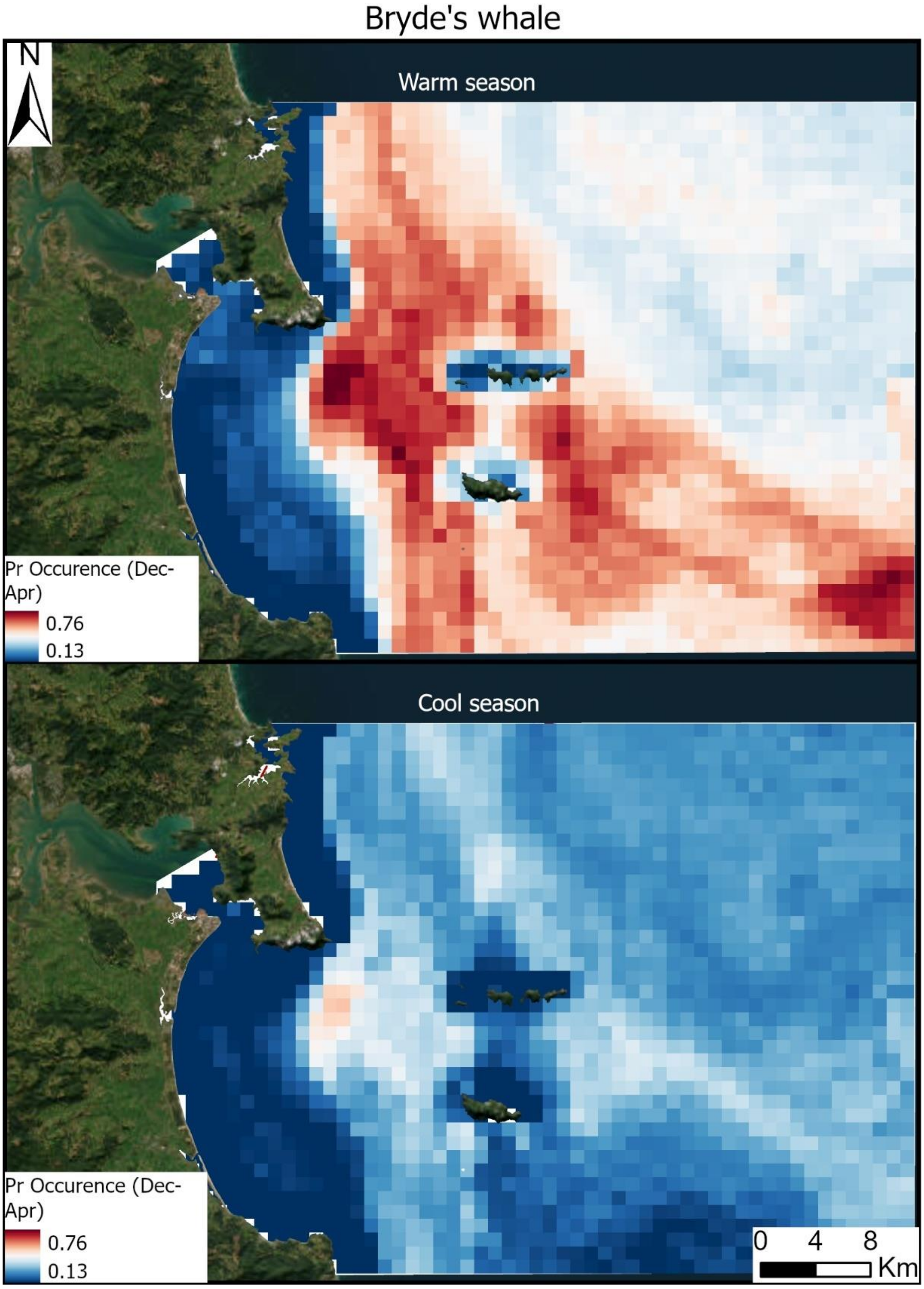

Figure 3-10: Distribution of Bryde's whale. Predictions of the distribution of Bryde's whale from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

Population demographics

Photo-ID was carried out during all encounters and 7 individuals were added to the North-eastern New Zealand Bryde's Whale Photo-identification Catalogue.

Behaviour

Foraging behaviour was regularly observed (61.1%, n = 22) during total (systematic and opportunistic) encounters with Bryde's whales. Foraging consisted of active participation of single or multiple (up to 5) whales in 'work-ups' alongside common dolphins, Takapu/Australasian Gannet and other seabirds as well as foraging behaviour in the absence of other megafauna species. For the latter, we often observed Bryde's whales engaged in 'chin-slap' behaviour where whales strike the underside of their lower jaw repeatedly on the surface of the water (Figure ref) which is often followed by a 'side-lunge' to ingest prey. This behaviour is typically regarded as a technique to disorientate and aggregate zooplanktonic prey during foraging events (Izadi et al. 2022).

Bryde's whale calves were observed during 4 encounters and confirms nursing behaviour is likely carried out within the study area.

Figure 3-11: Bryde's whale foraging.

3.2.5 False killer whales

Occurrence

There were 32 sightings of false killer whales. Of these, 9.4% (n = 3) were made during line-transect surveys, with the remainder (n = 29) collected opportunistically between December 2020 and March 2024. Monthly sighting rates from systematic surveys ranged from 0 km^{-1} in January, June and September to 0.005 km^{-1} in March (mean = 0.002 km^{-1}, Table 3-3). Group sizes ranged from 50 to ~ 150 (median = 80). False killer whales were observed in association with oceanic bottlenose dolphins during all encounters.

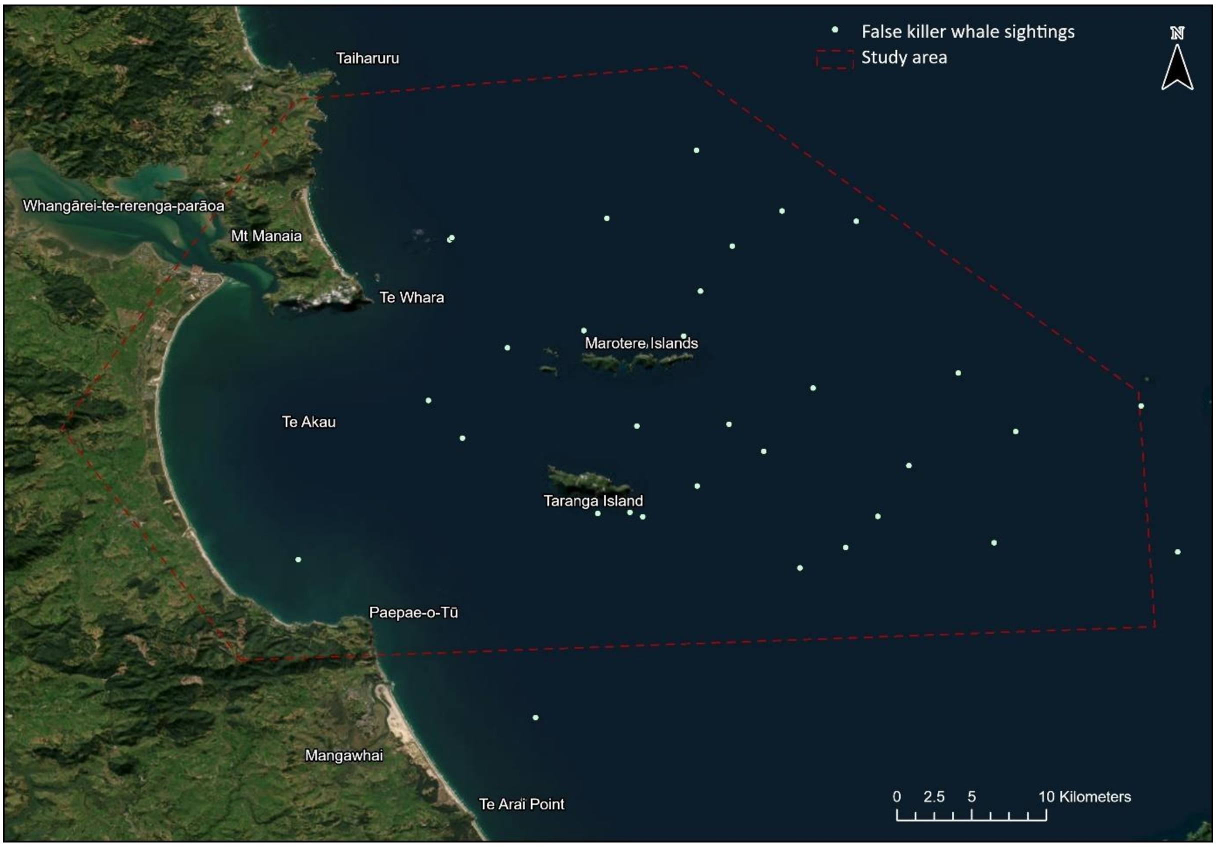

Figure 3-12: Sightings of false killer whales. Sighting locations for false killer whales throughout the study area. Sightings made both 'on effort' and opportunistically are shown...

Distribution

False killer whales appear to occur exclusively during summer and autumn with all sightings recorded between December and April. While they appear to occur primarily in deeper waters to the north and east of the Marotere islands, this species may also advance into shallow waters of Bream Bay and Whangārei Heads (Figure 3-12).

Species distribution models for false killer whales generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.89 (SD = 0.05) and 0.71 (SD = 0.10) for AUC and TSS respectively (Table 3-4). Predictions from the SDMs confirmed the highly seasonal presence of this species, with the predicted probability of occurrence being higher during the warmer months and lower in the cooler season (Figure 3-13). During the warm season, highest predicted probability of occurrence was in a broad area in from outer Bream Bay to offshore waters. Within this broad area, a hotspot of distribution was predicted east of both Taranga and the Marotere Islands (Figure 3-13). There was moderate predicted probability of occurrence nearshore waters within Bream Bay during the warm season (Figure 3-13). The predicted probability of occurrence of false killer whales during the cool season was predicted as uniformly low.

The most important variable for the false killer whale SDM were sea surface temperature (SST), accounting for 24.23% of the model performance, and gradient in SST (20.6%). Most other environmental variables made moderate or low contributions to the model, with the third most important being mixed layer depth (MLD with 6.94% importance (Table 3-5).

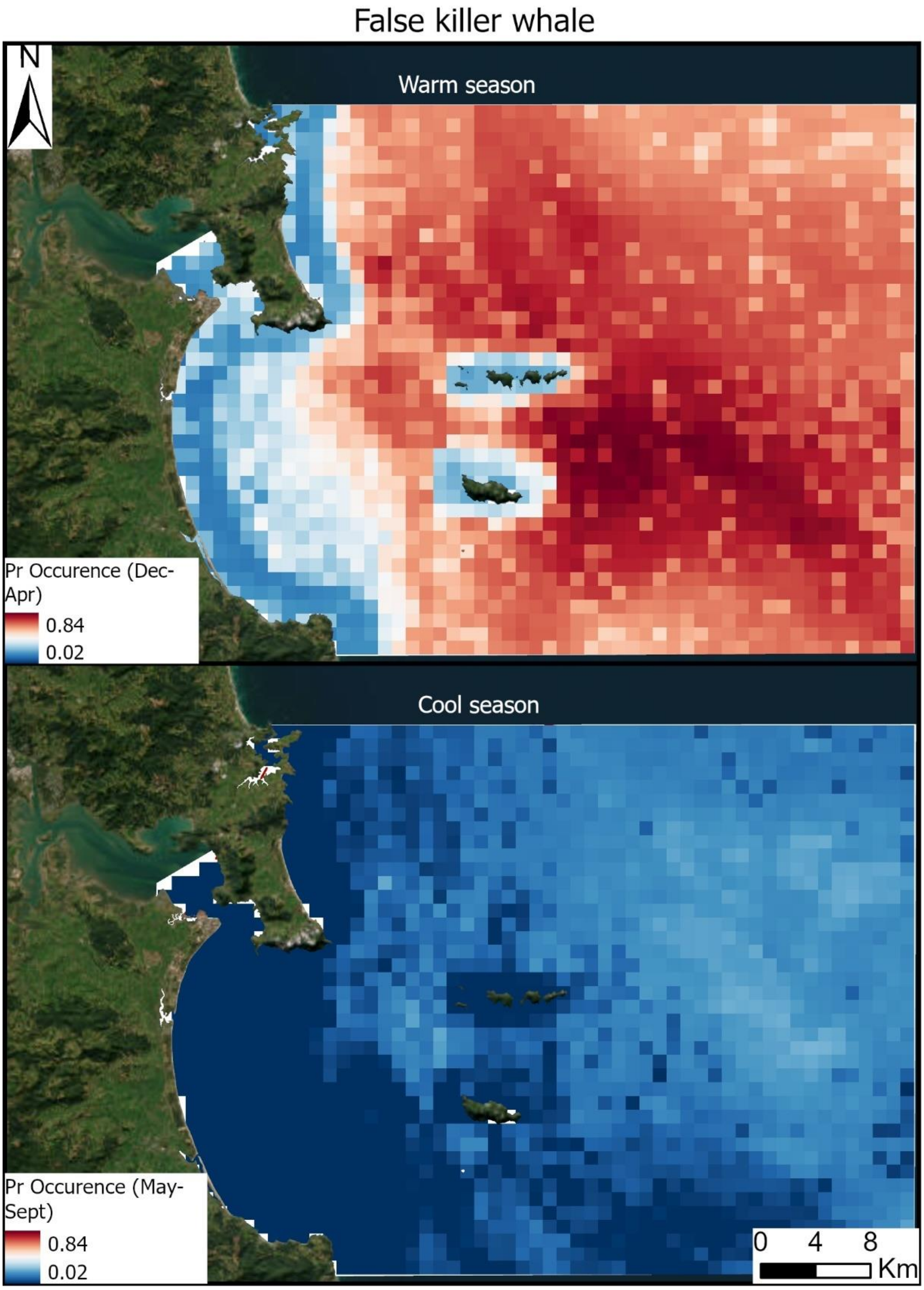

Figure 3-13: Distribution of false killer whale. Predictions of the distribution of false killer whales from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

Population demographics

A total of 134 individuals were photo-identified. Of these, 95.6% (n = 128) were sighted during more than one encounter and 73.9% (n = 99) were sighted during more than one season. All false killer whales photo-identified in the study area are linked by association into a single social network, with two distinct and stable social clusters. Photo-identification results from this study have been integrated within a wider project on the demographic parameters for New Zealand false killer whales. Preliminary population abundance for this population has been estimated as 127 (95% CI=114-141) using mark recapture modelling methods similar to those detailed above (Zaeschmar et al. 2022).

Behaviour

Feeding was observed during 81.3% of encounters (n = 26), including active prey chase events with oceanic bottlenose dolphins. Prey sharing both among false killer whales and between the two species was observed. Prey items included kahawai, kingfish, snapper and John Dory.

Juveniles were present during all encounters (n = 32). Neonates were only observed in December and January.

3.2.6 All other species

Long-finned pilot whales

There were 10 encounters with long-finned pilot whales. All encounters were recorded opportunistically between February 2019 and February 2024. All encounters were between December and April. Group size ranged from 20 to 30 (median = 27.5). Long-finned pilot whales were most frequently encountered in mixed species groups with false killer whales and oceanic bottlenose dolphins (60%, n = 6).

Long-finned pilot whales appear to occur mostly during summer and autumn months and in deeper waters to the north and east of the Marotere islands (Figure 3-14). Identified individuals were added to the New Zealand Long-Finned Pilot Whale Photo-identification Catalogue. Foraging was observed during 70% of encounters (n = 7), including all the six encounters with false killer whales.

Orca, blue whale, seals,

There were 2 sightings of single New Zealand fur seals, two sightings (one systematic, one opportunistic of a group of orca (group size = 5 and 8) and a single sighting of an individual blue whale (Figure 3-14). Both groups of orca and the blue whale were observed foraging.

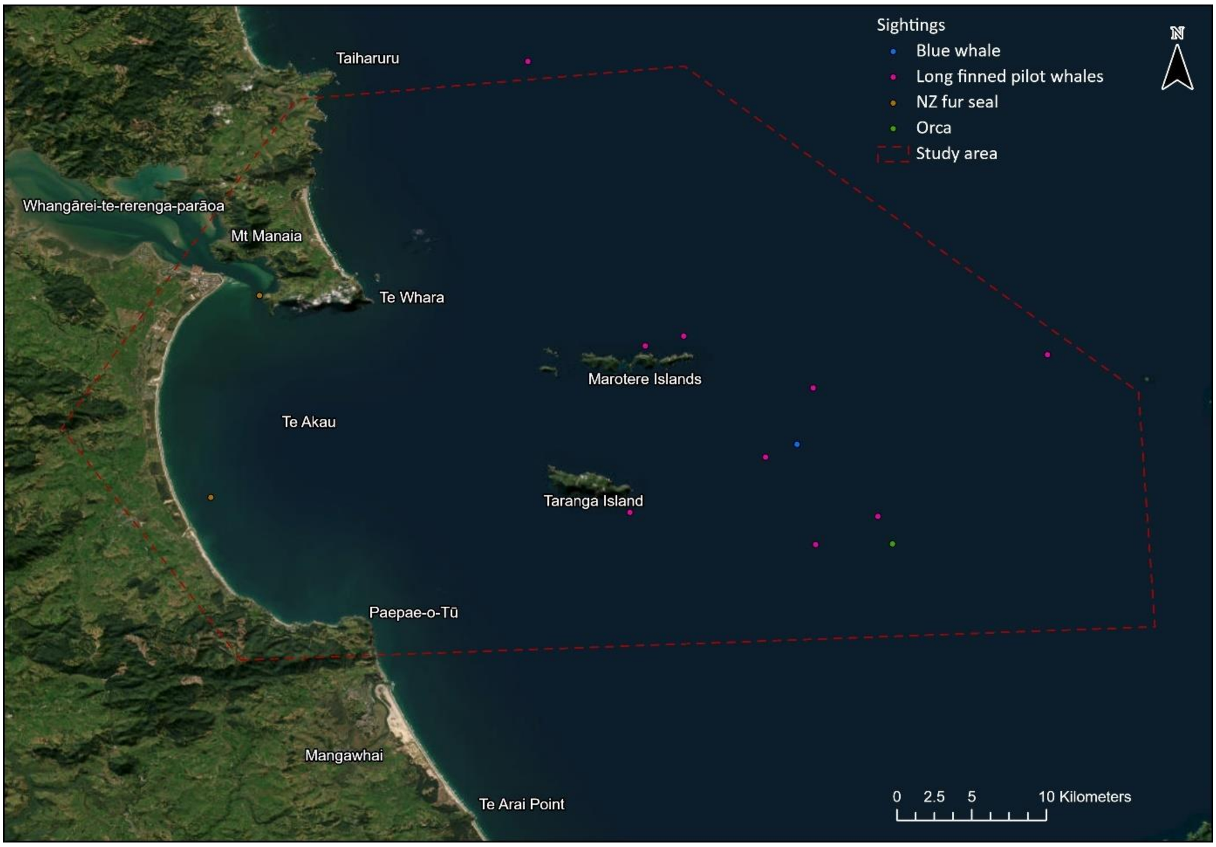

Figure 3-14: Other marine mammal sightings. Sighting locations for all other marine mammals throughout the study area. Sightings made both 'on effort' and opportunistically are shown.

3.3 Acoustic results

A total of 125 ten-minute acoustic recordings were taken and analysed for the detection of odontocete whistles. The largest number of recordings were taken in summer (n = 52) and the fewest in winter (n = 15). The highest proportion of recordings with positive detections were recorded during Autumn (64% of recordings), followed by Winter (47%), Summer (33%) and Spring (37%). Similarly, the mean number of positive detections per recording was highest in Autumn and Winter (Table 3-8).

Table 3-8: Acoustic detections. Table of acoustic recordings by season, proportion of recordings with positive odontocete detections, and mean number of detections per recording.

Season	Number of recordings	Proportion of recordings with +ve detections	Mean detections per recording
Summer	52	33%	15.5
Autumn	39	64%	47.4
Winter	15	47%	41.9
Spring	19	37%	19.1

The spatial locations of acoustic recordings were widely distributed throughout the study area. Positive detections of odontocete whistles were also made throughout, although there was a high incidence of positive detections north of the Marotere Islands and east of Taranga Island. Clusters of recordings with positive detections also occurred within Bream Bay, particularly off the harbour entrance (Figure 3-15). Areas with scarce positive detections were between the two Island groups and south of Taranga Island. For the former, it should be noted that detection radius maybe limited due to reduced propagation in more shallow water and screening from the Islands themselves (Figure 3-15).

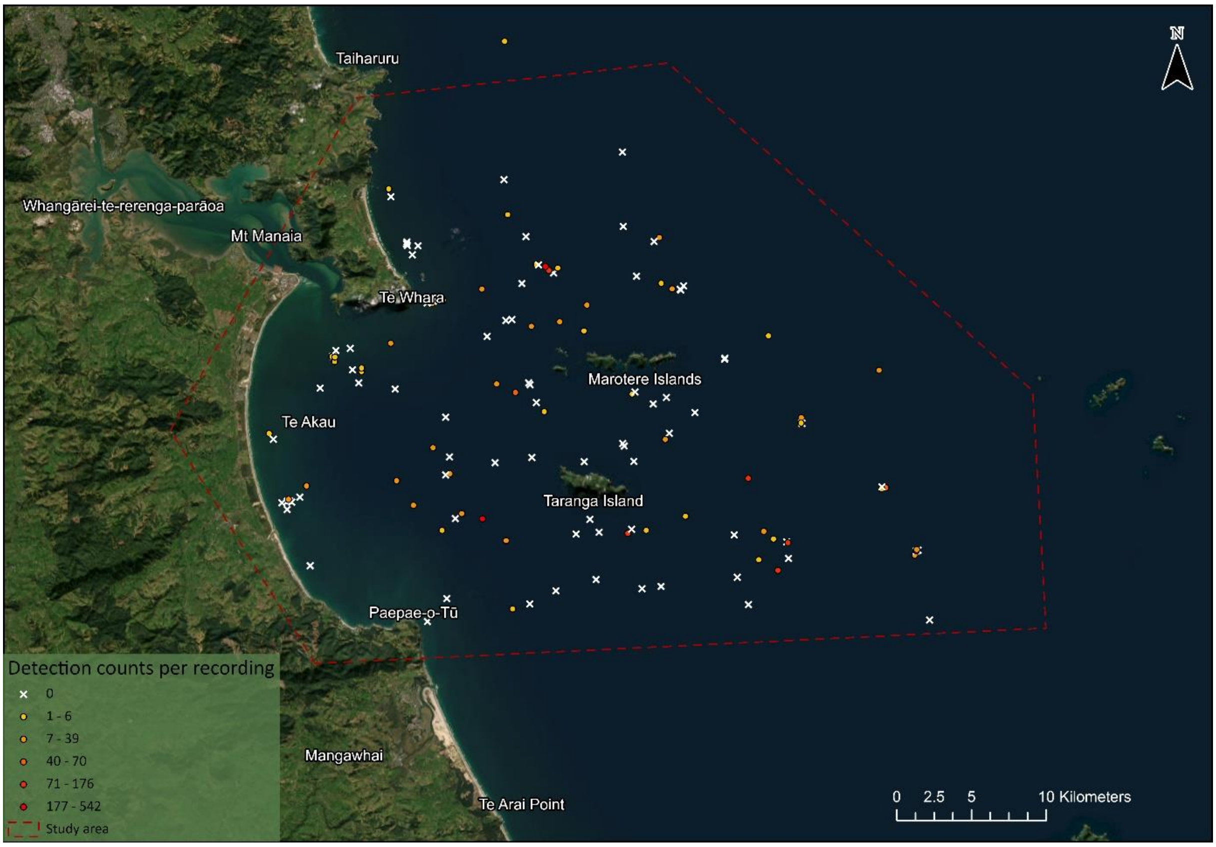

Figure 3-15: Acoustic detections. The location of acoustic recordings, the incidence of positive detections of odontocete whistles and the number of detections per 10-minute recording. Recordings with no detections are indicated as crosses.

Of the 15 acoustic recordings used to assess the accuracy of the automated detection algorithm, manual checking classed eight of the recordings as positive detections. The PAMGuard detection and post processing correctly classed those eight recordings as positive detections, plus one additional recording which was classed as a negative detection by manual checking. The true positive rate was thus 8/9 (89%) and the false positive rate was 1/6 (17%).

3.4 Other megafauna (sharks, mantas)

There were 15 encounters of manta rays, including 23 individuals. Of these, 53.3% (n = 8) were made during dedicated line-transect surveys with the remainder recorded opportunistically between December 2023 and January 2024. Manta rays were only observed between January and March. They appear to prefer deeper, open waters to the north and east of the Marotere Islands.

There were 18 sightings of sharks. Of these, 72.2% (n = 13) could be identified to the species level, resulting in 11 sightings of hammerhead sharks, and a single sighting each of a blue shark and a short-finned mako shark.

3.5 Seabirds

3.5.1 Korora

Occurrence

There were a total of 104 encounters with kororā involving 209 individuals throughout the study area. All encounters were recorded during the dedicated line-transect surveys. Kororā were sighted in all survey months. Monthly sighting rates ranged from 0.017 km^{-1} in September to 0.305 km^{-1} in March (mean = 0.136 km^{-1} Table 3-3). Group size ranged from 1 to 9 (median = 1).

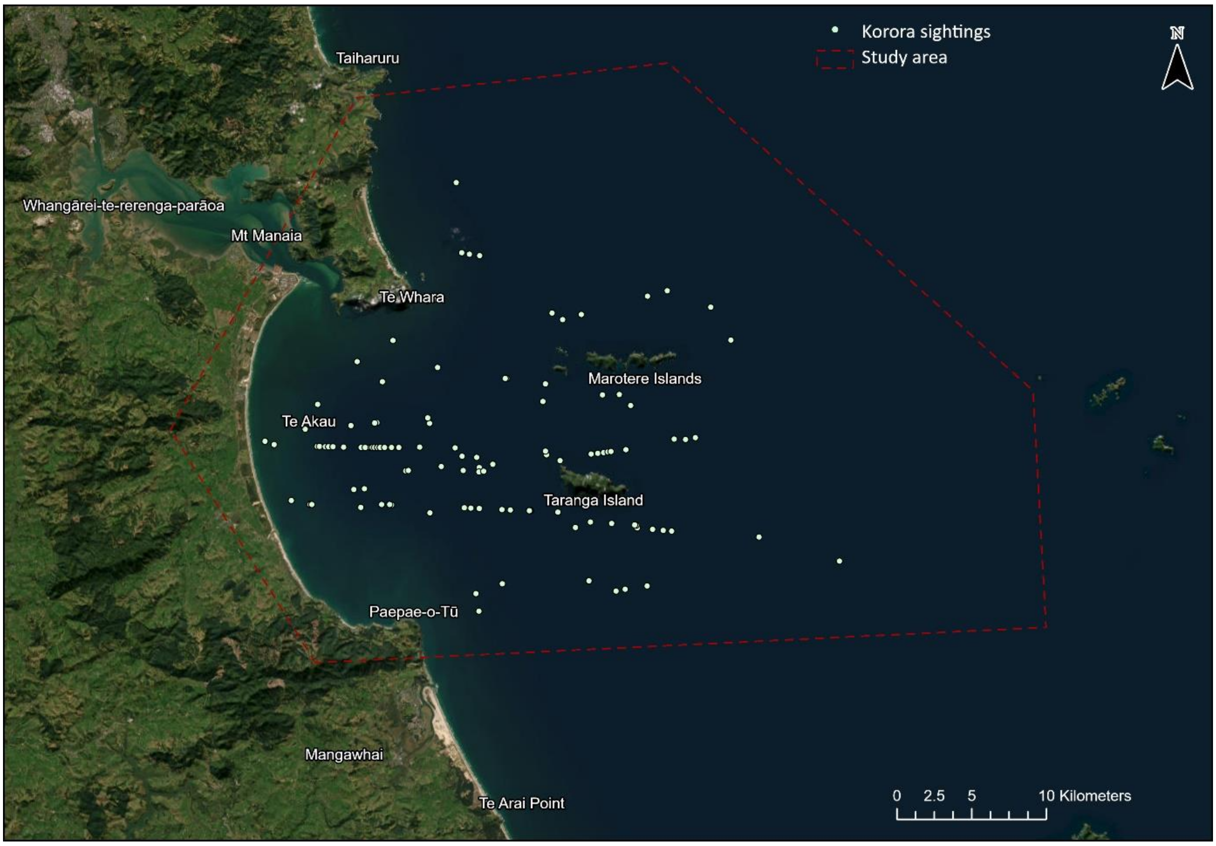

Figure 3-16: Sightings of kororā. Sighting locations for kororā throughout the study area. Sightings made both 'on effort' and opportunistically are shown.

Distribution

Species distribution models for kororā generated robust predictions of the species distribution and habitat use throughout the study area, with mean statistical validation scores of 0.89 (SD = 0.03) and 0.65 (SD = 0.06) for AUC and TSS respectively (Table 3-11). During the warm season, areas of high predicted probability of occurrence were throughout the central and western regions of the study area, with hotspots in southern Bream Bay and Te Paepae o Tu (Bream Tail) and off Ocean Beach. There was also high predicted probability of occurrence between the Marotere and Taranga Islands.

There was moderate predicted probability of occurrence within Whangārei Harbour during the warm season. Areas with low probability of occurrence included the offshore, eastern components of the study area (Figure 3-17).

Probability of occurrence of kororā was lower during the cooler months of the year (May – September), suggesting the species is less common in Bream Bay during this time of the year. Areas of relative importance (e.g., the locations with highest probability of occurrence) for the species within the cooler months remained broadly similar to warmer months with the exception of increased relative importance of nearshore habitat around Whangārei Heads and northwards to Taiharuru. The relative importance of Whangārei Harbour was also higher during the cooler months of the year (Figure 3-17).

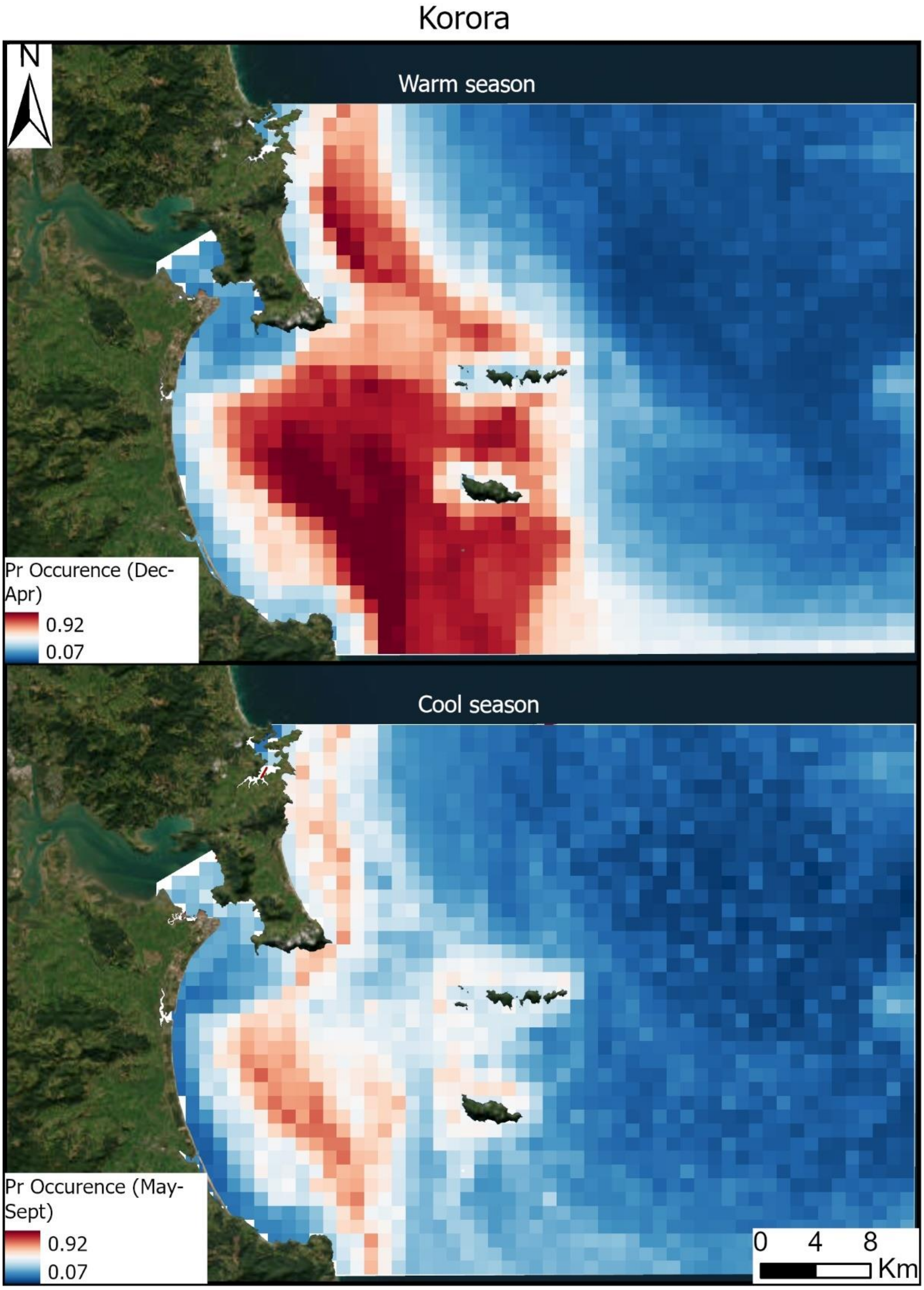

Figure 3-17: Kororā distribution. Predictions of the distribution of kororā from species distribution modelling indicated by the predicted probability of occurrence across the study area during the warm season (Dec-Apr) and cool season (May-Sept).

3.5.2 Other seabirds

A total of 223 10-minute seabird counts were undertaken during the seven surveys and were widely distributed throughout the study area (Table 3-9). The highest number of seabird counts were undertaken during surveys in December, with the lowest number in March.

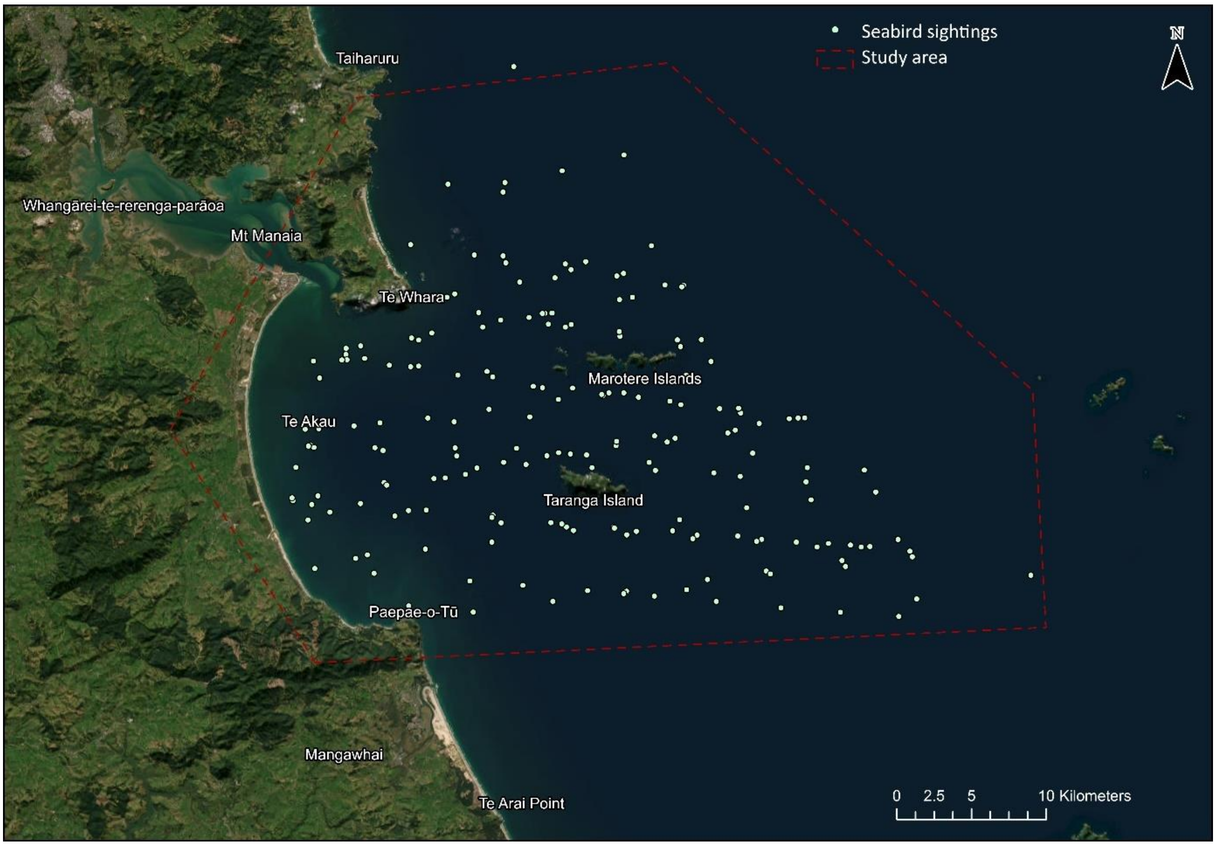

Figure 3-18: Seabird counts. Locations of systematic seabird counts throughout the study area. Each count consisted of 10-minute scan, with number of all species observed noted.

Table 3-9: Seasonal distribution of seabird counts. The number of seabird counts carried out across all four seasons covered by this study.

	December	January	March	June	September
Seabird counts	44	81	25	35	38

Species occurrence

Twenty-four seabird species or seabird species complexes (e.g., Prion sp.) were observed in the study area across all surveys (Table 3-10). Fluttering shearwater was the most commonly occurring species, being observed in 36.8% of the total seabird counts and being observed in all seasons. Other commonly occurring species included Buller's shearwater, Australasian gannet, diving petrel, flesh-footed shearwater, Cook's petrel (grouped with Pycroft petrel) and white-faced storm petrel. Grey-faced petrel (Oi), cape pigeon, black-browed albatross, and skuas were rarely encountered, occurring in 0.4% (former three species) and 0.9% (both skua taxa) of total counts respectively. There was marked seasonality in occurrence for some species.

For example, Black petrels and Buller's shearwater did not occur during winter surveys (June), while the three albatross species were present in September and December only. Several species occurred only during surveys in the cooler months of the year (Arctic skua, Grey-faced petrel, Cape pigeon). In contrast, the occurrence of Australasian gannet and fluttering shearwater was broadly similar across the seasons (Table 3-10).

Table 3-10: Summary of seabird counts. A summary of the species recorded in all seabird counts across the seasonal surveys (months) of this study. The occurrence (percentage of all counts in a given month) and the mean number of individuals per counts are given for all species observed throughout this study.

	December		January		March		June		September		Total
	% counts	mean ind.	% counts	mean ind.	% counts	mean ind.	% counts	mean ind.	% counts	mean ind.	% counts
Arctic skua	0	0	0	0	4	1.0	0	0	0	0	0.4
Australasian gannet	30	2.9	25	1.4	28	2.0	29	1.9	42	1.9	29.6
Black petrel	0	0	1	1.0	24	1.5	0	0	5	1.5	4.0
Black-backed gull	5	1.0	1	1.0	0	0	6	1.0	18	2.7	5.4
Black-browed albatross	2	1.0	0	0	0	0	0	0	0	0	0.4
Buller's albatross	0	0	0	0	0	0	0	0	18	1.6	3.1
Buller's shearwater	61	8.7	36	6.5	24	2.0	0	0	39	4.5	34.5
Cape pigeon	0	0	0	0	0	0	0	0	3	1.0	0.4
Cook's/Pycroft petrel	18	3.5	38	4.5	0	0	0	0	0	0	17.5
Diving petrel	39	3.8	0	0	0	0	71	4.9	61	8.7	29.1
Flesh-footed shearwater	50	3.1	37	7.5	20	22.0	0	0	21	2.1	29.1
Fluttering shearwater	77	26.2	21	11.2	16	4.0	31	2.8	42	3.6	36.8
Grey-faced petrel (Oi)	0	0	0	0	4	1.0	0	0	0	0	0.9
Grey headed albatross	0	0	0	0	0	0	0	0	5	1.0	0.4
Little shearwater	0	0	1	1.0	0	0	3	2.0	0	0	0.9
Northern giant petrel	2	1.0	0	0	0	0	0	0	11	1.3	2.2
NZ storm petrel	2	1.0	4	1.3	0	0	0	0	3	1.0	2.2
Other seabird spp.	0	0	1	1.0	8	1.0	6	3.0	3	21.0	2.7
Prion spp.	18	18.5	7	2.0	0	0	0	0	24	31.0	10.3
Red-billed gull	5	3.5	0	0	12	2.3	9	5.3	8	2.7	4.9
Skua spp. (brown)	2	4.0	1	1.0	0	0	0	0	0	0	0.9
Storm petrel spp. (NZ)	5	15.5	0	0	0	0	3	2.0	3	2.0	1.8
White-faced storm petrel	27	3.4	15	1.7	4	1.0	0	0	32	2.9	16.6
White-fronted tern	2	3.0	1	3.0	0	0	3	2.0	0	0	1.3

Distribution

Of the eight seabird species with more than 20 unique occurrences (i.e., occurred in more than 20 seabird counts), robust species distribution models were able to be fit for four species (Table 3-11). Across all eight species, AUC model evaluation scores ranged from 0.55 for Australasian gannet to 0.85 for Diving petrel. Weighted kernel density estimates were used to investigate seasonal distribution patterns for the four species for which a robust SDM could not be fit.

Table 3-11: Model evaluation for seabird species distribution models. Model evaluation statistics for species distribution models of eight commonly occurring seabirds within the study area. Mean area under the receiver operating curve (AUC) and the True test statistic (TSS) are calculated using data withheld from model fitting and are provided along with standard deviation (SD) across 100 model bootstraps. Good model performance is given by AUC > 0.7 and TSS > 0.4.

Species	Mean AUC (+/- SD)	Mean TSS (+/- SD)
Australasian gannet	0.55 (0.05)	0.20 (0.07)
Buller's shearwater	0.68 (0.05)	0.36 (0.08)
Cook’s petrel	0.83 (0.04)	0.60 (0.07)
Diving petrel	0.85 (0.08)	0.67 (0.12)
Prion spp.	0.79 (0.09)	0.58 (0.13)
Flesh-footed shearwater	0.72 (0.04)	0.43 (0.07)
Fluttering shearwater	0.68 (0.05)	0.38 (0.07)
White-faced storm petrel	0.66 (0.08)	0.35 (0.11)
Kororā	0.89 (0.03)	0.65 (0.06)

The most commonly occurring seabird species showed distinct spatial and temporal patterns of distribution throughout the study area. Cook’s petrel were widely distributed throughout the study area during summer, with hotspots in distribution in the south-west, offshore of Taranga Island and lower probability of occurrence inshore and around both Taranga and the Marotere Islands (Figure 3-19). The probability of occurrence of Cook’s petrel during the cooler months of the year was uniformly low, indicating a strong seasonal presence within the study area. In contrast, probability of occurrence for diving petrel (kuaka) was significantly lower during the warmer months. During the cool season, hotspots in distribution for diving petrel were notable in outer Bream Bay in a band between the coastline and the Islands and east of Taranga Island (Figure 3-19). Diving petrels had low probability of occurrence in nearshore waters and in the south-east of the study area during the cool season (Figure 3-19). Flesh-footed shearwaters had high probability of occurrence across both seasons, but with distinct seasonal distribution patterns.

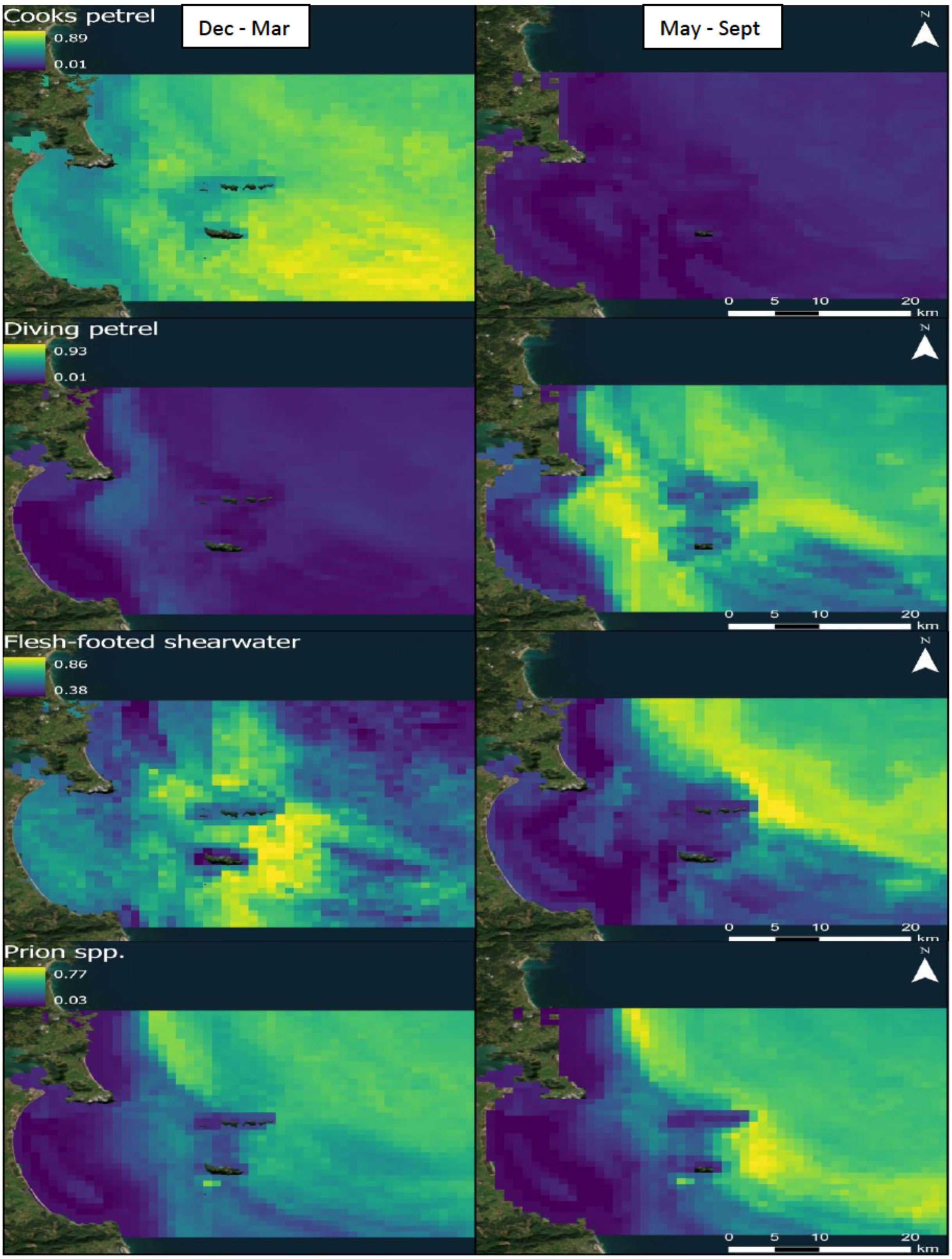

Figure 3-19: Seabird species distribution models. Seasonal predictions from species distribution models for four commonly occurring seabird species. Predictions in the right panel a four the warm (Dec - Mar) season while predictions on the left are for the cool (May - Sept) season. Values are probability of occurrence and are standardised to the same scale between seasons.

The importance of the environmental variables among the seabirds with robust species distribution models was variable among species. However, sea surface temperature (SST) was the most important predictor of seabird distribution for all species except prions (Table 3-12). SST contributed between 27.74% for Cook's Petrel and 5.57% for prions. For Kororā, other environmental variables of importance included chlorophyll a concentration (CHL) and bathymetry (Bathy). For Cook's Petrel, variables other than SST made moderate or minor contributions with CHL and gradient in SST being the next most important. Mixed layer depth (MLD) contributed almost 15% importance for diving petrel and turbidity (BBP) contributed a further 9.15% for this species. For the prions, BBP was the most importance variable for the model's predictive performance with 18.03% contribution. Other important variables for prions included light at the seafloor (EBED, 15.07%), SST gradient (13.16%) and bathymetric position index (BPI) – a measure of topographic complexity. With the exception of SST, the variables for flesh-footed shearwater were of similar importance, ranging between 7 and 10% contribution. The categorical variable 'Season' was the least importance variable for most species (Table 3-12).

Table 3-12: Relative importance of environmental variables. The standardised relative importance (% contribution) of environmental variables to the species distribution models for each seabird species with a robust SDM. Colour shading indicates a gradient from the most important variable (yellow) to least important (blue).

Species	Bathy	BBP	BPI_fine	CHL	EBED	MLD	Season	Slope	SST	SSTGrad	TC
Kororā	11.12	9.32	6.07	14.01	8.08	6.88	3.71	5.81	19.64	8.4	6.98
Cook's/Pycroft petrel	7.29	5.92	5.98	10.57	7.32	5.41	8.05	6.71	27.74	8.29	6.73
Diving petrel	8.23	9.15	8.45	8.05	8.59	14.96	1.34	8.19	19.47	6.84	6.71
Prion spp.	7.95	18.03	12.19	8.11	15.07	8.30	0.40	5.63	5.57	13.16	5.58
Flesh-footed shearwater	8.92	9.50	8.96	8.79	9.32	7.65	4.66	7.86	17.70	9.13	7.51

Kernel density results

KDEs were performed for 4 species for which robust SDMs could not be fit (name them here). The effort and relative abundance weighted KDe analysis revealed distinct seasonal and spatial patterns for the four commonly occurring seabird species. Density was substantially higher for all four species during the warm season (Figure 3-20). For Australasian gannet/Takapu, the highest density area was centred on the Marotere Islands, with an additional high-density location in the south east of the study area. The relative importance of these areas was largely consistent between the seasons. Density was highest for Buller's shearwater inshore of Taranga and the Marotere Islands during summer, however medium density was distributed throughout the study area. In the cool season, Buller's shearwaters were less widely distributed, with the highest area of relative importance being located between Taranga and the Marotere Islands. The highest relative density of fluttering shearwaters during summer was located close to shore within inner Bream Bay, although the species was also widely distribution in the warmer months. In the cool season, areas of the highest relative importance were distinct from the cool season, and were located to the west of the Marotere Islands and offshore of Taranga Island. For white-faced storm petrel, warm season hotspots of relative density occurred on the northern side of the Marotere Islands, with an additional medium density zone south of Taranga Island. Similar locations were of high relative importance during the cool season, although density of storm petrels was lower during this season (Figure 3-20).

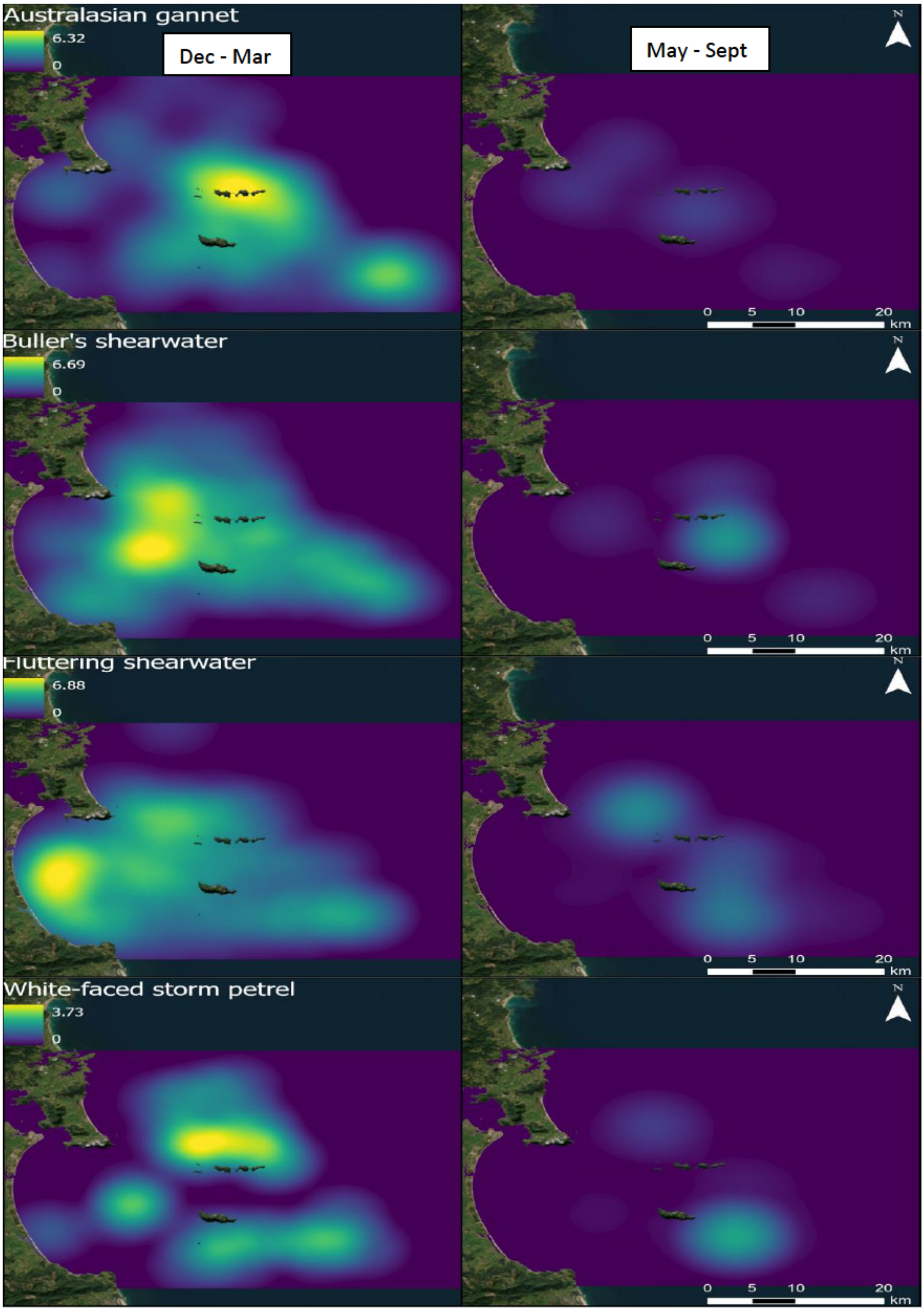

Figure 3-20: Kernel density analysis for seabirds. The spatial distribution of four commonly occurring seabird species inferred via kernel density estimation for the warm and cool seasons.

3.6 Mātauranga findings

Specific information on tohorā pooled from several sources is provided below. It should be noted that this information is highly sensitive and in itself is considered a taonga. The information should not reproduced without prior agreement and consultation with Patuharakeke.

Ngā Rima Tohorā o Manaia

To the east of our coastline of Te Ākau lie many islands that include Aotea and Hauturu (the Great and Little Barrier Islands) home to Ngāti Rehua, Te Uri-o-Hikihiki and Ngāti Manuhiri, Toutoru (Sail Rock), Marotiri and Taranga (the Hen and Chickens) and the Motu Kino and Pokohinu (Mokohinau) Islands. To the north-east are the Aorangi, Aorangaia and Tawhitirahi islands also known as the Poor Knights Islands. These are the ancestral lands of Ngāti Toki, Ngāti Manaia and Ngātiwai and consequently, by virtue of our whakapapa Patuharakeke also hold significant interests in these places. These island groups make up what are known as 'Ngā Rima Tohorā o Manaia', or the five whale families or groupings of Manaia.

The following extracts have been pooled from - Midwood H, & Chetham J. (August 2023). "Tiaki Tangaroa – tiaki ano mātou" Patuharakeke Traditional Research Report for the Whangārei Harbour Inquiry under the Marine and Coastal Area (Takutai Moana) Act 2011.

"Whales are a key taonga species, typically associated with our rohe and takiwā. They are viewed as a "tuakana" to us. In former days the waters off our shores abounded with species of both seal and whale and in recent times, over the last hundred or so years much interest has been created by the occasional visits and even strandings of these creatures. For our people particular thought is given to the possible portent of what these visits and strandings may indicate because these creatures are regarded as the lineal descendants of the tribal taniwha of the ancient past."

"In Patuharakeke lore it is told that when a whale stranded in our waterways a practice of old would be for the kuia of the tribe to embark on a waka, and karanga or call to the whale and guide its safe passage out to sea again. Wāhi tūpuna associated with this are Te Waiparāoa at Mangawhati and Te Hōpua/Ngātītī. This role would also have been performed by tohunga of the tribe and also at times when maleficent taniwha would endeavour to overcome people and the tohunga and his incantations would be at work either placating the taniwha or capturing or weakening the creature. "

"Whale strandings in particular were also emblematic (or tohu) that a person or persons of mana of our hapū or tribe had died. A stranding of a pod of Orca or Killer Whales occurred off Mair Bank around 80 years ago when the old male animals cried so it was heard for miles. These older whales lived for a week and the young ones of the pod lived three days longer. While this lasted, five whales were seen swimming together up and down the beach outside until they too stranded about 800 yards from the first pod."

Recent whaikōrero at Takahiwai on the subject expressed the following:
"Hei tāngaengae kia hono te tokorua nei, ara, Pukekauri me Whangārei Terenga parāoa - The umbilical cord that joins the two, namely - The Pukekauri ranges and Whangārei Terenga parāoa."

3.6.1 Tohorā and Kauri

A pūrākau that is significant to Patuharakeke is the relationship and connection between Kauri and Tohorā. It is said that long before the evolution of humans, some 20 million years ago, Kauri and Tohorā (Southern Right Whale) were brothers who lived together on the Whenua (land). Tohorā loved to visit the Moana (ocean) and one day, Tohorā had a calling to live in the moana. Excited, Tohorā asked Kauri to join him on his adventure, but Kauri could not leave the whenua. Instead, Kauri gave Tohorā his blessing to follow his calling. Tohorā gifted Kauri the scales of his skin to allow him to be protected and grow tall. In return, Kauri gifted Tohorā his oil to provide him with extra warmth on his travels across the ocean. Kauri was sad to see Tohorā leave him, so he made his way to the top of ridges and grew to the top of the canopy to see Tohorā voyaging back to Aotearoa. Tohorā would swim close to the coast and breach so that his brother could see him follow his calling.

The pūrākau of the Tohorā and the Kauri exchanging skins is commonly told by Northern tribes such as Ngātiwai and Ngāti Hine. It is reflected in a nuanced way through Patuharakeke pūrākau identifying the strong connections between our Pukekauri range in behind our Marae and Whangārei Terenga Parāoa. We as Patuharakeke see the main awa, Takahiwai, as the connection between Pukekauri and Whangārei Terenga Parāoa.

It is essentially the umbilical cord that connects the whenua to the moana at this place, our whakapapa to each other and connects the Kauri and the Tohorā. "

3.6.2 Patuharakeke Tohorā Mātauranga & Tāhuna Tohorā

Historically, Whangārei Terenga Parāoa has been a stranding hotspot for Tohorā, further reinforcing the connection between Patuharakeke and Tohorā. Patuharakeke are the first responders for Tohorā strandings in our rohe moana. In the event of a Tohorā stranding, Patuharakeke is called and actively seeks to refloat stranded marine mammals. It is of vital importance for Patuharakeke to see all taonga species thriving in their natural habitat, thriving in the domain of Tangaroa. If all refloating attempts are unsuccessful, the hauhake process is actioned in the presence of esteemed kaumatua and tōhunga. The tikanga and cultural practice of the tohorā hauhake process has been lost over time as an effect of colonisation, but due to a mass stranding even of Pilot Whale in Te Ākau in 2006, tohorā hauhake has become revitalised and is now a common practice for stranded/deceased tohorā in the Patuharakeke Takutai Moana. One significant part of the process is the naming tikanga, where stranded whales are named to enhance the mana of the tūpuna taonga and to carry on the whakapapa of the taonga post-stranding. The revitalisation of tohorā hauhake process has inspired generations to regain lost mātauranga that once highlighted the interconnected relationship of tohorā and Patuharakeke tāngata.

Tāhuna Tohorā (Figure 3-21) is a wāhi tapu and the designated area for the burial of stranded tohorā located within the Uretiti coastal dunes. The plaque reads: "He rāhui mo te Kōtohorā i tanu ai - Designated area for the burial of stranded whales. Ko Patuharakeke te mana whenua, ko Ngatiwai i tautoko"

Figure 3-21: Te Tāhuna Tohorā . Te Tāhuna Tohorā memorial at Uretiti Tohorā burial ground (left), Whānau of Patuharakeke digging to bury a stranded Aihe (right) (April, 2024).

3.6.3 Tohunga Tohorā

Whaea Ramari Stewart

During our wānanga/field programme in January 2024, we were honoured to have renowned tohunga tohorā Whaea Ramari Stewart join us to share her unique experiences with tohorā in Aotearoa. Whaea Ramari has spent considerable time in and around the rohe moana of Patuharakeke and shared her insights on the key species to be found in the area and the importance of the area both presently, and in the past for these taonga. Whaea Ramari also shared her personal connection to Whangārei Terenga Parāoa. Several kōrero stood out to Patuharakeke team members and the science team:

- Whaea Ramari's interpretation of the name of our harbour, highlighting the connection of highly respected and significant Chief of surrounding Iwi and hapū possessing patu made from Parāoa bone.
- The importance of rohe for aihe/common dolphin both in present day and historically. Whaea Ramari commented that while aihe remain very common in the study area, previous abundance was considerably higher.
- The relationship between manu moana and tohorā – where the distribution and behaviours of manu is a key tohu for tohorā occurrence.
- The importance of the rohe as a migratory corridor for Paikea (humpback whales). These whales passed through the rohe significant numbers during their southwards migration between their sub-tropical breeding grounds and the Antarctic, particularly common in November.
- Tohorā (southern right whales) were very commonly found in the rohe during both the winter months (i.e., their calving/breeding season). Cow/calf pairs passing through the rohe in September heading north to an area south-east of the Kermadecs, likely the Lau-Colville seamount chain.
- Bryde's whale are abundant in the area, and share similar spatial patterns with the other more migratory whales.
- All whale species are commonly encountered off the white, sandy beaches in the rohe. Especially around the 5 m depth contours (especially tohorā).
- An area in the north of the rohe between Whangārei Heads and Taiharuru is an important area for all whale species.

It was very significant for Patuharakeke to have Whaea Ramari Stewart onboard the Manawanui as she offered a unique perspective on her experience with Tohorā and how a te ao Māori worldview and mātauranga has positively influenced her holistic understanding of Tohorā.

Te Kaurinui Parata

From a Pūrākau perspective, Taranga and the Marotiri Islands tell a significant story. All of the islands in the Marotiri cluster are named after Māui and his whānau, Taranga being the mother of Māui. Māui, otherwise known as Māui-tikitiki-a-Taranga, had 4 brothers: Māuipae, Māuimua, Māuiroto, and Māuitaha. It is told that when Taranga gave birth to Māui-tikitiki-a-Taranga, he was stillborn or premature, therefore Taranga was wrapped Māui in a korowai made from the hair of her topknot (tikitiki) and sent him off to sea. This kōrero is significant to Patuharakeke in relation to the Marotiri islands, it gives whakapapa that are considered taonga tuku iho, but this understanding and meaning has been lost over time due to the renaming from Marotiri islands to “The Hen and Chicken Islands” by Captain James Cook. Taranga (“The Hen”), Māui-tikitiki-a-Taranga (small rock between Māuipae and Māuiroto), Māuipae (“Coppermine”), Māuimua (“Lady Alice”), Māuiroto (“Whatupuke”) and Māuitaha (“West Chick”) make up the cluster of islands commonly known as The Hen and Chicken Islands, but to Patuharakeke, they are known as Marotiri islands.

Ngāti Wai tradition integrates this pūrākau with that of the famous pūrākau of Māui catching Te-ika-a-Māui, with the action of ‘catching the fish’ occurring off the coast of Northland where our Tere Tohorā Karanga Tangata programme takes place. It is said that the highly productive waters of area that sustain such abundance were the key to catching te-ika-a-Māui and links with our understanding of the importance of the area for numerous taonga (including tohorā/aihe). When Maui landed te ika, it was attacked and cut into pieces by his brothers. The pieces that fell from te ika were called Nga Unahi me nga Taratara o Te Ika roa o Maui or the scales from the fish of Maui and became the many Islands and rocky outcrops throughout the rohe moana of Ngāti wai and Patuharakeke.

4 Discussion

The present study is the first dedicated megafauna survey of the wider Te Ākau/Bream Bay area. Despite its proximity to the well-studied waters of the Tīkapa Moana/Hauraki Gulf and Te Peiwharangi/Bay of Islands and its known anthropogenic impacts, the area's megafauna has, until now, been poorly studied. There have been limited studies focussing primarily on the potential environmental impacts of marine construction, in particular its associated discharge, noise, and shipping implications (Clement 2020; Clement 2021; Clement 2022). The study area has been previously described as disturbed habitat that cannot be considered optimal for marine mammals but acknowledges the regular presence of various coastal cetacean species (Clement 2022). Yet, the findings presented herein strongly indicate that the area constitutes important habitat for marine megafauna, in particular a range of cetacean species, many of which are classed as threatened or at risk (Baker et al. 2019).

4.1 Importance of the area for tohorā/marine mammals

The combination of our systematic line-transect surveys, acoustic monitoring, and the integration of opportunistic sightings from aligned research projects have provided strong evidence for the importance of the Te Ākau/Bream Bay area for marine megafauna. Few places in New Zealand hold such high species richness of marine mammals, sharks/rays and seabirds – with Tīkapa Moana/Hauraki Gulf being one of the few comparable locations (Dwyer et al. 2016; Gaskin & Rayner 2017; Stephenson et al. 2023b). For example, marine mammal surveys at Banks Peninsula (NZ Whale and Dolphin Trust, unpublished data[2]), the Bay of Islands (Tezanos Pinto 2009), Fiordland (Bräger & Schneider 1998) report lower marine mammal species richness than seven species observed in this study (Table 3-2).

In part, the richness documented here is likely due to the occurrence of sub-tropical and transient species that use the area regularly in the summer (e.g., false killer whales, oceanic bottlenose, Manta ray), as well as the occurrence of more temperate species (e.g., long-finned pilot whale). The high species richness documented in Te Ākau/Bream Bay is particularly noteworthy given the relatively

[2] Sightings database for surveys in Banks Peninsula Marine Mammal Sanctuary. Average of 2 species seen per year

short duration of our study – where surveys over at least three years are often required to fully understand patterns in species occurrence for such highly dynamic species (Dawson et al. 2008).

In addition to high diversity, our results have revealed the importance of the area for two threatened marine mammal species, Bryde's whale and bottlenose dolphins. Summaries for each of the marine mammals species commonly encountered within the study area are provided below.

Bryde's whales

Bryde's whales are classed as Nationally Critical, the highest designation in the New Zealand Threat Level Classification system (Baker et al. 2019). This classification is due to their assumed small population size and the susceptibility to mortality due to vessel strike within Tīkapa Moana/Hauraki Gulf (Constantine et al. 2015). Bryde's whales are regularly encountered in Tīkapa Moana/Hauraki Gulf which has been identified as important habitat for the species (Wiseman et al. 2011; Constantine et al. 2015). Bryde's whale are also regularly sighted to the north of Te Ākau/Bream Bay (e.g., Bay of Islands, Baker et al. 2007).

Sighting rates of Bryde's whales reported within Tīkapa Moana/Hauraki Gulf are similar or lower than those generated in Te Ākau/Bream Bay by this study (Dwyer et al. 2016; Hamilton et al. 2023). For example, Dwyer et al. (2016) reported sighting rates less than 0.01 for all seasons and all years (with one exception) in the inner Hauraki Gulf, compared to an average sighting rate of 0.013 in this study (Table 3-3). Further, the seasonal peaks in sighting rates within Bream Bay (e.g., 0.018 and 0.019 for January and March respectively, Table 3-3) are over double that reported in the inner Hauraki Gulf (Dwyer et al. 2016). Sightings rates in the outer Hauraki Gulf (around Aotea/Great Barrier Island) are similar to those reported in this study, with the exception of high sightings rates across all season during a single year of surveys that was not observed in subsequent years (Dwyer et al. 2016). Further, Hamilton et al. (2023) and (Tezanos-Pinto et al. 2017) report average sighting rates for Bryde's whales in the Hauraki Gulf substantially less than the rates reported in this study (Table 3-3). Thus, it is reasonable to conclude that Bryde's whales have at least similar (and potentially higher) relative density in Te Ākau/Bream Bay compared to the currently recognised New Zealand hotspot for the species.

In addition to the study area having high density of Bryde's whales, the area is also clearly important for key behaviours including foraging, with the majority of encounters recording active foraging behaviour. Successful foraging is crucial for population health of marine mammals (Baker et al. 2007) and thus the likelihood that Te Ākau/Bream Bay is important foraging habitat for this threatened species adds further weight to the significance of the area for Bryde's whales. Calves were observed during 16% of encounter with Bryde's whales which is higher than the 10% of observations with calves reported in Tīkapa Moana/Hauraki Gulf (Wiseman et al. 2011). While any meaningful comparison between the two areas in terms of potential nursery areas would require further investigation, we can confidently state that nursing Bryde's whales are regularly found within the study area.

Bottlenose dolphins

Two ecotypes of bottlenose dolphin were documented in the study area, the widely studied coastal ecotype and the poorly known offshore ecotype. Our findings suggest that this area is regularly used by both ecotypes, albeit at lower densities during the winter months (Figure 3-3). The coastal ecotype is currently classed as Nationally Endangered (Baker et al. 2019) based on a population estimate of <1,000 mature individuals and reported declines in abundance in Fiordland and northeastern North Island populations which includes the study area (Currey et al. 2009; Tezanos-Pinto et al. 2013). Our sightings and acoustic data show that coastal bottlenose dolphins use the study area widely and extensively throughout most of the year (Table 3-3, Table 3-8). With recapture rates above 70%, it is evident that there is a high degree of residency and site-fidelity to this area. Further, sighting rates (e.g., relative density) of coastal bottlenose encountered during line transects in the study (mean = 0.005/km) were similar or greater than those reported from the Bay of Islands (mean between 1994 and 2006 = 0.007 km^{-1}) (Tezanos Pinto 2009)), the inner Hauraki Gulf (<0.003/km) (Dwyer et al. 2016) and Queen Charlotte & Pelorus Sound (mean = 0.005 km^{-1}, (Merriman et al. 2009)). We note that the summer sighting rate observed in this study (0.009 km^{-1}) is higher than these areas of known importance for coastal bottlenose dolphins. Other locations including Dusky Sound (Bennington et al. 2023), Aotea/Great Barrier Island (Dwyer et al. 2016) and Admiralty Bay (Merriman et al. 2009) have sighting rates higher than those reported here.

The high recapture rates of marked individuals enabled a robust population abundance estimate of 288 (95%CI = 242 – 384) to be calculated for coastal bottlenose dolphins in Te Ākau/Bream Bay. While the current abundance of bottlenose dolphins in the Bay of Islands is notably low (approximately 35 individuals, Brough et al. in prep), the highest abundance ever recorded in that area was 240 (95%CI = 99–581) individuals in 1997 (Tezanos-Pinto et al. 2013). The abundance of bottlenose dolphins in the Marlborough Sounds is 211 individuals (95% CI: 195-232) (Merriman et al. 2009), and the two monitored populations in Fiordland (Doubtful and Dusky Sound) have population abundances of 55 (95% CI: 53–58) and 123 (95% CI: 121–124) respectively (Bennington et al. 2020). A wide-ranging population of bottlenose dolphins inhabits the south of the South Island with a minimum population size of 92 (95%CI = 80–111) (Brough et al. 2015). Thus, the abundance estimate calculated for Te Ākau/Bream Bay in this study confirms the area has one of the largest populations of semi-resident bottlenose dolphins in Aotearoa.

It is highly likely individuals from the study area migrate between adjacent areas along the north-east coast including the Bay of Islands, Aotea/Great Barrier Island and the Hauraki Gulf. For example, (Berghan et al. 2008) found around 59% of bottlenose dolphins catalogued in the Hauraki Gulf had also been observed in the Bay of Islands. Continued matching and collaboration between projects along the north-east of the North Island is important to report on the status of this population, particularly given documented declines in the adjacent Bay of Islands region (Tezanos Pinto et al. 2013). Declines in the Bay of Islands have been attributed to low calf survival (Tezanos-Pinto et al. 2015), a feature that has also been linked to population decline in Fiordland (Currey et al. 2009). The large number (n = 27) of individual calves documented in this study highlight the importance of the study area for coastal bottlenose dolphins.

Oceanic bottlenose dolphins have also been shown to use the study area frequently and extensively during summer and autumn. Our data suggest some degree of resource partitioning, with the coastal form encountered more frequently close to shore and/or in shallower waters (Figure 3-3, Figure 3-6). However, there remains a significant level of spatial overlap, particularly in the area north of the Marotere Islands. The offshore ecotype was most frequently observed in association with false killer whales. Oceanic bottlenose dolphins remain understudied in Aotearoa waters but baseline studies suggest that they are frequent visitors in inshore waters of the study area during summer and autumn (Zaeschmar et al. 2020). The numerous sightings and rare overlap with coastal bottlenose dolphin ecotypes substantiates the importance of this study area for the species.

False killer whales

False killer whales frequent the study area regularly between December and April. They are typically considered an offshore species that remains understudied (Baird 2018). Yet, the waters off north-eastern New Zealand are one of the few documented regions globally where false killer whales enter continental shelf waters for prolonged periods of time (Zaeschmar et al. 2014). Within this region, the study area is of particular importance during autumn months as evidenced by long-term sightings data (Zaeschmar et al. 2020) and the sightings generated as part of this study. Moreover, sightings are not confined to areas of greater water depth. Rather, false killer whales have been regularly observed in shallow nearshore waters (< 50 m) within the study area and appear to utilise a variety of habitats. The individuals observed form part of a tightly connected group of <150 individuals who have been documented to frequent the area for almost 20 years. False killer whales are classed as At Risk (Naturally Uncommon, Baker et al. 2019) due to their low numbers.

Common dolphins

Common dolphins were the most frequently sighted cetacean species within the study area (Table 3-3). While we could not reliably classify odontocete whistles to species, common dolphins were likely the species most frequently detected during our acoustic recordings (Table 3-8). These findings are consistent with their widespread abundance in Aotearoa waters (Stockin & Orams 2009). The sighting rates of common dolphins reported in this study (mean = 0.016 km^{-1}) are similar to those reporting in the Hauraki Gulf by (Stockin et al. 2008) (mean = 0.021 km^{-1})[3] and by Dwyer et al. 2016 (range ~0.008 to 0.042 km^{-1}). Seasonal fluctuations in sighting rates were also similar between this study and (Stockin et al. 2008), with higher sighting rates in winter. While not directly comparable due to differences in survey methodology, (Meissner et al. 2015) recorded a high sighting rate of 0.066 km^{-1} for common dolphins in the Bay of Plenty. Thus, similar to the other cetacean species, the study area is likely to be used by common dolphins to a degree comparable to the nearby Hauraki Gulf. Large feeding events involving common dolphins and often Bryde's whales were routinely observed in the study area, highlighting its significance as an important foraging habitat for both species.

Other species

While less common, the other marine megafauna species encountered during our surveys make importance contributions to the biodiversity of the study area. Killer whales are listed as nationally critical under the NZ threat classification system (Baker et al. 2019), and their occurrence in the study area adds additional weight to the importance for this region. Long-finned pilot whales occur commonly throughout the deeper shelf and shelf-break waters around Aotearoa. Their regular occurrence in the study area showcases the diversity of habitats within a relatively small area off the Northland coast. Non-mammal megafauna including sharks and manta rays are becoming increasing recognised components of New Zealand marine megafauna that play important roles in pelagic marine ecosystems (Bornatowski et al. 2018). The sightings of manta rays in this study will contribute to ongoing research on their populations, distribution and habitat use (Cooper 2024).

4.2 Seabirds

Our seabird surveys have provided the first information on the occurrence and distribution of key species within the wider Te Ākau/Bream Bay area. The twenty-four species recorded during

[3] Adjusted from sightings per 60mins using vessel speed provided (15 kn)

systematic bird counts provide a good representation of the seabird community of coastal north-eastern New Zealand. However, it should be noted that our species list includes several species complexes that are likely representative of multiple species (e.g., prions, skuas, storm-petrels). Further, common nearshore species (e.g., shags, some terns) are not well represented likely due to a lack of survey effort in nearshore and harbour habitat. Twenty-seven species of seabird are known to breed within the Hauraki Gulf and surrounding areas, and the area has a high diversity of transient species (Gaskin & Rayner 2017; Gaskin 2021). Our at-sea surveys have collected a high proportion of the species that reside in the area.

There are few other studies with which to compare the at-sea observed diversity recorded in this study. Surveys off the coast of the Far North have reported a similar number of species to this study (23 species) (Winterle Daudt 2024). Recent surveys of coastal habitat in several locations on the east coast of the South Island reported 27 seabird species in Dunedin, 13 at Moeraki, 12 at Timaru, 29 at Banks Peninsula (Bourke & Bennington 2024). Banks Peninsula and Dunedin are well known for their high seabird diversity. That the species richness recorded via at-sea surveys in our study is comparable to locations with known high diversity suggests Te Ākau/Bream Bay is an important location for seabirds.

In addition to the high seabird diversity, we observed several species of importance due to their threatened status or cultural importance. Many Aotearoa seabird species are considered 'threatened' or 'at-risk' under the NZ Threat Classification System (NZTCS) (Robertson et al. 2021). Threatened species observed during this study include NZ storm petrel, brown skua, and black petrel; at-risk species include little penguin, red-billed gull, white-fronted tern, Buller's shearwater, Cook's/Pycroft's petrel. The common occurrence of several of these threatened or at-risk species substantiates the importance of this area for seabirds.

4.3 Spatiotemporal patterns

The calculation of seasonal sighting rates and the generation of seasonally dynamic species distribution models revealed the key locations and times of the year marine mammals and seabirds aggregate within the study area. There were strong seasonal signatures for most marine mammals. Both bottlenose dolphin ecotypes, Bryde's whale, false killer whale and to a lesser extent common dolphins had higher relative density and probability of occurrence in the warmer months. Seasonal variation in cetacean distribution is well known for many species throughout Aotearoa waters (Brough et al. 2019; Bennington et al. 2023; Stephenson et al. 2023b). Oceanic bottlenose dolphins and false killer whales are known for their seasonal presence in coastal Northland waters during the warm season; their location in the cool season is not known (Zaeschmar et al. 2014). Coastal bottlenose dolphins in Fiordland have seasonal patterns of distribution, and they spread into deeper, more open water during the winter (Henderson 2013). Seasonal distribution in Bryde's whales is well known in the Hauraki Gulf and elsewhere within their Aotearoa range, where whales are typically less common during winter compared to summer (Baker & Madon 2007; Dwyer et al. 2016; Stephenson et al. 2023b), although there is interannual variability in this trend (Dwyer et al. 2016). Common dolphin distribution is generally assumed to be seasonally variable, with increased use of areas closer to shore in the austral summer (Stockin & Orams 2009). There are, however, some exceptions to this seasonal pattern. In the Hauraki Gulf, common dolphins have a higher probability of occurrence in the Hauraki Gulf during the austral winter and spring (Dwyer et al. 2020), and in the Bay of Islands the species is more common in the autumn (Constantine 1995). The seasonality in the distribution of marine mammals is typically thought to follow that of their prey (Torres et al. 2008; Brough et al. 2023), or to be related to particular habitat requirement for key life history stages (e.g., calving) (Rayment et al. 2015; Sprogis et al. 2018).

The most commonly occurring marine mammal species each had distinct spatial patterns in distribution and habitat use. Coastal bottlenose dolphins were more commonly associated with nearshore habitat, although they also had important hotspots approximately 10 km offshore north of Whangārei Heads and around the offshore Island (Figure 3-3). The frequent use of nearshore habitat by this species increases their risk to anthropogenic stressors (see below), the impacts of which have been well documented in other areas in Aotearoa (Lusseau 2003; Constantine et al. 2004; Dawson & Slooten 2005; Currey et al. 2009). Key habitat for oceanic bottlenose was located largely offshore of the Taranga/Marotere Islands (Zaeschmar et al. 2020).

False killer whales, widely regarded as a pelagic top-predator (Baird 2009), had important hotspots within offshore components of the study area, although they were also frequently sighted around the offshore Islands (Figure 3-13). The use of coastal-shelf environment by false killer whales is known from tropical ecosystems (Baird et al. 2010; Weir et al. 2013), but the persistent use of coastal habitat seen in this study is unique among sub-tropical/temperate regions (Zaeschmar et al. 2014). Key locations for Bryde's whales in the study area focussed on a band of habitat an intermediate distance from the coastline, including hotspots within Te Ākau/Bream Bay itself (Figure 3-10).

Use of coastal embayments by Bryde's whales is well known in the inner Hauraki Gulf (Wiseman et al. 2011; Stephenson et al. 2023b) and the Bay of Islands (Baker & Madon 2007). As with coastal bottlenose dolphins, persistent use of nearshore habitat raises concerns for the impact of stressors associated with coastal habitat (see below). Given the high incidence of foraging observed by Bryde's whales in this study, it is likely that this band of important habitat provides good quality foraging opportunities via increased availability of prey (zooplankton and small fish) (Izadi et al. 2022). Important habitat for common dolphins overlapped that of Bryde's whales, although the core common dolphin habitat was distributed further offshore, beyond the Marotere/Taranga Island groups (Figure 3-8). Overlap between common dolphins and Bryde's whales is unsurprising given the frequent multi-species foraging aggregations observed in this study and in the Hauraki Gulf (Gostischa et al. 2021). The more offshore distribution of common dolphins matches closely with that observed in the Bay of Islands (Constantine & Baker 1997), the Bay of Plenty (Meissner et al. 2015), and in the Hauraki Gulf ((Dwyer et al. 2020; Stephenson et al. 2023b)) – although common dolphins also regularly occur within inshore habitat during in the latter location (Stockin et al. 2008; Dwyer et al. 2020; Stephenson et al. 2023b).

Highly dynamic patterns in seabird distribution and habitat use were also noted in this study. In particular, the lower occurrence of most species during the cool season (Figure 3-17, Figure 3-19). While many of the species breed in the surrounding area, several (e.g., Cook's/Pycroft petrel, black petrel, Buller's shearwater, flesh-footed shearwater, white-faced storm petrel) undergo seasonal migrations to areas throughout the Pacific during the NZ winter, and thus the lower occurrence during the cool season is expected (Heather & Robertson 2015). Flesh-footed shearwaters also had high probability of occurrence during the cool season, which is likely due to their arrival back from the north Pacific for breeding at the Marotere Islands in September (Taylor 2022).

We also encountered lower occurrence for species expected to be present year-round including kororā/little penguin, Australasian Gannet and fluttering shearwater (Figure 3-19, Figure 3-20). For these resident species, it may be that the study area is not as routinely used during the cooler season, and individuals forage more selectively elsewhere. Alternatively, the survey conditions experienced during the cooler season may reduce the sightability of seabirds in general, causing some downward bias on sightings rates and probability of occurrence (Lambert et al. 2024). Two species (diving petrels and prions) were more common during the cool season, in contrast with the other commonly occurring species (Figure 3-19, Figure 3-20). Diving petrels tagged from Northland have recently been shown to undertake seasonal (summer) migrations south to the polar front (Rayner et al. 2017), which would explain reduced presence in the study area during the warm season.

Spatially, each of the common seabird species had distinct distribution patterns. Key habitat for kororā was distributed throughout the nearshore component of the study area with hotspots between Taranga and Te Paepae o Tu (Bream Tail) and off Oceans Beach. Key habitat in the cool season was identified closer inshore within Bream Bay (Figure 3-16). As kororā are central place foragers, their foraging (at-sea) distribution is influenced by the proximity of their colonies which occur on both offshore Island groups and around Whangārei Heads. The use of inner Bream Bay by kororā raises concern due to the potential habitat modification and anthropogenic stressors in this area. Cook's/Pycroft petrel were distributed widely throughout the study area during the warm season, but had hotspots around Taranga and towards Hauturu – breeding colonies for both species (Taylor 2013; Taylor & Rayner 2022). During the cool season, the key habitat for diving petrel was inshore of the Islands (Figure 3-19) – an area shared with Bryde's whales.

As both species forage on zooplankton, this area may be important for this prey community. Flesh-footed shearwaters had distinct seasonal patterns in distribution with more offshore use during the September breeding season (Figure 3-19. Similarly, key habitat for Buller's and fluttering shearwater was concentrated further inshore during the warm season. Seasonal inshore-offshore patterns of space use are common in seabirds and typically relate to the seasonal availability of their prey community (Montevecchi et al. 2009; Suryan et al. 2016). White-faced storm petrels and Australasian Gannets shared a high density area around and north of the Marotere Islands. These two species represent distinct seabird foraging guilds, thus their shared overlap in this area suggest the location may be productive habitat for both zooplankton and small epipelagic fish.

4.4 Te aō Māori perspectives

The mana whenua of Te Ākau/Bream Bay have held a historical, deep understanding of the importance of the area for marine megafauna. From kōrero associated with place names (e.g., Te Rerenga Parāoa, Ngā Rima Tohorā o Manaia and nearby Whangaparāoa), and pūrākau including tohorā and the kauri it is clear there is long-term affinity between Patuharakeke and their tipuna and nga tamaraki o te tinirau. Thus, the importance of Te Ākau/Bream Bay for marine mammals clearly aligns with the historical understanding of the ecology of the area.

The high use of the area by resident marine mammals and seabirds and the high occurrence of wide-ranging species (e.g., false killer whales, pilot whales) suggest there are persistent ecological features to draw these species to the study area. It is likely that oceanographic features occur in this area that enhance the availability or catchability of prey. This may occur via aggregation (e.g., entrainment) or via increases in productivity via upwelling events or oceanographic features such as fronts, eddies or island wakes (Owen 1981; Johnston et al. 2005; Johnston & Read 2007). Such features are known to occur along the Northland's coast due to the way the south-flowing east Auckland current interacts with topography (Stevens et al. 2021). The high productivity and abundance of life in these waters closely with the Ngatiwai pūrākau around the naming of the Islands in this area, where the area was the chosen fishing grounds for Maui and his brothers and the location where Maui fished Te-Ika-a-Maui/the North Island, thus the Islands being named for the brother of Maui and Maui's mother (Taranga).

Specific mātauranga around the summertime aggregation of whales within the coastal waters and around Te Rerenga from the Final Report clearly correspond with our survey results where Bryde's whales, false killer whales and other marine mammals were significantly more common during summer. Interesting, Parāoa is usually taken to represent the sperm whale, a deep-diving specialist not typically found in coastal habitat. It may be that Parāoa was a term used more widely for whales generally (such as tohorā and upokuhue), but more research is required to determine such usage.

Our wānanga were gifted significant species and area-specific knowledge from guest tohunga tohorā. Much of this information closely fit with our observations from the survey programme including the high abundance of Bryde's whales and common dolphins within the study area and the overlap between several seabird species and whales. Importantly, other information was more reflective of the way things were in the past. Knowledge on the historical use of the harbour and surrounding waters by tohorā/southern right whales is vital for Patuharakeke given the extirpation of this species due to industrial whaling (Carroll et al. 2014). Tohorā are currently rebuilding their population after being decimated to near extinction during the commercial whaling era (Carroll et al. 2014). These charismatic whales use coastal, nearshore areas heavily during the winter calving season (Carroll et al. 2014; Rayment et al. 2015) and during periods of migration (see section 3.6).

The return of tohorā would be highly significant for Patuharakeke, who anticipate their return by striving to keep their coastal habitat in the best possible condition. Similarly, the use of Te Ākau waters by migrating Paikea/humpback whales during their southern migration was not recorded during our surveys and is likely more representative of a historical state before Soviet-era whaling significantly reduced the Oceania humpback population (Ivashchenko & Clapham 2014). As with tohorā, this mātauranga provides critical insights on a historical baseline that serve a pou for the future.

Populations of coastal marine mammals are likely strongly influenced from impacts on land (e.g., sedimentation, eutrophication, pollutants). The pūrākau surrounding the relationship between tohorā and the kauri provide strong guidance for engaging in kaitiakitanga of marine mammals by exemplifying the relationship between the terrestrial and marine ecosystem. The health of one system is intricately connected to the other.

4.5 Kaitiakitanga

The marine mammals and seabirds identified as key components of the Te Ākau/Bream Bay and Te Rerenga in the Final Report of the Whangārei Harbour ecosystem face a range of threats to their populations. The extent of these threats depends on spatial and temporal overlap with key stressors and the severity of interactions. To guide kaitiakitanga, several of these are discussed below.

The key threat to Bryde's whales in Aotearoa is mortality due to vessel strike, which has had population-level consequences in the Hauraki Gulf (Constantine et al. 2015). Vessel-induced mortality has decreased significantly after the introduction of voluntary speed restrictions for large vessels within Tīkapa Moana/Hauraki Gulf (Ebdon et al. 2020). The study area is currently not subject to any vessel speed restrictions. The high probability of occurrence of Bryde's whales in Te Ākau/Bream Bay, overlapping the major shipping lanes to and from Northport, confirm the importance of considering similar vessel management in this area. This is particularly important, given the potential for shipping traffic to increase in the study area due to port expansion.

As mentioned above, the impacts of adjacent land use may have impacts on species that regularly use near-shore habitat. For species including coastal bottlenose, Bryde's whale, killer whales, kororā, fluttering and Buller's shearwaters, the impact of land-use on coastal water quality (e.g., turbidity, nutrient enrichment) and sedimentation may degrade foraging habitat or impact prey availability/catchability. Large-scale developments that result in degradation of coastal habitats should consider the importance of this area for these species. Further, extractive marine practices (e.g., mining) should be carefully managed to avoid overlap with areas of importance with coastal megafauna.

Many of the cetaceans (common and bottlenose dolphins, false killer whales) and seabirds (black petrels, shearwaters) face considerable threats due to bycatch in commercial fishing, particularly long-line fisheries. For black petrels, bycatch is the key threat facing this species that is endemic to this region ((Bell 2016). Long-line fishing occurs in the most offshore component of the study area and research documenting potential high incidental capture of seabirds in the fishery highlights the importance of determining any population level consequences of this threat (Abraham & Richard 2020).

A range of other stressors including noise pollution from coastal development and shipping, disease, overfishing, climate change and combinations of several stressors may impact populations in this important area. Ongoing research should aim to assess population status of these taonga species and discern the impact of any stressors that occur within this area.

4.6 Summary of key findings

Over multiple years of systematic surveys, opportunistic encounters and pooling of insights from te aō Māori, this project has provided a robust baseline on ecology of marine mammals and seabirds within Te Ākau/Bream Bay and Te Rerenga Pāraoa. Key findings of Tere Tohorā, Karanga Tangata include:

- Establishing the importance of the wider Te Ākau/Bream Bay for marine mammals. The area has high diversity of marine mammal species (at least 7 species) and the relative density of key species including Bryde's whales, coastal and oceanic bottlenose dolphins, common dolphins and false killer whales is comparable or higher than documented areas of importance for these species.
- Documentation of the largest population of semi-resident coastal bottlenose dolphins in Aotearoa with an abundance of 288 individuals with high residency in Te Ākau/Bream Bay.
- Determination of the spatial and temporal distribution patterns of 5 commonly occurring marine mammal and 8 seabird species, and the identification of hotspots for each species.
- Regular foraging behaviour observed by all the commonly occurring marine mammals confirms this area is likely an important foraging area for multiple species.
- The confirmation of a diverse seabird community with at least 24 species, and a high proportion of threatened and at-risk species.
- The alignment of key findings across dual knowledge-systems to confirm the importance of this area for marine megafauna.

4.7 Conclusions

This baseline study has confirmed the importance of Te Ākau/Bream Bay for marine mammals and seabirds. This information comes as no surprise to mana whenua/mana moana who have long-standing traditions and associations with the region's megafauna. The biodiversity values presented here are also somewhat expected given the proximity to the well-studied Tīkapa Moana/Hauraki Gulf, and general knowledge on the biodiversity of north-eastern Aotearoa. However, accurate documentation of the importance of this area from both conventional science and te aō Māori approach provides Patuharakeke, their whanaunga and wider partners with robust information that can be used to inform the practice of kaitiakitanga of this rohe moana of special significance.

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Appendix D Marine Mammal Acoustic Monitoring, Pākiri Embayment, 2019

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

This appendix presents an excerpt (Sections 2 and 3) from:

Styles Group 2020. Assessment of Underwater Noise Effects: Proposed Offshore (<25 m depth) sand extraction: Managwhai – Pākiri Coast. Report prepared for McCallum Bros Ltd by Dr Matt Pine, Styles Group. Report Date 30 June 2020.

Key findings from the marine mammal acoustic monitoring that was undertaken as part of this assessment are as follows:

- Two hydrophone arrays were deployed in 30 m of water off the northern end of Pākiri Beach;
- Data was collected for a total of 69 days over two deployments: the first between 19 March and 25 April 2019, and the second between 9 May and 10 June 2019;
- A total of 64 dolphin detection events were made, and although detections could not be attributed to species level, it is assumed that detections were either common dolphins or bottlenose dolphins. Feeding buzzes were frequently detected and confirm that dolphins foraged in the vicinity of the hydrophones; and
- Baleen whale vocalisations were detected at least once on 25 days of the 69 days of data collection. All baleen whale detections were assumed to be Bryde's whales based on their residence status in and around the Hauraki Gulf.

2.0 The Existing Underwater Soundscape

Marine mammals (as well as fish and marine invertebrates) depend on underwater sound for critical life processes. These processes include, but are not limited to, keeping group members together while navigating turbid coastal waters, communication between family members, locating prey during feeding, mediating mating behaviours, and avoiding predation (Montgomery et al., 2006; Popper et al., 2001; Radford et al., 2007; Richardson and Thomson, 1995; Slabbekoorn et al., 2010; Stanley et al., 2010). Their ability to communicate and sense their environment using sound is therefore linked to the ambient sound environment; whereby the biologically-important signal must be audible over the background sound level within some critical bandwidth. Coastal activities, including pile driving, dredging, shipping, drilling, etc, can cause ambient sound levels over wide frequency bandwidths to rise – to the point where biologically-important signals for marine mammals can be masked, leading to increased stress and sub-lethal behavioural responses (Southall et al. 2007; Nowacek et al. 2007). Underwater noise pollution can therefore degrade marine mammal habitats within sites where offshore (up to 25m depth) activities take place.

Notwithstanding, the extent of which possible effects may occur is not always homogenous across sites or regions but vary according to the physical environment. Generally, noise effects can only occur if the invading noise source is audible (audibility being a function of both the ambient sound levels and hearing thresholds of the listener). Therefore, in order to properly assess the spatial extent of possible acoustic disturbances, the ambient soundscape must be fully considered and incorporated into the effects modelling (in the context of the species' hearing thresholds).

2.1 Methodology

2.1.1 Study Site and Recorders

To characterise the ambient soundscape within the area, we deployed four SoundTrap 300HF recorders (two arrays, providing sampling redundancy) off the northern end of Pakiri Beach (Figure 2). That area was chosen due to dredging operations occurring nearer Mangawhai. The sampling rates were at 96 kHz, while the click detectors operated at the full sampling rate of 576 kHz. The arrays were deployed along the 30m depth contour between 19 March and 25 April 2019, and then again between 9 May and 10 June 2019.

The hydrophone component of the SoundTrap recorders was calibrated by the manufacturer and field-calibration checks before and after deployments were undertaken using a calibrated piston phone (GRASS Type 42AA, SPL 114 dB re 20 µPa, nominal frequency 250 Hz), a calibrated (using a Brüel & Kjaer Type 4231 Sound Calibrator) sound level meter (Brüel & Kjaer 2250 Type 1 SLM with a Brüel & Kjaer ½ inch Condenser Microphone Type 4189) and specialist acoustic software. Electronic calibration of the recorder component was done at the start of every recording event by comparing a set of automated tones of known frequency and voltage amplitude to the full-scale response level provided by the manufacturer for the appropriate gain setting, and verified using the piston phone.

Figure 2: Google Earth image showing the locations of the two hydrophone arrays used to characterise the existing soundscape.

The two arrays were identical for sampling redundancy reasons.

2.1.2 Overview of Analysis Procedure

The sound pressure levels (*SPL*s), daily in-band sound energy contributions (as a percentage), power spectral densities (*PSD*s), and third octave band levels (*TOL*s) were calculated, along with the statistical variation. The *PSD* data were plotted as long-term spectral averages (*LTSA*). *LTSA* plots are useful in allowing large time series data to be viewed and analysed in a more efficient way. In total, 3,318 sound files were generated and viewing all those files as individual spectrograms would be near impossible. *LTSA* plots provide the means to compress the data and view all recordings as a whole, revealing an overview of the spectrum for the monitoring period. The .WAV files were uploaded to PAMScan's file directory and restructured into 1-min time-bins. Acoustic analyses were then undertaken on each minute and the 1-min time averaging was then applied (generating the time-averaged data for the *LTSA*). The statistical analyses of the *PSD*s (percentile levels (1st, 5th, 25th, 50th, 75th, 90th and 99th percentiles) and spectral probability densities) and *TOL*s (boxplots) were then performed and plotted. Bandpass filters for four bandwidths (10 – 100 Hz, 100 – 1000 Hz, 1 – 10 kHz and 10 – 32 kHz) were then applied to the raw waveform for each 1 minute of data. The bandpass filtered 1-min L_{eqs} were then calculated for each time-bin, generating a single mean value for each time bin and frequency bandwidth. The *SPL* data were then batch processed by individual days (each 1-min bin was time stamped, determined by the file name of each recording) and averaged over each day (so a single mean value for each day was obtained). The in-band energy contributions of each frequency band were calculated at the same time as the daily L_{eqs}, expect an additional algorithm was used that took the daily acoustic energy in each frequency band, compared it to the total energy in the whole bandwidth, then multiplied it by 100 to generate a percentage. The results were plotted for the whole monitoring period, showing the change in each day.

2.2 Results: The Existing Soundscape

All figures in this section are provided in Appendix B, and referenced as such.

The relative broadband (10 Hz – 48 kHz) daily *SPL*s varied by approximately 15 dB re 1 µPa (between 96 dB re 1 µPa (on 25 March) and 111 dB re 1 µPa (on 14 April) over the survey period and are provided in Figure 18. The hourly broadband *SPL*s are provided in Figure 19, and do show dawn and dusk choruses (typical of nearshore habitats (Pine 2013)). Broken down into smaller bandwidths, the bands between 100 Hz and 10 kHz showed similar trends to the broadband levels. Unlike busy harbours, the *SPL*s below 100 Hz were generally lower than the 1 – 10 kHz band, reflecting the fewer vessels in the study area.

The relative in-band daily *SPL* contributions over the survey period are also provided Figure 20. The relative in-band daily *SPL* contributions were generally higher for the lower frequency band 100 – 1000 Hz, followed by the mid-frequency band 1 – 10 kHz. This did differ on occasion, with inclement weather (as particularly evident in the *LTSA* data, Figure 21) increasing levels below 100 Hz (Figure 20).

The *LTSA* plot is provided in Figure 21. The *LTSA* plot reveals similar trends to the in-band contributions, but at a much finer frequency resolution (every 1 Hz). Figure 22 and 23 respectively show the statistical plots for the *PSD* and *TOL* data from the whole survey period (between March and June 2019). These plots are useful for showing the variation in the decibel levels for each frequency or frequency band, as well as the corresponding spectral probabilities. This descriptive statistical analysis revealed considerable variation in the frequency-dependent sound levels. Generally, the ambient noise floor (represented by the 1st and 5th percentiles in the *PSD* data, Figure 22) shows a shallow slope with no distinct rises between 500 and 2000 Hz – which is typical of a sandy bottom habitat with limited vessel traffic (Radford et al. 2010). The higher percentiles (the 95th and 99th percentiles and represented the more transient events) do reflect the presence of vessels (also seen in the *LTSA* data) but have limited influence on the averaged and median sound levels.

Overall, the ambient soundscape is typical of a sandy beach habitat that is not inside or near a busy harbour.

3.0 Marine Mammal Detections

3.1 Data analysis

Automated detectors and classifiers for marine mammal vocalisations were run through all acoustic data from the northern array. The detectors were focused on dolphins (species unidentifiable beyond a broadband click species, i.e. bottlenose and common dolphins) and whales (baleen whales, assumed to be Bryde's whales based on their resident status within the Hauraki Gulf and time of the year during which this study took place).

Dolphins were detected in the acoustic dataset based on their echolocation clicks and whistles using PAMGuard[4] (Figure 3, Putland 2017). Detection data from the on-board click detector in the SoundTrap 300HF units were also processed in PAMGuard, as well as the .WAV snippets. Snapping shrimp were a prevalent source of false positives in the detection data and so positive detections were only logged when a train source was identified and manually verified by assessing the waveform, spectrum, Wigner plot, *PSD* and in some cases, playing back the edited audio file itself. Once a true positive was confirmed, the start time, end time and duration of that detection event were logged, as well as the minimum inter-click interval (to determine the presence of foraging buzzes, and thus foraging activity). A single detection event was defined as the time between the first and last confirmed vocalisation (either echolocation clicks or whistles) after no vocalisations were detected for more than 30min followings the last detection (Pine et al. 2017).

Whale vocalisations were detected using a custom-written detector similar to that described by Hendricks et al. (2018), but modified for the Mangawhai – Pakiri region. The detector first runs through an adaptive entropy band detector, then runs an additional algorithm based on the spectrogram itself to confirm the presence and location of a whale's call within the recording. The detector worked by breaking the signal into 10-second windows and performing the processing in each window with 50% overlap. Using an optimised-sized Hann window, the entropy in each window was calculated and compared those to a dynamic threshold based on the background entropy after being scaled for the variance per unit of time. When the entropy dropped below the set threshold, the program indexed the number of successful triggers and flagged the detection when the number of successive triggers reached the required minimum (Hendricks et al. 2018). The start and end times were then extracted and a 120 second spectrogram around the detection was generated and saved as a .PNG image for reference. Those spectrograms were then binarised based on adaptive thresholds inside a predetermined window to identify the call's contours for cross-correlation with known calls. If the contours of the detection met the required criteria, the .PNG was moved to a new directory for quick manual verification.

[4] PAMGuard is an open source software designed specifically for bioacoustic analyses of passive acoustic data and the detection and classification of marine mammal vocalisations. It is the most commonly used software for passive acoustic monitoring of marine mammals worldwide. See www.pamguard.org

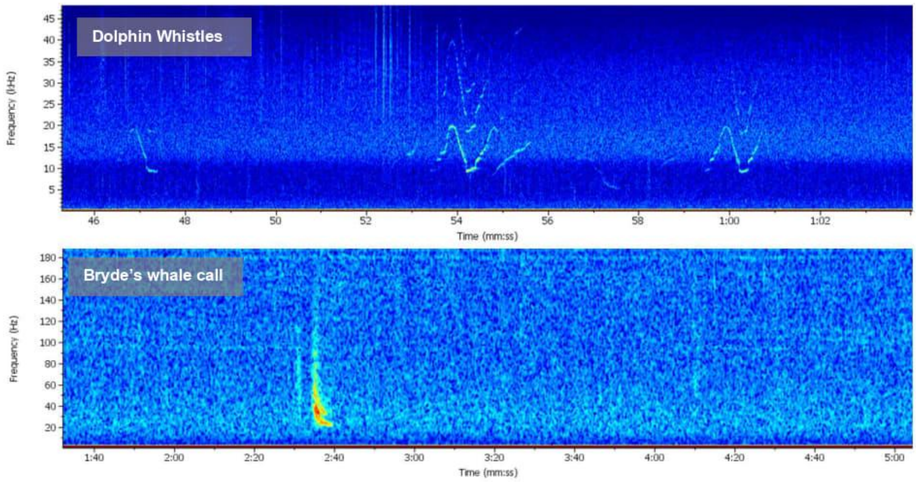

Figure 3: Spectrogram showing examples of detected dolphin whistles (lower end of echolocation clicks also visible between 52 and 54 seconds) (Top Panel); and a single Bryde's whale call (Bottom Panel).

3.2 Results: Marine Mammal Detections

A total of 64 detection events (comprising of thousands of echolocation clicks spanning 22hr 24min) of dolphins (either bottlenose or common dolphins) were confirmed, while 477 Bryde's whale calls were detected over the 69 recording days (Figure 4). Of the 64 dolphin detection events, 36% of them contained feeding buzzes. A summary of dolphin detections are provided in Table 1 and the activity plots (including foraging activity) are provided Figures' 5 through 7.

Table 1: Durations of the dolphin detection events

Median (h:mm:ss)	Average (h:mm:ss)	Min (h:mm:ss)	Max (h:mm:ss)
0:12:00	0:20:22	0:03:00	1:36:00

Bryde's whale vocalisations were detected at least once during 25 days out of the 69 day deployment (i.e. 36% of all days monitored contained at least 1 whale call).

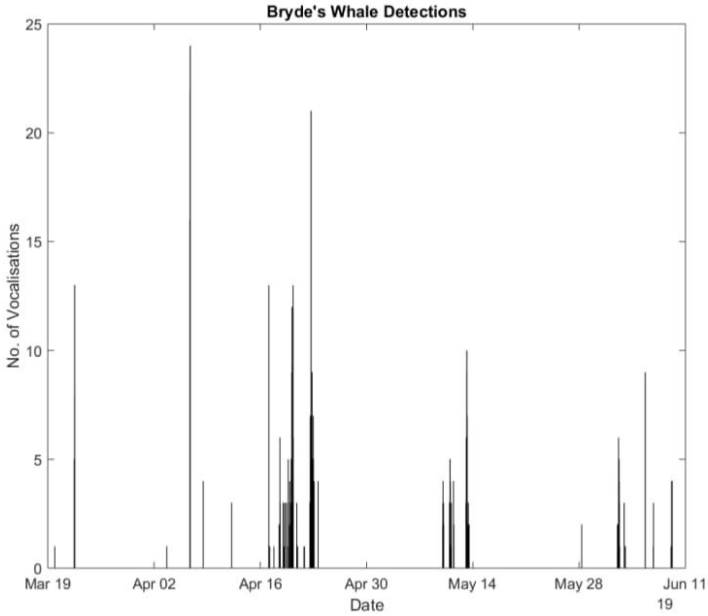

Figure 4: Acoustic detections of Bryde's whales during the monitoring period.

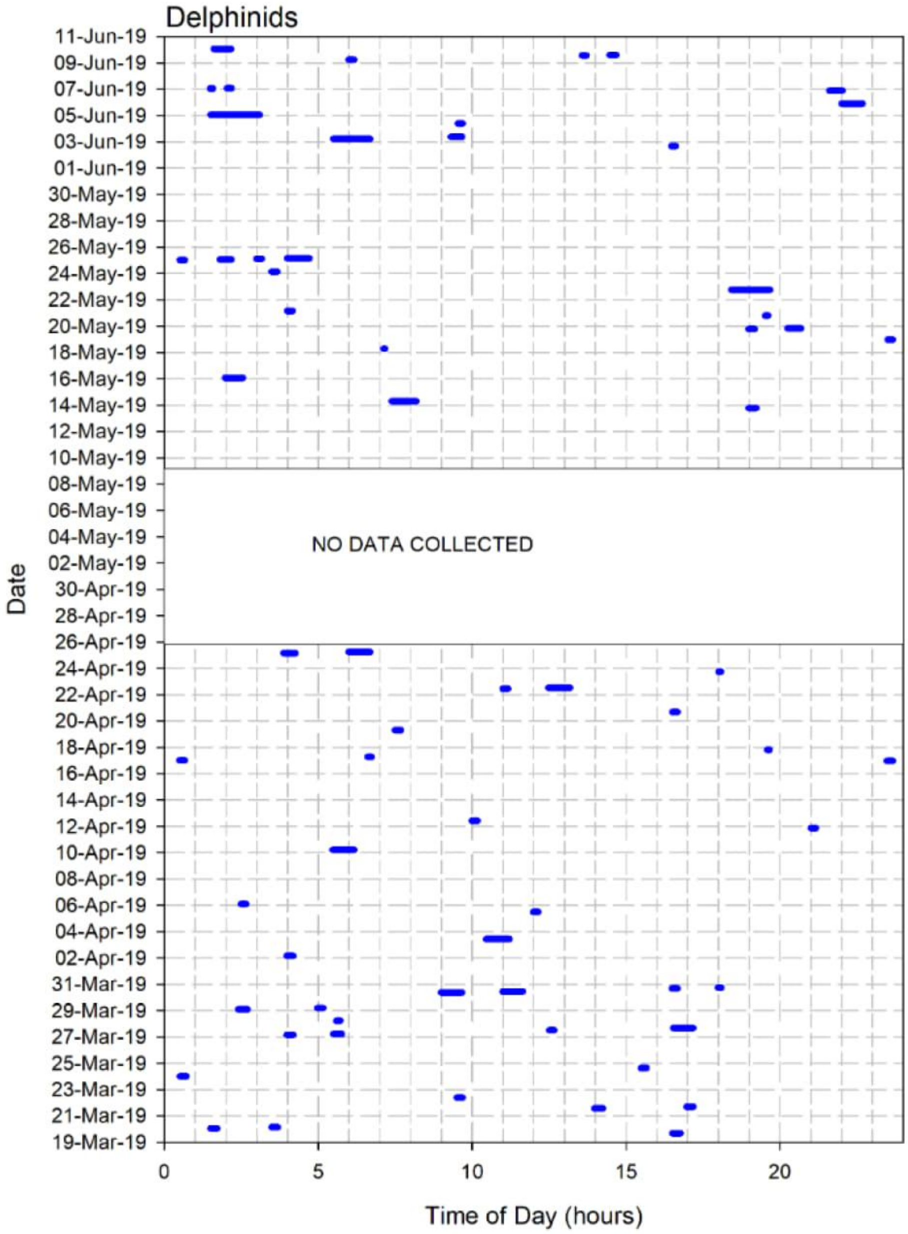

Figure 5: Actograms showing bottlenose/common dolphins during the monitoring period.

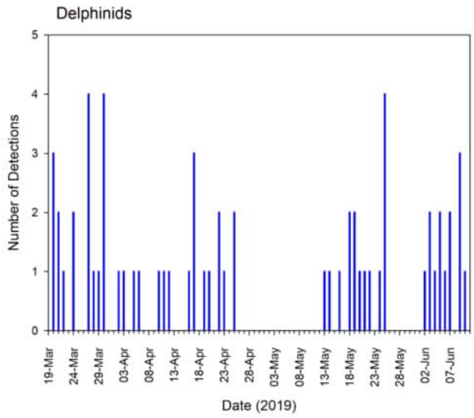

Figure 6: Number of acoustic detections of bottlenose/common dolphins per day over the monitoring period.

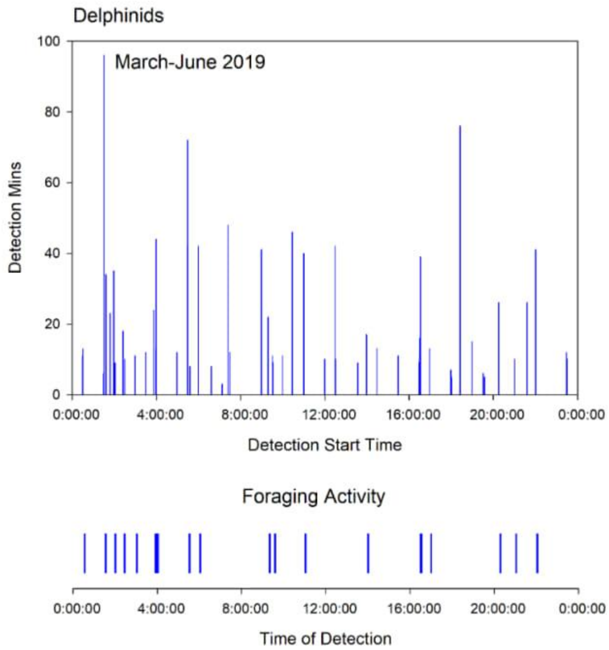

Figure 7: Plots showing detection durations of bottlenose/common dolphins (presented as detection minutes) (top panel) and occurrence of feeding buzzes (bottom panel) over the day.

These data have not been time averaged, but are the actual durations overlaid for the monitoring period

Appendix E Marine Mammal Acoustic Monitoring, Whangarei Harbour, 2020 - 2023

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

This appendix presents an excerpt (Appendix 1: Clement & Pine, 2023) from:

Clement, D. 2023. Statement of Rebuttal Evidence of Deanna Marie Clement (Potential Effects of Proposed Northport Reclamation on Marine Mammals). Resource Consent Application by Northport Limited before the Whangarei District Council and the Northland Regional Council. Dated 3 October 2023.

Key findings from the marine mammal acoustic monitoring that was undertaken as part of this assessment are as follows:

- Hydrophone arrays were moored in three separate locations (Calliope, Passage Island and Sinclair) near Whangarei Harbour Entrance;
- Nineteen separate deployments were made starting on 19 June 2020 and ending on the 5 September 2023. The number of monitoring days varied between hydrophone locations (Calliope = 599 days; Passage Island = 425; Sinclair = 523);
- Overall dolphins and orca were only detected on 9 – 15% of the days sampled and detections rates were highest in winter and spring;
- Orca detections were made less frequently than dolphins;
- Baleen whale calls were only detected at the Calliope mooring which was the seaward most mooring). “As these low frequency calls can be detected at distances greater than 10 kilometres from the whale, a single recorder cannot triangulate the caller’s location. Hence, it was assumed these calls were from Te Ākau Bream Bay or beyond as no whale calls were recorded at the other moorings”; and
- Dolphins detections were made during both day and night, indicating that no diurnal pattern is relevant to harbour use,

APPENDIX 1: SUMMARY OF NORTHPORT MARINE MAMMAL MONITORING DATA

Summary of Whangarei Marine Mammal Acoustic Monitoring Results

D Clement and M Pine 2023

Northport undertook an underwater acoustic monitoring programme in order to collate ambient background noise for further noise propagation modeling and effects radii. Figure 1 shows the deployment locations of the three separate moorings. The underwater recorders also collected any echolocation clicks and calls from the various odontocete (toothed whales) and baleen whale species that were vocalising as they travelled in and out of the Whangarei Harbour entrance and near the moorings.

Figure 1. The deployment and retrieval locations of the three monitoring moorings in relation to the relevant bays.

Results

Nineteen separate deployments were made starting on 19 June 2020 and ending on the 5 September 2023. As Table 1 highlights, recorders were not deployments continuously across the three moorings or over the entire three years of sampling. More information on the acoustic programme is included in Pine (2022). The dataset suffered from the normal field work problems (e.g. missed sampling periods, failed equipment, bad weather delays, battery or memory failure, data corruption, etc.). Due to some of these reasons, the data itself has been more difficult to analyse than most and is one of the reasons that the final data were not fully available until now.

Table 1: ***A list of the deployment dates and the actual sampling days at each of the different mooring locations. Dashed lines indicate breaks of more than one month in deployments. * two recorders were deployed at this location over the same period.***

Year	Start Date	End Date	Calliope	Passage Island	Sinclair
2020	19/06/2020	24/07/2020	33	31	55 *
	24/07/2020	28/08/2020	35	35	0
	28/08/2020	08/10/2020	38	38	30
	05/10/2020	29/10/2020	24	0	29
	29/10/2020	02/12/2020	34	34	34
2021	07/07/2021	30/08/2021	46	6	0
	30/08/2021	02/10/2021	33	33	0
	05/10/2021	18/11/2021	0	0	44
	18/11/2021	21/12/2021	25	38	34
2022	21/12/2021	21/01/2022	31	35	0
	21/01/2022	26/02/2022	36	38	26
	05/05/2022	05/06/2022	31	33	31
	09/09/2022	16/10/2022	35	34	37
2023	20/12/2022	20/01/2023	31	21	0
	20/01/2023	22/02/2023	31	0	31
	20/02/2023	21/03/2023	29	17	29
	21/03/2023	21/04/2023	30	0	27
	12/05/2023	14/06/2023	37	32	32
	14/06/2023	05/09/2023	41	0	82

Table 2 provides a summary of the total number of sampling days and detections events at each of the three moorings. Calliope (at the entrance to the harbour) recorded more sampling effort, as well as detections, while Passage Island had the least effort. The total number of days in which at least one detection was recorded was standardised by the total days of effort at each mooring over the seasons. Overall, detection rates indicated that dolphins / orca were only present and vocalising in the harbour entrance area around 9 to 15% of the days sampled.

As evident in Figure 2, lower rates of detections were found over summer and autumn at all three locations despite high effort levels in same cases. These findings are in general agreement with the most odontocete species' occurrence trends discussed in Clement (2022). Detections rates were fairly similar at the two mooring locations inside the harbour entrance (i.e. Passage Island and Sinclair) while generally greater at Calliope over most seasons even after standardising for the differences in effort. This finding suggests that not all odontocetes visiting the harbour entrance chose to travel past Taurikura Bay and into the harbour.

Interannual variation between detections was also notable (Figure 3). In general, detection rates were greater during 2020 than most other equivalent seasons in subsequent sampling years.

Table 1. ***Summary of the total number of recorded vocalisation detection events for all odontocetes species and associated parameters with moorings at Calliope, Passage Island and Sinclair across various deployments between 19 June 2020 to 5 September 2023.***

Mooring	No. of days recording	No. of minutes detected	No. of events	No. days with at least 1 detection	Percent days with detections
Calliope	599	1509	150	89	15%
Passage Island	425	593	91	38	9%
Sinclair	523	937	100	51	10%

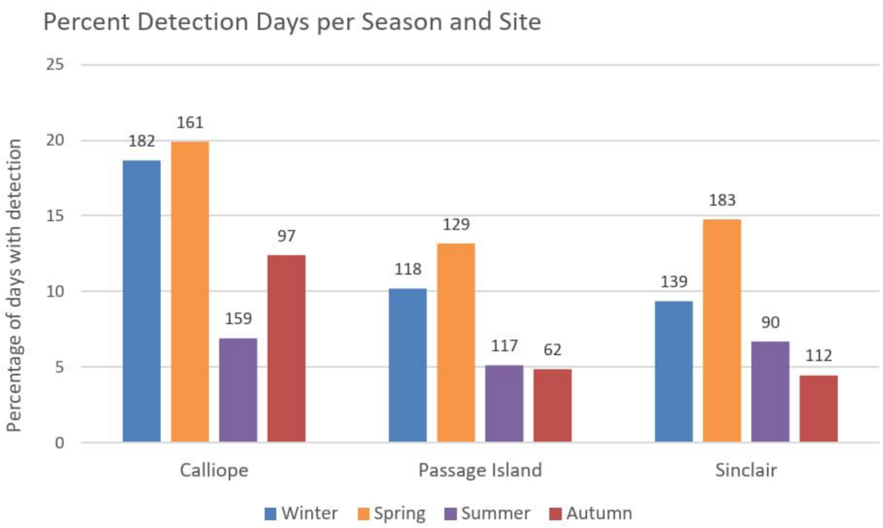

Figure 2. ***The proportion (%) of days with dolphin detection events (i.e. days with at least one detection) standardised by the number of sampling days for each season[6] and by mooring location. Numbers at the top of the columns represent the total sampling days in each season for each mooring across all three sampling years.***

[6] Standard austral seasonal definitions were used. Winter = June, July, August; Spring = September, October, November; Summer = December, January, February; Autumn = March, April, May.


Calliope
Passage Island
Sinclair
Sampling Days
0
10
20
30
40
50
60
70
80
90
100
winter
spring
summer
autumn
2020
2021
2022
2023
Days effort
Days with detection

Figure 3. ***The number of underwater acoustic sampling days with no dolphin detections (yellow bars) and the number of sampling days with at least one dolphin detection (green bars) by season for each separate mooring over the three sampling years.***

Dr Pine was able to distinguish some orca vocalisations from other mid-frequency odontocete species. With underwater acoustics, the larger the size of the animal, the louder they can vocalise. As orca calls are able to travel the furthest of the delphinids, they are more likely to be picked up by the acoustic mooring stations.

Orca calls were heard on three separate days at Calliope mooring and on one of the same days at Passage Island over a 10 day period in September / October 2020. Approximately a month later (November 2020), orca were detected twice over the course of the same day at Sinclair mooring. Orca calls were not heard again until in September 2021 when two separate occasions were detected 11 days apart and later in March 2023 on one occasion from the Passage Island mooring. We note that the seasonality of these detections are in line with expectations from Clement (2022). From the time of the detections, these orca visits may have lasted between several minutes and up to several hours, the acoustics cannot determine duration accurately given duty cycling and detection distances.

Baleen whales were detected only at the Calliope mooring but are not yet available. As these low frequency calls can be detected at distances greater than 10 kilometres from the whale, a single recorder cannot triangulate the caller's location. Hence, it was assumed these calls were from Bream Bay or beyond as no whale calls were recorded at the other moorings.

Multiple odontocete detections were often recorded on the same day. Unfortunately, the recorders are not able to distinguish between the vocalisations of individual dolphins and so cannot determine if it is the same group entering and leaving the harbour or just new groups passing by. Clusters of events also occurred over multiple days usually lasting between 2 to 4 days when it appears several groups are moving back and forth along the channels near the moorings. The longest continuous detection events in which animal remained near the recorders varied from 61 and 94 minutes. These findings also support the general dolphin trends discussed in Clement (2022).

Finally, whether dolphins may be using the harbour more or less during day or night time hours was also assessed. The time of each detection was simply categorised into a breakdown of day-time (06:01 to 18:00) vs night-time (18:01 to 06:00) hours, but does not consider the changes in season or daylight savings at the moment (Figure 4). At this stage, it appears that dolphins are using these areas of the harbour fairly equally between day and night. More variation between day and night detections appears to occur at the Passage Island and Sinclair moorings, but the low number of detections in some seasons make any further interpretation questionable.

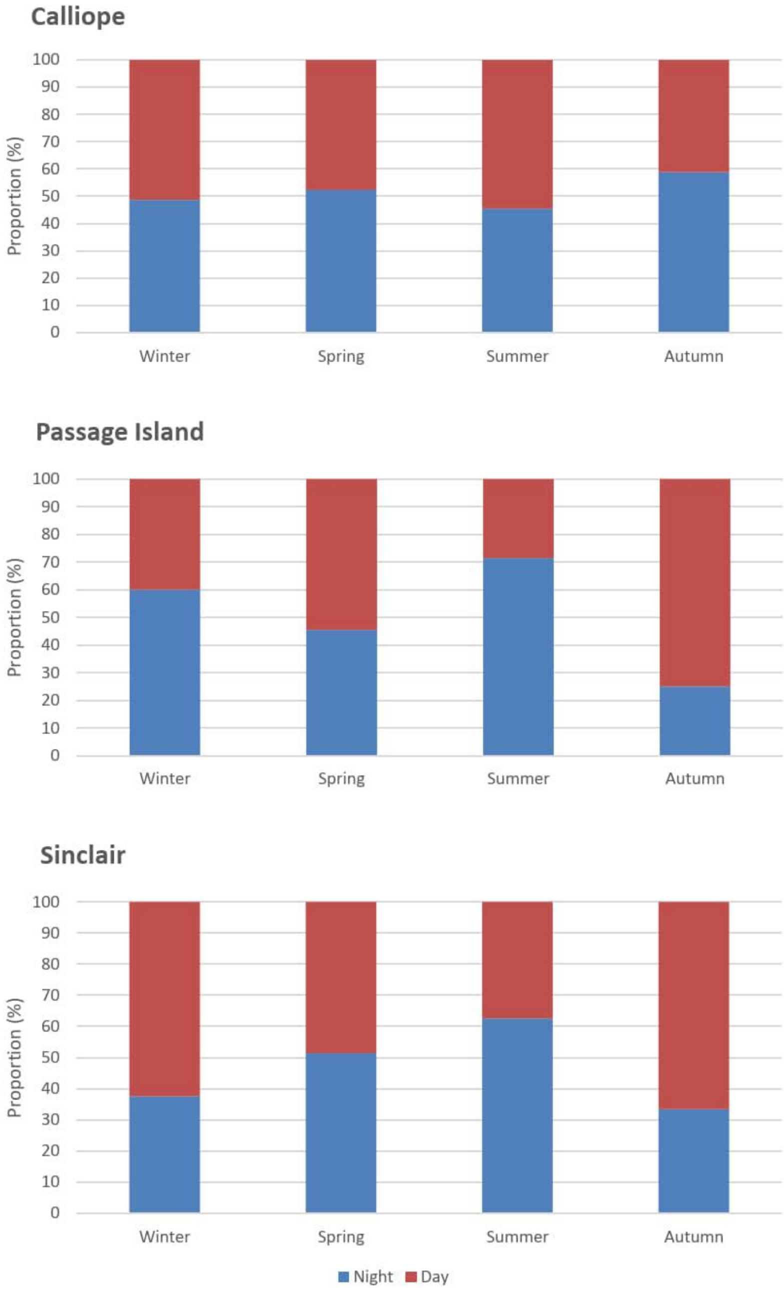

Figure 4: The proportion of all detections that occurred during the day-time (06:01 to 18:00) or during the night-time (18:01 to 06:00) for each mooring across all seasons.

Appendix F Information of Cultural Relevance to Marine Mammals

Te Ākau Bream Bay Sand Extraction

Marine Mammal Environmental Impact Assessment

McCallum Bros Limited

SLR Project No.: 840.030119.00001

13 January 2026

This appendix recognises the cultural affiliation that tangata whenua have with marine mammal species. The information outlined below was supplied by Patuharakeke Te Iwi Trust Board or downloaded from their website and is described here as it is of relevance to marine mammals.

Patuharakeke Te Iwi Trust Board Strategic Plan

The Strategic Plan for Patuharakeke Te Iwi Trust Board identifies six strategic pou (pillars of central belief). One of which is Te Taiao (Environment) and the goals and measures of this pou are listed below.

GOALS	MEASURES
• Hapu initiated research	Making informed decisions based on our research
• Relationships	Like-minded partnerships
• Capability & Capacity	Become a sustainable unit
• Succession	Include rangatahi (whānau & kaumatua) in the mahi
• Land Use	Environmental management - ki uta ki tai
• Legislation	Influence policies & plans to increase the health of our Taiao

The first of these goals promotes hapu initiated research and, with regard to marine mammals, Patuharakeke Tw Iwi Trust Board is running a Tohorā (whale) research programme as follows:

"This research serves as an opportunity to reconnect our people and taitamariki with the moana and empowers us to undertake research of our own. With this, we are sharing knowledge first-hand, which allows whānau to have hands-on experience with research equipment, such as hydrophone, recording temperature and depth probe data, binocular observations, species identification etc.

With this vision in mind, we believe that we are instilling important values in our rangatahi and sparking interest in the science and environmental management sector.

This research project has demonstrated how mātauranga māori and western science can be applied equally and when practised appropriately under the right tikanga, we get better outcomes that benefit both te ao māori and pākehā/western science.

These findings highlight the importance of a long-term monitoring programme and will significantly help us build on our understanding of marine biodiversity in and around Te Patuharakeke rohe moana."

The results of this research are presented in **Section 3.2.2** of this report.

Place names and Mātauranga

In Appendix 2 of the Northport Cultural Effects Assessment (**CEA**) (Patuharakeke Te Iwi Trust Board, 2022) Dr Nuttal notes that the te reo name of Whangārei Harbour is '*Whangarei Te Rerenga Parāoa'* which translates to the '*gathering place of whales*' and reflects that historically whales gathered there to feed during summer.

Further to this, the Refinery New Zealand CEA (Patuharakeke Te Iwi Trust Board, 2017) includes the following content:

"The name given to the harbour – "Whangarei Te Rerenga Paraoa" is associated with different meanings according to various tribal traditions. A well-known korero is that the

name given to this place signifies that it was a gathering place of chiefs of Ngapuhi—the word 'paraoa' being a metaphor for chiefs. Ngatiwai tradition states that the harbour was a passing or gathering place for whales. This is corroborated in the Marsden Point Port hearing evidence where it is referred to as a "Riu" or passageway for Tohora and was mentioned on numerous occasions by hui participants during the recent series of hui. Whales have a special place in Patuharakeke tradition, they are seen as a kaitiaki or guardians and tribal korero states that the people named and called to known and favoured sea mammals and also chanted them back out to safety during strandings. Moreover, whales are seen as an indicator of cultural health. Therefore, the rare recent visit of a Humpback Whale to Reotahi Marine Reserve earlier this year was seen as a positive sign. The harbour also supports regular visits by pods of Orca and Dolphins that frequent the Whangarei coastline."

"The Cultural Values Assessment report provided context on the importance of marine mammal species to the cultural identity of tāngata whenua o Whangārei Te Rerenga Paraoa and their relevance in light of the name given to the harbour. The channel into the harbour is considered to be a pathway for whales, and while it is regularly used by pods of dolphins and orca, formerly rare species are once again returning to the harbour."

Appendix 3 of the Northport CEA (Patuharakeke Te Iwi Trust Board, 2022) passes comment on the significance of not only Whangārei Harbour, but also Te Ākau Bream Bay stating that Patuharakeke Te Iwi Trust Board considers that the harbour and Te Ākau Bream Bay are important for marine mammals from a cultural (and ecological) perspective.

Hapū Environmental Management Plan

The (Patuharakeke Te Iwi Trust Board, 2014) includes the following content on marine mammals:

"Whangarei Terenga Paraoa translates as "the meeting place of the whales". Whales have a special place in Patuharakeke tradition, they are seen as a kaitiaki or guardians and tribal korero states our tupuna named and called to known and favoured sea mammals and also chanted them back out to safety during strandings. After being hunted to the point of collapse last century they have recovered only to be at risk from marine pollution (heavy metals, toxins, plastics etc), noise pollution, boat strike, harassment from some tourist operators and boat operators, set nets and other commercial fishing practices, plummeting food resources, and the effects of sonar to name a few.

There are a number of theories as to why marine mammals strand, but it seems likely to be at least partially due to the increasing human-induced pressure their habitat is under. Our affinity and spiritual connection with whales and dolphins mean Patuharakeke as kaitiaki have a foremost responsibility to advocate for the protection of these intelligent and majestic creatures. Whilst whale strandings are a sad occasion for Patuharakeke, they provide us with a valuable opportunity to revive matauranga associated with the preparation of whalebones for carving and obtaining other resources such as oil/ spermaceti. The Department of Conservation holds statutory responsibility for marine mammals under the Marine Mammals Protection Act 1978 and the Conservation Act 1987. We are fortunate that Ngatiwai developed the first protocol with DOC for the management of whale strandings. This provides for the recovery of bone and teeth by tangata whenua and the provision of scientific samples.

To date we have built our capability in this area through collaboration with Ngatiwai and have developed Patuharakeke Whale Stranding Guidelines to guide the process and communications with DOC. A mass stranding of Pilot whales in Te Ākau Bay in 2006 provided an opportunity for Patuharakeke to host a national tohora wananga. The wananga was a great success and allowed the building of more connections with hapu and iwi with knowledge and/or interest in whales and the recovery of resources from beached whales.

Tikanga around flensing, boning out, burial, naming and gifting of bone and so forth were shared and developed. Patuharakeke have since demarcated and named the site where the whales were buried (for later uplifting and cleansing) as a waahi tapu (the "Tahuna Tohora").

Issues

a) *The habitat of marine mammals is facing immense human-induced pressures.*

b) *Patuharakeke have developed a formal process around Marine mammal strandings and their cultural harvest. However, we do not yet have the appropriate holding permits in place for taonga such as whalebone. Presently DOC requires that we get permission from Ngatiwai Trust Board to utilise their holding permit.*

Objectives

a) *Increased numbers of healthy whales and dolphins inhabiting and migrating through our coastal waters and harbour.*

b) *A strong partnership between DOC and Patuharakeke with regard to the management of marine mammal strandings and cultural harvest in our rohe.*

c) *Revival of matauranga and tikanga associated with marine mammal strandings and cultural use.*

Policies

a) *The cultural, spiritual, historic and traditional association of Patuharakeke with marine mammals, and the rights to exercise rangatiratanga and kaitiakitanga over marine mammals is guaranteed by Te Tiriti o Waitangi.*

b) *The relationship between Patuharakeke and DOC for the recovery, disposal, storage and distribution of beached marine mammals shall be guided by the principles of partnership.*

c) *To require that a standard procedure be introduced that Patuharakeke are involved in the determination of burial sites for beached whales that do not survive, and that burial locations are retained as waahi taonga and therefore protected from inappropriate use and development.*

Methods

a) *Patuharakeke will continue to advocate for a clean and healthy marine environment for marine life, including dolphins and whales.*

b) *Patuharakeke will continue to utilise and update the Patuharakeke Whale Stranding Guideline as necessary.*

c) *Patuharakeke will apply for a holding permit for whale bone and other taonga through DOC as a priority.*

d) *Patuharakeke will continue to work collaboratively with Ngatiwai and other hapu and iwi to build knowledge and understanding with regard to the cultural harvest of stranded marine mammals.*

e) *Patuhakeke will work with NGO's (e.g. Project Jonah) to build our capability in marine mammal rescue techniques."*

Making Sustainability Happen