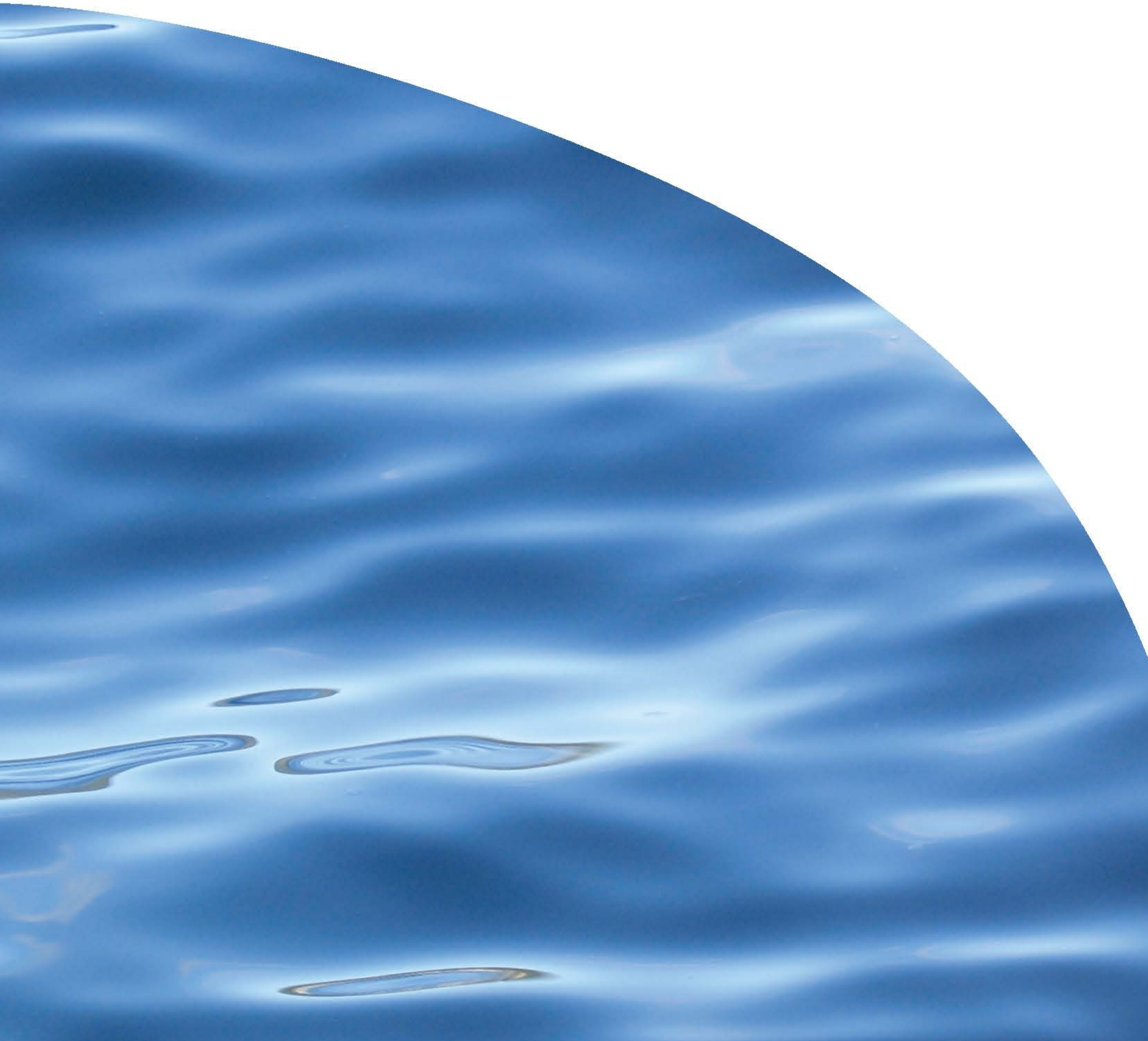
REPORT NO. 2711

PHASE 1: PRELIMINARY REVIEW OF POTENTIAL DREDGING EFFECTS ON MARINE MAMMALS IN THE WHANGAREI HARBOUR REGION



PHASE 1: PRELIMINARY REVIEW OF POTENTIAL DREDGING EFFECTS ON MARINE MAMMALS IN THE WHANGAREI HARBOUR REGION

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EXECUTIVE SUMMARY

Refining New Zealand Limited (RNZ) is proposing to utilise more heavily-laden tankers to transport crude oil to their refinery in Whangarei Harbour, resulting in fewer ship movements. To accommodate heavier vessels, Whangarei's harbour entrance and various locations along the shipping channel would need to be dredged and some areas re-aligned. RNZ contracted the Cawthron Institute (Cawthron) to outline and assess any actual and potential effects on marine mammals from proposed channel deepening and spoil disposal activities.

The purpose of this Phase 1 report is to review national and international literature and provide context for better understanding of the existing environment. This in turn, enables the potential effects associated with dredging and disposal operations on marine mammals to be assessed in Phase 2 of this project. The potential impacts viewed as most plausible for marine mammals include:

- short-term avoidance of habitats due to dredge presence and / or underwater noise disturbance
- short-term changes in behaviour due to dredge presence and / or underwater noise disturbance
- potential auditory masking
- possible small-scale changes in prey availability.

This report also reviews which species of marine mammals regularly utilise Whangarei Harbour and the wider Bream Bay coastal waters. The marine mammals most likely to be affected by the proposed project include those species that frequent the Whangarei Harbour and Bream Bay regions year-round or on a semi-regular basis: bottlenose dolphins (*Tursiops truncatus*), orca (*Orcinus orca*), Bryde's whale (*Balaenoptera edeni)* and common dolphins (*Delphinus delphis*). Other species that need to be considered because of various life history dynamics (*e.g.* low population numbers) or species-specific sensitivities (*e.g.* underwater noise) include: pilot whales, some beaked whale species, southern right whales and possibly pygmy sperm whales. Given the significance of their name for the harbour (Whangarei te rerenga parāoa [the gathering place of whales]), Tangata Whenua also hold most of these species in high regard.

Additional background information is currently being gathered by the following Phase 1 studies (listed below) and will be used to help determine which of the discussed effects are most relevant to this particular proposal.

- underwater noise characteristics and levels within Whangarei Harbour; including sound recordings from the oil tankers referred to in the project proposal
- contaminant(s) presence and any detectable concentrations in dredging materials
- expected effects on the seabed, fish and ecological systems
- modelled and predicted turbidity plume dynamics.

Despite the lack of data specific to the Whangarei Harbour and Bream Bay region for some species discussed in this review, a monitoring programme involving opportunistic visual sightings and simultaneous passive acoustic monitoring of marine mammals is recommended rather than systematic marine mammal surveys. As such, any vessels collecting information for the project in the vicinity of the proposal and other nearby regions (*i.e.* benthic sampling in channel and proposed spoil disposal areas), as well as any regular users of the Harbour entrance (*i.e.* tug boats), would be encouraged to record and report any marine mammal sightings. Passive acoustic monitoring stations placed around the proposal area would 'listen' and record the acoustic presence (day and night) of any marine mammals vocalising within range of the devices. This monitoring would be in addition to the acoustic work done by Styles Group in Phase 1 of this project.

Visual sightings, in conjunction with acoustic detections, should be collected within the proposal area prior to and during dredging and disposal activities and for a period after all operations have ceased. While this monitoring information will lack some statistical robustness, it will help confirm which species might be expected within the vicinity of proposed works, their potential seasonality and relative frequency as well as monitor for the species' continued presence both during and after activities have ceased. Any monitoring data in proximity to the proposed project sites would also help inform decisions around site selection for possible disposal areas and provide an important context for any incidents involving marine mammals while the dredging is underway. The results of the other Phase 1 reports, along with the findings of this review and any monitoring information, will be used in the subsequent Phase 2 report assessing potential dredging effects on marine mammals and any possible mitigation options for this proposal.

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1. INTRODUCTION

Refining New Zealand Limited (RNZ) is New Zealand's only oil refinery and is based at Marsden Point at the entrance to Whangarei Harbour. In order to improve competitiveness by reducing freight costs, the company is proposing to deepen the entrance channel to Whangarei Harbour so that more heavily-laden tankers (which require deeper drafts) can access its jetty, resulting in fewer ship movements. To accommodate heavier vessels, the harbour entrance and various locations along the shipping channel would need to be dredged and some areas re-aligned. The proposal will also include disposal of the dredge spoil in the coastal marine area and is likely to involve further modifications to the jetty.

RNZ contracted the Cawthron Institute (Cawthron) to outline and assess any actual and potential effects on marine mammals from proposed channel deepening to Whangarei Harbour and from spoil disposal activities. This scope of this contract is divided into two phases. This report constitutes the Phase 1 assessment and includes the following:

1. a review of national and international literature to provide context and so enable the existing environment to be better understood. This in turn enables the potential effects associated with dredging/disposal activities on marine mammals to be assessed in the next phase (Phase 2) of this project, in particular:
    a. known versus potential effects
    b. indirect versus direct effects.

2. a desktop review of resident and transient marine mammals populations utilising Whangarei Harbour and the wider Bream Bay coastal ecosystems with reference to:
    a. abundance and seasonal distribution information
    b. presence of any known important habitats, such as nursing or feeding areas
    c. known life history dynamics that may make a species more vulnerable to dredging and disposal activities.

This preliminary review, along with additional information from other Phase 1 reports (*e.g.* underwater noise, ecology, spoil disposal modelling) and any ongoing sighting reports of marine mammals with the proposal area, will form the basis of the Phase 2 assessment. The Phase 2 report will be a comprehensive assessment of environmental effects focused on marine mammals in the proposal area and is intended to support the final resource consent application.

2. POTENTIAL EFFECTS OF DREDGING ACTIVITIES AND SPOIL DISPOSAL ON MARINE MAMMALS

Interactions between marine mammals and coastal development usually result from an overlap between the spatial location of the development and important habitats of the species. The direct effects of such overlap range from physical interactions with the animals (*e.g*. vessel strikes or entanglements) to avoidance or even abandonment of the area by the species due to the general increase in activity (*e.g*. noise or traffic). Indirect effects may result from physical changes to the habitat itself that adversely affect the health of the local ecosystem and / or impinge on important prey resources.

Despite the frequent use of dredges in most ports, harbours and coastal development projects, little research has focused on the effects of dredging operations on marine mammals specifically (see review by Todd *et al.* 2015 and references therein). The following section describes the direct and indirect effects that dredging can have on marine mammals based on available (predominantly overseas) studies while relying on a wider range of research focused on coastal development and marine mammals in general.

2.1. Direct effects

The act of breaking and / or removing bottom substrate in itself is not expected to directly affect any marine mammals. Instead, the associated vessel activity, resulting production of underwater sound, and physical activities within the harbour entrance are the more likely circumstances under which marine mammals could be affected.

2.1.1. Vessel strikes

Mysticete (baleen whales)

Vessel strikes are a well-known source of injury and mortality for several species of baleen whales, more generally, around the world (Laist *et al.* 2001). Only one out of the 134 worldwide collision cases reported (in which the vessel type was known) between 1975 and 2002 involved a dredge. In South Africa, a southern right whale cow / calf pair surfaced directly in front of a 110 m dredge while it was underway and the calf was subsequently killed (Jensen & Silber 2004).

A global review by Laist *et al*. (2001) found that the whales more commonly struck by vessels were: fin whales (*Balaenoptera physalus*), right whales (*Eubalaena glacialis* and *E. australis*), humpback whales (*Megaptera novaeangliae*), sperm whales (*Physeter macrocephalus*), and gray whales (*Eschrichtius robustus*). In New Zealand waters, at least five baleen whale species have been found wrapped around the bows of container ships entering Auckland Harbour (Stone & Yoshinaga 2000; Clement 2009; Constantine *et al*. 2015). These species include; Bryde's whale (*Balaenoptera*

edeni), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), minke whale (*Balaenoptera acutorostrata*) and fin whale (*B. physalus*).

The likelihood of vessel strike depends on a number of factors including vessel type, speed, location and the species and behaviour of marine mammals (Van Waerebeek *et al.* 2007). Although all types and sizes of vessels have hit whales, the most severe collisions (*e.g.* fatal injury or mortality) occurred with large (> 80 m) and fast moving (> 14 kn or > 26 km/h) ships (Laist *et al*. 2001; Jensen & Silber 2004). However, the size of the vessel appears to be less significant than its speed. The risk of collision and the likelihood that it will result in severe injury or death both increase above speeds of 10-14 kn (Todd *et al.* 2015).

A review of baleen whale responses to vessels found that most animals will exhibit avoidance behaviours when approached by fast vessels, a vessel producing rapidly changing noises and / or when a vessel directly approached the animal (Richardson 1995). However, as the author pointed out, an attempt by the whale to avoid the vessel is not always effective at preventing collisions. Particular species (see above) and certain age groups (*i.e*. calves and juveniles) are noted as being more susceptible to vessel strike (Todd *et al.* 2015). Behaviours such as feeding and resting have also been shown to increase the risk of vessel strike. This is thought to be related to the animal being distracted, and therefore less focussed on vessel movements (Laist *et al*. 2001).

Odontocetes

In general, most odontocete species (*i.e*. toothed whales and dolphins) demonstrate few avoidance behaviours around most ships and boats. In fact some populations regularly tolerate heavy vessel traffic while others often approach the vessels themselves (Richardson 1995). The author even states, '...we know of no clear evidence that toothed whales have abandoned significant parts of their range because of vessel traffic' (Richardson 1995, p 262). However, it should be noted that odontocete reactions to vessels can vary greatly between species, populations and even individual animals. In New Zealand, recent reports documented lethal injuries on both common and bottlenose dolphins in the Hauraki Gulf consistent with vessel strike (Martinez & Stockin 2013; Dwyer *et al*. 2014), despite these species regularly interacting with vessels.

A review of dredging effects by Todd *et al*. (2015) suggests that the risk of collision between dredges and marine mammals will be minimal if the activity avoids critical habitats and seasons when the species of concern may be distracted or have calves present. Collision risks are considered greatest mainly when the dredge or other vessel, including oil tankers, are in transit and / or when in areas of heavy shipping traffic.

2.1.2. Underwater noise

Increasing underwater noise levels are always a concern in regards to marine mammals. Noise has the potential to negatively affect cetacean species since they rely heavily on underwater sounds for communication, orientation, predator avoidance and foraging. Potential effects associated with increases in underwater noise include auditory damage, behavioural changes, and acoustic masking (see *Todd et al.* 2015 and references therein).

Dredging, as well as spoil disposal, will involve a temporary increase in vessel traffic and mechanical activities that will generally increase the amount of anthropogenic underwater sound produced in an area. Compared to a powerful ship, dredges produce relatively lower sound levels;180-190 dB re: 1 µPa rms @ 1 m[1] versus 124–186 dB re: 1 µPa rms @ 1 m, respectively (OSPAR 2009; Todd *et al.* 2015 and references therein). However, the two differ in that a dredge may be actively operating within one general area (< 10 km) for longer periods of time (weeks or months) while a ship rarely remains in the same area for long (minutes or hours). The noise produced by dredging is continuous, broad-band sound generally below 1 kHz (Todd *et al.* 2015), yet, the associated noise characteristics can vary depending on the:

a) type of dredge
b) dredging operational stage
c) environmental conditions.

Environmental factors that may lessen the noise produced from dredging, and thus the distances at which it can be detected are; depth of water, ambient level of suspended sediments and the types of sediment being dredged. For example, shallower depths will attenuate (*i.e*. reduce the strength of a signal) some of the lower frequency sounds created. Richards *et al* (1996) reported that suspended sediments in concentrations of 20 mg/L can cause an attenuation of 3 dB over 100 m, but only in the higher frequency range (~100 kHz). Gerstein & Blue (2006) found maintenance dredging of soft and / or unconsolidated sediment also tends to absorb or dampen lower frequency sounds.

Auditory damage

Baleen whales generally communicate at low frequencies, and as such are more susceptible to noise related impacts from dredging (Todd *et al.* 2015). However, auditory injury due to a permanent threshold shift (PTS)[2] was considered unlikely at the noise levels that baleen whales are exposed to through dredging, although

[1] The term 'dB re 1 µPa @ 1 m' represents the sound pressure level at one metre distance from the source and 'rms' levels are often used or long duration or continuous noise sources instead of 'peak' levels.

[2] Southall *et al*. 2007 – proposed injury criteria for individual marine mammals exposed to 'discrete' noise events (either single or multiple exposures within a 24-h period). For low, mid- and high frequency cetaceans, the *sound pressure level* is 230 db re: 1 µPa (peak)(flat) for single, multiple and non-pulses . For low, mid- and high frequency cetaceans, the *sound exposure level* is 198 db re: 1 µPa^2-s (M_{lf}) for single, multiple pulses and 215 db re: 1 µPa^2-s (M_{lf}) for non-pulses.

temporary threshold shifts (TSS) are not able to be ruled out in cases of long-term exposure (Todd *et al.* 2015).

While more detailed research is needed in terms of individual species' sensitivity to low frequency sound, the hearing of most odontocetes (*e.g.* orca and dolphins) significantly decreases in sensitivity at frequencies below 1–2 kHz (Au 2000). This physiological difference in the functional frequency in dolphins should minimise any direct hearing effects caused by a general increase in lower frequency noise production. This may help explain the continued presence of dolphin populations worldwide in high activity coastal regions. It should be noted that preliminary reviews on beaked whales found that these species may be more sensitive to noise relative to other more coastal species, and thus, the PTS and TSS limits may need to be more precautionary in their presence (Cox *et al.* 2006; Southall *et al.* 2007).

Avoidance of habitat/behavioural changes

Since the 1980s, marine dredging has been recognised as a source of underwater noise in coastal waters (*e.g.* Greene 1987). Yet isolating the underwater noise effects of dredging on its own are difficult since most dredging is often associated with other noise-producing activities (*e.g*. increased vessel activity, reclamation, pile driving). A few studies have, however, specifically examined the effects of dredging noise on marine mammals or attempted to tease apart these effects from other coincident construction sources.

Recent overseas studies have suggested that dredging noise may have the potential to cause temporary avoidence of habitats or behavioural changes in local marine mammal populations. In Northern Germany, short-term avoidance by harbour porpoises was evident within 600 m of dredge operations (Diederichs *et al.* 2010). Similar avoidance responses have been documented for bottlenose dolphins in foraging areas in Aberdeen Harbour. Although the harbour is a busy shipping route and the dolphins are presumably accustomed to vessel noise, bottlenose dolphin presence declined with an increase in dredging activity and not just vessel presence (Pirotta *et al.* 2013). However, a third study in Alaska was inconclusive (Hoffman 2010). While beluga numbers declined in relation to dredging works, some individual animals appeared to habituate over time as they were found in close proximity to working dredges.

Richardson (1995) concluded that marine mammal reactions to anthropogenic noise differ depending on: the species (and even between individuals of the same species), characteristics of the noise sources (*i.e*. variability and rate of change, ambient levels), and local environmental factors. As such, the potential effects of noise need to be assessed on a case-by-case basis.

Acoustic masking

Depending on the overlap in the hearing range of a species, dredging and other noises can mask important intra-species communication noises as well as interfere with other acoustic cues from predators or nearby vessels (*e.g*. Lammers *et al*. 2013; Erbe 2002; Gerstein & Blue 2006). Masking of these communicative noises can have implications on population dynamics. For example, reproductive success can be affected if the noise is in the area of an important breeding ground and is ongoing for a long period (Todd *et al.* 2015).

In regards to the possible impacts of underwater noise associated with dredging activities on marine mammals, the review by Todd *et al* (2015) suggested that '…most effects concern short, perhaps medium-term behavioural reactions and masking of low-frequency calls in baleen whales and seals. Temporary hearing loss is possible if receivers [individual animals] stay for extended periods near the dredger, but auditory injury is unlikely.'

2.1.3. Operational loss and possible entanglements

Potentially harmful operational by-products of any type of coastal development can include such items as lost ropes, support buoys, bags and plastics (Weeber & Gibbs 1998), items often collectively known as marine debris (Laist *et al.* 1999). As most marine materials are now manufactured from a range of plastics, they often tend to float and persist rather than degrading quickly as is generally the case with more natural fibre materials (Laist *et al.* 1999).

The major hazard associated with marine debris from coastal development projects to whales and dolphins is the possibility of entanglement (Laist *et al.* 1999). Whales and dolphins 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 and lines). However, marine debris generation is generally minimal and any subsequent effects on marine mammals can be non-existent in well-maintained coastal development projects with proper waste management programmes in place.

2.2. Indirect effects

Coastal dredging and the associated spoil disposal 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 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 and / or spoil disposal activities could have on the ecosystem as a whole, and more specifically on the abundance, distribution and/or health of marine mammal prey resources.

2.2.1. Quality of dredge spoil

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).

Most odontocetes feed on a variety of fish, cephalopods, birds or other marine mammals placing them at or near the top of their ecosystem trophic levels. Hence, carnivorous marine mammals suffer not only from high bioaccumulation, but also biomagnification due to their trophic feeding level. Evans' (2003) review of pollutant concentrations in Southern Hemisphere marine mammals found that coastal and higher trophic level species tended to have higher concentrations of most pollutants than species ranging further offshore. Reviews by Ross (2000) and Fossi & Marsili (2003) have also indicated that such contaminants may indirectly affect marine mammal reproductive and / or endocrine systems.

The level of exposure to contaminants for marine mammals will depend on the chemical characteristics of the spoil sediments and the subsequent uptake by relevant prey resources, as well as the general feeding habits and range of any local marine mammal species. However, predicting the potential risk to individual marine mammal species from contaminants is difficult due to the lack of available information around most species' dynamics, individual sensitivities to pollutants and non-point sources of pollutants throughout most species' ranges (Jones 1998). Todd *et al*. (2015) notes that linking toxins presence in marine mammals to dredging activity is confounded by any lag in contaminant uptake as well as their resulting impacts. However, the authors point out that risks are greatest when contaminated sediments are dredged (*i.e*. not all sediments have heavy contaminant loads) and exposure will likely be spatially restricted.

2.2.2. Ecological effects on habitat and prey species

Benthic disturbance and loss

Dredging, including spoil disposal, causes the immediate loss of existing benthic biota and permanently alters the habitat within the immediate region of activity to some degree (Todd *et al*. 2015). However, the level of effect that habitat loss will have on the harbour ecosystem will depend on the proportion of available similar habitat that it comprises. In addition, the flow-on effects of any physical or ecological changes (either within these habitats or to existing biota) on local marine mammal species will depend on their ecological significance to prey resources in the area. For example, the loss or reduced use of critical fish nursery habitats (such as seagrass beds) through direct removal, smothering from spoil disposal and / or a general increase in turbidity may result in future declines in several local fish populations. While most marine mammals would not necessarily feed within the beds, the size of some fish populations may be temporally reduced locally due to a lack or avoidance of suitable breeding habitat. Such a decline may result in local marine mammals having to search elsewhere for adequate food sources (Todd *et al.* 2015).

For these reasons, dredging activities are expected to directly affect local food webs. However, the duration and extent of such changes will vary temporally and be dependent upon the benthic species impacted and the scale of the dredging activity. As a result, Todd *et al*. (2015) suggest that minor changes (*i.e.* positive or negative) in the prey resources of local marine mammal could potentially occur.

Turbidity plumes

Turbidity plumes are generated from the re-suspension of sediments at the dredging site and any marine location where dredged sediments (spoil) are later deposited. There is potential for such plumes to be additive to existing turbidity levels, or become entrained in local gyres and eddies. High turbidity levels and movements of any sediment plumes created by dredging and / or disposal activities are a concern to fauna within or adjacent to work sites (*e.g.* Sneddon 2009).

Marine mammals are known to inhabit fairly turbid environments worldwide. 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. But 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).

Research has demonstrated that most turbidity plumes generally fade into ambient turbidity levels relatively quickly (*i.e*. within one hour to 4-5 tidal cycles; Hitchcock & Bell 2004) and are fairly spatial constrained in their impacts, generally dissipating towards background levels within less than 1 km of the point of origin (Sneddon 2009). Given the amount of detailed data available, predictive modelling of the

location and duration of resulting turbidity plume is generally accurate. Such models can be used to mitigate around sensitive time periods (*i.e*. fish spawning) and locations. Hence, any impacts on local food organisms should be short-term and limited in scale, and therefore, are not expected to have any substantial effects on local marine mammals (Todd *et al*. 2015).

2.3. Summary

The purpose of this section is to review which known dredging effects on marine mammals need to be considered and which unknown effects might need to be examined further in the context of this proposal. Based on available overseas studies, the most likely effects of marine dredging on local marine mammals range from short-term avoidance or changes in behaviour (due to dredge presence and / or underwater noise), potential auditory masking to possible small-scale changes in prey availability. However, as noted in the review by Todd *et al*. (2015), such effects are largely dependent on the location, the marine mammal species present and the context of the project (*e.g*. equipment used, duration, spoil volumes).

This Phase 1 review suggests that most direct impacts, such as increases in vessel collisions and effects from underwater noise, will be temporary in nature and limited in spatial extent. However, Todd *et al* (2015) suggests that several of these effects can be further minimised by implementing appropriate mitigation measures. Accidental interactions between particular species and dredging activities can be avoided by adopting operational guidelines and standards, such as preferred seasons for particularly disruptive activities or cessation of activities when noise-sensitive animals are within a specified range of dredging operations.

Alternatively, if marine mammals are attracted to dredging activities, any resulting entanglement risks can be minimised by adopting regular maintenance measures around all aspects of the project, particularly any ropes or lines. Monitoring records of the presence (and absence) of marine mammal species in the vicinity or general region of the activities along with any detailed observations of their time spent under or around the vessels should be compiled where possible either through the use of visual sightings and / or passive acoustic recordings. A well-kept database can be used to understand which species may be more attracted to various dredging activities and what aspects of dredging or spoil disposal they may be interacting with most frequently. Finally, it is important to revisit and amend any mitigation measures in place while dredging operations are underway to respond to any new data. Such information is crucial towards continuing to investigate and develop appropriate and effective mitigation measures in the context of this proposal.

Possible indirect effects of dredging on marine mammals are more complex and less well-understood. While indirect impacts can vary widely, the most relevant to marine

mammals are usually those that impinge upon the abundance and / or health of local prey resources. Predictive modelling of some of these effects (*i.e*. turbidity plume dynamics) is possible and these can be used to mitigate around sensitive time periods (*i.e*. fish spawning) and locations. With these further considerations, indirect impacts are unlikely to have any adverse effects on local marine mammals (*e.g*. Todd *et al*. 2015).

3. MARINE MAMMALS FOUND NEAR WHANGAREI HARBOUR

Whangarei Heads was once known as 'Whangarei Te Rerenga Paraoa', which means 'Whangarei, the gathering place of whales'[3]. While this reference is also thought to be a metaphor for the gathering place of chiefs (Chetham 2015), the significance of whale migrations past this region is supported by the number of whaling stations found north near Whangamumu and along the entire eastern coastline of the North Island during the late 1800s and early 1900s (Dawbin 1956).

Out of the more than 50 species of cetaceans (whales, dolphins and porpoises) and pinnipeds (seal and sea lions) known to live or migrate through New Zealand waters, at least 27 cetacean and two pinniped species have stranded or been sighted along the northeastern coastline of the North Island. However, detailed information on abundance, distribution and critical habitats is available for a limited number only of New Zealand's marine mammals, despite recent advances in survey techniques. To date, marine mammal research in New Zealand has been concentrated in locations nearest to universities or other research providers (*e.g.* Hauraki Gulf or Bay of Islands), or has focused on unique or endangered species (*e.g.* Hector's dolphin or southern right whale). Nevertheless, in the absence of adequate population information, the potential risks to marine mammal species associated with various anthropogenic activities can still be assessed based on the species' life-history dynamics (*e.g.* species-specific sensitivities, conservation listing, life-span, main prey sources) gathered within New Zealand (*e.g.* local and national databases, New Zealand Threat Classification System, NABIS) and internationally (*e.g.* peer-reviewed journals, IUCN Red List of Threatened Species).

In the absence of any long-term and spatially-explicit baseline research on marine mammals in the Whangarei and Bream Bay region, species information and sighting data were collated from on-going research (*i.e*. University of Auckland, Massey University-Albany, Orca Research Trust) throughout the northeastern coastal region as well as opportunistic sightings and strandings (*e.g.* Department of Conservation—DOC databases and tourism reports). This information was used to evaluate those species most likely to be affected by the proposed project and to determine what is currently known about any seasonal and distribution trends within the project's vicinity.

Figure 1 highlights the various marine mammal species found to frequent the Whangarei and / or Bream Bay coastal area in the context of other nearby regions (*i.e.* the Bay of Islands and Hauraki Gulf), given that these species range across long distances. It is important to note that each reported opportunistic sighting does not necessarily represent unique animals. Consequently, the number of sightings in Figure 1 does not equate to the actual number of animals known to occur in these regions. In addition, the location and the time of year that most opportunistic sightings

[3] A history of Ngati Wai – First of Four Instalments by Morore Piripi (http://teaohou.natlib.govt.nz/journals/teaohou/image/Mao37TeA/Mao37TeA018.html)

are recorded may reflect a closer proximity to larger towns or harbours and / or where the majority of coastal activities (*e.g.* tour boats, recreational fishing, diving *etc*.) tend to occur.

Most sightings were reported around the Bay of Islands (BOI) and Hauraki Gulf regions (Figure 1). The large number of reported sightings in these particular areas is most likely a reflection of the number of marine tour companies operating within those vicinities, several of which advertise marine mammal tours and swims. Finally, the distribution and commonality inferences for less studied species, discussed below and in Appendix 1, are expected to change with time and more scientific information.

A list of the more prevalent Northland species is presented in Table 1 and divided into three general categories that describe what is currently known about their distribution patterns within this particular region. In addition, a list of potential effects due to dredging activities, as reviewed by Todd *et al.* (2015), is included in Table 1 for each species.

- *Resident* — a species that lives (either remaining to feed and / or breed) within Northland and surrounding waters either permanently (year-round) or for regular time periods.
- *Migrant* — a species that regularly travels through part(s) of Northland and surrounding waters, remaining for only short or temporary time periods that may be predictable seasonally.
- *Visitor* — a species that may wander into Northland and surrounding waters intermittently, depending on Northland's proximity to the species' normal distribution range, visits may occur seasonally, infrequently or rarely.

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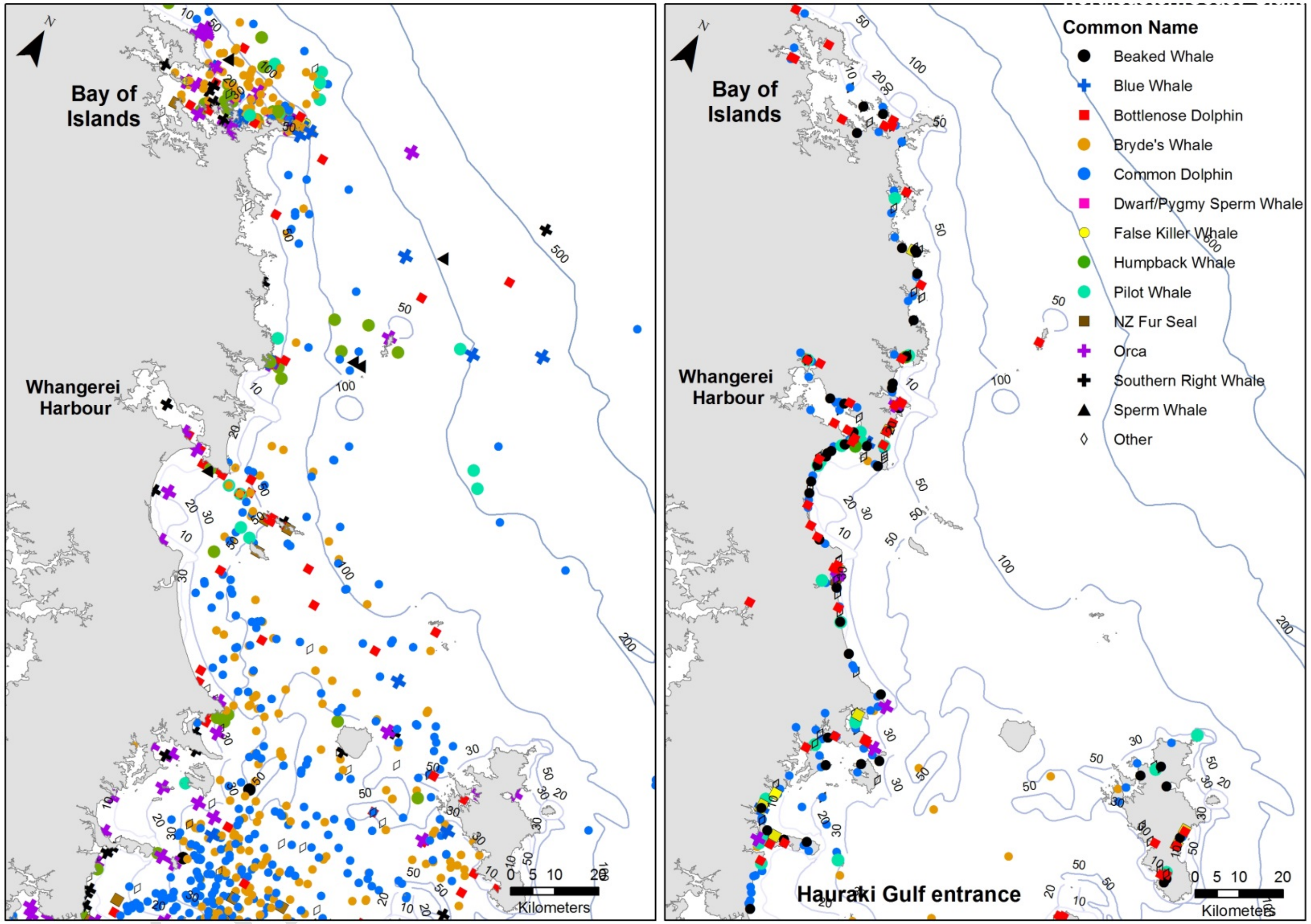

Figure 1. Opportunistic sightings (left) and strandings (right) of marine mammals prevalent in northeastern coastal waters between the Bay of Islands to the north and Whangaparaoa and Great Barrier Island to the south (Department of Conservation's sighting and stranding database).

Table 1. The residency patterns of marine mammal species known to frequent Northland and nearby waters. Species' conservation threat status is listed for both the New Zealand system (Baker *et al*. 2010) and international IUCN system (ver 3.1). See Appendix 1 for species-specific details.

Common name	**Species name**	**NZ threat classification**		**IUCN red listing**	**Residency category in Northland**	**Potential effects of dredging activities (Todd *et al*. 2015)** *
RESIDENTS						
Bottlenose dolphin	*Tursiops truncatus*	NZ native & resident, evaluated	Nationally Endangered	Data Deficient	Seasonal to Year-Round Resident	Altered feeding patterns (Lammers *et al*. 2001), increased shipping traffic & potential disturbance to the nursing areas
Orca (killer whale)	*Orcinus orca*	NZ native & resident, threatened	Nationally Critical	Data Deficient	Seasonal to Semi-Resident	Increased boat traffic, masking, alterations to prey availability, habitat avoidance or behaviour alterations
Bryde's whale	*Balaenoptera brydei/edeni*	NZ native & resident, threatened	Nationally Critical	Data Deficient	Seasonal to Semi-Resident	Behavioural alterations & masking
Common dolphin	*Delphinus delphis/capensis*	NZ native & resident, evaluated	Not Threatened	Least Concern	Seasonal to Year-Round Resident	Habitat alterations & changes to prey distribution
NZ fur seal	*Arctocephalus forsteri*	NZ native & resident, evaluated	Not Threatened	Least Concern	Seasonal Resident	Habitat alterations & changes to prey availability, increase turbidity, masking, incidental capture or injury, avoidance and increase in shipping traffic
Long-finned pilot whale	*Globicephala melas*	NZ native & resident, evaluated	Not Threatened	Data Deficient	Potential Offshore Semi-Resident	Increased shipping traffic & chance of collisions & changes to prey availability
Beaked whales	Ziphiidae species (seven species)	NZ native & resident, not evaluated	Data Deficient	Data Deficient to Least Concern	Potential Offshore Resident to Rare Visitor	Change to behavioural (surfacing, feeding) patterns, avoidance & increased shipping traffic

* Proposed effects by Todd *et al.* (2015) are largely dependent on the location, the scale and context of the project (*e.g*. equipment used, duration, spoil volumes).

Common name	Species name	NZ threat classification		IUCN red listing	Residency category in Northland	Potential effects of dredging activities (Todd *et al*. 2015) *
MIGRANTS						
Southern right whale	*Eubalaena australis*	NZ native & resident, threatened	Nationally Endangered	Least Concern	Seasonal Migrant	Collision with a dredging vessel (Best *et al*. 2001), habitat avoidance, behavioural changes & masking
Humpback whale	*Megaptera novaeangliae*	NZ native, evaluated,	Migrant	Endangered	Seasonal Migrant	Movement away from habitat (Borggaard *et al*. 1999), noise pollution, habitat degradation, behavioural alterations, masking of conspecifics at close range (< 1 km), alterations to migration routes & avoidance (Lammers *et al*. 2001)
False killer whale	*Pseudorca crassidens*	NZ native & resident, evaluated	Not threatened	Data Deficient	Potential Offshore Migrant	Increased shipping traffic, habitat destruction & changes to prey availability
VISITORS						
Sperm whale	*Physeter macrocephalus*	NZ native	Not threatened	Vulnerable	Potential Offshore Visitor	Increased shipping traffic, changes to cephalopod availability or distribution
Pygmy sperm whale	*Kogia breviceps*	NZ native & resident, not evaluated	Data Deficient	Data Deficient	Potential Offshore Visitor	Changes to cephalopod availability or distribution & increased shipping traffic
Blue whale	*Balaenoptera musculus* (spp. *brevicauda & intermedia)*	NZ native	Migrant	Critically Endangered to Data Deficient	Infrequent to Rare Visitor	Increased shipping, behavioural alterations & masking

* Proposed effects by Todd *et al.* (2015) are largely dependent on the location, the scale and context of the project (*e.g.* equipment used, duration, spoil volumes).

Several of the species highlighted in Figure 1 and Table 1 are known to be year-round or seasonal residents of the coastal regions surrounding Whangarei Harbour and Bream Bay region. The more common species occurring along the Whangarei coastline, and therefore most likely to be affected by the proposed project, include bottlenose dolphins (*Tursiops truncatus*), orca (*Orcinus orca*), Bryde's whale (*Balaenoptera edeni)* and common dolphins (*Delphinus delphis*). A short summary of these and other relevant species is given below with more detailed information on their abundance, distribution and life-history characteristics provided in Appendix 1.

Residents include an inshore population of bottlenose dolphins known to range between Doubtless Bay to the north and Tauranga to the south (Constantine 2002). This Northland population shows varying degrees of site fidelity along this region, with consistent seasonal movements from deeper offshore waters in the summer to shallower inshore waters over winter throughout (*e.g.* Hartel *et al.* 2014; Dwyer *et al*. 2014). It is important to note that the number of individuals visiting the BOI is decreasing (Tezanos-Pinto *et al.* 2013). The decline may be due to high calf-mortality (Tezanos-Pinto *et al.* 2014) and / or simultaneous emigration to other areas within this region (Dwyer *et al.* 2014). This decline supports their current up-listing to *nationally endangered* by the New Zealand Threat Classification System (Baker *et al.* 2010) and makes them potentially more vulnerable to disturbance or changes within their distribution range.

Orca, belonging to a small regional North Island sub-population, are frequently sighted along the coastline between the BOI and Hauraki Gulf (Visser 2000). As frequent transients through Whangarei waters (Figure 1), they can be observed year-round but are more common in these waters during late winter and early spring where they may be targeting torpedo rays for food (Visser 2000, 2007, pers. comm. 11 March 2015.). Visser (2007) suggests that the tendency by orca to forage in and around enclosed harbours makes this species more susceptible to harbour developments. Orca are currently listed as *nationally critical* by the New Zealand Threat Classification System (Baker *et al.* 2010) based on low abundance.

Less information is known about the Bryde's whale populations in the proposal area compared to other nearby regions. Bryde's whales regularly frequent Whangarei waters (Figure 1), perhaps as they travel between BOI and the Hauraki Gulf hotspots. A small, residential population of whales is found year-round within the Hauraki Gulf region (Wiseman 2008; Wiseman *et al*. 2011). Here, their natural tendency to remain just below the surface of the water most of the time (91%) and their spatial overlap with the main shipping channels of Auckland makes them highly vulnerable to ship strikes (Constantine *et al.* 2015). This species is listed as *nationally critical* in New Zealand waters (Baker *et al.* 2010) due to low abundance and the high proportion of mortalities due to ship strikes (Constantine *et al.* 2015).

Several localised populations of common dolphins are also found year-round in the coastal waters off the BOI to Hauraki Gulf, being more prevalent within inshore waters over winter and spring months (Constantine & Baker 1997, Stockin *et al*. 2008a). This species feeds on surface fish, such as schooling pilchards and yellow-eyed mullet, but also more pelagic fish species over continental shelf regions (*e.g.* Constantine & Baker 1997, Neumann & Orams 2005). Little is known about their actual population sizes and movements between these locations, however the Hauraki Gulf region may be an important calving and / or nursing area (Stockin *et al.* 2008a; Dwyer 2014).

With established breeding colonies and several regular haul-out sites, New Zealand fur seals are considered year-round residents within Bay of Plenty and Coromandel Peninsula waters. More frequent sightings of fur seals are now reported within Hauraki Gulf waters as well as the occasional visiting seal within the Whangarei region as this species appears to be expanding northward. Fur seals are considered non-migratory, but are known to easily and repeatedly cover large distances to find food. Some adults will travel out to open waters over winter while younger animals focus over shallower continental shelf waters. The departure of pups from colonies around late winter / spring months may be one explanation for recent sightings of fur seals off Whangarei over July 2015 (J Chetham, pers. comm. 23 July 2015).

Several baleen whale species migrate through Northland waters from early winter (May) to the late spring months (November). Most whale species begin their northern migrations in late autumn or winter; humpbacks travel from May to August and southern right whales from July to September. Southern right whales can be observed with newborn calves from August onwards, particularly around the Northland region (Carroll *et al.* 2014), and may remain in any one area for up to four weeks (Patenaude 2003). The south-bound migration of humpback whales with their newborn calves begins in late September, passing through Northland waters until late November / December. Less is known about the timing of blue whale migrations past New Zealand, although most sightings are observed from late winter to early summer. Of these species, only southern right whales are considered *nationally endangered* by the New Zealand Threat Classification System (Baker *et al.* 2010), as their preference for shallow, protected bays and coastal waters (particularly for calving) overlaps with numerous anthropogenic activities in New Zealand's waters.

Potential offshore residents, migrants and visitors to Northland waters include pilot whales, several species of beaked whales, false killer whales, sperm whales and pygmy sperm whales (DOC databases; Baker 2001; Zaeschmar *et al.* 2014; Brabyn 1990). Despite little sighting data, the strong prevalence of whale strandings from late spring to autumn suggests a general inshore movement within Northland waters for several of these species (particularly pilot whales) over summer months. It is important to note that some deep-water species are now thought to be more acoustically sensitive than other, more inshore marine mammal species (Cox *et al*. 2006).

When considering potential implications of coastal developments on local marine mammal population, the importance of Whangarei waters needs to be placed in the context of the species' regional and New Zealand-wide distribution (see Appendix 1). The North Island's northeastern coastline represents the largest known groupings of common dolphins, pygmy sperm whales, several beaked whale species and false killer whales, while potentially supporting isolated sub-populations of bottlenose dolphins, orca and Bryde's whale. Coastal species appear to take advantage of more protected, inshore waters during the cooler winter months, while offshore species are observed migrating into inshore waters over the warmer summer months.

Based on the available data and in reference to the New Zealand Coastal Policy Statement (*i.e*. Objective 1 and Policy 11), Whangarei Harbour and nearby Bream Bay waters are currently not considered to be ecologically significant in terms of feeding, resting or breeding habitats for marine mammals relative to other regions along the northeastern coastline. Instead, Whangarei Harbour and Bream Bay coastal waters represent a small fraction of similar habitats available to support those marine mammal species utilising this larger coastal region.

4. REVIEW SUMMARY

The purpose of this Phase 1 review was to enable the existing environment to be better understood. This in turn, enables the potential effects associated with dredging and disposal operations on marine mammals to be assessed in the context of the proposal in Phase 2 of this project. The dredging impacts regarded by Todd *et al.* (2015) as most plausible for marine mammals include:

- short-term avoidance of habitats due to dredge presence and / or underwater noise disturbance
- short-term changes in behaviour due to dredge presence and / or underwater noise disturbance
- potential auditory masking
- possible small-scale changes in prey availability.

Additional background information is currently being gathered by other Phase 1 studies (listed below) to help further determine which of the discussed effects are most relevant to this particular proposal, in order for appropriate mitigation / avoidance measures to be designed and implemented. This includes:

- underwater noise characteristics and levels within Whangarei Harbour; including sound recordings from the oil tankers referred to in the project proposal
- contaminant(s) presence and any detectable concentrations in dredging materials
- expected effects on benthic, fish and ecological systems
- modelled and predicted turbidity plume dynamics.

The marine mammals most likely to be affected by the proposed project include those species that frequent the Whangarei Harbour and Bream Bay regions year-round or on a semi-regular basis (see Table 1). Other species of concern include those that are more vulnerable to anthropogenic impacts due to various life-history dynamics (*e.g.* low population numbers) or species-specific sensitivities (*e.g.* underwater noise). Given the reference to whales in their name for the harbour, Tangata Whenua o Whangarei Te Rerenga Paraoa are also concerned about the continued presence of these species in the region. Table 2 summarises these species and any associated concerns.

Despite the lack of data specific to the Whangarei Harbour and Bream Bay region for some species discussed in this review, no systematic marine mammal surveys are recommended. Even with a high level of long-term effort, it would be highly unlikely that any statistical conclusion could be reached in terms of an impact's effect due to the highly variable nature of these species, their population dynamics and low sample sizes.

Table 2. Marine mammal species that may be affected by the proposal and areas of concern.

Species	Resident or semi-resident	Conservation concern	Acoustically sensitive	Tangata whenua concern
Bottlenose dolphin	✓	✓		✓
Orca	✓	✓	✓	✓
Bryde's whale	✓	✓	✓	✓
Common dolphin	✓			✓
NZ fur seal				✓
Pilot whale			✓	✓
Beaked whale			✓	✓
Southern right whale		✓	✓	✓
Humpback whale			✓	✓
Sperm whale			✓	✓
Pygmy sperm whale			✓	✓

Instead, a monitoring programme for marine mammals is recommended that would involve opportunistic visual sightings combined with simultaneous passive underwater acoustic monitoring. Opportunistic sightings could be recorded by any vessels already collecting information for the project in the vicinity of the proposal and other nearby regions (*i.e.* benthic sampling in channel and proposed spoil disposal areas). Any regular users of the Whangarei Harbour entrance (*i.e.* tug boats) would also be encouraged to record and report opportunistic marine mammal sightings.

Passive acoustic recorders (*i.e.* C-Pods or other moored underwater acoustic recorders) automatically record the detection of any designated frequencies that are likely to be from marine mammals within a few hundred metres of the device. Acoustic recorders are limited in range and cannot assess if marine mammals are present but not echo-locating and / or vocalising. However, the advantage of a series of acoustic stations placed around the proposal area would be that they would 'listen' for the presence of any marine mammals both day and night and when sea conditions are not favourable for visual sightings.

Visual sightings, in conjunction with acoustic detections, should be collected within the proposal area prior to and during dredging and disposal activities and for a period after all operations have ceased. While this monitoring information will lack some statistical robustness, it will help confirm which species might be expected within the vicinity of proposed works, their potential seasonality and relative frequency, as well as monitor for the species' continued presence both during and after activities have ceased. The results of the other Phase 1 reports, along with the findings of this review and any monitoring data, will be used in the subsequent Phase 2 report assessing potential dredging effects on marine mammals and any possible mitigation options for this proposal.

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6. APPENDICES

Appendix 1 Marine mammals in Whangarei Harbour

A1. 1 Bottlenose Dolphins (*Tursiops truncatus*)

A1.1.1. 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 2; Tezanos-Pinto *et al*. 2008). 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 (BOI): Hartel *et al*. 2014; Great Barrier Island (GBI): 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*. BOI: Hartel *et al.* 2014; GBI: 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 BOI 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 several stranding records of bottlenose dolphins from in and around Whangarei Harbour and Bream Bay (Figure 1; DOC stranding database). Recent (1990 onwards) strandings in close vicinity of the proposed area include individual strandings on Marsden Point, Waipu Spit and inside Whangarei Harbour (One Tree Point). The DOC sighting database also shows six recent sightings of bottlenose dolphin of group size between 3 and 21, off the Bream Head area (Figure 1). The sightings were predominantly observed during summer months.

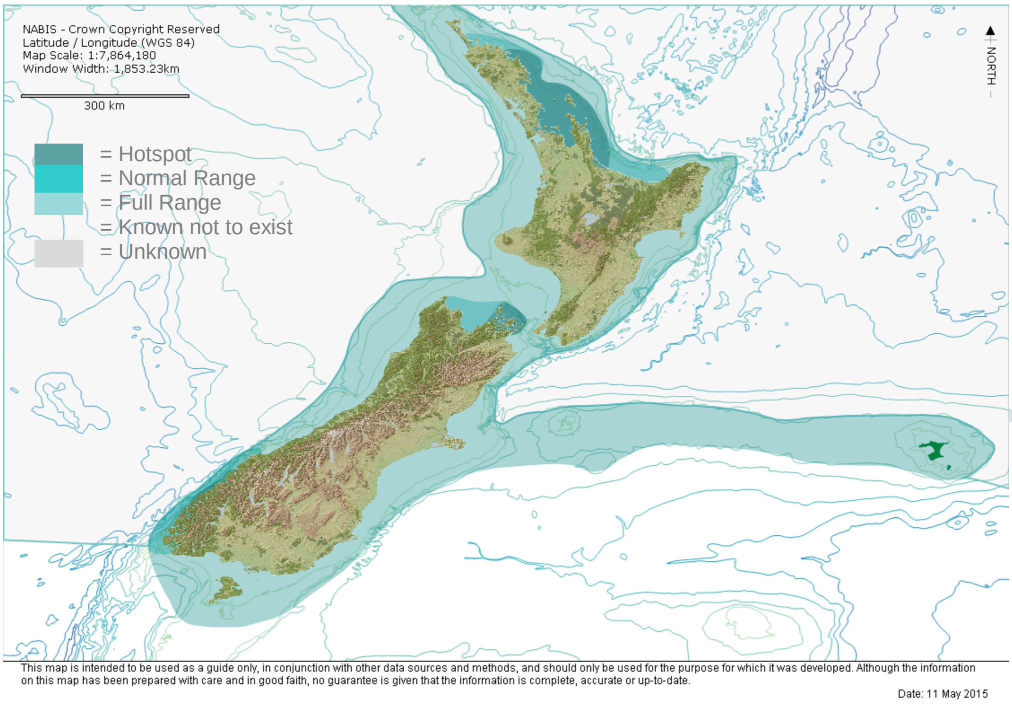

Figure 2. The general distribution pattern of bottlenose dolphins in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed May 2015).

A1.1.2. 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 & 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*).

A1.1.3. Conservation status

In New Zealand, bottlenose dolphins are classified as *nationally endangered* (Baker *et al*. 2010), 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 BOI, 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).

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 Whangarei 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 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. In addition, the subsequent increase in shipping traffic can also be considered a possible effect of channel dredging/deepening.

A1. 2 Common Dolphins (*Delphinus delphis*)

A1.2.1. Distribution and abundance

While this species is 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 (Figure 3). They are particularly prevalent off the east coast of the North Island (Gaskin 1968) from the Bay of Islands (Constantine & Baker 1997), the Hauraki Gulf (Stockin *et al*. 2008a) and the southern portion of the Bay of Plenty (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 1968).

Common dolphins are present in New Zealand coastal waters year-round, but localised populations in the Bay of Plenty 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).

Sightings of common dolphins in the DOC database show they frequent the stretch of water from GBI and Hauraki Gulf region and past Bream Head (Figure 1). In close vicinity of the study area, common dolphins have been sighted in medium to large groups (20–100 individuals; DOC sighting database). There are no sightings recorded in this database in depths less than 30 m within Whangarei Harbour or Bream Bay proper. However, there are 30 recent strandings, 16 of which occurred along the Bream Bay stretch of beach, one at Peach Cove, and 13 in Whangarei Harbour (predominantly at Parua Bay and near Onerahi—Figure 1; DOC stranding database).

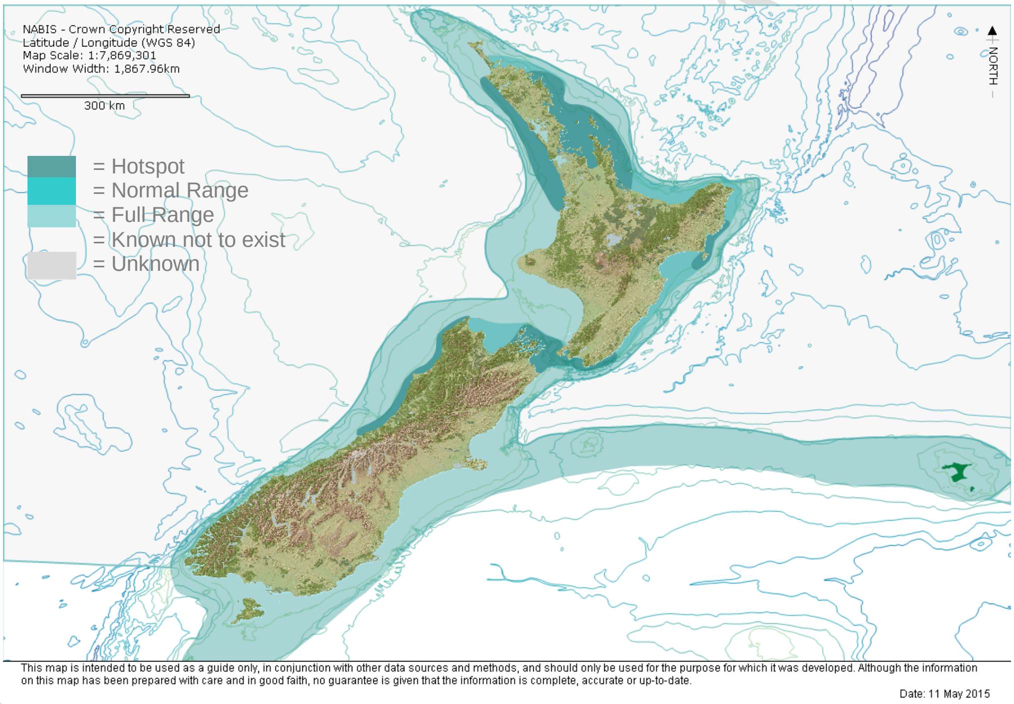

Figure 3. The general distribution pattern of common dolphins in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed May 2015).

A1.2.2. 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*).

A1.2.3. Conservation status

According to the current New Zealand Threat Classification System, common dolphins are considered *not threatened* (Baker *et al*. 2010) 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 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.

A1. 3 Orca (Orcinus orca)

A1.3.1. 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 less than 200 (95% CI=71–167) individuals (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 4). There appears to be little to no mixing between the North Island 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 sub-populations (Figure 4; 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*. 2014; Visser 2000, 2007). Orca have been reported to regularly frequent the Whangarei Harbour (Visser 2007), and two sightings exist in the DOC database in Bream Bay and Whangarei Harbour. Strandings, while fairly infrequent, reflect a similar trend (Figure 1). 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.

A1.3.2. Life-history dynamics

Orcas 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, orcas most commonly forage on rays (Visser 1999a), which may account for their tendency to frequent fairly shallow waters (Hupman *et al*. 2014). 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). It has been suggested that the benthic region around the Whangarei Harbour entrance is a location where the orca specifically feed on New Zealand torpedo rays (*Torpedo fairchildi*; I Visser; pers. comm.).

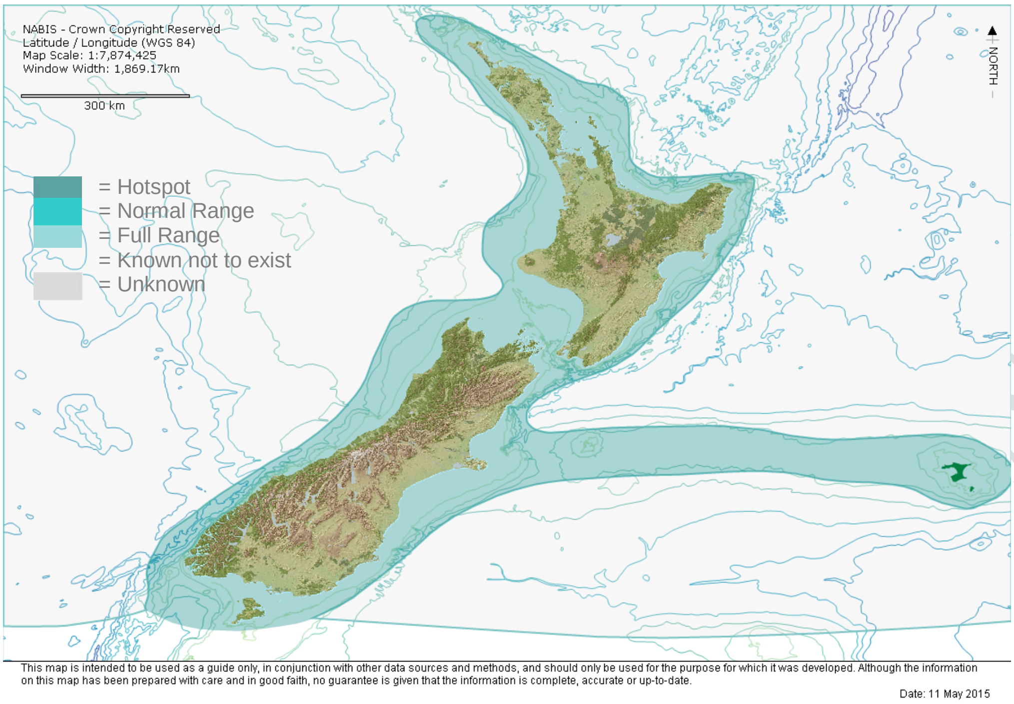

Figure 4. The general distribution pattern of orca in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed May 2015).

A1.3.3. 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* 2010).

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 any alterations in prey availability, possible habitat avoidance and / or behaviour alterations, increased boat traffic and underwater sound masking (noise pollution).

A1. 4 Bryde's Whale (Balaenoptera edeni)

A1.4.1. 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 5; Gaskin 1968). Baker & 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 159 whales (95% CI = 97–33) is known to occur in the Hauraki Gulf (Wiseman 2008). This population is found year-round within 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; 14 sightings were made (since 2000) in the Parry Channel area alone (Figure 1). However, the database reports only two strandings of this species within Whangarei Harbour and the Bream Bay region.

A1.4.2. 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 and only occasionally on krill (*e.g*. euphasusiids; Baker & Madon 2007; Wiseman *et al.* 2011) as its baleen is not as fine as other whales (Baker 1999).

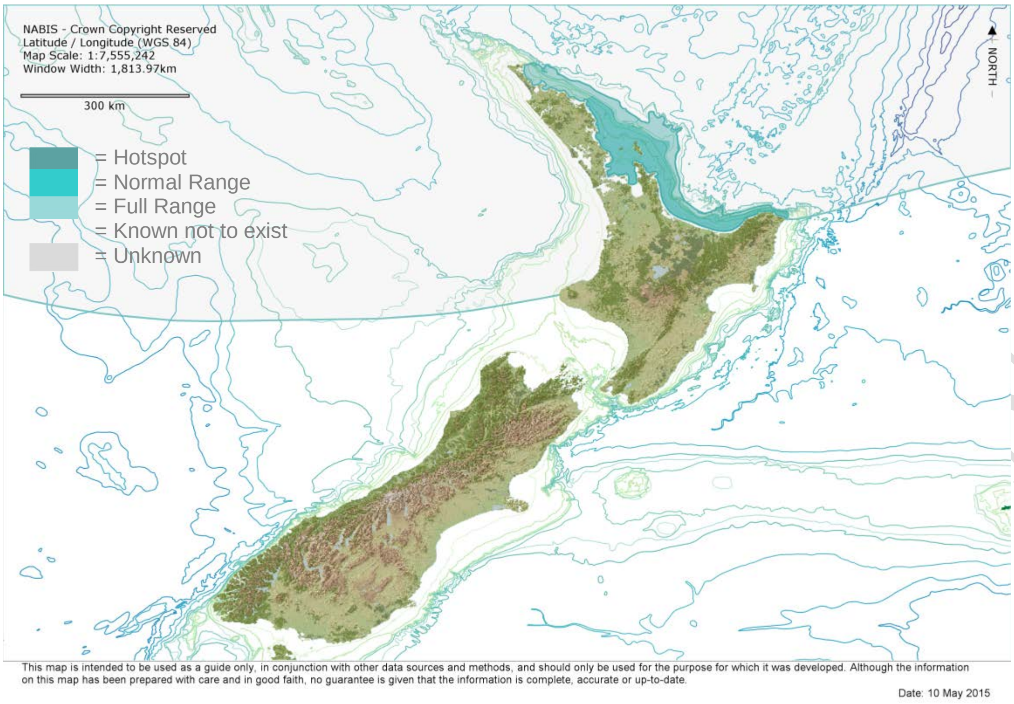

Figure 5. The general distribution pattern of Bryde's whales in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed May 2015).

A1.4.3. Conservation status

Bryde's whale is listed as *data deficient* worldwide (Reilly *et al.* 2008a). 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*. 2010). This listing is based on the small number of whales using the Hauraki Gulf, New Zealand's largest and busiest port, as a potential feeding and breeding ground (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 surface waters where they are vulnerable (Behrens & Constantine 2008; 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.

A1. 5 New Zealand fur seals (*Arctocephalus forsteri*)

A1.5.1. Distribution and abundance

New Zealand fur seals are found around New Zealand as well as western and southern Australia and several of the sub-Antarctic islands (Figure 6). 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 (BOI). The most recent stranding was reported in Mangawhai Beach in 2012 (DOC database; Figure 1).

A1.5.2. 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).

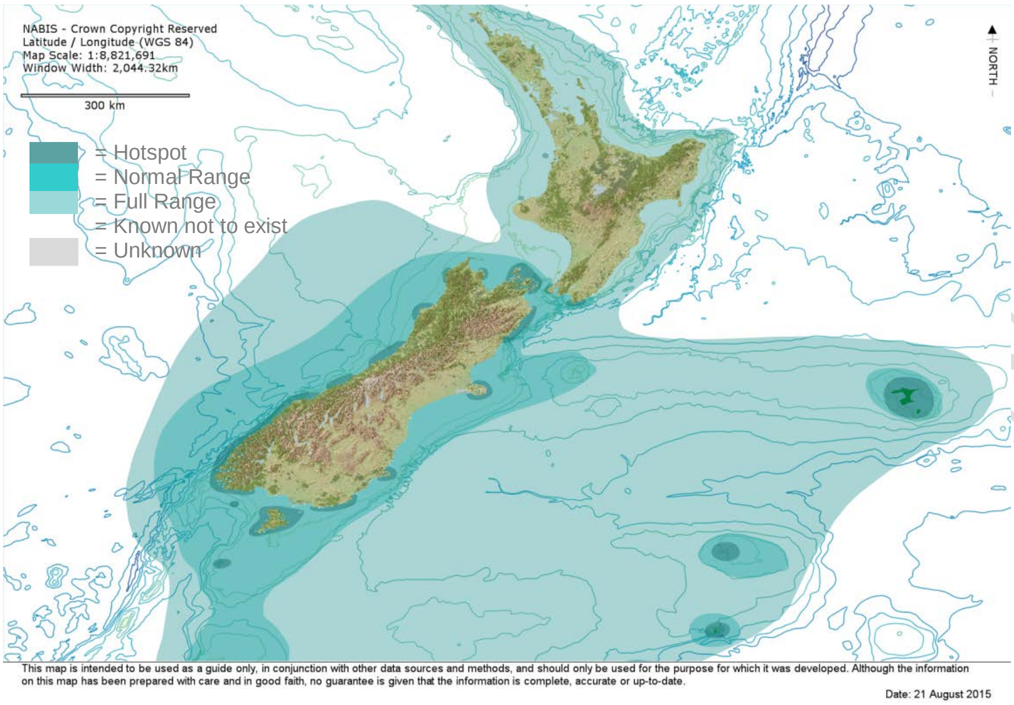

Figure 6. The general distribution pattern of New Zealand fur seals in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed August 2015).

A1.5.3. 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*. 2010). Current threats at sea include entanglement in trawl fisheries, particularly squid, 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.

A1. 6 Pilot whales (*Globicephala* spp.)

A1.6.1. 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, the first record of the short-finned pilot whale (*G.*

macrorhynchus) was 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 trends (Carwardine 1995).

Despite regular sightings of pilot whales, little is known about their abundance or seasonal distribution patterns around New Zealand. Of the six opportunistic sightings reported in close vicinity of the study area, all were in summer (December and January), and all were of moderate group size (12–25 individuals). The sightings were in the northern part of Parry Channel (Figure 1).

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, BOP, and Hawke's Bay regions (Brabyn 1990). There have been 55 recent strandings (since 1990) of *Globicephala* spp. reported from Waikato to Northland. Mass strandings of pilot whales have also occurred in close vicinity to the proposed area with seven historic records in and around the Whangarei Harbour entrance between 1923 and 1982. 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).

A1.6.2. 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 comprised of 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).

A1.6.3. 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 actually of two or more different species. According to the New Zealand Threat Classification System, short-finned pilot whales are listed as *migrant* and the long-finned as *not threatened* (Baker *et al*. 2010).

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.

A1. 7 Beaked whales (Ziphiidae family)

A1.7.1. Distribution and abundance

The whales of the family Ziphiidae, collectively known as beaked whales, are among the least known of all marine mammals. They are rarely seen at sea, spending long periods underwater and are relatively inconspicuous at the surface (Carwardine 1995). The sightings that have been recorded suggest that beaked whales occur largely offshore and in deep waters, often associated near ocean trenches where they are thought to feed mainly on cephalopods (Baker 1999; Taylor *et al*. 2008b, 2008c, 2008d). Most sightings are of single animals and as such, most species are thought to travel alone or in small groups. Very little is known concerning the population status of the different beaked whale species.

Of the 21 known species, 12 have been sighted or found stranded around New Zealand (Table 3). In general, the North Island's east coast, Cook Strait and the Chatham Islands appear to be hotspots for beaked whale strandings (Brabyn 1990). Sixteen strandings of beaked whales have occurred near the proposed area and include three different species (*Mesoplodon bowdoini, M. grayi,* and *M. layardii;* Figure 1). *M. grayi* has stranded on ten separate occasions since 1990; near Marsden Point, Ruakaka Beach and inside the Whangarei Harbour. There are no live sightings of beaked whales in close vicinity of the proposed area, probably due to their offshore and deep-water water distribution.

A1.7.2. Species-specific information

Some beaked whale species are fairly cosmopolitan in their distribution and even abundant within their range, such as the Cuvier's beaked whale or southern bottlenose whale, hence their IUCN listing of *least concern*. With other species, too little is known to make any assumptions in regards to their possible distribution. However, it is believed that the Northland offshore waters may represent important habitats for at least three species of beaked whales.

Gray's beaked whale (*Mesoplodon grayi*)
Gray's beaked whale is New Zealand's most frequently stranded beaked whale (Brabyn 1990). It is also thought to be circumpolar below 30˚S (Taylor *et al.* 2008d). Approximately 188 stranding events, including several rare mass strandings of this species have occurred around New Zealand since 1873. In June 2001, a rare sighting of two whales occurred in Mahurangi Harbour near Warkworth over several days (Dalebout *et al*. 2004). Dalebout *et al*. (2004) suggests this species may concentrate in a 'hotspot' of water between the North / South islands and the Chatham Rise region based on additional offshore sightings.

Strap-toothed whale (*Mesoplodon layardii*)
This species is believed to be distributed throughout cold temperate waters of the Southern Hemisphere, mainly between 35° and 60°S (Taylor *et al*. 2008c). Being a deep water species, its diet consist almost entirely of oceanic squid. Most strandings occur between January and April, suggesting an inshore movement over the summer months (Baker 2001).

Andrew's beaked whale (*Mesoplodon bowdoini*)
Little can be discussed about the Andrew's beaked whale as there have been only 34 world-wide strandings, the majority occurring around New Zealand (Baker 2001). Taylor *et al.* (2008b) suggest New Zealand may represent an area of concentration for this poorly-known species.

A1.7.3. Conservation status

Beaked whale species are listed by the IUCN as *data deficient* to *least concern* by the IUCN and *data deficient* or *vagrant* by the New Zealand Threat Classification System (Baker *et al*. 2010). In general, beaked whales suffer from few anthropogenic threats, with the exception of some low level bycatch in fisheries, due to their deep water distribution. Recent evidence has suggested that beaked whales are extremely sensitive to high levels of anthropogenic sound, especially military sonar and seismic surveys (Cox *et al*. 2006). The use of active sonar during military trials and exercises has been correlated with a number of mass strandings of beaked whale species around the world (Taylor *et al*. 2008b, 2008c, 2008d). Todd *et al.* (2015) notes that dredging activity may lead to avoidance or changes in behavioural patterns (*i.e.* surfacing and feeding) or subsequent impacts due to increased shipping traffic.

Table 3. The species and status of beaked whale species found around New Zealand and the eastern North Island coastline.

Common name	Scientific name	Stranded in NZ	Stranded east NI	IUCN status	Status in Northland waters
Gray's beaked whale (Scamperdown whale)	*Mesoplodon grayi*	ü	ü	Data Deficient	Potential Offshore Resident
Strap-toothed whale	*Mesoplodon layardii*	ü	ü	Data Deficient	Potential Offshore Resident
Andrew's beaked whale	*Mesoplodon bowdoini*	ü	ü	Data Deficient	Regular to Frequent Visitor
Cuvier's beaked whale	*Ziphius cavirostris*	ü	ü	Least Concern	Regular to Frequent Visitor
Hector's beaked whale	*Mesoplodon hectori*	ü	ü	Data Deficient	Regular to Frequent Visitor
Southern bottlenose whale	*Hyperodon planifrons*	ü	ü	Least Concern	Infrequent Visitor
Arnoux's beaked whale	*Berardius arnuxii*	ü	ü	Data Deficient	Rare to Infrequent Visitor
Blainville's beaked whale	*Mesoplodon densirostris*	ü	ü	Data Deficient	Rare to Infrequent Visitor
Spade-toothed whale	*Mesoplodon traversii*	ü	ü	Data Deficient	Unknown
Ginkgo-toothed beaked whale	*Mesoplodon ginkgodens*	ü		Data Deficient	Unknown
Lesser beaked whale	*Mesoplodon peruvianusi*	ü		Data Deficient	Unknown
Shepherd's beaked whale	*Tasmacetus shepherdi*	ü		Data Deficient	Unknown

A1. 8 Southern Right Whale (*Eubalaena australis*)

A1.8.1. 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 (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 7). Three of these sightings occurred between Cavalli Islands (Bay of Islands), Tutukaka and Whangarei in 2003. As recently as 2008, two right whales were sighted within the Whangarei Harbour and along Bream Bay beaches. 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).

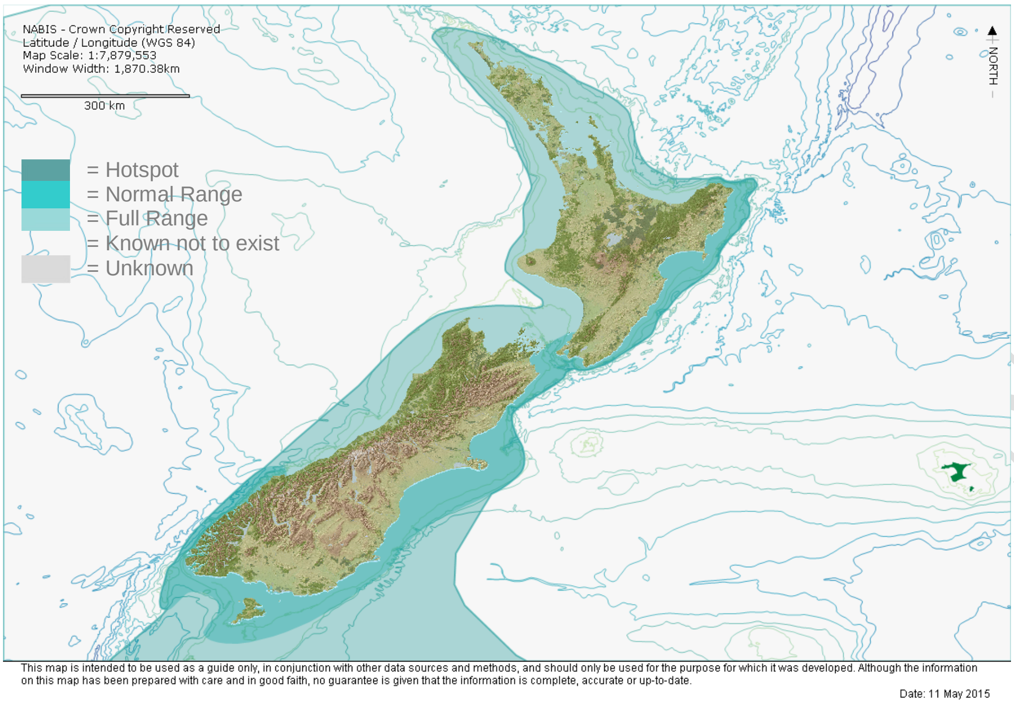

Figure 7. The general distribution pattern of southern right whales in New Zealand coastal waters based on New Zealand's National Aquatic Biodiversity Information System (NABIS) sighting database (modified from https://www.nabis.govt.nz/nabis_prd/map.jsp accessed May 2015).

A1.8.2. 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).

A1.8.3. 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 *nationally endangered* (Baker *et al*. 2010). Patenaude (2003) specifically points out

the importance of mainland coastal regions for right whales, particularly cow/calf pairs, within Northland waters.

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).

A1. 9 Humpback Whale (Megaptera novaeangliae)

A1.9.1. 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 number between 250–500 animals as only 157 sightings have been made between 1970 and 1999 (Dawson

1985; Gibbs & Childerhouse 2000). Recent and ongoing studies have noted an apparent increase in humpback numbers 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).

One humpback whale stranding has been reported on Mair Bank, near the Whangarei Harbour entrance (DOC stranding database; Figure 1). 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, Refining NZ staff pers. comm.).

A1.9.2. 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'

A1.9.3. 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 (Borggaard *et al.* 1999), noise pollution, habitat degradation, behavioural alterations, masking of conspecifics at close range (< 1 km), alterations to migration routes and avoidance (Lammers *et al.* 2001).

A1. 10 False Killer Whale (*Pseudorca crassidens*)

A1.10.1. Distribution and abundance

This completely black and slender toothed whale resembles a pilot and/or melon-headed whale and is one of the lesser known marine mammal species globally (Zaeschmar *et al.* 2014). It is thought that the distribution of false killer whales is predominantly oceanic (Baird *et al.* 2008), with some occasional shoreward migrations observed off northern Australia (Palmer *et al.* 2009). There are no global estimates of abundance for false killer whales, as there is evidence of both broad-scale and small-scale limits on gene flow, indicating additional sub-species or sub-population structure (Baird *et al*. 2008).

While New Zealand sits potentially at the edge of its distribution limits, several sightings and strandings of false killer whales have been recorded around mainly North Island waters. However, little is known about their general occurrence and distribution in New Zealand waters (Zaeschmar *et al.* 2013). A recent study compiled all records of false killer whale sightings from 1995–2012 along the northeastern coast of the North Island; specifically the Three Kings Islands, Poor Knights Islands, Hauraki Gulf and Bay of Plenty (Zaeschmar *et al.* 2014). The majority of these sightings occurred in shallow (< 100 m) nearshore waters, despite their previously documented open ocean tendencies (*e.g*. Baird *et al.* 2008). Occurrence in Northland's continental shelf waters is thought to be seasonal (December to May only) and associated with warmer shoreward currents (between 18–23 °C). Zaeschmar *et al.* (2014), noting that this seasonality in occurrence, combined with observed scarring on this species and other associated species, suggest a potential wider distribution range centered further offshore in warmer, more pelagic waters.

While most recorded sightings of this species have occurred near the Bay of Islands (Zaeschmar *et al.* 2014), approximately half of all the reported strandings (around 28) have occurred along the East Cape and Hawke's Bay coastlines to the south (Brabyn 1990; DOC stranding database). Stranding events are irregular at best, spanning from 1870 to 2005 and ranging from single animals to a few large mass strandings (> 200 animals).

A1.10.2. Life-history dynamics

This species is long-lived (*i.e*. 50-60 years old) and known to be particularly social occurring in large groups with long-term associations (> 15 years; Palmer *et al*. 2009).

Group sizes along northeastern waters have ranged from 20 to 150, with calves often observed (Zaeschmar *et al.* 2014; DOC database). These findings match reports from other regions in which average group sizes were 30, but several hundred animals have been sighted in active and very social groups (DOC database).

In New Zealand waters, this species is most often observed closely associated with large groups of bottlenose dolphins (Zaeschmar *et al.* 2014). The diet of false killer whales is based primarily on larger fish, such as tuna and hapuku, although they have been observed feeding on kahawai in New Zealand (Zaeschmar *et al.* 2013) and a variety of cephalopods overseas (Carwardine 1995). Despite often associating with other cetaceans while travelling and foraging, they have been seen eating other dolphins and even attacking baleen calves (Taylor *et al*. 2008e).

A1.10.3. Conservation status

The false killer whale is listed by the IUCN as *data deficient* (Taylor *et al*. 2008e) and within the New Zealand as *not threatened* (Baker *et al*. 2010). However, the long-term site fidelity of several individuals over numerous years to the northeastern region of the North Island as documented by Zaeschmar *et al.* (2014) suggests the possible existence of an offshore sub-population in this region.

The main threats to this species include incidental mortalities in several long-line and driftnet fisheries around the world, reduction in prey availability and hunted for meat by some smaller island nations, such as Indonesia and Taiwan (Taylor *et al*. 2008e, Reeves *et al*. 2009). Todd *et al*. (2015) suggest that this species may be sensitive to increased boat traffic and any habitat destruction or change in prey availability due to dredging activities.

A1. 11 Sperm whales (Physeter macrocephalus)

A1.11.1 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.* 2008f). 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 1).

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.

A1.11.2. 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 fairly unique 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).

A1.11.3. Conservation status

The sperm whale is listed by the IUCN as *vulnerable* (IUCN 2015), 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 a *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.

A1. 12 Pygmy sperm whales (*Kogia breviceps*)

A1.12.1. Distribution and abundance

This species is one of the smallest toothed whales with a square head, similar to a sperm whale, and robust body. The full range and abundance of the pygmy sperm whale is uncertain, as until 1966 it had not been distinguished from the dwarf sperm whale (*Kogia sima*). Most information has come from strandings as very few live sightings exist worldwide. This species appears to prefer deep, continental shelf waters within warm temperate, subtropical and tropical seas (Taylor *et al*. 2012). They are thought to be relatively inconspicuous at the surface as well as diving for long periods. As such, the lack of live sighting information may be due more to their subtle behaviour than actual rarity.

Pygmy sperm whales are the cetaceans that strand most frequently in New Zealand, suggesting that pygmy sperm whales are not uncommon in New Zealand waters. Brabyn (1990) recorded 147 stranding events in New Zealand waters between 1840 and 1989. Almost all of these strandings occurred around the North Island with the majority recorded along Hawke's Bay coasts (Brabyn 1990, DOC stranding database). Strandings occurred year-round but fewer were reported over late winter and early spring months (Brabyn 1990; DOC stranding database). Most strandings were of single, live animals with only a few small group strandings.

Only one recent stranding is reported in near vicinity of the proposed area, a single animal north of Bream Head (Kauri Mountain Beach) in 2003 (DOC stranding database). However, strandings of mostly single animals have also occurred further afield in Whangaparoa Bay, Omaha, Mimiwhangata Beach and Great Barrier Island (Figure 1). There were no live sightings in the database for these species between Cape Colville and the Bay of Islands.

A1.12.2. Life-history dynamics

Little is known about pygmy sperm whale group dynamics. Group sizes have ranged from a single animal to groups as large as 10 (Carwardine 1995). The diet of this species in northern New Zealand waters was found to be primarily cephalopods (23 different species) with some fish and crustaceans (Beatson 2007). The cephalopods found in *Kogia* stomachs were exclusively oceanic and mesopelagic, mostly juvenile and known to undergo vertical migration. Up to 77 different prey

species were also found in the stomach of a pygmy sperm whale off South Africa, suggesting *Kogia* are perhaps more opportunistic feeders (Plön *et al*. 1999).

A1.12.3. Conservation status

Pygmy sperm whales are listed as *data deficient* by both the IUCN (Taylor *et al*. 2012) and New Zealand Threat Classification System (Baker *et al*. 2010). In terms of the New Zealand system, this particular classification recognises that this species may be a resident, and as such has not been sufficiently evaluated due to lack of information.

Threats to this species are unknown but are potentially thought to include an indirect impact from any localised depletion of deep-sea squid species, due to their dietary reliance and low level bycatch. Beaston (2007) noted that the intensive scampi fishery off Hawke's Bay has the potential to affect local *Kogia* in both ways, and even more so if the area proves to be a nursery ground for calves. Like most beaked whales, this deep water species is also thought to be acoustically sensitive to loud anthropogenic sounds; such as navy sonar or seismic exploration (Taylor *et al*. 2012). Todd *et al* (2015) also noted dredging had the potential to adversely affect this species if such activities impacted or changed cephalopod availability/distribution and/or increased shipping traffic.

A1. 13 Blue whales (*Balaenoptera musculus* spp *intermedia/brevicauda*)

A1.13.1. Distribution and abundance

Despite being the largest mammal, little is known about blue whales, particularly in the southern Pacific waters. It has been estimated that only 2% of the pre-whaling population exists currently (Reilly *et al*. 2008b). There are currently two recognised sub-species in the Southern Hemisphere—the Antarctic form (*Balaenoptera musculus* ssp *intermedia*) and the pygmy blue whale (*B. musculus* ssp *brevicauda;* Reilly *et al*. 2008b). The Antarctic form, thought to be the more abundant prior to whaling, spends most of the summer feeding in Antarctic waters. Their winter distributions are still unknown. The pygmy blue whale prefers warmer waters found mainly north of 55˚S year-round. They are patchy in their distribution but a fairly continuous population is thought to exist from Indonesia to Tasmania (around Western Australia; Reilly *et al*. 2008b).

Blue whale sightings within New Zealand waters are infrequent but less rare in more recent years. Between 2000 and 2007, at least five blue whales were sighted near BOI waters between August and November (Figure 1). However, only three stranding of blue whales has been reported along Northland waters, at Orewa and Taurikura (Whangarei Harbour) since 1925.

A1.13.2. Conservation status

Little is known about the current status of blue whale populations. According to the IUCN, these species are listed as *endangered* on the basis of a reduction in the population of at least 50% over the last three generations (Reilly *et al*. 2008b). Both sub-species are listed as *migrants* within New Zealand waters (Baker *et al*. 2010).

It should be noted that although the International Whaling Commission (IWC) agreed a moratorium on commercial whaling in 1982, hunting of some rorqual whales still continues and includes those that migrate through New Zealand waters. In addition to whaling, rorqual whales are also susceptible to vessel collisions and entanglement in fishing gear. Sei and blue whales are perhaps the exceptions as their more offshore distribution appears to prevent most human-related risks / threats. Climate change and its reduction in the extent of Antarctic sea ice will possibly have the greatest impact on rorqual species in the future.