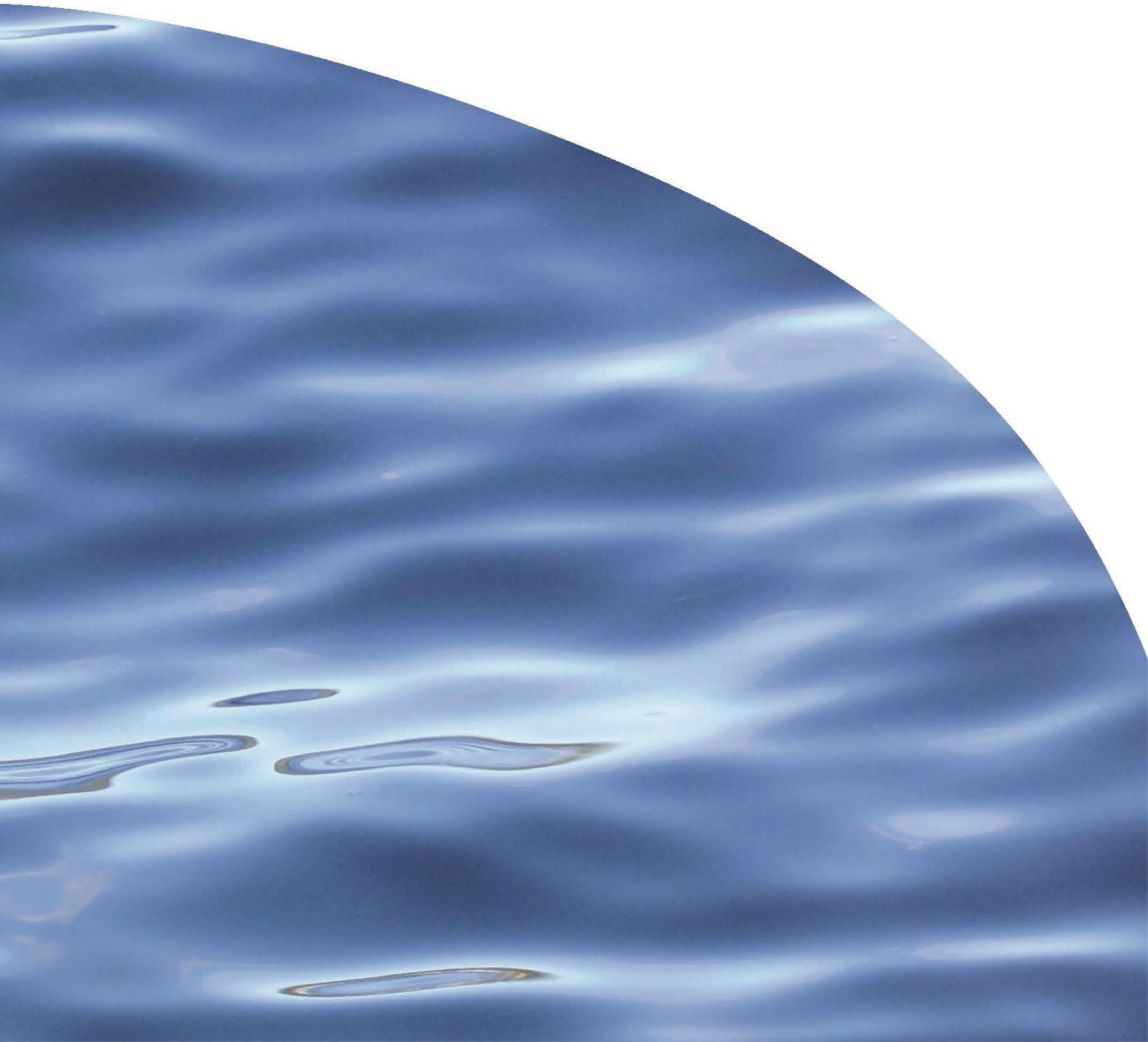
CAWTHRON
The power of science®

REPORT NO. 3471

PAKIRI OFFSHORE SAND EXTRACTION: MARINE MAMMAL ASSESSMENT OF EFFECTS



PAKIRI OFFSHORE SAND EXTRACTION: MARINE MAMMAL ASSESSMENT OF EFFECTS

DEANNA CLEMENT, OLIVIA JOHNSTON

Prepared for McCallum Brothers Limited

CAWTHRON INSTITUTE
98 Halifax Street East, Nelson 7010 | Private Bag 2, Nelson 7042 | New Zealand
Ph. +64 3 548 2319 | Fax. +64 3 546 9464
www.cawthron.org.nz

REVIEWED BY:
Simon Childerhouse

APPROVED FOR RELEASE BY:
Grant Hopkins

ISSUE DATE: 13 August 2020

RECOMMENDED CITATION: Clement D, Johnston O 2020. Pakiri offshore sand extraction: marine mammal assessment of effects. Prepared for McCallum Brothers Ltd. Cawthron Report No. 3471. 40 p. plus appendices.

EXECUTIVE SUMMARY

Sand supplier McCallum Brothers Limited® (MBL) is applying for new resource consents to extract coastal sand from a zone between the Auckland / Northland regional boundary and the Poutawa stream, between 15 m and 25 m water depths. MBL have been dredging sand in the Mangawhai-Pakiri embayment for more than 75 years, currently extracting up to 76,000 m^3 of sand each year from between the 5 and 10m bathymetric contour. Cawthron Institute has been contracted to provide a technical assessment of the potential effects on marine mammals arising from continuing the existing extraction activities within a new consent area.

MBL operations within the Mangawhai-Pakiri embayment involve return trips of dredge vessels to and from the Ports of Auckland daily with no local on-shore components. Dredge vessels currently undertake approximately 16 to 18-hour return trips. Dredging on the embayment takes an average of 3-4 hr, most of which (greater than 90%) occurs overnight (i.e. 7pm to 6am). Dredging activities are avoided or minimised over the weekends as much as possible.

A large proportion of New Zealand's marine mammals live or migrate along the north-eastern coastline of the North Island. Both the Hauraki Gulf and Bay of Islands are known tourist destinations to view local and migrating species. The species most likely to be affected by the proposal are common and bottlenose dolphins, orca and Bryde's whales. Other species of interest include NZ fur seals, southern right and humpback whales, pilot whales, and sperm whales due to potential vulnerabilities or conservation status. Based on the limited data available, the Mangawhai / Bream Bay coastal waters are not considered ecologically significant habitats for nearly all of these species. The exception is the small population of critically endangered Bryde's whales that utilise Hauraki Gulf waters as important resting and feeding habitats throughout the year. The general region also supports populations of nationally endangered or threatened bottlenose dolphins, orca and southern right whales that need to be considered.

Based on the effects highlighted in this report, the overall risk of any significant adverse effects arising from the proposed consent activities is assessed as less than minor to negligible. To ensure that the most appropriate measures are in place and to reduce any identified risks, several suggested best management practices and formalising of existing operational mitigation actions are recommended as part of the development of a Marine Mammal Management Plan (MMMP).The report also addresses the collision risks of dredge vessel transiting through Hauraki Gulf water and suggests continuing to reduce any accidental interactions with Bryde's whales by continuing to implement the Ports of Auckland's Hauraki Gulf voluntary transit protocol for commercial shipping.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF APPENDICES

1. INTRODUCTION

Sand suppliers McCallum Brothers Limited® (MBL) are applying for consent to extract coastal sand in an offshore zone adjacent to their existing extraction area located between Mangawhai and Pakiri, North Auckland. MBL have been dredging sand in the Mangawhai-Pakiri embayment for more than 75 years. The current coastal permits were granted by the Environment Court in May 2006 for a 14-year period, which allows MBL to extract sand volumes of up to 76,000 m^3/year from the inshore area between the Auckland/Northland regional boundary and the Poutawa Stream (Figure 1). Based on feedback during consultation and to improve operations, MBL are proposing the movement of the extraction area further offshore between the current inshore coastal permit held by MBL and the offshore permit held by Kaipara Ltd (approximately 15–25 m water depth, Figure 1). As part of the consent application preparation, MBL have contracted Cawthron Institute (Cawthron) to provide a technical assessment of effects of the sand extraction operations on marine mammals.

1.1. Scope of assessment

This report provides an assessment of potential effects on marine mammals from the extraction of coastal sand between Pakiri and Mangawhai. The report includes descriptions of the proposed sand-extracting activity and the existing environment from a marine mammal perspective. It focuses on three key assessment components:

1. Desktop review of resident and transient marine mammal populations using the wider Bream Bay to Cape Rodney coastal ecosystems with reference to:
    a. abundance and seasonal distribution information
    b. presence of any known important habitats, such as nursing or feeding areas; and known life history dynamics that may make a species more vulnerable to sand dredging activities.
2. Reference / review of comparable national and international literature as well as the collection of any necessary data to describe the potential marine mammal effects associated with sand extraction activities.
3. Identification of any potential marine mammal effects; specifically considering the types of effects, their spatial scales and durations, likelihood, and potential consequences.

This report, along with additional information from other assessment of effects reports (e.g. underwater noise, ecology—benthic fauna and fish, water quality modelling), will form the basis of a comprehensive assessment of environmental effects focused on marine mammals in the proposal area and is intended to support the final resource consent application. Recommendations for management and monitoring, if necessary based on the assessment, are included.

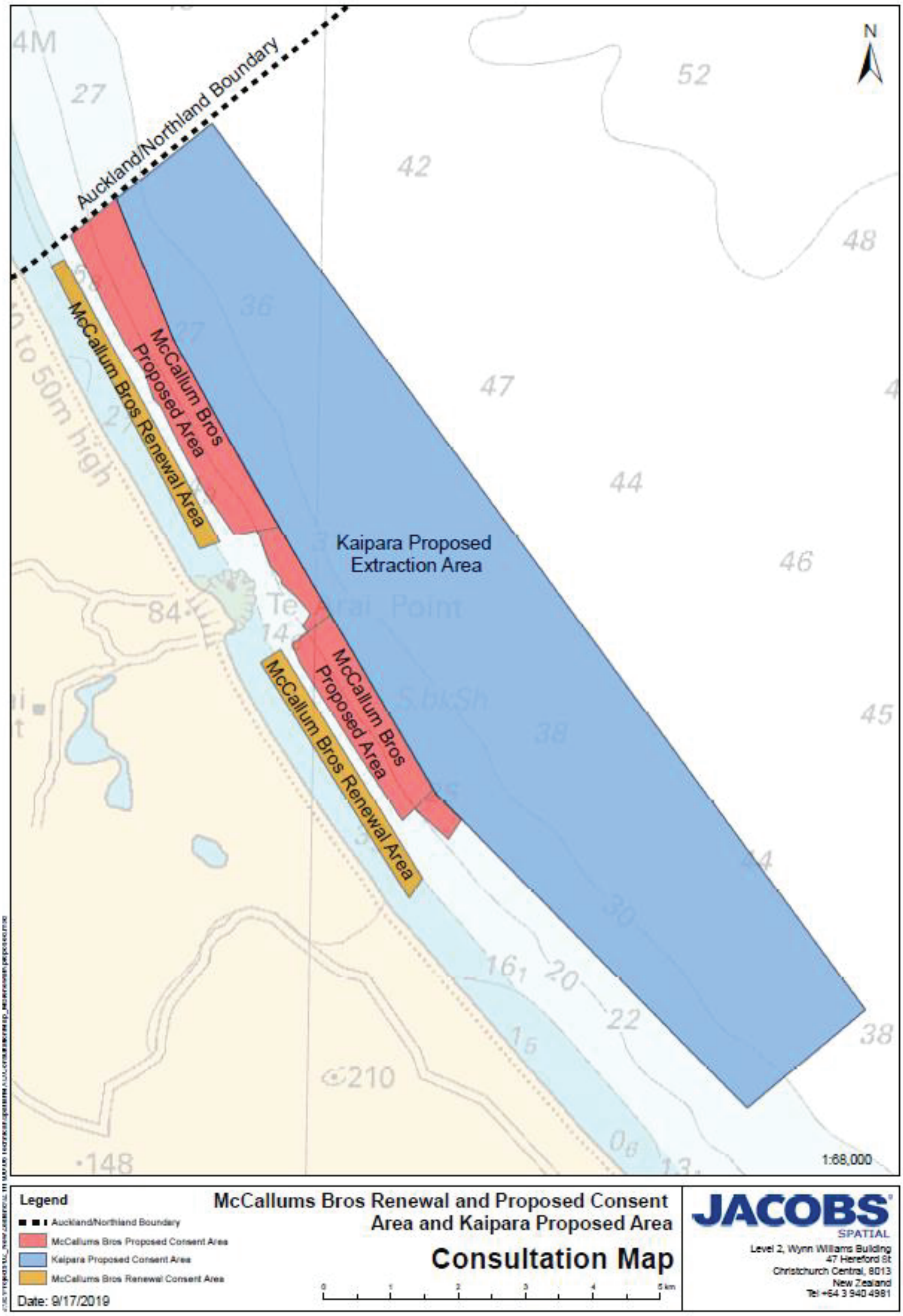


Figure 1. The proposed new consent area (red) along the Pakiri coastline with reference to the existing MBL consent area (yellow) and that of Kaipara Ltd (blue). Map provided by McCallum Bros Limited.

2. ACTIVITY CHARACTERISATION

2.1. Sand extracting at Mangawhai-Pakiri

The current MBL sand extraction operation at the Mangawhai-Pakiri embayment relies on dredging and pumping of a sand slurry from the seabed to the trailing suction dredge *William Fraser*. Trailing suction dredgers operate by sucking material from the seabed as a sand slurry, using a trailing suction head fitted to pipes that trail over the bed as the ship slowly steams over the extraction area. The sand pumps lift the extracted sand slurry through the pipework to pass through sand screens to be deposited in the onboard hopper. A schematic diagram of a trailing suction hopper dredge is presented in Figure 2. This figure illustrates the various physical and environmental effects that can be associated with dredging seafloor sediments with a vessel similar to the *William Fraser*. Those potential effects that are most relevant to local and visiting marine mammals are discussed further in Section 4.

A key component of this activity is that once the dredge vessel is fully loaded, it returns directly by sea to the MBL depot at Ports of Auckland for unloading, hence there are no local on-shore components to the extraction operation. MBL dredging operations within the current Mangawhai-Pakiri consent area can take place 24 hours a day, 7 days a week and any day throughout the year; however, weekend and day extraction activities are avoided or minimised as much as possible. The *William Fraser* normally leaves the Ports of Auckland around midday and begins dredging in the consent area by early evening. The average extraction time is 3.8 hours with a range of between 3 and 5.5 hours. Once the vessel or barge has reached its load limit, the vessel returns to the Ports of Auckland. A round trip from Auckland averages about 16-18 hours. The overall proportion of sand extraction that occurs at night is at least 90% based on current operations.

MBL dredge vessel configurations to extract sand currently include:

- *William Fraser*—a 68-m long trailing suction dredger that undertakes all current extraction on all coastal permits. Cruising speed is around 8 knots loaded and 9.5 unloaded and extraction speed is 1.5 to 2.0 knots.
- *Kapua*—a 44-m motorised roll-on-roll-off landing craft that occasionally picks up loads of sand for distribution to the Hauraki Gulf islands. Cruising speed of 8 knots loaded and 9 knots unloaded.

While this assessment is based on current sand extraction activities (including schedules and vessels), MBL are proposing or have made the following operational changes in order to improve operations and reduce potential nearshore effects:

- Relocating the extraction area located further offshore (between 15–25 m water depths, Figure 1) to avoid Auckland Unitary Plan overlays/restrictions for

Outstanding Natural Landscape; High Natural Character; Surf Breaks; and Significant Ecological Area - Marine 2.

- Increasing extracted sand volumes to a maximum of 150,000 m^3 / yr but with a rolling five-year average of 125,000 m^3 / yr.
- The previous extraction vessels have been replaced by the larger, more efficient *William Fraser* that includes moon pool technology to reduce turbidity.
- With the improved efficiencies and technology of the *William Fraser*, MBL have shifted a larger proportion of the dredging to a night operation to reduce visual impacts of the vessel in the embayment.
- Reduced dredging and trip times with the *William Fraser* due to its increased efficiency of the dredging and screening gear.
- With the increased hopper capacity of the *William Fraser,* the number of vessel trips has almost halved while extracting the same equivalent extracted volumes. Even with the greater volume applied for in this consent, there will be no increase on the historical number of trips required.

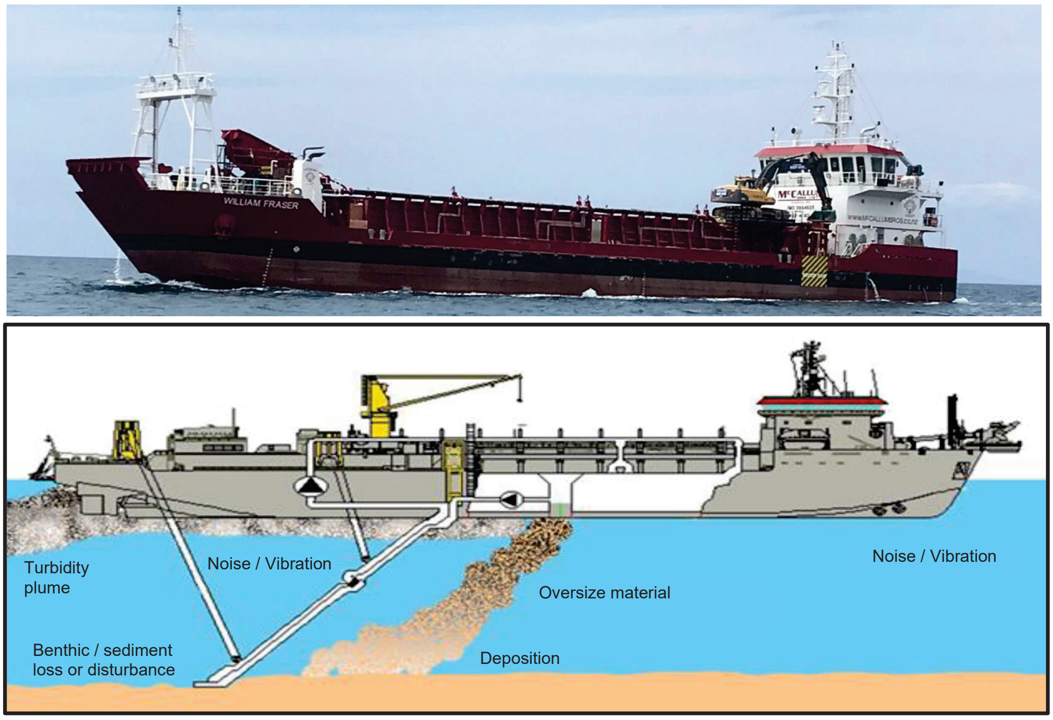


Figure 2. Top: MBL vessel, *William Fraser*, extracting sand from the current Pakiri coastal area. Bottom: Generic illustration of sand extraction and possible impacts, not all of which will be applicable to the current proposal (modified from Bioresearches 2019).

3. ENVIRONMENT CHARACTERISATION

3.1. General approach

When considering the potential implications of marine activities on marine mammals, the appropriate scale of consideration is not just the level of the proposed activities but also the spatial scales relevant to the marine mammal species involved. For most marine mammals, normal home ranges can vary between hundreds to thousands of kilometres. Southern right whales, for example, are considered only infrequent seasonal visitors through Mangawhai / Bream Bay waters. Yet mother / calf pairs pass by this stretch of water each year to reach Northland nursery grounds during their winter migration. Hence, the importance of these coastal waters needs to be considered in the context of the relevant species' regional and New Zealand-wide distributions.

To date, several university research programmes have been undertaken on marine mammal species in the Bay of Islands and within the Hauraki Gulf regions since the mid-1990s (see specific study details in Appendix 1). However, no marine mammal studies have focused on the Mangawhai / Bream Bay region. In the absence of any long-term and spatially explicit baseline research on marine mammals in the greater Mangawhai area, species information and sighting data were collated from ongoing research throughout the central-eastern coastal region (e.g. Massey University-Albany, University of Auckland, Orca Research Trust). In addition, opportunistic sightings reported to DOC (including the public, tourism vessels, seismic surveys, etc.) and strandings (previously collated through Te Papa National Museum and now DOC) were reviewed (see Appendix 1).

Without adequate population information (e.g. growth trends, total abundance), the potential risks to marine mammal species associated with various anthropogenic activities must be assessed based on a general understanding of the species' life-history dynamics (e.g. species-specific sensitivities, conservation listing, life span, main prey sources) summarised from New Zealand and international data sources. Collectively, this information is used to determine what is currently known about any relevant species' occurrence, behaviour, and distribution within the area of interest and to evaluate those species most likely to be affected by the proposed project.

3.2. General site description

Out of the more than 50 species of cetaceans (whales, dolphins and porpoises) and pinnipeds (seals and sea lions) known to live or migrate through New Zealand waters, at least 27 cetacean and two pinniped species have been sighted or stranded along the north-eastern coastline of the North Island. Figure 3 and Figure 4 highlight the various marine mammal species recorded between the Bay of Islands to the north and the entrance to the Hauraki Gulf and Great Barrier Island to the south over several decades. It is important to note again that most of these sightings are collected opportunistically rather than systematically. Consequently, the number of sightings in these figures do not necessarily represent unique animals (i.e. the same animal may be reported by multiple members of public or on separate days / in separate years) or their regular distribution patterns. As effort is not considered with opportunistic data, favourite fishing spots and tour boat tracks are likely to be over-represented especially during periods of more favourable conditions (e.g. summer, daylight).

The majority of opportunistic sightings were recorded around the Bay of Islands and Hauraki Gulf regions (Figure 3, Figure 4), most likely a reflection of the marine tour companies operating within these vicinities that offer marine mammal tours and regularly report their sightings to DOC. Various sightings observed by MBL vessels over the last year and short-term underwater acoustic sampling by Pine (2020a) were used to confirm those species more likely to occur near the consent area and wider Hauraki Gulf region (e.g. Figure 5).

For this assessment, less importance is placed on the location of sightings with more emphasis on the presence and timing of an identified species in the Mangawhai / Bream Bay region. The more prevalent species are listed in Table 1 and divided into three general categories that describe the current knowledge about their distribution patterns within Mangawhai / Bream Bay and nearby waters. Species' information is likely to change as more systematic research becomes available, particularly for less common species.

- *Resident* — a species that lives (remains and feeds and / or breeds) within Mangawhai or nearby waters either permanently (year-round) or for regular time periods.
- *Migrant* — a species that periodically travels through part(s) of Mangawhai waters but remain only for temporary time periods that may be predictable seasonally.
- *Visitor* — a species that visits Northland or nearby waters intermittently. Depending on Mangawhai's proximity to the species' normal distribution range, visits may occur seasonally, infrequently or rarely.

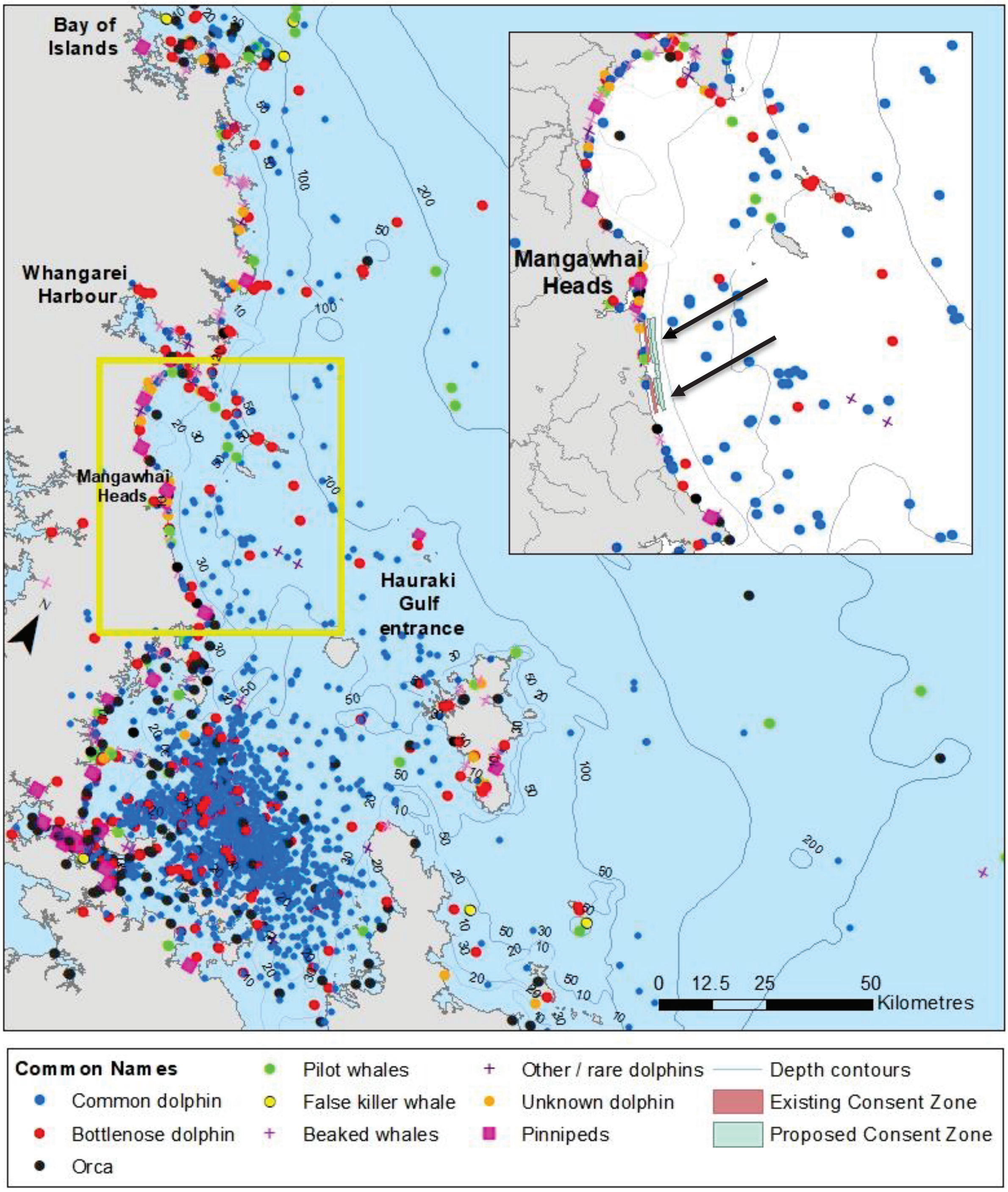


Figure 3. All Department of Conservation (DOC) sightings (1978–2018) and strandings (1869–2018) reported between Bay of Islands and Hauraki Gulf. Toothed whales and dolphins plus pinnipeds (seals) are shown in the image above; migrating whale species are shown in Figure 4. The general area represented by the inset map is indicated on the larger map by the yellow rectangle and the proposed consent area (green) is indicated on the inset map with black arrows.

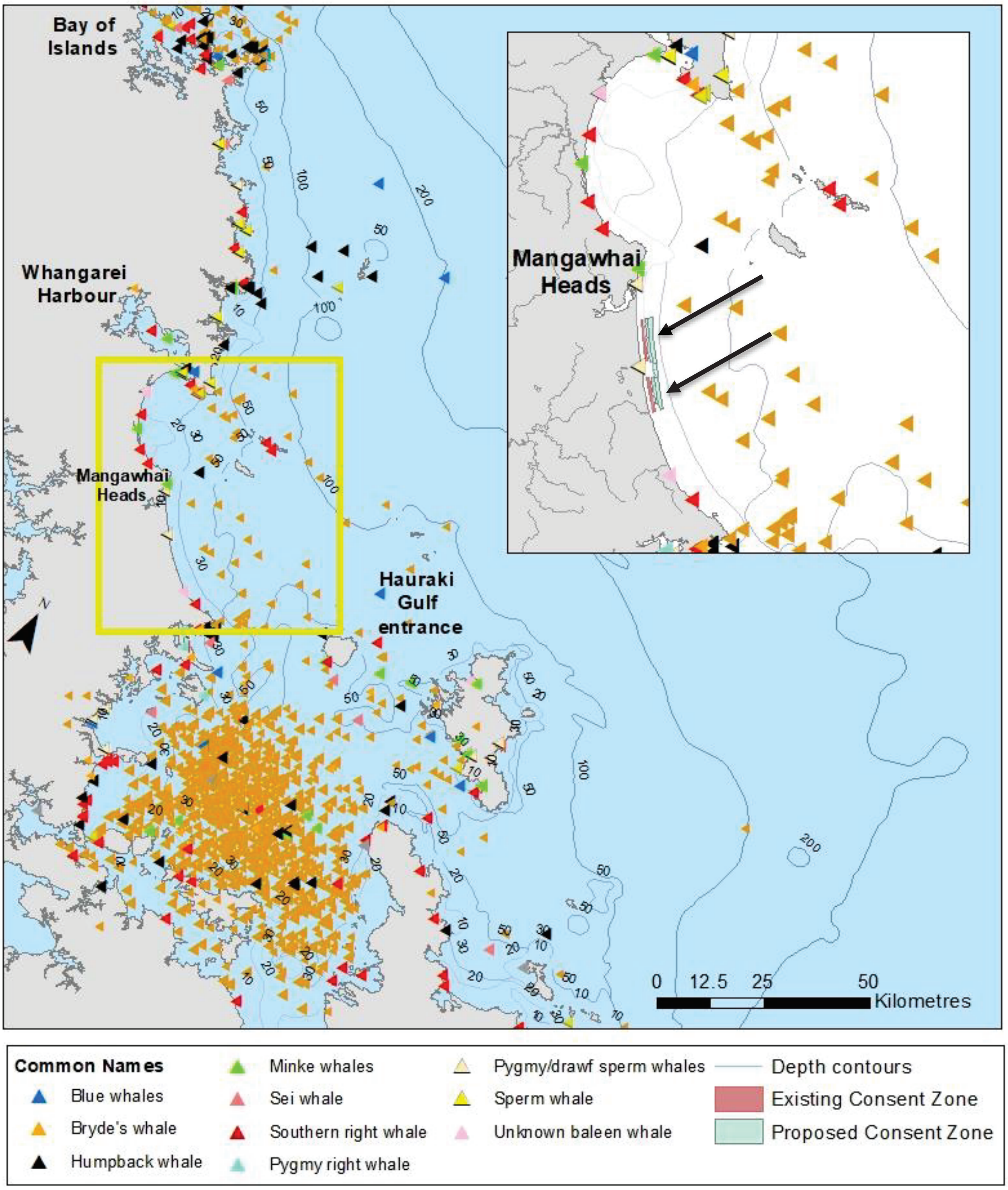


Figure 4. All Department of Conservation (DOC) sightings (1978–2018) and strandings (1869–2018) of migrating whale species reported between Bay of Islands and Hauraki Gulf. The general area represented by the inset map is indicated on the larger map by the yellow rectangle and the proposed consent area (green) is indicated on the inset map with black arrows.

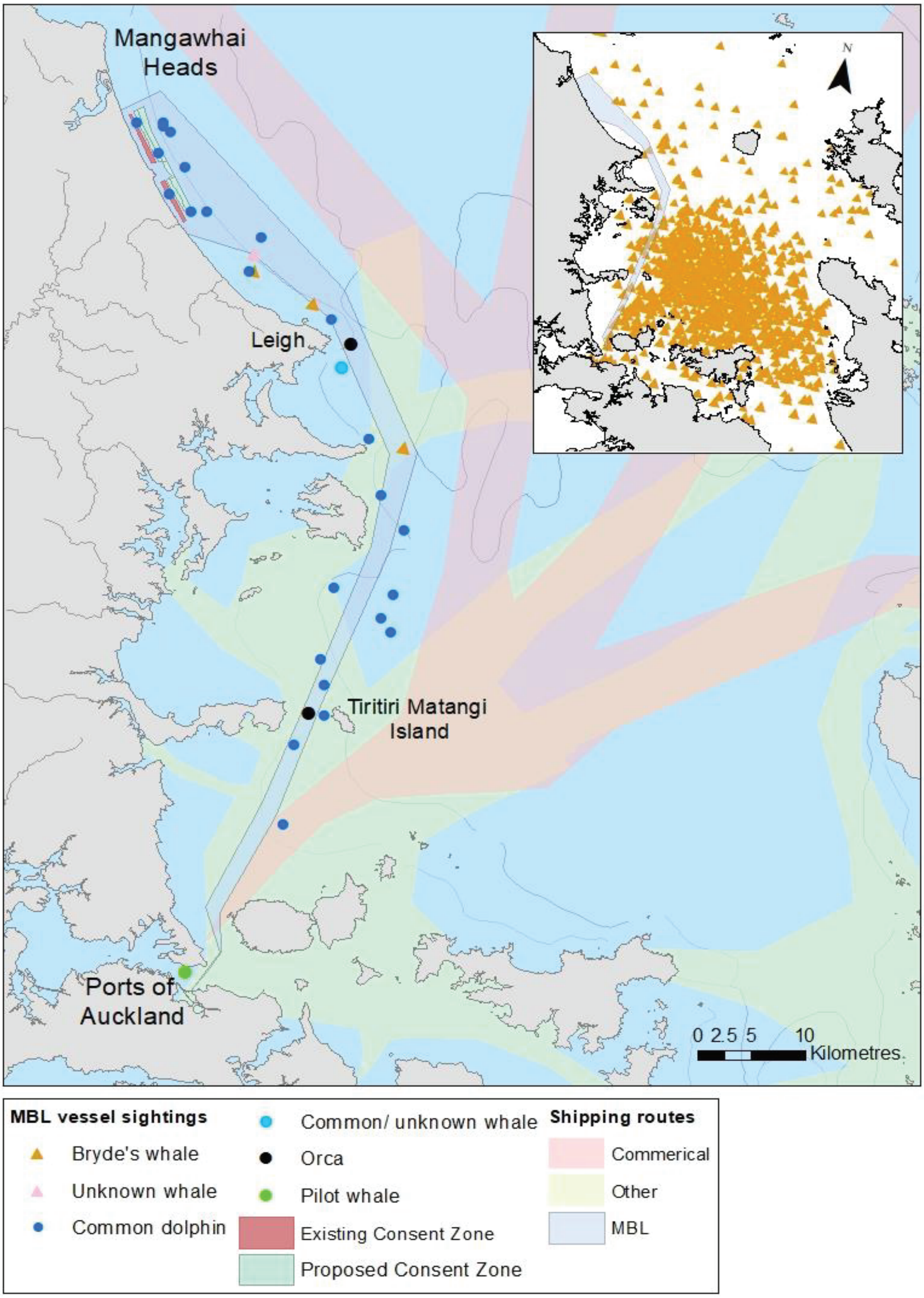


Figure 5 Map of all the marine mammal sightings recorded on MBL vessels since August 2018 overlaying the generalised shipping routes of commercial, MBL and other vessels within the Hauraki Gulf region (modified from Constantine et al. 2012). The inset map demonstrates where the MBL vessel route lies with respect to Bryde's whale sightings in the Gulf (e.g. Constantine et al. 2015; DOC database).

Table 1. The residency patterns of marine mammal species known to frequent Mangawhai / Bream Bay and nearby waters. Species' conservation threat status is listed for the New Zealand system (NZTCS——Baker et al. 2019) and internationally (IUCN system, ver 3.1). Modified from Clement and Elvines (2015).

Common name	Species name	NZ Threat Classification System	IUCN Listing	Residency category in Northland	Patterns of Seasonality (relative to proposal area)
Common dolphin	*Delphinus delphis/capensis*	Not Threatened	Least Concern	Seasonal to Year-Round Resident	Common throughout north-eastern waters year-round. Feed on schooling or more pelagic fish species. Generally observed in waters deeper off Mangawhai / Bream Bay with occasional inshore sightings in the proposal area.
Bottlenose dolphin	*Tursiops truncatus*	Nationally Endangered	Data Deficient	Seasonal to Year-Round Resident	Resident sub-population to north in Bay of Islands that ranges between Doubtless Bay, Great Barrier Island and Tauranga. Occasional visits to Mangawhai / Bream Bay perhaps more over summer months. Generalist feeders. Currently in decline.
NZ fur seal	*Arctocephalus forsteri*	Not Threatened	Least Concern	Seasonal to Year-Round Resident	Present year-round with multiple haul-out sites and breeding colonies in the Hauraki Gulf and regular sightings on offshore islands and Bay of Islands. More susceptible to human effects at breeding colonies. Feed mainly over shelf waters but inshore regions as well.
Orca (killer whale)	*Orcinus orca*	Nationally Critical	Data Deficient	Seasonal to Semi-Resident	Frequent north-eastern waters year-round, more common in late winter / early spring. Forage in harbours, estuaries and sandy beaches on rays, fish and other marine mammal species.
Bryde's whale	*Balaenoptera edeni brydei*	Nationally Critical	Data Deficient	Seasonal to Semi-Resident	Most commonly observed whale species in north-eastern waters year-round, and particularly within the Hauraki Gulf. Feed on small schooling fish, salps and krill. Regularly move through Mangawhai / Bream Bay travelling between Bay of Islands and Hauraki Gulf.
Pilot whale	*Globicephala melas / macrohynchus*	Not Threatened to Data Deficient	Data Deficient	Offshore Semi-Resident	While a more offshore species, inshore sightings occur mainly over summer months. Forages off shelf waters. Known for frequent and mass strandings in Bream Bay and surrounding waters.
Southern right whale	*Eubalaena australis*	At Risk - Recovering	Least Concern	Seasonal Migrant	Generally use more inshore, shallow regions of Northland during seasonal migration periods, particularly with new-born calves. Once present, they can remain in the Northland region for several days to weeks. Most often seen between August and November.
Humpback whale	*Megaptera novaeangliae*	Migrant	Endangered	Seasonal Migrant	Pass by Mangawhai / Bream Bay on both north and south migrations but more prevalent and closer to shore on southern return migration when with calves (mainly Oct to late Dec).
Sperm whale	*Physeter macrocephalus*	Not threatened	Vulnerable	Offshore Visitor	Increased sightings along the north-eastern coasts, mainly over summer and autumn months. Taonga species.

3.3. Species of interest

Several of the species highlighted in Table 1 are known to be year-round or seasonal residents of the coastal regions surrounding the Mangawhai Heads and Bream Bay areas (Figure 3, Figure 4). The more common species occurring along the Mangawhai coastline, and therefore most likely to be affected by the proposed project, include common dolphins (*Delphinus delphis*), bottlenose dolphins (*Tursiops truncatus*), orca (*Orcinus orca*), and Bryde's whale (*Balaenoptera edeni*). Other species of interest include those that may be less frequent visitors but are more vulnerable to anthropogenic (human-made) impacts due to their current conservation status (e.g. southern right whales are 'at risk–recovering') or species-specific sensitivities (e.g. underwater noise sensitivities of pilot whales). Given the significance of whales to several iwi in the wider region[1], additional species are considered (Clement & Elvines 2015). Appendix 2 summarises those marine mammal species considered further in terms of any effects associated with this proposal.

Based on the available species data, and in reference to Section 6(c) of the Resource Management Act (RMA)[2], Policy 11 of the New Zealand Coastal Policy Statement (NZCPS), and the Auckland Unitary Plan[3,], there is no evidence indicating that any of these species have home ranges restricted solely to Mangawhai and nearby Bream Bay waters. While several whale species have migration routes through this region, these coastal waters are not considered an important migration corridor as most whales generally pass by the area further offshore. Hence, the proposal area itself is not considered ecologically more significant in terms of feeding, resting or breeding habitats for any marine mammal species relative to nearby coastal regions or those further along the north-eastern coastline based on current knowledge.

The situation is different for the 'nationally critical' Bryde's whale. The Hauraki Gulf is one of the few New Zealand locations where this species occurs year-round. Gulf waters are considered important resting and feeding habitat for a population of less than 200 mature whales (Constantine et al. 2015). Their tendency to remain just below the surface and their distribution across inner Gulf water contribute to their high vessel strike risk (Figure 5). As highlighted in Table 1, these waters also support other endangered species, such as bottlenose dolphins, orca and southern right whales. These species are relevant in regard to Policy 11(a) of the NZCPS, which refers to avoiding adverse effects on nationally and / or internationally recognised threatened species.

[1] Whangarei Heads was previously known as 'Whangarei Te Rerenga Paraoa', which translates as 'Whangarei, the gathering place of whales'.

[2] Section 6(c) - the protection of areas of significant indigenous vegetation and significant habitats of indigenous fauna.

[3] AUP Objectives and Policies; Mineral Extraction - Section F2.6.1.2 & F2.6.1.3 Obj 1, Policy 3(b), 3(d) and 3(j); Underwater Noise – Section F2.18.2 & F2.18.3 Obj 1 Policy 3(a), 3(b); Section D9.3 Policy 9(a)i.

4. POTENTIAL EFFECTS

The most consequential interactions between marine mammals and coastal development usually result from a direct overlap between the spatial location of an anthropogenic activity and important habitats of the species (i.e. feeding or nursing grounds). Despite the frequent use of dredges in most ports and coastal development projects, little research has focused specifically on the effects of dredging operations on marine mammals (see review by Todd et al. 2015 and references therein). Irrespective of this lack of research, the act of disturbing and / or removing bottom substrate in itself is not expected to directly affect any marine mammals known to frequent Mangawhai waters (e.g. Todd et al. 2015). Instead, the activities more likely to affect marine mammals are the production of underwater sound and vessel movements associated within the general extraction region. Possible indirect effects of sand extraction include physical changes to the habitat itself that adversely affect the health of the local ecosystem and / or impinge on important prey resources.

The likelihood of these potential effects on local or visiting marine mammals is discussed in the following sections and summarised in Table 4. The recommended management options based on these risks are discussed in Section 5 and summarised in Table 5.

4.1. Underwater noise

The proposed sand extracting and associated activities (e.g. vessel traffic, dredging activities) are mechanical sources that generate underwater noise (e.g. CEDA 2011; WODA 2013). Materially increasing underwater noise has the potential to adversely affect both cetacean and pinniped species as they rely heavily on underwater sounds for communication, orientation, predator avoidance and foraging. Nowacek et al. (2007) noted that underwater noises can elicit three types of responses in marine mammals: behavioural (e.g. changes in surfacing or diving patterns), acoustic (e.g. changes in type or timing of vocalisations) and physiological (e.g. auditory threshold shifts and stress).

For effects-based monitoring, these responses are often quantified as 1) behavioural effects, 2) masking effects, 3) temporary auditory shifts (TTS – temporary threshold shift), or 4) permanent auditory injury (PTS – permanent threshold shift; Todd et al. 2015; see Pine 2020a for more details). In humans, the onset of TTS is often described as the muffled effect your hearing might have after a loud concert; the longer the exposure time, the longer this temporary effect lasts. PTS results in alternations of hearing function leading to actual physical damage and irreversible hearing loss. PTS can occur suddenly through trauma (i.e. intense impulses) or develop gradually over time.

Marine mammal hearing

Marine mammals have different hearing sensitivities depending on their mode of communication, navigation and behaviour. These differences have been generalised into five groups based on the sensitivity of their hearing across the different frequencies (Table 2). Species from three of these categories (low and medium frequency cetaceans and otariid pinnipeds) are found within the associated proposal areas (see Section 3.3).

The lower frequency hearing sensitivity of baleen whales (LF cetaceans) overlaps with most anthropogenic underwater noise, including the dredging activities proposed for this project. As a result, baleen whales are the species most susceptible to any noise effects from dredging (e.g. Clark et al. 2009). Most odontocetes (MF cetaceans) likely detect low-frequency sounds but they generally communicate over a wider frequency band than baleen whales (e.g. 150 Hz–160 kHz; NOAA 2018). However, their sensitivity significantly decreases at frequencies below 1–2 kHz (Au 2000; Southall et al. 2007). They also have the capability to echolocate (produce biological sonar) for navigation and hunting. Pinnipeds' hearing ranges are thought to vary more widely (otariid pinnipeds = 60 Hz–39 kHz and phocid pinnipeds = 50 Hz to 86 kHz; NOAA 2018), including some ultrasonic frequencies, with some being quite sensitive to frequencies below 1 kHz (based on overseas research on Atlantic grey and harbour seals; Thomsen et al. 2009).

Table 2. Summary of the generalised hearing range defining the different marine mammal hearing sensitivity groups used by the USA National Oceanic and Atmospheric Administration (NOAA) agency. Source: NOAA 2018.

Hearing Group	Generalised Hearing Range
Low-frequency (LF) cetaceans - baleen whales	7 Hz to 35 kHz
Mid-frequency (MF) cetaceans - toothed dolphins and whales, beaked whales	150 Hz to 160 kHz
High-frequency (HF) cetaceans - porpoises, Hector's / Māui dolphin	275 Hz to 160 kHz
Phocid pinnipeds (PW) - leopard seal, elephant seal	50 Hz to 86 kHz
Otariid pinnipeds (OP) - sea lions and fur seals	60 Hz to 39 kHz

Dredge noise

The underwater noises produced from dredging activities are continuous, broad-band sounds at frequencies mostly below 1 kHz (Todd et al. 2015). Underwater noise reviews by CEDA (2011) and WODA (2013) found that suction dredges (similar to the methods proposed in this application) produce mostly low frequency, omni-directional sounds between 100–500 Hz (Figure 6). Their bandwidths can fluctuate as low as

20 Hz and as high as 20 kHz as sound levels will be dependent on the specific vessel, the sediment extraction process and the types of sediment being extracted, with coarser gravel causing greater sound levels (WODA 2013, references therein).

Empirical measurements of the dredger, the *William Fraser*, were taken within an existing offshore consent site [4] while extracting as proposed. The average broadband source level was calculated at 168 dB re 1 µPa @ 1m with a main energy component between 200 Hz and 2000 Hz (or 2 kHz; Pine 2020a). This level is significantly lower than noise levels that are produced by a large ship, which is between 180–190 dB *re*1 µPa rms @ 1 m (OSPAR 2009; Todd et al. 2015; Pine & Styles 2016).

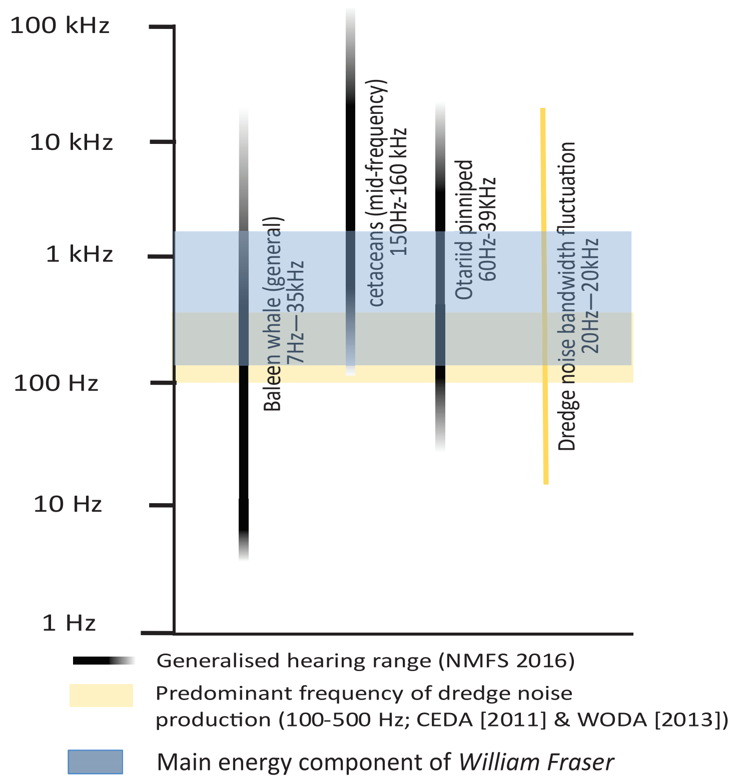


Figure 6. Schematic summary of the overlap in frequency of the three marine mammal hearing sensitivity groups relevant to this proposal with general dredge noise production.

Although no underwater noise guidelines exist for dredging activities and marine mammals within New Zealand, several overseas regulators provide context and guidance on appropriate noise thresholds and mitigation measures for avoiding adverse noise effects on marine mammals (e.g. United States—NOAA 2018, Australia—DPTI 2012). Pine (2020b) used the most recent NOAA (2018) thresholds

[4] The *William Fraser* followed the 30 m contour, as per the offshore consent owned by Kaipara Ltd but operated by MBL.

to estimate the area over which underwater noise effects from the proposed dredging operation would occur. These estimates are based on the measured sound exposure levels of the newly-built *William Fraser*, and the relevant species of concern.

Pine (2020b) has estimated that the potential for the most injurious effects—the onset of temporary threshold shifts (TTS) or permanent threshold shifts (PTS)—are unlikely to occur for all three for the different marine mammal groups of interest[5]. Using a new custom approach[6], Pine (2020b) also estimated potential distances from the dredger that low level behavioural responses[7] and moderate level behavioural responses[8] may occur for the species of interest (Table 3). As expected, the probability of a behavioural response (either low or moderate) occurring varies by species (e.g. from 400 m to just over a kilometre) and increases as an individual animal gets closer to the dredge vessel. These distances are compared to the more generic 120 dB re 1 µPa rms threshold applied by NOAA (2011) that has been used previously in lieu of species-specific data for behavioural impacts (see Appendix 3).

Pine (2020b) also calculated distances from the dredger where the associated noises might interfere or prevent an animal from hearing natural acoustic signals (e.g. members of the same species trying to communicate across particular frequencies / levels while in proximity of the operating dredge). The estimated reductions in an animal's listening space (e.g. volume of ocean around an individual) as it approaches a dredger are listed in Table 3 and illustrated in Appendix 3. For all species (Bryde's whale, orca, bottlenose dolphin and NZ fur seal), the greatest risk of reduction to their listening space (> 75%) would be limited to within a 20 m or less from the dredge vessel when in operation (Table 3).

[5] Based on NOAA (2018) safe distance method that 'allows one to determine the distance that receiver would have to remain in order to not exceed some predetermined exposed threshold'.

[6] This method is based on the specified dose-response function and behavioural thresholds from Joy et al. (2019) and uses the categories of 'low' and 'moderate' behavioural responses as suggested by NOAA (2018); limited behavioural response data of bowhead whales and killer whales to underwater noises in the North Hemisphere.

[7] For example. minor changes in swimming direction / speed, surface intervals, respiration rates, vocalisation behaviours.

[8] For example. moderate to extensive changes in swimming direction / speed, surface intervals, respiration rates, cessation of vocalisations.

Table 3. Estimated distance ranges for potential behavioural impacts and listening space reduction (i.e. masking) of the three modelled hearing groups in Pine (2020a). Distances equate to the maximum distance estimated from sound propagation models developed for the consent area by Pine (2020b) and listed in Appendix 3. LF = Low Frequency group, MF = Mid-Frequency group, and OP = Otariid Pinniped group.

William Fraser	**Chance of behavioural effect**	**LF** (baleen whales) Max Distance (m) *	**MF** (orca) Max Distance (m) *	**MF** (other delphinids) Max Distance (m) *	**OP** (fur seal) Max Distance (m) **
PTS (permanent threshold shift)	-	0.0	0.0	0.0	0.0
TTS (temporary threshold shift)	-	0.0	0.0	0.0	< 1.0
Low Behavioural Response #	0%	1234	411	411	-
	25%	314	87	87	-
	50%	241	51	51	-
	75%	124	15	15	-
Moderate Behavioural Response ^	0%	-	308	308	-
	25%	-	54	54	-
	50%	-	4	4	-
	75%	-	NA	NA	-
	Percent reduction	**LF** (baleen whales)	**MF** (orca)	**MF** (other delphinids)	**OP** (fur seal)
Listening Space (Masking)	0%	4013	5637	5630	5657
	25%	1230	1077	1057	1157
	50%	92	348	318	466
	75%	NA	NA	NA	17

* Where available, these were based on the relevant species audiogram data (Pine 2020a). Masking result for whales were calculated based on fin whale audiograms.

** Masking range based on northern fur seal audiogram data in the absence of NZ fur seal audiogram.

For whales, the received level at which there was 50% risk of a low behavioural response occurring was set at 120 dB re 1 μPa (based on bowhead whale behavioural responses to continuous noise – Southall et al. 2007) and for MF species, 129.5 dB re 1 μPa was used (based on killer whale behavioural data – Joy et al. 2019).

^ There are no data available to inform received level for moderate behavioural effects for whales. MF species were based on orca data (Joy et al. 2019) with a 50% risk of a moderate behavioural response occurring at 137.2 dB re 1 μPa.

Overall, any effects from underwater noise generated from this dredging proposal will likely be transitory and non-injurious, based on the estimates of Pine (2020b). The overall levels and character of dredging noise will be much less than the numerous vessels currently travelling to and from the Ports of Auckland on a daily basis. The likelihood of any hearing injury effects (TTS or PTS) occurring is considered *not applicable*. Effects will be limited predominantly to the temporary masking of some noise signals when animals are within several kilometres of the dredge and a range of potential behavioural responses at closer proximity (< 400 m). The most relevant factors contributing to this assessment are summarised below:

Spatial and temporal factors

- Only a few migrating whales are sighted within the wider Mangawhai / Bream Bay area each year; the majority pass by in deeper, more offshore waters (e.g. further than 5 to 10 nm).
- Most whales occur in the area for a limited period each year, restricted mainly to winter months and some spring months when most only remain for a day or up to a week. The exception is Bryde's whales, which are found in the region throughout the year.
- Most odontocete and pinniped species known to frequent Mangawhai and Hauraki Gulf waters are regularly exposed to similar types and levels of underwater noise from commercial and recreational vessels throughout their entire distributional range.
- Mangawhai region is not considered unique or particularly important feeding, resting or nursery habitats for any residential or visiting species.

Known acoustic factors

- Mainly lower-frequency noise generated by proposed dredge vessels and activities, but at levels significantly lower than most commercial vessels currently passing by this region and / or Hauraki Gulf.
- Dredge sound levels are not expected to exceed PTS at all or TTS criteria at greater than one metre from dredge (Pine 2020b).
- A range of potential behavioural and masking effects are possible, but the risk is greatest (> 75%) only in very close proximity to the dredge (~100 m to not applicable).

4.2. Vessel strike

Current sand extraction activities take place year-round. Given that MBL's vessels' unloaded speeds are less than 10 knots, and even slower when loaded with sand, a typical extraction return trip lasts approximately 16-18 hours from the Ports of Auckland. The current extraction schedule involves around 130 return trips to the consent zone each year (compared with 127 trips in 2018/19 with previous vessels).

Given the increased volume capacity of the *William Fraser* and the proposed increase of extraction volume, trip numbers to the new consent area are expected to remain similar to current rates.

Vessel strikes are a well-known source of injury and mortality for several species of marine mammals around the world, particularly baleen whales (Laist et al. 2001). In New Zealand waters, vessel strikes are often associated with large fast vessels, such as container or carrier ships (e.g. DOC website). Between 1996 and 2014, 17 Bryde's whale deaths in the Hauraki Gulf have been attributed to vessel strike and the speeds at which commercial ships pass through the area (Constantine et al. 2015).

The likelihood of vessel strike depends on a number of operational factors including vessel type, speed, and location (van Waerebeek et al. 2007). The greatest increase in both the risk of a collision and the likelihood that it will result in severe injury or death occurs at speeds over 11 knots (Vanderlaan & Taggart 2007; Gende et al. 2011). The slower speeds in which dredge vessels generally travel may explain why only one out of the 134 worldwide reported collisions that occurred between 1975 and 2002 was with a dredge vessel (Jensen & Silber 2004). In South Africa, a southern right whale cow / calf pair surfaced directly in front of a 110 m dredge (speed unknown) while it was underway and the calf was subsequently struck, cut by the propellers and later died (Jensen & Silber 2004).

A recent worldwide review of dredging effects suggests that the risk of collision between dredge vessels and marine mammals can also be minimised if the activity avoids critical habitats and seasons when the species of concern may be more 'distracted' while feeding or resting (Todd et al. 2015). Some species (i.e. baleen whales) and certain age groups (i.e. calves and juveniles) are noted as being more susceptible to vessel strike than others.

In this case, the species considered most vulnerable to any potential vessel collisions include Bryde's, southern right and humpback whales and to a much lesser extent, bottlenose dolphins and orca (given their current endangered species status rather than propensity for vessel strike). The likelihood of a vessel collision (injury or mortality) within the proposal area is assessed as *low* for migrating baleen whales and odontocete species within the sand extraction consent region. This conclusion is based on the relevant factors as summarised below:

Spatial and temporal factors

- Low probability of the dredge vessel encountering a migrating whale within the consent area as the majority of whales are likely to pass further offshore in deeper waters (e.g. further than 5 nm).
- Most whales occur in the area for a limited period each year; mainly in the winter months and some spring months, and most only remain for a day up to a week.

- Most odontocete and pinniped species known to frequent Mangawhai waters are in regular contact with all types and speeds of commercial and recreational vessels throughout their entire distributional range.

Known collision factors

- In the 115 years of operation and 75 years of sand extraction in the Omaha to Mangawhai area, there has been no known collisions between any of the dredge vessels and marine mammals.
- Low probability of the dredge vessel striking an individual animal, given the vessel will be slow moving while extracting sand and the operating speed of the *William Fraser* unloaded is less than 10 knots.
- Most dolphin species have a general attraction to boats and safely approach and / or bowride. Fur seals often respond neutrally to boats when in the water (although they may bowride occasionally).
- Mangawhai waters are not considered unique or important feeding, resting or nursery habitats for any residential or visiting species, hence individuals are less likely to be 'distracted' by such activities, and are thus less vulnerable to collision risk.

While the transiting of dredging vessels to and from the Ports of Auckland does not require resource consent, their passage through the Hauraki Gulf is the main region where a collision risk with marine mammals is more likely to occur. Bryde's whales have an extremely high vessel strike rate within Gulf waters given their tendency to rest or remain just below the water's surface (i.e. < 12 m) for large periods of time, making it difficult for vessels to see them. Hence, while the likelihood of a vessel collision (injury or mortality) when travelling through the Hauraki Gulf is still assessed as *low* for migrating baleen whales and odontocete species, it is *moderate* for Bryde's whales. To reduce the likelihood of a strike to as close to zero as possible and avoid any risk of a mortality, several mitigation actions are already in place (Table 3) and a few further actions have been recommended (see Table 4). These conclusions are based on the relevant factors as summarised below:

Spatial and temporal factors

- Moderate overlap between Bryde's whale distribution within the Hauraki Gulf and the general transit route of dredge vessels (e.g. Figure 5).
- Bryde's whales are regularly found within inner Gulf waters where they are known to rest and feed throughout the year.

Known collision factors

- In the 115 years of operation and 75 years of transiting through the Hauraki Gulf area, there has been no known interactions or collisions between any of the dredge vessels and marine mammals.

- When travelling to and from the Ports of Auckland, the normal operating speed of the unloaded *William Fraser* (10 knots or less) should be slow enough for the animals to manoeuvre out of the path of the vessel or be spotted by crew and avoided.
- A voluntary transit protocol to minimise Bryde's whale collisions was initiated in 2013 between the shipping industry and the Ports of Auckland for the Hauraki Gulf region. The protocol recommends lowering the average speed of commercial ships within the inner Gulf to 10 knots. Implementation of the protocol (i.e. reducing average speed to 10 knots) has been estimated to reduce the probability of a lethal ship strike from 51% to 16% (Riekkola 2013).

4.3. Vessel lighting

To date, the effects of artificial lighting on marine mammals is relatively unknown with little to no research in this area nationally or internationally. As most dredging occurs in the late afternoon or evening, dredge vessels and any barges will have standard navigation and safety lighting in operation. However, any lighting footprint will most likely be confined to within a few hundred metres of the vessel and within surface to sub-surface depths.

Night lighting on more stationary or slow-moving vessels has the potential to attract small food species including plankton, larvae and bait fish. This attraction in turn might similarly attract any small cetaceans, such as common and bottlenose dolphins, already in the area to the vessel. However, marine mammals will more likely be attracted to increases in noise or changes in vessel activity rather than the lights themselves. To help reduce any potential responses to dredge vessel lighting, some simple mitigation suggestions are recommended in Section 5 and Table 5.

4.4. Operational loss and possible entanglement

The nature of dredge operating activities and the equipment involved means the likelihood of marine wildlife entanglement in marine debris is *low* (Table 4). Marine debris collectively includes such items as lost ropes, support buoys, bags and plastics (e.g. Laist et al. 1999). Whales, dolphins and pinnipeds are often attracted to floating debris, with a potential risk of becoming entangled in floating lines and netting (e.g. Suisted & Neale 2004; Groom & Coughran 2012). Loose, thin lines pose the greatest entanglement risk (e.g. lines used to tie up boats, floats and other equipment) and especially lost ropes or lines.

However, marine debris generation is generally non-existent in well-maintained coastal projects with proper waste management programmes in place (e.g. secure onboard storage of lines, ropes, and waste) in order to comply with the NZ Maritime

Rules Part 180. In such cases, any subsequent effects to marine mammals are expected to be *negligible*.

4.5. Indirect effects through the ecosystem

The extraction of coastal sand within any established ecosystem will result in some change to that system. However, the nature and extent of such change will be dependent on many variables, including the scale and duration of dredging. Currently there is little to no research on how ecosystem changes due to dredging activities might indirectly affect marine mammals. While most cetaceans are generalist feeders and flexible in their habits, some species have been known to dramatically alter their distribution patterns in response to even small changes in prey availability (e.g. bottlenose dolphins: Bearzi et al. 2004) and / or ecosystem dynamics (e.g. North Atlantic right whales: Baumgartner et al. 2007). The following section focuses on potential indirect effects that dredging activities could have on the ecosystem as a whole, and more specifically on the abundance, distribution and / or health of marine mammal prey resources.

4.5.1. Exposure to resuspended contaminants

Contaminants and bacteria adsorb to marine sediments, leading to their accumulation and bioturbation over time. Dredging re-suspends these sediments and may result in the contaminants becoming bioavailable to potential prey species. Pollutants, present in prey items, are taken up by marine mammals through their absorption with prey fat and are subsequently concentrated within their blubber or other tissue layers. Marine mammals are particularly vulnerable to the bioaccumulation of lipophilic (fat soluble) environmental chemicals, such as organochlorine insecticides (dioxins and pesticides including DDT) and PCBs (industrially-associated polychlorinated biphenyls) due to their thick layers of vascularised blubber (Woodley et al. 1991; Weisbrod et al. 2000).

The review by Todd et al. (2015) noted that exposure risks from any resuspended contaminants due to dredging activities are greatest to marine mammals only when dredging contaminated sediments (i.e. not all sediments have heavy contaminant loads) and concluded that in even those cases, exposure was still spatially restricted. Potential exposure to contaminants for any local marine mammals will depend on the chemical characteristics (e.g. types of contaminants, bioavailability), the subsequent uptake by relevant prey resources (e.g. plankton, fish, rays, cephalopods) and the feeding habits and ranges of the marine mammal species (e.g. Jones 1998; Evans 2003). The Mangawhai-Pakiri coastal region, relative to other regions along the north-eastern coastline, is not currently considered unique or important feeding habitat for local or visiting marine mammals (see Section 3.3). In fact, most local species, such as bottlenose dolphins, common dolphins and fur seals, are generalist feeders that will opportunistically forage throughout the entire proposal area, along most north-eastern coastal regions, and more offshore waters. Orca are considered more specialist feeders; they regularly forage for rays among estuarine mud and sand flats areas from the Bay of Islands to Auckland Harbour (Visser 1999a). Some migrating species (i.e. humpback whales) may not even feed while passing through New Zealand waters during parts of their migration (Dawbin 1956).

Sediment sampling associated with the sand extraction activities has not identified any contaminants (e.g. heavy metals, PCBs or PAHs) that represent a risk for the ecology of Mangawhai waters (Gibbs 2019). Therefore, the likelihood for bioaccumulation and biomagnification effects on local marine mammal species from the resuspension and dispersal of any contaminants during extraction activities is *not applicabl*e to *low* and the overall effect assessed as *nil to negligible*.

4.5.2. Ecological effect on habitat and prey species

Benthic disturbance and loss

The dredging of sediments causes the immediate loss of some benthic biota and temporarily alters the habitat within the immediate region of activity to some degree due to the loss of sand to the extraction process (e.g. Todd et al. 2015; see Figure 2). However, the level of effect that this loss will have on the coastal ecosystem depends on the proportion of available habitat that is similar. Any subsequent flow-on effects of physical habitat or biota changes to local marine mammal species are dependent on their reliance of prey resources in the area.

In situ observations of the current extraction methods found burrowing fauna at the proposed site were not affected to the same extent as seen with more stationary or slow-moving harbour dredging techniques (Bioresearches 2019). As it is unlikely that these sites currently serve as unique or important feeding grounds for any marine mammal species (given the marine mammal data available), any benthic flow-on effects to local marine mammals are expected to be *nil* to *negligible*.

Turbidity plumes

Turbidity plumes are generated from the re-suspension of sediments at the dredging site (Figure 2). High turbidity levels and movements of any sediment plumes created by dredging activities can be a concern to fauna within or adjacent to work sites (e.g. Todd et al. 2015). There is potential for such plumes to be additive to existing turbidity levels or become entrained in local gyres and eddies.

Marine mammals are known to inhabit fairly turbid environments worldwide and especially within New Zealand’s nearshore environments. While they have very good vision, it does not appear to be the sense they rely upon most for foraging. Instead, odontocetes mainly depend on their sonar systems for underwater navigation and searching for food. Even baleen whales, which do not have the ability to echolocate, regularly forage in dark, benthic environments stirring up sediments to find prey. Thus, turbidity plumes are more likely to affect marine mammals indirectly via their prey resources rather than directly (Todd et al. 2015).

Based on modelling and *in situ* sampling at the existing site, and taking into consideration the lack of fine sediment particles present in the area, any effects of increased turbidity will be limited in their spatial extent, fade to ambient levels relatively quickly (e.g. 250 m) and thus, will be constrained in their impacts (Bioresearches 2019; Gibbs 2019). Overall, any turbidity plumes generated from extraction activities are not expected to have any detrimental or long-term flow-on effects to local marine mammals in the region, and therefore will be *nil to negligible*.

Table 4. Summary of potential effects on marine mammal species from sand extracting of the Pakiri coastal area with mitigation measures (*see Section 5 and Table 5 for more details).

Potential environmental effects	Spatial scale of effect on marine mammals	Persistence / duration of effect for marine mammals	Consequences for marine mammals	Likelihood	Avoidance Factors / Mitigation Options*	Significance Level of Residual Effect
Behavioural and / or physical responses to underwater sound	**Small to Large** Behavioural / masking responses predicted at varying distances	**Short to Persistent** Whales only present in proposal area for a day to weeks; ~5 hrs of dredging noise daily for duration of consent.	**Individual Level:** Individuals may avoid or approach dredging activities; individuals subject to potential behavioural responses and acoustic masking but only within close proximity	**Not Applicable** – TTS / PTS **to** **Low –** behavioural **to** **Moderate –** masking	• Very low probability of whale presence near proposal area • Regular maintenance and proper up-keep of all dredging equipment and the vessel • *In situ* verification of noise levels associated with any new vessels or dredgers	**Nil –** TTS / PTS **to** **Less than Minor –** behavioural, masking
Marine mammal / vessel collision risk: Extraction area	**Large** Extraction over several km^2	**Short to Persistent** Animals only present in proposal area for a day to weeks but for length of consent	**Individual Level:** Death or injury of non-threatened species	**Low –** Mangawhai region	• Very low probability of whale encounter (other than Bryde's whales mainly in Gulf water) • Relatively slow speeds of dredging vessels help reduce consequences of a collision to injury rather than mortality • Continuous recording of all sightings (including absences) • Adoption of Ports of Auckland Hauraki Gulf voluntary transit protocol for shipping that include speed limits and crew member on watch while transiting through Gulf waters in daylight hours	**Negligible**
MBL vessel route through Hauraki Gulf	**Large** Daily movements between sites and port (~80 km)	**Short to Persistent** Daily transits through Gulf limited duration but for length of consent	**Population Level:** Death or injury of endangered or threatened species	**Moderate –** Hauraki Gulf		**Less than Minor**
Attraction to artificial lighting on vessel(s)	**Small** Dependent on types of lights	**Short and Persistent** Daily for ~5 hrs while extracting	**Individual Level** Local attraction of pinnipeds and some dolphins	**Low to Moderate**	• Minimum amounts of lighting and proper positioning to reduce the attraction of wildlife	**Nil to Negligible**
Entanglement in operational gear and / or debris	**Small to Medium** Limited to immediate waters around operating dredge vessels	**Short to Persistent** Daily for ~5 hrs while extracting	**Population Level:** Death or injury of endangered or threatened species **Individual Level:** Death or injury of pinniped or dolphin	**Low** **Low**	• Avoid use of loose rope and other lines • Compliance with NZ Maritime Rules Part 180	**Nil to Negligible**
Contaminant effects from dredged sediments	**Small to Large** Limited to immediate waters and habitats adjacent to extraction sites	**Short to Persistent** Dependent on type and level of any contamination in sediments	**Individual Level** Limited potential for any individual to consume more than few prey species exposed to dredging sediments	**Not Applicable to Low**	• Tested sediments have low to less than trace levels of contaminants and a low silt content (i.e. relatively lower potential for contaminant accumulation), with limited bioavailability and solubility • Only localised spread of spoil (e.g. 250m from source)	**Nil to Negligible**
Habitat and / or prey disturbance from loss of benthic habitat and increased turbidity	**Small to Large** Limited to immediate waters and habitats adjacent to extraction sites	**Short to Persistent** Periodic disturbance to benthos; plume expected to settle out within less than a day	**Individual Level** Possible avoidance of disturbed area, individuals may approach site(s) for opportunistic foraging	**Not Applicable to Low**	• No unique feeding habitats in the proposed areas, and areas represent only a small portion of similar available habitat • Use of sub-surface moon pool technology to ensure turbidity limits	**Nil to Negligible**

Ranking of terms used in table:

- Spatial scale of effect: Small (tens of metres), Medium (hundreds of metres), Large (> 1 km)
- Duration of effect: Short (days to weeks), Moderate (weeks to months), Persistent (years or more)
- Consequence: Individual, Regional, Population
- Likelihood of effect: Not Applicable (NA), Low (< 25%), Moderate (25–75%), High (> 75%)
- Significance of effect: Nil (no effects at all), Negligible (effect too small to be discernible or of concern), Less than Minor (discernible effect but too small to affect others), Minor (noticeable but will not cause any significant adverse effects), More than Minor (noticeable that may cause adverse impact but could be mitigated), Significant (noticeable and will have serious adverse impact but could be potential mitigated)

5. MANAGEMENT OF EFFECTS

Overall, the residual effect of any impacts from sand extraction activities on local and visiting marine mammals is considered to be *less than minor to negligible* (Table 4). This assessment is based on the consideration of the types of effects, their spatial scales and durations, and relevant species' information. It also takes into consideration existing operational aspects, as well as natural avoidance factors, that currently help mitigate adverse effects on marine mammals.

However, given that some of the possible consequences of rare events (i.e. vessel strike) could have population level effects (i.e. injury or death of a threatened animal), further mitigation is discussed and several recommended actions are listed in Table 5 to help reduce these risks to as close to zero as possible. Importantly, several best management practices (BMPs) are recommended even where effects are expected to be negligible.

To ensure that the most appropriate measures are in place, it is suggested that a marine mammal management plan (MMMP) be developed by a marine mammal expert in consultation with DOC. This plan should at least outline in detail: (i) mitigation procedures referred to in Table 5, (ii) any procedures that will need to be reviewed for effectiveness during operations (e.g. standardised sighting protocol) and (iii) determine timelines for any subsequent reporting requirements (if warranted).

Acoustic measurements suggest that the chance of any auditory injury effects on marine mammal hearing (i.e. TTS / PTS) are not applicable, and hence, additional safety or shut down zones are not warranted. Instead, we recommend that MBL continue to collect marine mammal sighting data while dredging and transiting during daylight hours. The collection of additional information on how often, which species and in what conditions (including parts of the dredging cycle) a marine mammal might approach the dredge vessel while dredging is underway is recommended as it will inform future consents or renewals.

To help ensure the low likelihood of a vessel strike and avoid any risk of a mortality if a collision does occur, we have recommended MBL formally adopt several existing operation actions as well as suggest some additional mitigations (see Table 5 and Appendix 4). Collision risk is highest when transiting through the Hauraki Gulf region and when the vessel(s) are unloaded and travelling their fastest. We suggest designating a crew member (e.g. skipper) to maintain a watch (daylight only) for any sign of animals when transiting these higher-risk regions, setting speed limits and the adoption of simple and common-sense best boating behaviour guidelines around marine mammals by the dredge vessel. These recommendations are in line with the Ports of Auckland's Hauraki Gulf voluntary transit protocol for commercial shipping to protect Bryde's whales (e.g. Hauraki Gulf Forum 2018), a protocol which MBL has already adopted for all of its vessels. Together, these further actions will ensure that all available information is being used to help locate, reduce and avoid any interactions between the dredge vessel and any visiting marine mammals that may occur within the proposal area and the Gulf during the course of this project.

Table 5. Proposed mitigation goals and practices to mitigate or minimise the risk of any adverse effects of sand extracting activities on marine mammals along the Pakiri coastline and transiting through the Hauraki Gulf. BMPs – best management practices, DOC – Department of Conservation, AC – Auckland Council, MMPA- Marine Mammal Protection Act 1978.

Management goal	**Mitigation / Management actions (e.g. BMPs)**	**Reporting**
1. Minimise the avoidance (attraction) or potential for injury of marine wildlife to dredging activities	1a. Use best practical options (BPO) to minimise underwater noise effects.	• Measure underwater noise levels from any new vessel or dredger as soon as practical.
	1b. Regular maintenance and proper up-keep of all dredging equipment and the vessel (e.g. lubrication and repair of winches, generators).	• Nothing required, self-checking as part of marine mammal management plan with up-to-date records available.
	1c. Record marine mammal interactions with the dredge, noting the dredging cycle, conditions and animal's behaviour.	• Record and report the type and frequency of marine mammal interactions (including absences and effort), in a standardised format. Annual records provided AC and made publicly available (e.g. web). • Encourage the collection of additional information on species' behavioural responses during dredging operations.
	1d. Ensure only minimum amount of boat lighting used, minimise light 'spill' overboard to reduce attraction of prey fish.	• Nothing required, self-checking as part of marine mammal management plan • Encourage or support specific research into effects
2. Minimise the risk of dredge vessel collisions with any marine mammal and aim for zero injury/mortality	2a. Adoption of best boating guidelines for marine mammals, including speed limits, to reduce any chances of mortality from vessel strikes (see Appendix 4).	• Record all vessel strike incidents or near incidents regardless of outcome (e.g. injury or mortality) in a standardised format. This is consistent with the Hauraki Gulf's voluntary shipping protocol and MMPA
	2b. Establish and maintain a watch for marine mammals while transiting through Gulf waters during daylight hours.	• In case of a fatal marine mammal incident, carcass(es) recovered (if possible) and given to DOC, and further steps taken in consultation with DOC to reduce the risk of future incidences. This is consistent with the MMPA
	2c. Continue to record marine mammal interactions to build a baseline occurrence in waters near the proposal site as well as to and from port.	• •Record and report the type and frequency of marine mammal sightings (including absences and effort), in a standardised format. Annual records provided AC and made publicly available (e.g. web).
3. Aim to minimise entanglement with a goal of zero mortality	3a. Avoid loose rope and / or nets around or off vessels. All deck lines should be tied up when not in use or under some degree of tension.	• Nothing required, self-checking as part of marine mammal management plan with up-to-date records available.
	3b. Minimise potential for loss of rubbish and debris from vessels and recover lost material.	• Nothing required, self-checking as part of marine mammal management plan with up-to-date records available.
	3c. Record all entanglement incidents regardless of outcome (e.g. injury or mortality).	• Records available to DOC and AC. In case of a fatal incident, carcass(es) recovered, given to DOC, and steps taken in consultation with DOC to reduce the risk of future incidences.

6. CONCLUSIONS

This report describes the local and visiting marine mammals that utilise and / or are influenced by Mangawhai / Bream Bay coastal waters and the nearby Hauraki Gulf ecosystem. Information on the various species was reviewed for any life history dynamics that could make them more vulnerable to dredging activities, or where the proposed sand extraction sites may overlap with any ecologically significant feeding, resting or breeding habitats. This enabled the potential effects associated with the dredging components on marine mammals to be assessed.

The marine mammals most likely affected by the proposal include the few species that frequent the wider region associated with Mangawhai / Bream Bay year-round or on a semi-regular basis. These species include common dolphins, bottlenose dolphins, orca, and Bryde's whales. Other species including NZ fur seals, southern right and humpback whales, pilot whales, and sperm whales were also considered because of their records of occurrence in the general area, their known species-specific sensitivities (e.g. underwater noise); and / or potential public and iwi concerns.

Mangawhai / Bream Bay coastal waters are not considered ecologically significant habitats for most of these species. Instead, these waters represent only a small fraction of similar habitats available to these marine mammals throughout nearby coastal regions. Nonetheless, it is important to note that several of the above listed species are nationally and / or internationally recognised as threatened species that live in semi-isolated sub-populations, and thus need to be considered in regard to Policy 11(a) of the NZCPS. Furthermore, the nearby Hauraki Gulf is important year-round habitat for a small local population of critically endangered Bryde's whales.

In light of the potential direct and indirect effects highlighted in this report, the overall risk of any significant adverse effects for marine mammals arising from the proposed offshore consent is assessed as *less than minor* to *negligible*. These conclusions were based in part on other consultant reports. Recommended mitigation actions are aimed mainly at formalising existing best practices. The report also addresses the collision effects of dredge vessels transiting through Hauraki Gulf water and suggests reducing the possibility of any accidental interactions with Bryde's whales by continuing to implement the Ports of Auckland's Hauraki Gulf voluntary transit protocol for commercial shipping.

Records on the presence (and absence) of marine mammal species in the general region of the activities, along with any detailed observations of their time spent under or around dredge vessels, should continue to be compiled. A well-kept database can be used to understand which species may be more attracted to various dredging activities and what aspects of dredging they may be avoiding. Such information is crucial towards developing appropriate and effective mitigation measures for marine mammals and any future dredging operations.

7. REFERENCES

Au WWL 2000. Hearing in whales and dolphins: an overview. In: Au WWL, Popper AN, Fay RR (eds). Hearing by whales and dolphins. New York, USA. Springer-Verlag Inc. pp. 1-42.

Baker AN 1983. Whales and dolphins of New Zealand and Australia; an identification guide. Victoria University Press, Wellington.

Baker AN 1999. Whales and dolphins of New Zealand and Australia; an identification guide. Victoria University Press, Wellington. 133 p.

Baker AN, Madon B 2007. Bryde's whales (*Balaenoptera* cf. *brydei* Olsen 1913) in the Hauraki Gulf and northeastern New Zealand waters. Science for Conservation 272. Department of Conservation, Wellington. 23 p.

Baker CS, Clapham PJ 2004. Modelling the past and future of whales and whaling. Trends in Ecology and Evolution 19(7): 365-371.

Baker CS, Chilvers B, Constantine R, DuFresne S, Mattlin R, van Helden A, Hitchmough R 2010. Conservation status of New Zealand marine mammals (suborders Cetacea and Pinnipedia), 2009. New Zealand Journal of Marine and Freshwater Research 44(2): 101-115.

Baker CS, Boren L, Childerhouse S, Constantine R, van Helden A, Lundquist D, Rayment W, Rolfe JR 2019. Conservation status of New Zealand marine mammals, 2019. New Zealand Threat Classification Series 29. Department of Conservation, Wellington. 18 p.

Baumgartner MF, Mayo CA, Kenney RD 2007. Enormous carnivores, microscopic food, and a restaurant that's hard to find. In Kraus SD, Rolland RM (eds) The urban whale – North Atlantic right whales at the crossroads. Cambridge Massachusetts, Harvard University Press. pp. 138-171.

Bearzi G, Quondam F, Politi E 2004. Bottlenose dolphins foraging alongside fish farm cages in eastern Ionian Sea coastal waters. European Research on Cetaceans 15: 292-293.

Beatson EL, O'Shea S 2009. Stomach contents of long-finned pilot whales, *Globicephala melas*, mass-stranded on Farewell Spit, Golden Bay in 2005 and 2008. New Zealand Journal of Zoology 36: 47-58.

Beatson EL, O'Shea S, Stone C, Shortland T 2007. Notes on New Zealand mammals: Second report on the stomach contents of long-finned pilot whales, *Globicephala melas*. New Zealand Journal of Zoology 34: 359-362.

Best PB, Brandao A, Butterworth DS 2001. Demographic parameters of southern right whales off South Africa. Journal of Cetacean Research and Management Special Issue 2: 161-169.

Bioresearches 2019. Assessment of Ecological Effects: Following sand extraction from the Pakiri Sand extraction areas. Report for McCallum Brothers Limited. pp 68.

Brabyn MW 1990. An analysis of the New Zealand whale strandings. Master of Science thesis. University of Canterbury, Christchurch, New Zealand. 85 p.

Brabyn MW 1991. An analysis of the New Zealand whale stranding record. Conservation Science & Research No. 29, Department of Conservation, Wellington.

Carroll E, Patenaude N, Childerhouse S, Kraus S, Fewster R, Baker C 2011a. Abundance of the New Zealand subantarctic southern right whale population estimated from photo-identification and genotype mark-recapture. Marine Biology 158(11): 2565-2575.

Carroll E, Patenaude N, Alexander A, Steel D, Harcourt R, Childerhouse S, Smith S, Bannister J, Constantine R, Baker CS 2011b. Population structure and individual movement of southern right whales around New Zealand and Australia. Marine Ecology Progress Series 432: 257-268.

Carroll EL, Rayment WJ, Alexander AM, Baker CS, Patenaude NJ, Steel D, Constantine R, Cole R, Boren LJ, Childerhouse S 2014. Reestablishment of former wintering grounds by New Zealand southern right whales. Marine Mammal Science 30(1): 206-220.

Carwardine M 1995. Whales, dolphins and porpoises. Dorling Kindersley Ltd, London. 256 p.

CEDA 2011. CEDA Position Paper: Underwater sound in relation to dredging. 6 p. www.dredging.org.

Chetham J 2015. Cultural values assessment: of Refining NZ Limited's proposal to make modifications to the Whangarei Harbour to allow larger freight parcels/oil tankers to enter the harbour. Prepared by Patuharakeke Te Iwi Trust Board Inc. for Refining NZ. 27 p.

Childerhouse S, Gibbs N 2006. Preliminary report for the Cook Strait humpback whale survey 2006. Unpublished report to the Department of Conservation, New Zealand.

Childerhouse S, Jackson J, Baker CS, Gales N, Clapham PJ, Brownell Jr RL 2008. *Megaptera novaeangliae* (Oceania sub-population). IUCN Red List of Threatened Species. Version 2009.1.

Childerhouse S, Double M, Gales N 2010. Satellite tracking of southern right whales (*Eubalaena australis*) at the Auckland Islands, New Zealand. Unpublished report (SC/62/BRG19) presented to the Scientific Committee of the International Whaling Commission, Cambridge, UK.

Clapham P, Mikhalev Y, Franklin W, Paton D, Baker CS, Ivashchenko YV, Brownell RL Jr 2009. Catches of humpback whales, *Megaptera novaeangliae*, by the Soviet Union and other nations in the Southern Ocean, 1947–1973. Marine Fisheries Review 71(1): 39-43

Clark CW, Ellison WT, Southall BL, Hatch L, Van Parijs SM, Frankel A, Ponirakis D 2009. Acoustic masking in marine ecosystems: intuitions, analysis, and implication. Marine Ecology Progress Series 395: 201-222.

Clement D, Elvines D 2015. Phase 1: Preliminary review of potential dredging effects on marine mammals in the Whangarei Harbour region. Prepared for Chancery Green on behalf of Refining New Zealand Limited. Cawthron Report No. 2711. 31 p. plus appendix.

Constantine R 2002. The behavioural ecology of the bottlenose dolphins (*Tursiops truncatus)* of northeastern New Zealand: a population exposed to tourism. Ph.D thesis. University of Auckland, Auckland, New Zealand, 233 p.

Constantine R, Baker CS 1997. Monitoring the commercial swim-with-dolphin operations in the Bay of Islands. Science for Conservation, 56. Department of Conservation, Wellington.

Constantine R, Brunton DH, Baker CS 2003. Effects of tourism on behavioural ecology of bottlenose dolphins of northeastern New Zealand. DOC Science Internal Series 153. Department of Conservation, Wellington. 26 p.

Constantine R, Russell K, Gibbs N, Childerhouse S, Baker CS 2007. Photo-identification of humpback whales (*Megaptera novaeangliae*) in New Zealand waters and their migratory connections to breeding grounds of Oceania. Marine Mammal Science 23(3): 715–720.

Constantine R, Aguilar de Soto N, Johnson M 2012. Sharing the waters: minimising ship collisions with Bryde’s whales in the Hauraki Gulf. DOC Research Progress Series: February 2012. 22 p.

Constantine R, Johnson M, Riekkola L, Jervis S, Kozmian-Ledward L, Dennis T, Torres LG, Aguilar de Soto N 2015. Mitigation of vessel-strike mortality of endangered Bryde’s whales in the Hauraki Gulf, New Zealand. Biological Conservation 186: 149-157.

Dawbin WH 1956. The migration of humpback whales which pass the New Zealand coast. Transactions of the Royal Society of New Zealand 84(1): 147-196.

DPTI (Department of Planning, Transport and Infrastructure) 2012. Underwater piling noise guidelines; version 1. Government of South Australia. November 2012. 32p. (https://www.dpti.sa.gov.au/__data/assets/pdf_file/0004/88591/DOCS_AND_FILES-7139711-v2-Environment_-_Noise_-_DPTI_Final_word_editing_version_Underwater_Piling_Noise_Guide.pdf)

DuFresne SP, Grant AR, Norden WS, Pierre JP 2007. Factors affecting cetacean bycatch in a New Zealand trawl fishery. DOC Research & Development Series 282, Department of Conservation, Wellington, New Zealand. 18 p.

Dwyer S, Tezanos-Pinto G, Visser I, Pawley M, Meissner A, Berghan J, Stockin K 2014. Overlooking a potential hotspot at Great Barrier Island for the nationally endangered bottlenose dolphin of New Zealand. Endangered Species Research 25: 97-114.

Evans K 2003. Pollution and marine mammals in the Southern Hemisphere: potential or present threat? In: Gales N, Hindell M, Kirkwood R (eds). Marine mammals – fisheries, tourism and management issues. Australia, CSIRO Publishing. pp.1-19.

Gaborit-Haverkort T 2012. The occurrence and habitat use of common dolphins (*Delphinus* sp.) in the central Bay of Plenty, New Zealand. MSc thesis, Massey University, Auckland, New Zealand.

Gaskin DE 1964. Return of the southern right whale (*Eubalaena australis* Desm.) to New Zealand waters, 1963. Fisheries Research Bulletin No. 67, Fisheries Research Division, New Zealand Marine Department, Wellington.

Gaskin DE 1968a. Distribution of Delphinidae (Cetacea) in relation to sea surface temperatures off eastern and southern New Zealand. New Zealand Journal of Marine and Freshwater Research 2: 527-534.

Gaskin DE 1968b. The New Zealand Cetacea. Fisheries Research Bulletin, no. 1. New Zealand Marine Department, Wellington. 92 p.

Gaskin DE 1972. Whales, dolphins and seals with special reference to the New Zealand region. Heinemann Educational Books Ltd. 200 p.

Gaskin DE 1992. Status of the common dolphin, *Delphinus delphis,* in Canada. Canadian Field Naturalist 106: 55-63.

Gaskin DE, Cawthorn MW 1967. Diet and feeding habit of the sperm whale (*Physeter catodon*) in the Cook Strait region of New Zealand. New Zealand Journal of Marine and Freshwater Research 2: 156-179.

Gende SM, Hendrix AN, Harris KR, Eichenlaub B, Nielsen J, Pyare S 2011. A Bayesian approach for understanding the role of ship speed in whale–ship encounters. Ecological Applications 21(6): 2232-2240.

Gibbs E 2019. Pakiri sand extraction consent application: water quality technical report. Prepared for McCallum Brothers Limited. Project No. IZ111900. 55 p.

Gibbs N, Childerhouse S 2000. Humpback whales around New Zealand. Conservation Advisory Science Notes No. 287, Department of Conservation, Wellington. 35 p.

Gibbs NJ, Dunlop RA, Gibbs EJ, Heberley JA, Olavarría C 2018. The potential beginning of a postwhaling recovery in New Zealand humpback whales (*Megaptera novaeangliae*). Marine Mammal Science 34: 499-513. doi:10.1111/mms.12468

Goldsworthy S, Gales N 2008. *Arctocephalus forsteri*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1. <www.iucnredlist.org>. Downloaded on 28 October 2009.

Greig AP, Secchi ER, Zerbini AN, Dalla-Rosa L 2001. Stranding events of southern right whales, *Eubalaena australis*, in southern Brazil. Journal of Cetacean Research and Management Special Issue 2: 157-160.

Groom C, Coughran D 2012. Entanglements of baleen whales off the coast of Western Australia between 1982 and 2010: patterns of occurrence, outcomes and management responses. Pacific Conservation Biology 18(3): 203.

Hammond PS, Bearzi G, Bjørge A, Forney K, Karczmarski L, Kasuya T, Perrin WF, Scott MD, Wang JY, Wells RS, Wilson B 2008. *Delphinus delphis*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.

Hartel EF, Constantine R, Torres LG 2014. Changes in habitat use patterns by bottlenose dolphins over a 10-year period render static management boundaries ineffective. Aquatic Conservation: Marine and Freshwater Ecosystems 25(5): 701-711.

Hauraki Gulf Forum 2018. State of our Gulf: Hauraki Gulf / Tikapa Moana / Te Moana-nui-a-toi State of Environment Report. Hauraki Gulf Forum -Auckland Council. 127 p.

Hupman K, Visser IN, Martinez E, Stockin KA 2015. Using platforms of opportunity to determine the occurrence and group characteristics of orca (*Orcinus orca*) in the Hauraki Gulf, New Zealand. New Zealand Journal of Marine and Freshwater Research 491: 132-149.

Jaquet N, Dawson S, Slooten E 2001. Seasonal distribution and diving behaviour of male sperm whales off Kaikoura: foraging implications. Canadian Journal of Zoology 78(3): 407-419.

Jensen AS, Silber GK 2004. Large whale ship strike database. US Department of Commerce, NOAA Technical Memorandum NMFS-OPR-25. 37 p.

Jones PD 1998. Analysis of organic contaminants in New Zealand marine mammals. Conservation Advisory Science Notes No. 184. Department of Conservation, Wellington, New Zealand. 8 p.

Joy R, Tollit D, Wood J 2019. Potential benefits of vessel slowdowns on endangered southern resident killer whales. Frontiers in Marine Science 6: 344.

Kraus SD, Rolland RM 2007. Right whales in the urban ocean. In: The urban whale – North Atlantic right whales at the crossroads. Kraus SD, Rolland RM (eds). Cambridge Massachusetts, Harvard University Press. Pp. 1-38.

Laist DW, Coe JM, O'Hara KJ 1999. Marine debris pollution. In Twiss Jr, Reeves RR (eds) Conservation and management of marine mammals. Smithsonian Institution Press, Washington DC. pp. 342–363.

Laist DW, Knowlton AR, Mead JG, Collet AS, Podesta M 2001. Collisions between ships and whales. Marine Mammal Science 17(1): 35-75.

Lammers MO, Pack AA, Lyman EG, Espiritu L 2001. Trends in collisions between vessels and North Pacific humpback whales *Megaptera novaeangliae*) in Hawaiian waters (1975–2011). Journal of Cetacean Research and Management 13: 73–80.

Leatherwood S, Reeves RR, Foster L 1983. The Sierra Club handbook of whales and dolphins. Sierra Club Books. San Francisco. 302pp.

Lettevall E, Richter C, Jaquet N, Slooten E, Dawson S, Whitehead H, Christal J, McCall-Howard P 2002. Social structure and residency in aggregations of male sperm whales. Canadian Journal of Zoology 80(7): 1189-1196.

Lloyd BD 2003. Potential effects of mussel farming on New Zealand's marine mammals and seabirds: a discussion paper. Department of Conservation, Wellington. vii + 34 p.

Meynier L, Stockin KA, Bando MKH, Duignan PJ 2008. Stomach contents of common dolphins (*Delphinus* sp.) from New Zealand waters. New Zealand Journal of Marine and Freshwater Research 42: 257-268.

Neumann DR 2001. Seasonal movements of short beaked common dolphins (*Delphinus delphis*) in the north-western BOP, New Zealand: influence of sea surface temperature and El Niño / La Niña. New Zealand Journal of Marine and Freshwater Research 35: 371-374.

Neumann DR, Orams MB 2005. Behaviour and ecology of common dolphins (*Delphinus delphis*) and the impact of tourism in Mercury Bay, North Island, New Zealand. Science for Conservation 254. Department of Conservation, Wellington.

Neumann DR, Leitenberger A, Orams MB 2002. Photo-identification of short-beaked common dolphins (*Delphinus delphis*) in north-east New Zealand: a photo-catalogue of recognisable individuals. New Zealand Journal of Marine and Freshwater Research 36: 593–604.

NOAA (National Oceanic and Atmospheric Administration) 2011. Interim sound threshold guidance for marine mammals. http://www.nwr.noaa.gov/Marine-Mammals/MM-sound-thrshld.cfm

NOAA (National Oceanic and Atmospheric Administration) 2018. Revision to: Technical guidance for assessing the effects of anthropogenic sound on marine mammal hearing (Version 2.0): underwater thresholds for onset of permanent and temporary thresholds shifts. U.S. Dept. of Commerce, NOAA. NOAA Technical Memorandum NMFS-OPR-59. 178 p.

Nowacek DP, Thorne LH, Johnston DW, Tyack PL 2007. Responses of cetaceans to anthropogenic noise. Mammal Review 37(2): 81-115.

O'Callaghan TM, Baker CS 2002. Summer cetacean community, with particular reference to Bryde's whales, in the Hauraki Gulf, New Zealand. DOC Science Internal Series 55. Department of Conservation, Wellington. 18 p.

Olavarría C, Baker C, Tezanos-Pinto G 2014. Low mtDNA genetic diversity among killer whales around New Zealand. New Zealand Journal of Marine and Freshwater Research 48(1): 147-153.

OSPAR 2009. Assessment of the environmental impact of underwater noise. OSPAR Commission.http://qsr2010.ospar.org/media/assessments/p00436_JAMP_Assessment_Noise.pdf

Patenaude N 2000. Southern right whales wintering in the Auckland Islands. Conservation Advisory Science Notes No. 321. Department of Conservation, Wellington. 31 p.

Patenaude N 2003. Sightings of southern right whales around 'mainland' New Zealand. Science for Conservation 225. 43 p.

Peters CH, Stockin KA 2016. Responses of bottlenose dolphin to vessel activity in Northland, New Zealand. Prepared for Department of Conservation, Northland February 2016. Massey University CMRG. 122 p.

Pine M, Styles J 2016. Whangarei Harbour entrance and Marsden Point channel realignment and deepening: underwater acoustic modelling for the marine mammal impact assessment. Prepared for Chancery Green on behalf of Refining New Zealand. October 2016.

Pine MK. 2020a.Underwater Noise Effects: Pakiri Sand Extraction. Technical report from Styles Group Underwater Acoustics prepared for McCallum Brothers Limited. Report Version 3, dated 14 January 2020.

Pine MK. 2020b.Underwater noise effects associated with the new consent area for sand extraction along the Mangawhai-Pakiri Coast. Letter prepared for McCallum Brothers Limited, dated 1 February 2020.

Reilly SB, Bannister JL, Best PB, Brown M, Brownell RL Jr, Butterworth DS, Clapham PJ, Cooke J, Donovan G., Urbán J, Zerbini AN 2008. *Balaenoptera edeni*. The UCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.

Reilly SB, Bannister JL, Best PB, Brown M, Brownell RL Jr, Butterworth DS, Clapham PJ, Cooke J, Donovan G, Urbán J, Zerbini AN 2013. *Eubalaena australis*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>

Riekkola L 2013. Mitigating collisions between large vessels and Bryde's whales in the Hauraki Gulf, New Zealand. BSc (Hons) Thesis, University of Auckland, New Zealand.

Southall BL, Bowles AE, Ellison WT, Finneran JJ, Gentry RL, Greene CR Jr, Kastak D, Ketten DR, Miller JH, Nachtigall PE 2007. Marine mammal noise-exposure criteria: initial scientific recommendations. Bioacoustics 17(1-3): 273-275.

Stockin KA, Law RJ, Duignan PJ, Jones GW, Porter L, Mirimin L, Meynier L, Orams MB 2007. Trace elements, PCBs and organochlorine pesticides in New Zealand common dolphins (*Delphinus* sp.). Science of the Total Environment 387: 333-345.

Stockin KA, Lusseau D, Binedell V, Orams MB 2008b. Tourism affects the behavioural budget of common dolphins (*Delphinus sp*.) in the Hauraki Gulf, New Zealand. Marine Ecology Progress Series 355: 287-295.

Stockin KA, Pierce GJ, Binedell V, Wiseman N, Orams MB 2008a. Factors affecting the occurrence and demographics of common dolphins (*Delphinus* sp.) in the Hauraki Gulf, New Zealand. Aquatic Mammals 34: 200-211.

Suisted R, Neale D 2004. Department of Conservation Marine Mammal Action Plan for 2005–2010. Report by the Marine Conservation Unit, Wellington: Department of Conservation, 89 p.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL 2008a. *Globicephala melas*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL 2008b. *Physeter macrocephalus*. In: IUCN 2009. IUCN Red List of Threatened Species. Version 2009.1.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL 2011. *Globicephala macrorhynchus*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.

Taylor BL, Baird R, Barlow J, Dawson SM, Ford J, Mead JG, Notarbartolo di Sciara G, Wade P, Pitman RL 2013. *Orcinus orca*. The IUCN Red List of Threatened Species. Version 2014.3. <www.iucnredlist.org>.

Tezanos-Pinto G, Baker CS, Russell K, Martien K, Baird RW, Hutt A, Stone S, Mignucci-Giannoni AA, Caballero S, Endo T, Lavery S, Oremus M, Olavarri ́C, Garrigue C 2009. A worldwide perspective on the population structure and genetic diversity of bottlenose dolphins (*Tursiops truncatus*) in New Zealand Journal of Heredity 100(1): 11-24.

Tezanos-Pinto G, Constantine R, Brooks L, Jackson JA, Mourão F, Wells S, Scott Baker C 2013. Decline in local abundance of bottlenose dolphins (*Tursiops truncatus*) in the Bay of Islands, New Zealand. Marine Mammal Science 29(4): E390-E410.

Tezanos-Pinto G, Constantine R, Mourão F, Berghan J, Scott Baker C 2014. High calf mortality in bottlenose dolphins in the Bay of Islands, New Zealand–a local unit in decline. Marine Mammal Science 31(2): 540-559..

Thomsen F, McCully S, Wood D, Pace F, White P 2009. A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters with particular emphasis on aggregate dredging: Phase 1 Scoping and review of key issues. MEPF 08/P21. 49 p.

Todd VL, Todd IB, Gardiner JC, Morrin EC, MacPherson NA, DiMarzio NA, Thomsen F 2015. A review of impacts of marine dredging activities on marine mammals. ICES Journal of Marine Science/Journal du Conseil 72(2): 328-340.

Townsend AJ, de Lange PJ, Duffy CAJ, Miskelly CM, Molloy J, Norton DA 2007. New Zealand threat classification system manual. Department of Conservation, Wellington. 35 p.

Vanderlaan ASM, Taggart BT 2007. Vessel collisons with whales: the probability of lethal injury based on vessel speed. Marine Mammal Science 23(1): 144-156.

van Waerebeek K, Baker AN, Félix F, Gedamke J, Iñiguez M, Sanino GP, Secchi E, Sutaria D, van Helden A, Wang Y 2007. Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment. Latin American Journal of Aquatic Mammals 6 (1): 43-69.

Visser I 1999a. Benthic foraging on stingrays by killer whales in New Zealand (*Orcinus orca*) in New Zealand waters. Marine Mammal Science 15: 220-227.

Visser I 1999b. Summary of interactions between orca (*Orcinus orca*) and other cetaceans in New Zealand waters. New Zealand Natural Sciences 24: 101-112.

Visser I 2000. Orca (*Orcinus orca*) in New Zealand waters. PhD thesis, University of Auckland, New Zealand.Visser IN 2007. Killer whales in New Zealand waters: status and distribution with comments on foraging. Unpublished report (SC/59/SM19) to the Scientific Committee, International Whaling Commission.

Visser IN 2007. Killer whales in New Zealand waters: status and distribution with comments on foraging. Unpublished report (SC/59/SM19) to the Scientific Committee, International Whaling Commission.

Visser IN, Zaeschmar J, Halliday J, Abraham A, Ball P, Bradley R, Daly S, Hatwell T, Johnson T, Johnson W 2010. First record of predation on false killer whales (*Pseudorca crassidens*) by killer whales (*Orcinus orca*). Aquatic Mammals 36(2): 195-204.

Weisbrod AV, Shea D, Moore MJ, Stegeman JJ 2000. Organochlorine exposure and bioaccumulation in the endangered Northwest Atlantic right whale (*Eubalaena glacialis*) population. Environmental Toxicology and Chemistry 19: 654-666.

Wells RS, Scott MD, Irvine AB 1987. The social structure of free ranging bottlenose dolphins. In: Genoways HH (ed) Current Mammalogy. Plenum Press, New York. pp. 247-305.

Wiseman N 2008. Genetic identity and ecology of Bryde's whales in the Hauraki Gulf, New Zealand. PhD thesis, University of Auckland, Auckland, New Zealand. 259p

Wiseman N, Parsons S, Stockin KA, Baker CS 2011. Seasonal occurrence and distribution of Bryde's whales in the Hauraki Gulf, New Zealand. Marine Mammal Science 27 (4): E253-E267.

WODA 2013. WODA Technical guidance on: underwater sound in relation to dredging. June 2013. 8 p. www.dredging.org.

Woodley TH, Brown MW, Kraus SD, Gaskin DE 1991. Organochlorine levels in North Atlantic right whales (*Eubalaena glacialis*) blubber. Archives of Environmental Contamination and Toxicology 21: 141-145

8. APPENDICES

Appendix 1. Sources of marine mammal data and information

Only broad-scale, regional information is available for most marine mammals using the general Bream Bay / Mangawhai region. Multiple and finer-scale studies have been undertaken in both the Bay of Islands to the north and south in the wider Hauraki Gulf region. The studies and databases used to make summaries and assessments of the various marine mammal species discussed in this report are listed below:

- Department of Conservation opportunistic database and stranding record database 1869-2018
- Marine mammal tourism operations in the Bay of Islands and Hauraki Gulf region
- National Aquatic Biodiversity Information System (NABIS)
- MBL marine mammal sightings recorded since May 2018
- Scientific research through University of Auckland:
    - R Constantine – various studies in Bay of Islands, Bryde's whales in the Hauraki Gulf, and humpback whales around NZ
    - G Tezanos-Pinto – research on bottlenose dolphins in Bay of Islands,
    - E Carroll – various studies on southern right whales
- Scientific research through Massey University at Albany:
    - K Stockin 2007 – PhD on common dolphins in the Hauraki Gulf,
    - N Wiseman 2011 – studies on Bryde's whales in Hauraki Gulf,
    - S Dwyer 2015 – PhD on cetaceans in the Hauraki Gulf and Great Barrier Island,
    - K Hupman 2016 – PhD on common dolphins' fidelity in the Hauraki Gulf.
- Orca Research Trust - various Visser publications and sighting database
- Berkenbusch K, Abraham ER, Torres L 2013. New Zealand marine mammals and commercial fisheries. New Zealand Aquatic Environment and Biodiversity Report No. 119. 110 p.
- Clement D, Elvines D 2015. Phase 1: Preliminary review of potential dredging effects on marine mammals in the Whangarei Harbour region. Prepared for Chancery Green on behalf of Refining New Zealand Limited. Cawthron Report No. 2711. 31 p. plus appendix.

Appendix 2 Marine mammals in Mangawhai / Bream Bay waters

A2.1 Common Dolphins (*Delphinus delphis*)

A2.1.1. Distribution and abundance

While short-beaked common dolphins are perhaps the most numerous of all the cetaceans inhabiting New Zealand waters, little is known about their total population size or movement patterns except in a few locations around New Zealand. As Figure A2.1 demonstrates, they are particularly prevalent off the east coast of the North Island (Gaskin 1968b) from the Bay of Islands (Constantine & Baker 1997), the Hauraki Gulf (Stockin et al. 2008a) and the southern portion of the Bay of Plenty (BOP: Neumann et al. 2002; Gaborit-Haverkort 2012). New Zealand common dolphins are thought to be meso-pelagic and tend to be restricted to waters warmer than 14°C (Gaskin 1972); and as such, they appear to be less prevalent from Banks Peninsula south (Gaskin 1968a).

Short-beaked common dolphins are present in New Zealand coastal waters year-round, but localised populations in the BOP tend to be more prevalent within shallower coastal waters in summer (Gaborit-Haverkort 2012) and move to more offshore waters in winter (Neumann 2001). The reverse trends were observed in common dolphins within the Bay of Islands and Hauraki Gulf as this species moved into the bays and gulf over winter and spring months (Constantine & Baker 1997; Stockin et al. 2008a). Recent sightings of the closely related long-beaked common dolphin (*Delphinus capensis*) suggest they may occasionally occur within NZ waters as well.

Sightings of common dolphins in the DOC database show they frequent the stretch of water from Great Barrier Island (GBI) and Hauraki Gulf region and past Bream Head (Figure 3). Within the Mangawhai-Bream Bay areas, common dolphins have been sighted in small to large groups (5–100 individuals; DOC sighting database), but there are few sightings recorded in this database in depths less than 30 m. There are 36 strandings recorded between Bream Head to the north and Leigh to the south (Figure 3; DOC stranding database).

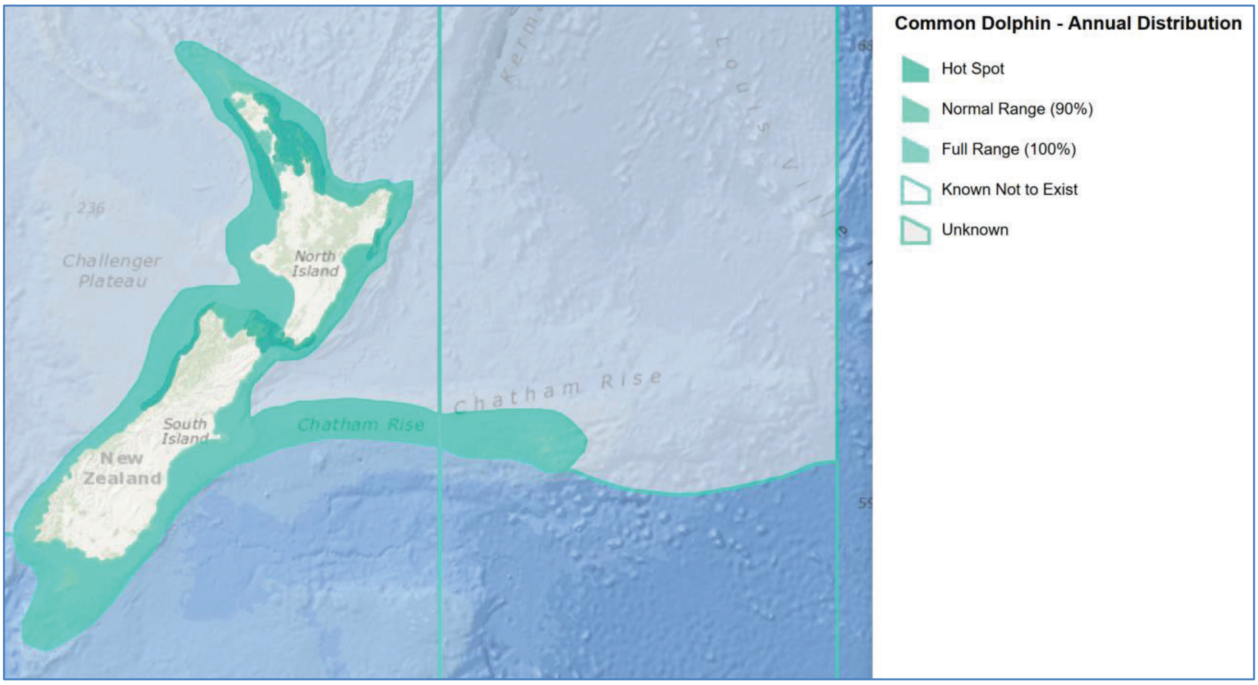


Figure A2.1. The general distribution pattern of common dolphins in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed September 2019).

A2.1.2. Life-history dynamics

Groups of common dolphins can range between two to at least 400 animals in New Zealand. Off the Bay of Islands, this species usually occurs in groups between 30-100 animals (Constantine & Baker 1997) while group size averaged around 50 animals in the Bay of Plenty (Neumann & Orams 2005). Group sizes were smaller in the Hauraki Gulf, averaging between 20–30 dolphins, and often had neonates and / or calves present, suggesting this region may be an important calving and / or nursing area for common dolphins (Stockin et al. 2008a). With a maximum age of only around 22 years, common dolphins mature between 7–12 years for males and 6–7 years for females, which breed at 1 to 3 year intervals.

Common dolphins in New Zealand are known to feed on both surface and pelagic fish species and are often seen herding schooling fish at the surface and feeding cooperatively. Common dolphins often occur over continental shelf regions where they feed on the organisms of the deep scattering layer (DSL): groups of relatively small invertebrates and fish that migrate to surface waters at night and return to depths during the day (Gaskin 1992). In the Bay of Islands, dolphins were observed feeding mainly on schooling pilchards (*Sardinops neopilchardus*) (Constantine & Baker 1997). Neumann & Orams (2005) videotaped dolphins in the Bay of Plenty region feeding on jack mackerel (*Trachurus* spp.), kahawai (*Arripis trutta*), yellow-eyed mullet (*Aldrichetta forsteri*), flying fish (*Cypselurus lineatus*), parore (*Girella tricuspidata*), and garfish (*Hyporamphus ihi*).

A2.1.3. Conservation status

According to the current New Zealand Threat Classification System, common dolphins are considered *not threatened* (Baker et al. 2019) and of *least concern* by the IUCN (Hammond et al. 2008). However, Meynier et al. (2008) consider this classification as 'ambiguous given that no population estimates exist for this species within New Zealand waters.'

The greatest risk to common dolphins in New Zealand waters appears to be entanglement in mid-water trawl fisheries (DuFresne et al. 2007). However, recent findings suggest that Hauraki Gulf populations may also be under additional anthropogenic stress from coastal pollution (Stockin et al. 2007), eco-tourism (Stockin et al. 2008b) and high boating activity due to their proximity to Auckland (Dwyer et al. 2014). Todd et al. (2015) noted that the most likely effects that dredging could have on common dolphin populations would be habitat alterations and/or changes to prey distribution.

A2.2 Bottlenose Dolphins (*Tursiops truncatus*)

A2.2.1. Distribution and abundance

In New Zealand waters, bottlenose dolphins are known to inhabit the coastal waters of Northland, the Marlborough Sounds and Fiordland with occasional sightings of animals around most other regions (Figure A2.2; Tezanos-Pinto et al. 2009). The Northland population, while isolated from the other regional populations, ranges between Doubtless Bay in the north and Tauranga in the south (a distance of ~400 km; Constantine 2002). Within this region, these dolphins appear to demonstrate varying degrees of fidelity to and use of the region (e.g. Bay of Islands: Hartel et al. 2014; Great Barrier Island: (Dwyer et al. 2014). Seasonal movements between deeper waters during summer and shallower waters over winter are consistent across the northeast coastal region (i.e. Bay of Islands: Hartel et al. 2014; Great Barrier Island: Dwyer et al. 2014).

An abundance estimate for the total Northland population has not been estimated to date. However, Tezanos-Pinto et al. (2013) estimated that approximately 483 dolphins (95% CI = 358–653) from this northern population used Bay of Islands waters at least once over a 10-year period. At the same time, Dwyer et al. (2014) estimated 171 animals (95% CI = 162–180) visited GBI over a three-year period.

There are over 20 stranding records of bottlenose dolphins between Bream Head and the proposal area (Figure 3; DOC stranding database). The DOC sighting database shows at least ten recent sightings of bottlenose dolphin within the same region (Figure 3). The sightings were predominantly observed during winter and spring months.

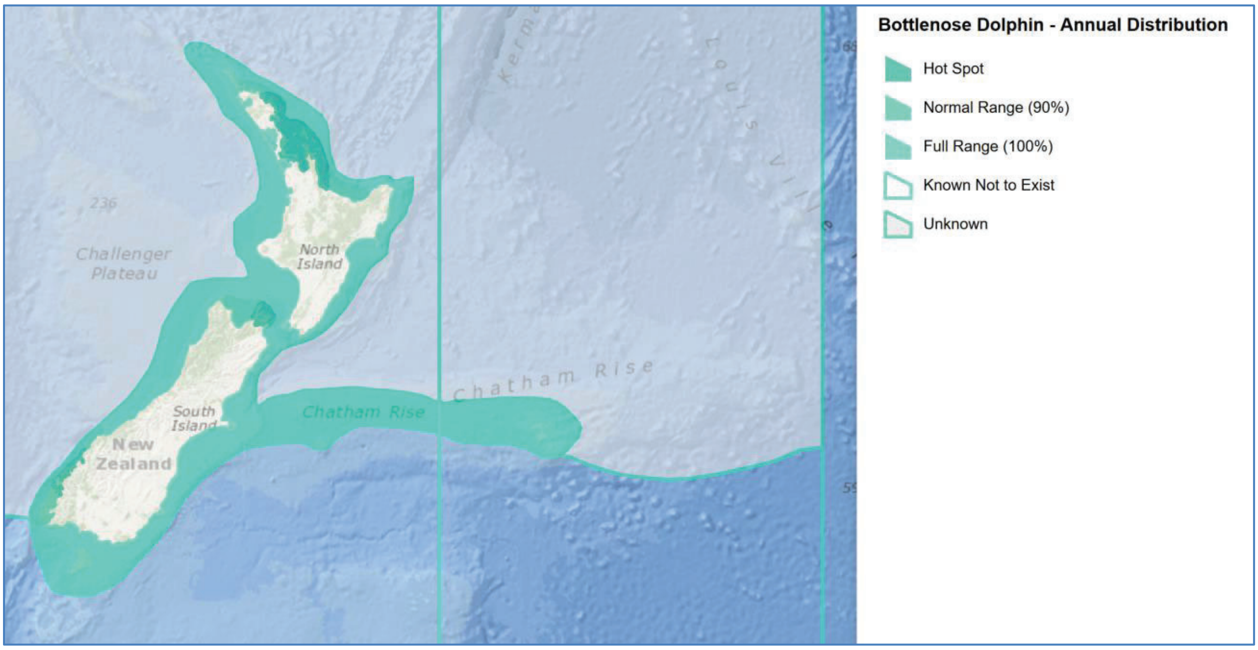


Figure A2.2 The general distribution pattern of bottlenose dolphins in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed Sept 2019).

A2.2.2. Life-history dynamics

Bottlenose dolphins are fairly long-lived (> 50 years), and individuals usually do not mature until 5–14 years of age (Wells et al. 1987). Young dolphins can remain with their mothers up to two years or more; as a result, most females breed at 3–5 year intervals. In New Zealand waters, bottlenose dolphins tend to travel in groups of up to 30 animals (Baker 1999). The median group size in the Bay of Islands population is around 12 animals, but varies from 1 to 60 dolphins (Tezanos-Pinto et al. 2008).

Most bottlenose dolphin groups are generalists in their feeding preferences and can be quite adaptive in their feeding styles. Constantine and Baker (1997) observed bottlenose dolphins in the Bay of Islands feeding on flounder (*Rhombosolea* spp.), yellow-eyed mullet (*Aldrichetta forsteri*), kahawai (*Arripis trutta*), parore (*Girella tricuspidata*), piper (*Hyporhampbus ihi*), blue maomao (*Scorpis violaceus*) and leatherjacket (*Parika scaber*).

A2.2.3. Conservation status

In New Zealand, bottlenose dolphins are classified as *nationally endangered* (Baker et al. 2019), which means New Zealand populations have demonstrated demographic isolation and appear to be limited in their overall home range (Townsend et al. 2007). Recent research suggests the Northland population, specifically those visiting Bay of Islands, has been undergoing a local decline of 7.5% annually since 2003 (Tezanos-Pinto et al. 2014). This decline may be due to high calf mortality in this population (Tezanos-Pinto et al. 2014) and / or emigration as simultaneous research has suggested that this population may now be using Great Barrier Island (northeast of Hauraki Gulf) as an important hotspot (Dwyer et al. 2014). Peters and Stockin (2016) reported that the number of uniquely identifiable individuals using the Bay of Islands (n = 96 in 2015) is less than previously reported with a 66% decline since 1999 (278 identified in 1997–1999 (Constantine 2002)) and a 40% decline since 2005 alone (159 in 2003–2005; Tezanos-Pinto et al. 2009).

Bottlenose dolphin populations in New Zealand are exposed to a growing eco-tourism industry (Constantine et al. 2003). Dolphin-watching and swim-with-dolphins tours are available the length of New Zealand, from the Bay of Islands and Auckland in the north to Doubtful Sound in the south. Constantine et al. (2003) found the greater amount of time that the Northland population spent interacting with boats has led to a decrease in resting and an increase in milling behaviours. The repercussions of this change in behavioural budgets when boats are present are still unknown but could reflect a reluctance of the dolphins to rest near boat traffic and / or uncertainty in their group cohesion.

Given the high calf mortality reported, restricting the occurrence of potentially hazardous marine activities during calving season (such as speed boat races) and limiting tour boats interactions around groups of mother and calves has been suggested (Tezanos-Pinto et al. 2014). In addition to the increasing risks from eco-tourism, this species is occasionally reported as by-catch in the New Zealand trawl fishery (DuFresne et al. 2007) and other potentially invasive human activities. Based on overseas research, Todd et al. (2015) suggested that dredging activities also have the potential to alter bottlenose dolphins’ feeding patterns and cause potential disturbance to any nursing areas, depending on the project scale, vessel types and equipment used.

A2.3 New Zealand Fur Seals (*Arctocephalus forsteri*)

A2.3.1. Distribution and abundance

New Zealand fur seals are found around New Zealand as well as western and southern Australia and several of the New Zealand sub-Antarctic islands (Figure A2.3). They are the most common pinniped species observed within New Zealand waters today, despite being harvested to near extinction by the mid-1800s by European sealers.

This species is considered non-migratory but is known to easily and repeatedly cover large distances within their currently defined range. Tagged pups have been known to disperse throughout New Zealand, even crossing over to Australia (Goldsworthy & Gales 2008). As they are good swimmers, they regularly travel out to the continental shelf and more open-ocean waters to feed.

In New Zealand, current estimates of fur seals number around 100,000 with some local populations increasing between 12% and 25% a year (Goldsworthy & Gales 2008). As the population has recovered and spread north into former territories, they have re-established breeding colonies / rookeries. Since 1991, fur seals have started breeding again on the North Island with colonies as far north as the Coromandel Peninsula. Known breeding colonies along the North Island's east coast include Cape Palliser, Castle Point, Motunau and Whale islands in the Bay of Plenty (DOC database).

The Department of Conservation keeps records of pinniped sightings reported by staff and members of the public. Regular sightings of adults and pups are now common in the Hauraki Gulf region with additional sightings around the Hen and Chickens Islands and to the north in Waihihi Bay (Bay of Islands). The most recent stranding was reported in Mangawhai Beach in 2012 (DOC database; Figure 3).

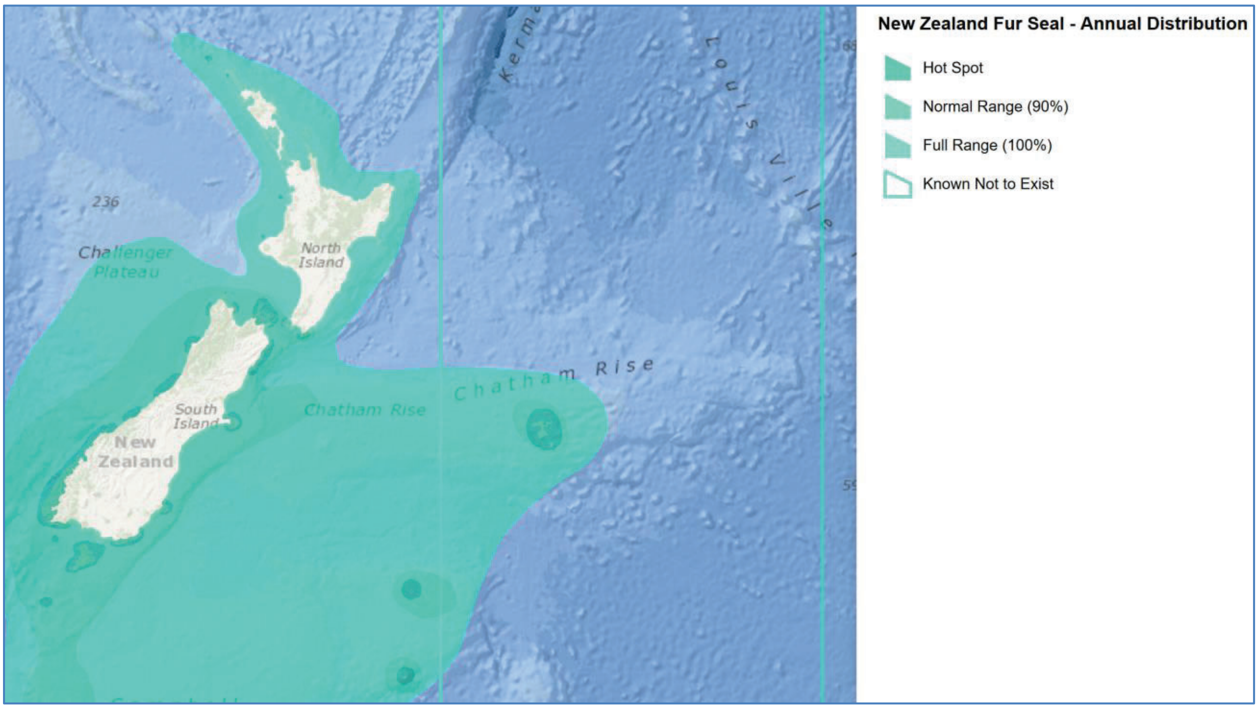


Figure A2.3. The general distribution pattern of New Zealand fur seals in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed Sept 2019).

A2.3.2. Life-history dynamics

Females generally give birth every year once they have reached sexual maturity. Males generally defend and breed with a harem of up to 5–8 females in their territory each year. The breeding season lasts from mid-November to mid-January (Goldsworthy & Gales 2008). By January most males are returning to sea. However, pups will remain within the colony, nursing from the female until they are weaned around late winter or spring. After that they disperse and are generally thought to return to the same breeding colony once they are sexually mature.

Fur seals feed on a large variety of prey items that can include fish, cephalopods and even birds. Nursing females will often travel further out into open water over winter to forage while juveniles feed on vertically migrating myctophid fish over shelf waters (Goldsworthy & Gales 2008).

A2.3.3. Conservation status

Due to their general abundance and sustained growth, New Zealand fur seals have been listed as *least concern* by IUCN (IUCN 2015, ver 3.1) and *not threatened* by the New Zealand Threat Classification System (Baker et al. 2019). Current threats at sea include entanglement in trawl fisheries, particularly hoki and southern blue whiting, and pollution such as oil spills (Goldsworthy & Gales 2008). On land, fur seals are susceptible to disturbance within their breeding colonies from humans and domestic animals, such as dogs, causing disruption in breeding and even site abandonment.

A2.4 Orca (*Orcinus orca*)

A2.4.1. Distribution and abundance

Orca occur in all oceans from the equator to polar regions, yet they generally prefer cooler waters (Carwardine 1995). A long-term study of orca sightings around New Zealand estimated an abundance of fewer than 200 individuals (95% CI = 71–167) (Visser 2000). At least three sub-populations of orca are thought to exist; a regional North Island population, a regional South Island population, and a population that travels back and forth between the two islands (Figure A2.4). There appears to be no mixing between the North and South Island regional groups (Visser 2000) and genetic studies suggest the population is geographically structured (Olavarría et al. 2014).

The east coast of the North Island appears to be an important region for both the North Island and the North-South Island sub-populations (Visser 2000). The highest frequency of orca sightings occurred in the outer Hauraki Gulf region and by the general public along the northeastern coastline of the North Island (Northland to Bay of Plenty) during late winter and early spring (Hupman et al. 2015; Visser 2000, 2007). Orca are regularly reported frequenting close to shore and around estuaries between the Hauraki Gulf and Whangarei Harbour (Visser 2007). Strandings, while fairly infrequent, reflect a similar trend (Figure 3). The majority of sightings (Visser and DOC), as well as strandings, occurred during early winter and most spring months, although occasional sightings of orca were reported in summer and autumn as well.

A2.4.2. Life-history dynamics

Orca are known to live up to 80 or 90 years and are thought to be one of the longest-lived toothed whales. As such, they only mature when between 11 and 21 years old and females give birth over five-year intervals.

They are a moderately gregarious species, being found in pods numbering a few to 30 individuals. Their group structure is fairly stable as they usually maintain close family groups (Carwardine 1995). The most common group size of orca in New Zealand is 12 animals, however groups can range from 2 to 22 (Visser 2000). While some New Zealand orca seem to remain within a fairly small home range, other orca have travelled 3,800 km in 34 days, an average of 111 km per day (Visser 1999a).

In New Zealand, orca most commonly forage on rays (Visser 1999a), which may account for their tendency to frequent fairly shallow waters (Hupman et al. 2015). They also feed on pelagic and reef fish (Visser 2000) and other cetaceans including common dolphins, dusky dolphins, bottlenose dolphins, humpback whales and sperm whales (Visser 1999b), and more recently, on false killer whales (Visser et al. 2010).

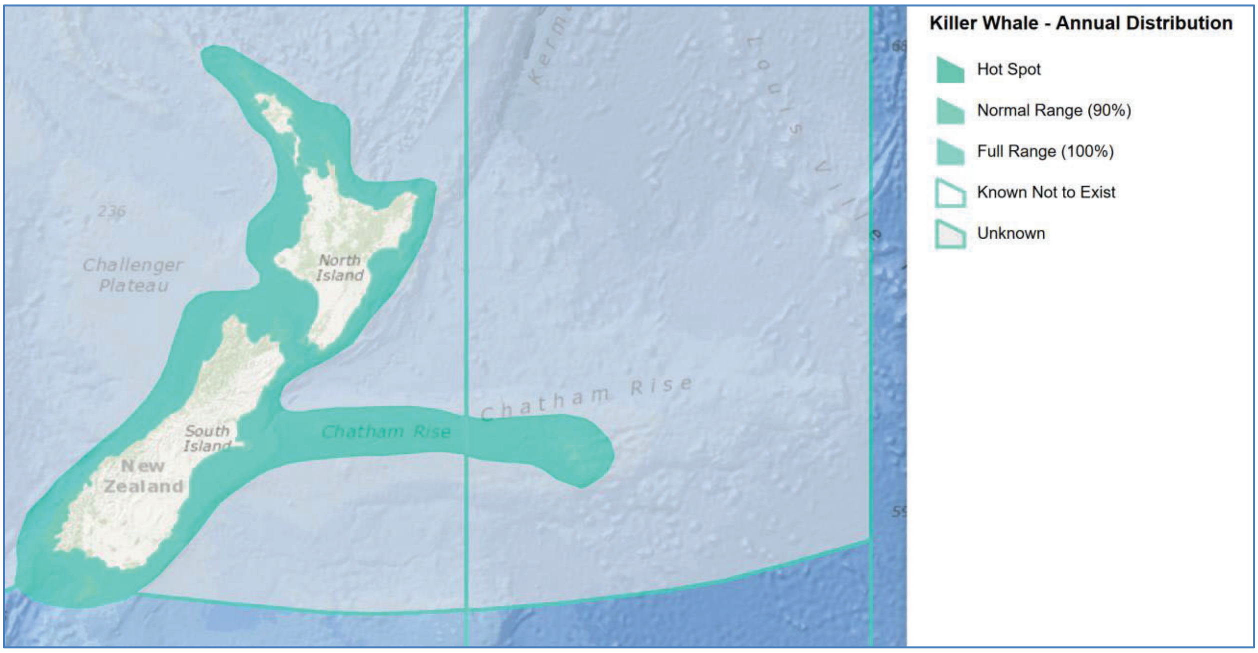


Figure A2.4. The general distribution pattern of orca in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed Sept 2019).

A2.4.3. Conservation status

The orca is listed as *data deficient* by the IUCN (Taylor et al. 2013), mainly due to the ambiguity around its current taxonomic units. It is felt that this species will be divided into several smaller new species or sub-species with new research, many of which will warrant higher categories of risk due to localised effects of impacts. According to the New Zealand Threat Classification, this species is listed as *nationally critical* due to lack of data and low abundance (Baker et al. 2019).

The main threats facing orca in New Zealand involve fisheries interactions, potentially heavy pollutant loads and the risk of vessel strike near busy ports and harbours (Visser 2000). Incidental mortalities of orca in fisheries are also summarised in Visser (2007) and include interactions with vessels and fishing gear / line entanglements. Visser (2007) suggests that the tendency for orca to forage in enclosed harbours makes this species more susceptible to harbour developments. The author notes that developments, such as dredging, have the potential to affect this species' foraging habitat, expose them to noise population and degrade their water quality. Todd et al. (2015) also suggests that the effects of dredging activities on orca are likely to include alterations in prey availability, possible habitat avoidance and / or behaviour alterations, increased boat traffic and underwater sound masking (noise pollution).

A2.5 Bryde's Whale (*Balaenoptera brydei / edeni*)

A2.5.1. Distribution and abundance

Bryde's whales are one of most commonly observed whales in New Zealand waters, being frequently reported off the North Island between North Cape and East Cape and as far south as Cook Strait (Figure A2.5; Gaskin 1968b). Baker and Madon (2007) reported Bryde's whales generally concentrating around headland features along the entire northeastern coast between North Cape and the Hauraki Gulf. This species is one of the only large whales that do not migrate to Antarctic feeding grounds in summer (Carwardine 1995). Instead, it is thought to seasonally migrate along the northeastern coast of the North Island to and from the subtropics (Gaskin 1972; Baker 1999).

A small inshore population of approximately 46 residents and 159 transient whales (95% CI = 97–337) is known to occur in the Hauraki Gulf (Wiseman 2008). This population is found year-round within inner Gulf waters with greater numbers observed in winter months between water depths of 12–60 m (Wiseman et al. 2011). Sightings of Bryde's whales in the DOC database show that the stretch of water from Great Barrier Island to Bream Head is a regular passageway for Bryde's whales travelling between the Hauraki Gulf and Bay of Islands hot-spots; 18 sightings were made (since 2000) in the Parry Channel area alone (Figure 4). However, the database reports only two strandings of this species between Bream Head and Leigh.

A2.5.2. Life-history dynamics

In New Zealand waters, Bryde's whales are usually observed individually or in small feeding groups (O'Callaghan & Baker 2002) but can occur in groups as large as 30 animals (Carwardine 1995). Tagged whales in the Hauraki Gulf spent 91% of their time at depths shallower than 14 m, but not on the surface itself. Like other rorqual whales, Bryde's whales feed mainly on shoals of small fish such as pilchards, salps and occasionally krill (e.g. euphasusiids; Baker & Madon 2007; Wiseman et al. 2011) as their baleen is not as fine as other whales (Baker 1999).

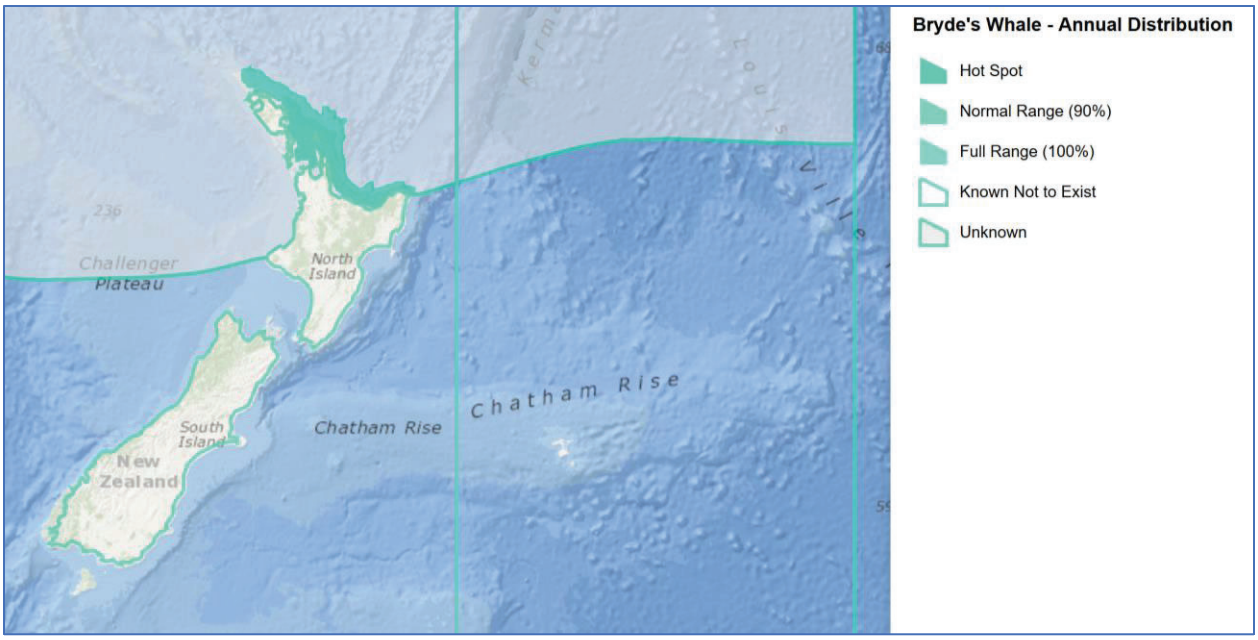


Figure A2.5. The general distribution pattern of Bryde's whales in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed Sept 2019).

A2.5.3. Conservation status

Bryde's whale is listed as *data deficient* worldwide (Reilly et al. 2008). This category is used when there is not enough information to assess risk of extinction, particularly in situations where possible subspecies or localised sub-population might be present. The New Zealand Threat Classification System lists this species as *nationally critical* within New Zealand waters (Baker et al. 2019). This listing is based on the small number of whales using the Hauraki Gulf, the entrance to New Zealand's largest and busiest port, as important feeding and breeding grounds (Constantine et al. 2015).

Threats include continued impacts of ship strikes due to a distribution that overlaps with heavy vessel traffic (Constantine et al. 2015). In the Hauraki Gulf, vessel strikes represent a relatively high proportion of mortality due to the majority of their time spent in sub-surface waters where they are vulnerable (Constantine et al. 2015). Additional threats to this species include entanglement in fishing gear and / or aquaculture farms (Lloyd 2003) as well as increased exposure to a growing eco-tourism industry along the northeastern coast of the North Island (Stockin et al. 2008b). Todd et al. (2015) suggests that dredging activity may lead to behavioural alterations and underwater masking of nearby noise in this species.

A2.6 Pilot Whales (*Globicephala* spp.)

A2.6.1. Distribution and abundance

Pilot whales are assumed to regularly travel through New Zealand waters as they strand frequently and often in very large numbers (e.g. > 200 animals; Gaskin 1968b; Brabyn 1990). For example, between 2005 and 2008 pilot whales accounted for 73% of all strandings (Beatson & O'Shea 2009). Before 1977, only the long-finned pilot whale (*Globicephala melas*) had been recorded in New Zealand (Gaskin 1968b). Most likely due to mis-identification in the past, the first record of the short-finned pilot whale (*G. macrorhynchus*) was only in 1977, and since then several more short-finned pilot whales have stranded within northern New Zealand regions (see Baker 1983).

Both species have a predominantly offshore distribution, preferring areas over the outer continental shelf and / or slope (Leatherwood et al. 1983). Migrations are not well documented and pilot whales are thought to be generally nomadic. Although some populations are thought to move inshore during summer and autumn, and then offshore again over the winter and spring, most groups of pilot whales likely follow prey movements (Carwardine 1995).

Despite regular sightings of pilot whales, little is known about their abundance or seasonal distribution patterns around New Zealand. Of the few opportunistic sightings reported in the general region, all were in summer (December and January), and all were of moderate group size (12–25 individuals). Strandings of long-finned pilot whales have been reported year-round, although they are slightly more frequent over summer months (Brabyn 1991). These whales seem to be particularly susceptible to stranding along Whangarei, Bay of Plenty, and Hawke's Bay regions of the North Island's east coast (Brabyn 1990). There have been 15 recent strandings of *Globicephala* spp. reported between Bream Head and Leigh. Mass strandings of pilot whales have also occurred in close vicinity to the proposed area. More recently, six mass strandings occurred along the northern Bream Bay / Ruakaka Beach area, but three of these may represent re-strandings events of the same group of animals (DOC stranding database; Figure 3).

A2.6.2. Life-history dynamics

Pilot whales are highly gregarious, sometimes forming pods of several hundred to more than 1000, although they are typically sighted in groups numbering fewer than 50 (Leatherwood et al. 1983). Group sizes reported along northeast coastline varied from one to as large as 100 whales with most sightings comprising at least 10 or more animals (DOC database). As with other deep water cetaceans, pilot whales tend to forage at night over shelf waters in order to take advantage of vertically migrating prey. Stomach contents from long-finned pilot whales stranded in New Zealand waters demonstrate a diet based solely on cephalopods; mainly squid (*Nototodarus* spp. and *Chiroteuthis* sp.) and octopus (*Pinnoctopus cordiformis;* Beatson et al. 2007; Beatson

& O'Shea 2009). Little is known about the short-finned pilot whale diet in New Zealand, but worldwide they also feed primarily on squid along with some fish (Taylor et al. 2011).

A2.6.3. Conservation status

Both *Globicephala* species are listed by the IUCN as *data deficient* (Taylor et al. 2008a, 2011). The worldwide status of both pilot whale species is not clear as there is evidence that each may consist of two or more different species. According to the New Zealand Threat Classification System, short-finned pilot whales are listed as *data deficient* and the long-finned as *not threatened* (Baker et al. 2019).

Being deep water species means that pilot whales are generally less susceptible to coastal threats. However, several hundreds of short-finned pilot whales are taken as by-catch in both the squid round-haul and long-line fisheries in the western and eastern Pacific (Taylor et al. 2011). There is also evidence that these species, like beaked whales, are particularly vulnerable to loud anthropogenic sound in the ocean, such as navy sonar and seismic exploration. Todd et al. (2015) notes that these species may be sensitive to any increases in shipping traffic, chance of collisions and/or change to prey availability as the result of dredging works.

A2.7 Southern Right Whale (*Eubalaena australis*)

A2.7.1. Distribution and abundance

Today, the overall abundance of right whales in the Southern Hemisphere (also known as southern right whales) is estimated between 7,000–8,000, only 10% of pre-whaling numbers (Baker & Clapham 2004). Present populations of southern right whales continue to follow a seasonal north-south migration pattern. They spend the warmer summer months feeding in unknown locations within the Southern Ocean (Patenaude 2000). During autumn, whales migrate back to warmer, temperate waters north of 50°S and winter breeding / calving grounds (Carwardine 1995; Patenaude 2000).

Within New Zealand, a small recovery in population numbers has been observed within the traditional breeding grounds of the sub-Antarctic islands, with researchers estimating the 1998 sub-Antarctic population to be around 900 animals (Carroll et al. 2011b). While this remnant population was known to exist off the Campbell and Auckland Islands since the 1940s, the first re-sighting of a right whale off the New Zealand mainland did not occur until 1963 (Gaskin 1964). The first re-sighting of a mother / calf pair was reported that same year near the Whangarei Heads by fishermen and later again within the Whangarei channel (Gaskin 1964).

More recent research has shown movement between the sub-Antarctic population and mainland New Zealand (Childerhouse et al. 2010; Carroll et al. 2011a). There is mounting evidence that the sub-Antarctic population is slowly re-colonising mainland New Zealand, with this part of the range becoming re-established as a secondary wintering ground (Figure A2.6, Carroll et al. 2014). Carroll et al. (2014) noted that one of the highest concentrations of southern right whale sightings was Northland between 2003 and 2010, in which 38% of these sightings were cow / calf pairs (Figure A2.6). Three of these sightings occurred between Cavalli Islands (Bay of Islands), Tutukaka and Whangarei in 2003 (Figure 4). Right whales were sighted within the Whangarei Harbour and along Bream Bay beaches close to Mangawhai Heads. Most Northland sightings occurred during August, September and occasionally October, with some mother and calf pairs reported.

Southern right whales can be slow migrators, especially cow / calf pairs, with a tendency to remain near continental and island masses. Migrating individuals have been noted remaining in the same area for days and / or weeks. Single whales were rarely sighted more than once a week, generally averaging 2.5 days while cow / calf pairs averaged 11.5 days and up to four weeks (Patenaude 2003).

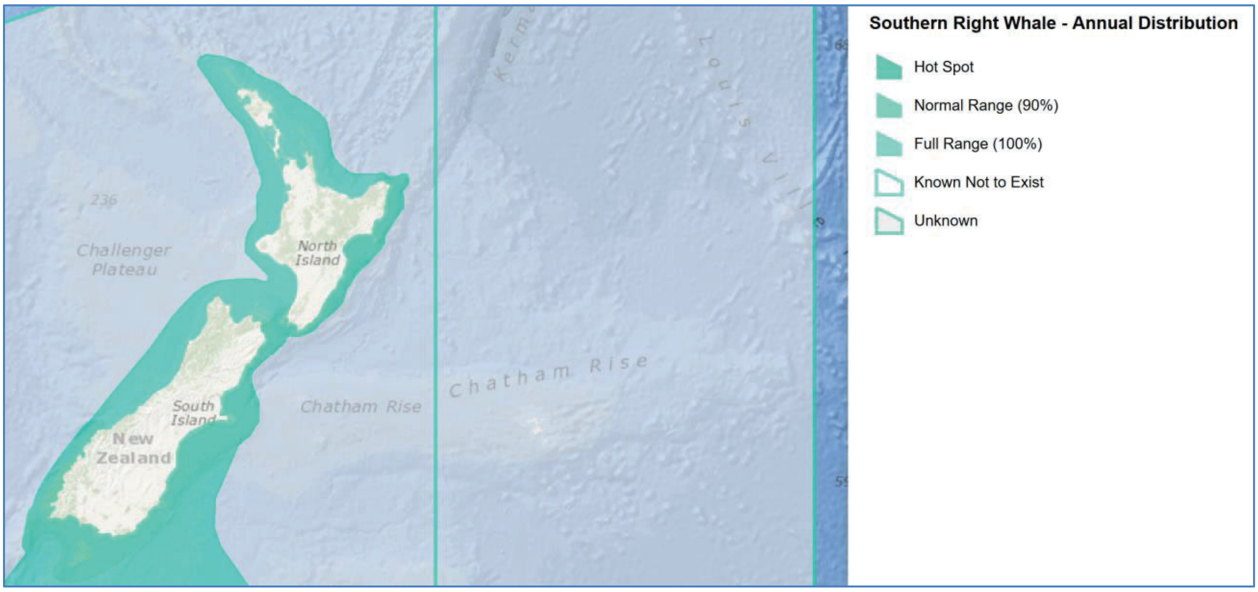


Figure A2.6. The general distribution pattern of southern right whales in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) mapping database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed Sept 2019).

A2.7.2. Life-history dynamics

As with most large mammals, southern right whales are slow breeders. Females usually mature between 5 and 10 years of age and then only give birth at 3–4 year intervals (Carwardine 1995). New Zealand right whales are fairly solitary animals that usually travel alone or in small groups of 2–3 individuals. However, breeding aggregations wintering off the Auckland Islands have been reported as large as 70 whales (Patenaude 2000).

Right whales feed mainly on krill, specialising on copepods and euphausiids. Due to their prey location, right whales spend the majority of their time at the surface. When feeding, they are most often seen skimming the water surface with their mouths open (Carwardine 1995).

A2.7.3. Conservation status

Southern right whales are considered a species of *least concern* as most southern populations are demonstrating large rates of increase (Reilly et al. 2013). This classification recognises the species is well below historical numbers, but considers most populations are exposed to low level threats at present. However, under the New Zealand Threat Classification System, southern right whales are classified as *at-risk recovering* (Baker et al. 2019). Patenaude (2003) specifically points out the importance of Northland coastal regions for cow/calf pairs.

Right whales' tendency to remain within coastal surface waters while feeding and migrating, and their natural curiosity places them at greater risk from some human impacts. Currently, the most significant threat to right whale populations worldwide is habitat change due to coastal development. These changes include anthropogenic activities such as increased vessel traffic, aquaculture, oil / gas exploration, fishing and general pollution (Kraus & Rolland 2007). The southern right whale's vulnerability to ship strikes and entanglements with fishing gear has also been reported along the South African (Best et al. 2001) and Brazilian coastlines (Greig et al. 2001). Todd et al. (2015) suggests that dredging activity may lead to habitat avoidance and / or behavioural changes in this species, while highlighting that the only reported marine mammal collision with a dredge vessel was a southern right whale calf struck off the South African coast (Best et al. 2001).

A2.8 Humpback Whale (*Megaptera novaeangliae*)

A2.8.1. Distribution and abundance

Similarly to right whales, humpback whales in the Southern Hemisphere numbered around 100,000 in the pre-whaling era (Leatherwood et al. 1983). Within the Southern Hemisphere, six distinct and isolated stocks are recognised. The humpback whales around New Zealand (Area V–breeding stock E) are thought to winter off Tonga, Samoa and Fiji, visiting New Zealand's coastal waters while migrating to and from summer feeding grounds in the Antarctic (Constantine et al. 2007). Humpbacks are thought to travel up along the east and west coasts of New Zealand during the autumn and back to Antarctic waters along the west and east coast again in the spring.

Humpbacks were thought to travel in straight lines from headland to headland, only occasionally passing inshore to bays, bights, and / or harbours. Previous North Island whaling stations depending mainly on humpback catches included Whangamumu (Bay of Islands), Bay of Plenty and Mahia Peninsula (Dawbin 1956). From detailed whaling logs, humpbacks on their north-bound migration were known to travel more offshore after coming around East Cape, passing between and around the Barrier Islands. It was to south of the Whangaruru and Whangamumu headlands that humpbacks approached the coast and followed it closely on their northbound migrations over winter. Whales returning on their southbound migrations were also known to pass along the same coastline, some venturing inshore to feed while others stayed further offshore between October and January.

The New Zealand stock of humpbacks is thought to be increasing around New Zealand with more whales sighted along the North Island's east coast during the southern migration period, September to December (Gibbs & Childerhouse 2000). A recent DOC study off Tory Channel demonstrated that the number of groups transiting through Cook Strait has increased by 13% over a 12-year period (Gibbs et al. 2018).

One humpback whale stranding has been reported on Mair Bank, near the Whangarei Harbour entrance (DOC stranding database; Figure 4). There have been numerous public sightings of this species with Northland waters; at least four public sightings recorded within close vicinity of the proposed area since 2004. The most recent sighting was in July 2014 when a lone humpback was observed and photographed within the Whangarei Harbour (Chetham 2015).

A2.8.2. Life-history dynamics

Both female and male humpbacks mature around five years of age. Females, once reproductively active, give birth every two years. As with the other marine mammals, a slow reproductive rate has slowed this species' population recovery. Humpback whales are found in groups of 2–3, though are often observed alone. As they migrate north past New Zealand, most humpbacks traditionally travelled singly or in pairs (Dawbin 1956). On their south-bound return, they tended to occur more in groups, most often with calves.

Their main prey items include krill and schooling fish (Leatherwood et al. 1983). Like right whales, humpbacks are often seen feeding along or just below the surface, although they are known for their innovative feeding techniques (Carwardine 1995). Their most well-known technique involves driving schools of fish to the surface using a cooperative feeding behaviour known as 'bubble netting'.

A2.8.3. Conservation status

Due to the recent revelation of illegal commercial whaling in the 1960s and 1970s by the Soviets within Southern Ocean waters (Clapham et al. 2009), and the slow population recovery (Childerhouse & Gibbs 2006) the Oceania stock of humpback whales is considered *endangered* by the IUCN (Childerhouse et al. 2008). This species is classified as a *migrant* under the New Zealand Threat Classification System (Baker et al. 2010) and considered as a *threatened migrant* by DOC's Marine Mammal Action Plan (Suisted & Neale 2004) due to the small number of animals regularly migrating through New Zealand waters.

In the absence of whaling, the greatest impact to this species is habitat competition and / or degradation, entanglements and ship strikes. Due to the overlap in food-rich habitats and their surface and sub-surface behaviours, humpbacks in the Southern Hemisphere are often entangled in fixed fishing gear within inshore waters (Leatherwood et al. 1983). Todd et al. (2015) noted that in regards to dredging activities, this species may be susceptible to habitat avoidance, noise pollution, habitat degradation, behavioural alterations, masking of conspecifics at close range (< 1 km), alterations to migration routes and avoidance (Lammers et al. 2001).

A2.9 Sperm Whales (*Physeter macrocephalus*)

A2.9.1 Distribution and abundance

This large and very distinct species is widely distributed in all oceans of the world, from the equator to the edges of polar ice (Leatherwood et al. 1983; Taylor et al. 2008b). In most areas sperm whales prefer deep waters, near the continental slope and / or submarine canyons where uneven bathymetry facilitates upwelling (Gaskin 1972). Mature males occur at higher latitudes than females and juveniles, which are rarely sighted at latitudes greater than 40–50°S. Most sperm whales migrate towards the poles in spring and summer returning to lower latitudes in winter (Carwardine 1995). However, some populations are resident year-round (Leatherwood et al. 1983).

Since they favour deep water, sperm whales are rarely seen close to the coast in New Zealand, except in regions with extreme bathymetry such as Kaikoura and Fiordland. From whaling catches, Gaskin (1972) found that sperm whales off the east of New Zealand congregated over the continental slope as they associated with the seasonal location of the Subtropical Convergence (as dictated by the East Cape and Southland Currents), and its eastern flow towards the Chatham Rise. Sperm whales were historically whaled along North Cape, East Cape, Foveaux Strait and the Kermadec Islands (located northeast of East Cape); however, most male sperm whales were caught around Cook Strait and Kaikoura (Gaskin 1968b). Male whales around Kaikoura exhibit a seasonal residency, in which they regularly return to this area as they presumably migrate to and from polar regions. There are no known coastal regions in New Zealand in which groups of female sperm whales (known as 'harems'—see below) are consistently found year-round (Jaquet et al. 2001). Recent sightings of this species have increased between the Bay of Islands and Bay of Plenty regions with an increase in ecotourism and marine mammal observers on offshore fisheries boats (DOC sighting database). Most sightings are between 10 and 100 nautical miles from shore and occur mainly during summer and autumn months, which may explain why only a few sightings are noted in the DOC database (Figure 4). Brabyn (1990) reported over 100 strandings of sperm whales around New Zealand with concentrations of single animal strandings mainly occur nearing between Wellington and Mahia Peninsula and off Kaipara Harbour.

A2.9.2. Life-history dynamics

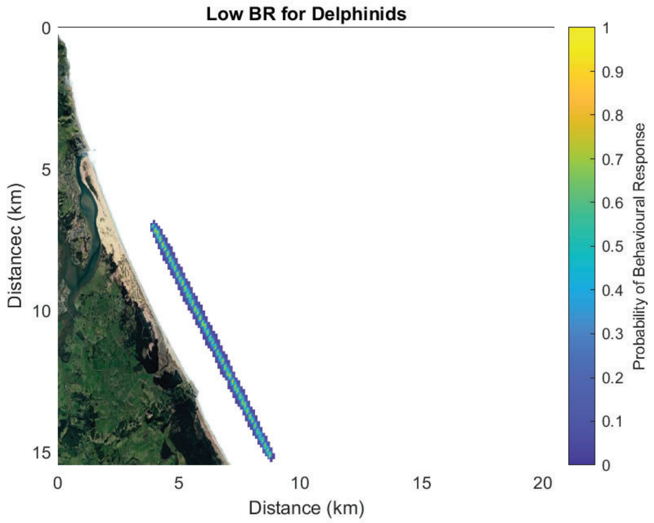
Male sperm whales are much larger than females. They generally tend to be solitary, forming only temporary aggregations with other males known as 'bachelor groups' when they are young and sexually immature (Lettevall et al. 2002). Females tend to group in more permanent 'harems' made up of different age classes of females and calves. As such group sizes in sperm whales vary between single animals to hundreds depending on the type of group.

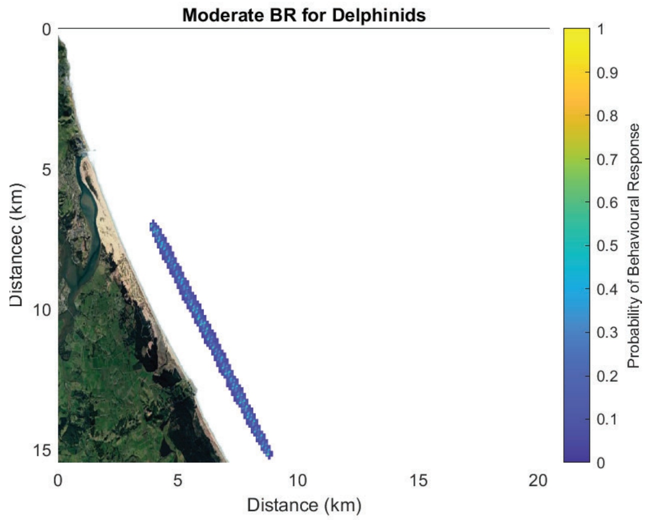
Sperm whales feed on deep-water squid and fish, such as groper and ling (Gaskin & Cawthorn 1967). This species is unusual in that they dive to deep depths to search out prey while most other cetaceans depend on diel vertical migrations to bring deeper prey within their foraging limits. Sperm whale diets off Cook Strait are thought to change seasonally depending on the distribution of their prey (Jaquet et al. 2001).

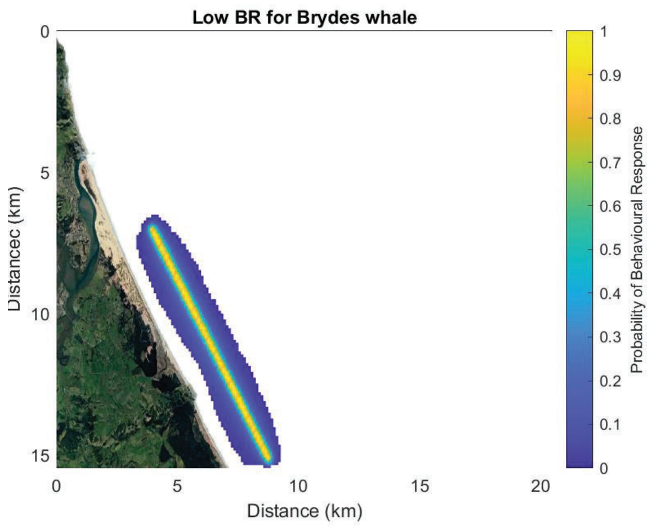
A2.9.3. Conservation status

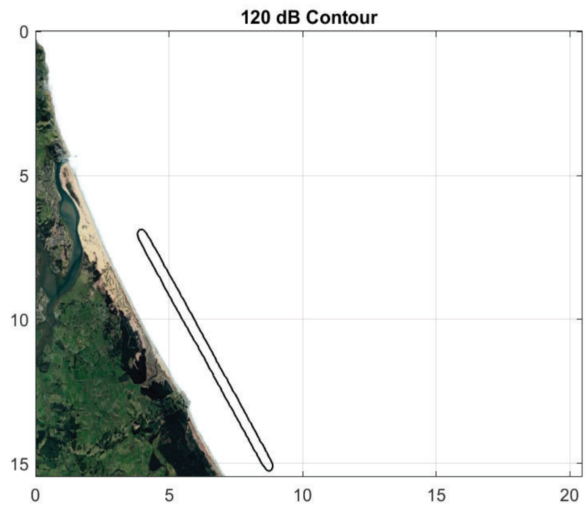
The sperm whale is listed by the IUCN as *vulnerable* (Taylor et al. 2008b), due to a population reduction of at least 20% over the last three generations and the continuation of illegal whaling by the USSR until the early 1980s. The New Zealand Threat Classification System lists this species as *not threatened* (Baker et al. 2010). With the cessation of whaling, sperm whales face very few threats. Low numbers of entanglements in fishing gear and boat strikes occur but tend to be more of a localised problem in certain regions. Of more concern is the low level of growth (~1% per year), perhaps due to localised depletion of mainly male whales during whaling years, which seem to be preventing some regional populations from recovering.

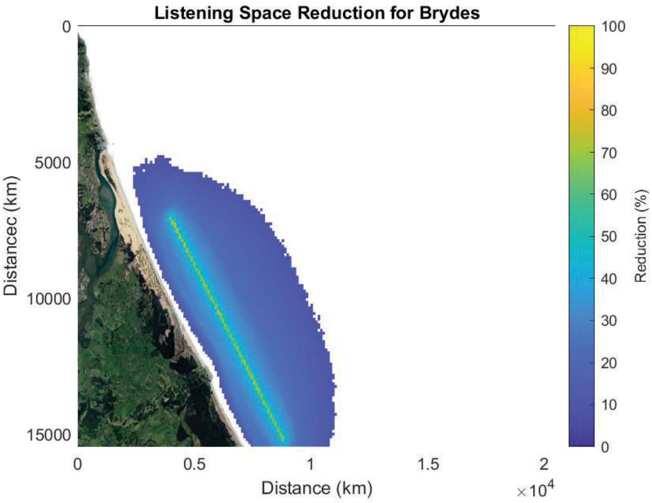
Appendix 3. Contour plots of the estimated range (in kilometres) of species' risk (as a percent) of behavioural responses (BR) and percent reduction in listening space. The plots are within the current consent sites and represent the area in which the dredges will be moving. Data are not available to calculate low or moderate BR in fur seals or moderate BR for Bryde's whales. The previously used behavioural impact threshold of 120 dB for continuous noise is given as a reference.

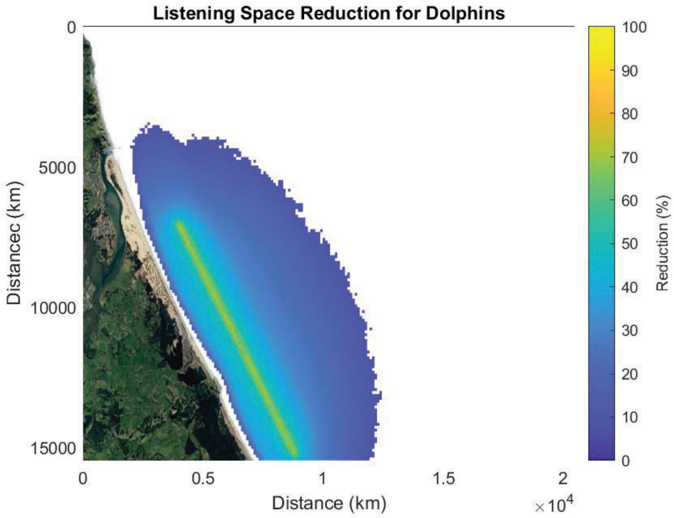


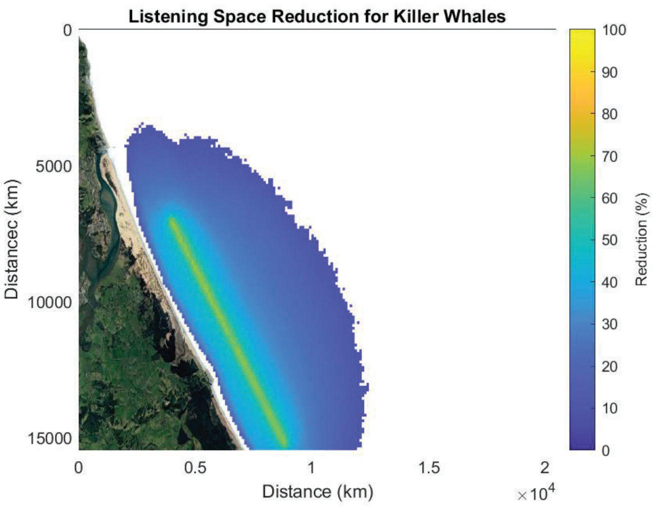


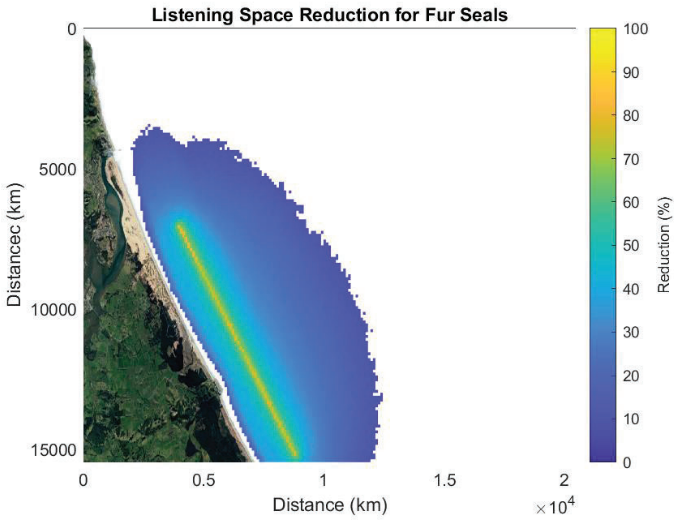





Listening Space Reduction for Brydes
Distancec (km)
0
5000
10000
15000
Distance (km)
0
0.5
1
1.5
2
×10^4
Reduction (%)
100
90
80
70
60
50
40
30
20
10
0


Listening Space Reduction for Dolphins
Distancec (km)
0
5000
10000
15000
Distance (km)
0
0.5
1
1.5
2
×10^4
Reduction (%)
100
90
80
70
60
50
40
30
20
10
0


Listening Space Reduction for Killer Whales
Distancec (km)
0
5000
10000
15000
Distance (km)
0
0.5
1
1.5
2
×10^4
Reduction (%)
100
90
80
70
60
50
40
30
20
10
0


Listening Space Reduction for Fur Seals
Distancec (km)
0
5000
10000
15000
Distance (km)
0
0.5
1
1.5
2
×10^4
Reduction (%)
100
90
80
70
60
50
40
30
20
10
0

Appendix 4. Best boating behaviour guidelines around marine mammals

The overall risk of a vessel strike between operating dredge vessels and marine mammals is low, but moderate while transiting within the Hauraki Gulf region. In the unlikely case that a vessel should encounter a marine mammal while working, implementing the following 'best practice' boating behaviours (used worldwide) around marine mammals shall reduce any chance of collision.

General practice

If a whale or dolphin is sighted, but not directly in the path of the vessel:

- Keep boat speed constant and / or slow down while maintaining current direction
- Avoid any abrupt or erratic changes in direction
- Maintain or resume normal operating speeds once well way from animals.

Large baleen whales—such as Bryde's or southern right whales

If a whale is sighted directly in the path of the vessel:

- If the whale is far enough ahead of the vessel (e.g. > 500 m) and can be avoided, slow to 'no-wake' if necessary and maintain a straight course away from the immediate sighting area (where practicable)
- If the whale is too close to the vessel and cannot be avoided, immediately place the engine in neutral and allow the boat to drift to one side of the sighting area where practicable (do not assume the whale will move out of the way)
- Avoid any abrupt or erratic changes in direction while at speed
- Once the whale has been re-sighted away from the vessel, slowly increase speed back to normal operation levels.

If a cow / calf pair is sighted within 500 m of an underway vessel:

- Gradually slow the boat while maintaining a course away from the immediate sighting area (where practicable)
- Allow the pair to pass
- Once the pair has been re-sighted away from the vessel (> 500 m), slowly increase speed back to normal operation levels
- Avoid any abrupt or erratic changes in direction while at speed.

If a whale and / or cow / calf pair approaches a stationary vessel:

- Keep the engine in neutral, and allow the animal to pass
- Maintain or resume normal operating speeds once well way from animals (> 500 m).

Small to medium whales and dolphins —– such as bottlenose dolphin or orca

If a dolphin(s) is sighted directly in the path of the vessel:

- Keep boat speed constant and / or slow down while maintaining a course slightly to one side of the group, do not drive through the middle of a pod
- Avoid any abrupt or erratic changes in direction
- Maintain or resume normal operating speeds once well way from animals.

If a dolphin(s) approaches an underway vessel to bow-ride or ride the stern wave:

- Keep boat speed constant and / or slow down while maintaining course
- Avoid any abrupt or erratic changes in direction
- Do not drive through the middle of a pod
- Maintain or resume normal operating speeds once well way from animals (> 500 m).