Department of Conservation
Te Papa Atawhai

Fisheries New Zealand
Tini a Tangaroa

Protecting Hector's and Māui Dolphins

Supporting Information and Rationale

New Zealand Government

Note: this document was updated on 17 June 2019 at 12.30pm. The changes were as follows:

- Amendments to the table on page 53 to clarify options relating to Pegasus Bay (east coast South Island).
- Changes for clarification to wording on page 16, bullet point two.

If you downloaded an earlier version, please refer to this document.

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This publication is also available on the Ministry for Primary Industries website at www.fisheries.govt.nz/dolphintmp

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Contents

Page

1 About this document

The purpose of this document is to provide supporting technical information and analysis for the consultation document: *Protecting Hector's and Māui Dolphins*.

Further information is provided in appendices to this document, and in supporting science documents available at the following link: https://www.fisheries.govt.nz/dolphintmp

2 Treaty of Waitangi

Māori have interests in both the protection of Hector's and Māui dolphins and the management of, and involvement in, activities that are discussed within this document. Ensuring partnership and delivery of commitments and obligations is important across all these aspects.

The responsibilities of the Department of Conservation (DOC) are discussed in Section 3. The obligations of Fisheries New Zealand under the Fisheries Act 1996 are discussed in Section 6 of this document.

The Department of Conservation has important responsibilities in terms of:

- Section 4 of the Conservation Act 1987;
- the Marine and Coastal Area (Takutai Moana) Act 2011;
- Treaty settlements;
- relationships with whānau, hapū and iwi.

These responsibilities require early and ongoing engagement with whānau, hapū and iwi, and their involvement in the decision-making process for those parts of the Hector's and Māui Dolphin Threat Management Plan (TMP) the Department of Conservation is leading. This engagement began in the early stages of the TMP review including:

- Direct involvement by some iwi representatives in the development of the risk assessment and vision and goals. This process involved several workshops and related communication spanning from November 2017 to March 2019.
- Hui with iwi and hapū from Northland to Taranaki, and representatives from iwi fisheries forums for the South Island (Te Tau Ihu and Ngāi Tahu agreed to work together on this kaupapa) between May and November 2018.

DOC and Fisheries New Zealand's ongoing engagement with whānau, hapū and iwi is happening alongside the wider public consultation process for the TMP. This supporting information and rationale document contributes to that ongoing engagement.

2.1 PRINCIPLES OF THE TREATY OF WAITANGI

Section 4 of the Conservation Act 1987 requires DOC to give effect to the principles of the Treaty of Waitangi, and DOC's primary relationships are with the Crown's Treaty partners. Therefore, DOC will achieve healthy partnerships with Māori and meet the Crown's obligations to Māori under the Conservation Act by applying Treaty principles in its work.

The Treaty principles that are most relevant to the conservation of Hector's and Māui dolphins are:

Partnership – mutual good faith and reasonableness
The Crown and Māori must act towards each other reasonably and in good faith. These mutual duties are the core of what has been described as the Treaty partnership.

Informed decision-making
Both the Crown and Māori need to be well informed of other other's interests and views. When exercising the right to govern, Crown decision-makers need to be fully informed, while for Māori, full information needs to be provided in order to contribute to the decision-making process. This is connected closely to the principles of good faith and active protection. Consultation is a means to achieve informed decision-making.

Active protection
The Crown must actively protect Māori interests retained under the Treaty as part of the promises made in the Treaty for the right to govern. This includes the promise to protect tino rangatiratanga and taonga. Active protection requires informed decision-making and judgement as to what is reasonable in the circumstances.

Redress and reconciliation
The Treaty relationship should include processes to address differences of view between the Crown and Māori. The Crown must preserve the capacity to provide redress for proven grievances from not upholding the promises made in the Treaty. Māori and the Crown should demonstrate reconciliation as grievances are addressed.

2.2 MARINE AND COASTAL AREA (TAKUTAI MOANA) ACT 2011

Under the Marine and Coastal Area (Takutai Moana) Act 2011, any iwi, hapū or whānau who consider they exercise kaitiakitanga in a part of the common marine and coastal area affected by the proposals in this document have a right to participate in the process and provide their views on the proposals. The Minister must have particular regard to the views of affected iwi, hapū or whānau in considering the proposals.

In the event of a dispute as to whether, or which iwi, hapū or whānau are affected by the proposals, the Director-General must seek and may rely on evidence that in his opinion is of sufficient authority to resolve whether or which iwi, hapū or whānau is affected.

Iwi, hapū or whānau who consider they exercise kaitiakitanga in a part of the common marine and coastal area affected by the proposals may advise the Director-General at this email address: marine@doc.govt.nz. Further information about the proposal is available on the DOC website (www.doc.govt.nz/dolphintmp). Views by any iwi, hapū or whānau who may be affected must be provided by 5 pm on 4 August.

Additionally, iwi, hapū and whānau have applied for recognition of a customary interest in part of the common marine and coastal area affected by the proposals in this document under the Marine and Coastal Area (Takutai Moana) Act. The Department of Conservation has a process for engaging with all groups that have sought recognition of a customary interest.

2.3 TREATY SETTLEMENTS

DOC and Fisheries New Zealand have commitments in Treaty of Waitangi settlements, particularly through protocols and relationship agreements, which require engagement early on the matter for consultation; ensure sufficient information and time is provided to enable effective participation; to engage with an open mind; and to report back on the outcome.

In addition, many Treaty settlements between iwi and the Crown recognise the cultural significance of marine mammals, including Hector's and Māui dolphins. DOC and Fisheries New Zealand have processes for engaging with affected iwi.

2.4 **EMBEDDING MĀTAURANGA MĀORI IN THE THREAT** MANAGEMENT PLAN

2.4.1 Acknowledging whakapapa and including mātauranga Māori in management

Tangata whenua have extensive knowledge of the life cycle, role and distribution of the dolphin populations in the marine ecosystem, and the impacts of perturbation of the ecosystems on populations. In addition many Māori consider all the elements of the ecosystem are related through whakapapa. Collectively this approach underpins mātauranga Māori (Māori knowledge and world view). Mātauranga Māori in respect of the dolphin populations and associated ecosystems has been developed over hundreds of years of interactions with the populations and associated ecosystems and forms a significant information base and management approach to mitigating threats to the affected dolphin populations.

The legislative base for many actions in the TMP require decision makers to use best available knowledge when making decisions. Best available knowledge should include mātauranga Māori. Progress has been made on these elements for the management of Māui and Hector's dolphins but there are still significant opportunities to partner and work more closely with tangata whenua through the development and implementation of the TMP.

2.4.2 Working alongside tangata whenua

Māui and Hector's dolphins are a taonga species to Māori. Māori have several names for the dolphins: Tutumairekurai, Aihe, Papakanua, Upokohue, Tukuperu, Tūpoupou and Hopuhopu are some.

The Principles of the Treaty require the Crown to act in good faith, provide for input of tangata whenua into the development of policies and programmes that affect their interests, act with an open mind, make informed decisions and protect Māori rights and interests. In addition, within the range of the dolphin populations affected by the TMP, the Crown has entered into Treaty settlements which specify which representatives of tangata whenua the Crown should engage with and how engagement should

proceed. The Treaty agreements are legally binding on both parties while in effect. To give effect to these agreements Iwi and the Crown have established a number of Forums across most of the range of threatened dolphin populations.

In addition the Government has recently provided guidance on the optimal approach to engagement with tangata whenua when Māori rights and interests are affected.

In total the agreements and principles of the Treaty are likely to require involvement of tangata whenua early in the process to identify areas of threat to the dolphin population, possible mitigation options, effects on Māori rights and interests, and proposed solutions.

The TMP will work with representatives of tangata whenua to establish and maintain effective input of tangata whenua into the management of threatened dolphin populations consistent with the Principles of the Treaty of Waitangi and Treaty settlement agreements with relevant iwi, and to recognise the value of Mātauranga Māori in management of threats.

3 Roles and responsibilities

3.1 CONSERVATION LEGISLATION

DOC is the leading central government agency responsible for the conservation of New Zealand's natural and historic heritage under the Conservation Act 1987. DOC may advocate for the protection of Hector's and Māui dolphins through statutory processes, for example, under the Resource Management Act 1991 (RMA) and the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act), or by encouraging protection through non-regulatory means.

DOC is responsible for administering the Marine Mammals Protection Act (1978) (MMP Act) and the Marine Mammals Protection Regulations 1992 (MMPR) in accordance with the Conservation General Policy and conservation management strategies.

The general purpose of the MMP Act (as set out in the long title of the Act) is "*to make provision for the protection, conservation, and management of marine mammals within New Zealand and within New Zealand fisheries waters.*"

The purpose of the MMPR "*is to make provision for the protection, conservation, and management of marine mammals and, in particular, —*
(a) *to regulate human contact or behaviour with marine mammals either by commercial operators or other persons, in order to prevent adverse effects on and interference with marine mammals:*
(b) to prescribe appropriate behaviour by commercial operators and other persons seeking to come into contact with marine mammals."

Under Section 22 of the MMP Act, the Minister of Conservation has the power to "*define any place and declare it to be a marine mammal sanctuary*" (a sanctuary). The consent of Ministers with control of any Crown-owned land, foreshore, seabed or waters of the sea declared to be a sanctuary is also required. When defining and declaring a sanctuary, the Minister of Conservation may specify activities that may or may not occur within the sanctuary. These provisions have been used previously to:

- Prohibit recreational and commercial set-netting in the West Coast North Island Marine Mammal Sanctuary between two and seven nautical miles offshore from Pariokariwa Point to the Waiwhakaiho River.
- Prohibit seabed mining out to two nautical miles along the full length of the West Coast North Island Marine Mammal Sanctuary, and out to four nautical miles from south of Raglan Harbour to north of Manukau Harbour.
- Restrict seismic surveying in marine mammal sanctuaries created to protect Hector's dolphins.

The Minister of Conservation also has the power to approve a population management plan for a threatened species, including marine mammals that are listed as threatened. Population management plans provides a mechanism for addressing fishing-related threats. However, under the current legislation a population management plan for Hector's and Māui dolphins cannot be established due to the unrealistic population recovery rates prescribed by the MMP Act[1]. Therefore, a threat management plan approach has been taken to achieve protection of the dolphins.

3.2 CONSERVATION GENERAL POLICY AND CONSERVATION MANAGEMENT STRATEGIES

Decision-making under the MMP Act and MMPR is directed by the Conservation General Policy and conservation management strategies. The following policies from the Conservation General Policy apply to the TMP:

- Marine protected species should be managed for their long-term viability and recovery throughout their natural range.
- Human interactions with marine mammals and other marine protected species should be managed to avoid or minimise adverse effects on populations and individuals.
- The Department [DOC] should work with other agencies and interests to protect marine species.

[1] The MMP Act requires a maximum allowable level of fishing-related mortality to be set, which allows recovery of the species to non-threatened status within 20 years, which is not biologically feasible for Hector's and Māui dolphins.

- The Department [DOC] should undertake statutory advocacy to protect natural resources, in particular where –
  - significant marine habitats and ecosystems are threatened with loss or decline; or
  - activities taking place or proposed in places linked to public conservation lands and waters could have adverse effects on them; or
  - proposed activities are likely to cause further loss, degradation or fragmentation of significant places.

The proposed vision, goals and objectives of the Hector's and Māui Dolphin TMP must align with the policies above. In addition, it should be noted that the Conservation General Policy promotes the importance of public participation in conservation management.

Conservation Management Strategies (CMS) are 10-year regional strategies prepared under the Conservation Act 1987 and must implement the Conservation General Policy. They provide an overview of conservation issues and give direction for the management of public conservation land and waters, and species for which DOC has responsibility (including Hector's and Māui dolphins).

The following CMS are relevant to the Hector's and Māui Dolphin TMP:

CMS	Reason
Northland	These CMS regions contain the known core habitat and range for Hector's and Maui dolphins. It is also where proposed options for change are included in the discussion document.
Auckland	
Waikato	
Whanganui (includes Taranaki)	
Wellington	
Nelson/Marlborough	These CMS regions contain the known range for Hector's dolphins and proposed options for change are included in the discussion document.
Canterbury	
Otago	
Southland	
West Coast	This CMS region is a known range for Hector's dolphins.

Note that whilst it is known that Hector's dolphins are present at certain times in the East Coast/Hawkes Bay CMS region, no options for change is proposed as their presence is considered to be more transitory.

Copies of Conservation Management Strategies and an analysis of their relevant provisions are available on the DOC website (CMS documents; www.doc.govt.nz/tmp-review).

3.3 FISHERIES LEGISLATION

The Minister of Fisheries has a main role in ensuring fishing-related mortality of marine mammals or other wildlife is managed. The provisions that apply for this purpose, in the absence of a population management plan for a species, state that the Minister of Fisheries may:

- after consultation with the Minister of Conservation, take such measures he or she considers necessary to avoid, remedy or mitigate the effect of fishing-related mortality on any protected species, and such measures may include setting a limit on fishing-related mortality [Fisheries Act 1996, Section 15(2)];
- recommend the making of regulations under Section 298 of the Fisheries Act 1996, for the purposes or implementing any measures referred to in Section 15(2);
- by notice in the *Gazette*, prohibit all or any fishing or fishing methods in an area, in accordance with Section 15(2), for the purpose of ensuring that any limit on fishing-related mortality is not exceeded [Fisheries Act 1996, Section 15(5)(b)].

3.4 OTHER AGENCIES

In addition to DOC and Fisheries New Zealand, various other central and local government agencies have mandates and responsibilities which affect the coastal and marine environment and, therefore, marine mammals. These include Biosecurity New Zealand (MPI), Maritime New Zealand, the Ministry of Business Innovation and Employment (MBIE), the Environmental Protection Authority (EPA), the Ministry for the Environment (MfE), and local government.

For many threats to Hector's and Māui dolphins, DOC works with those agencies that lead or have a mandate for managing the effects of the activity. This engagement may include through statutory processes under the EEZ Act and via regional policy statements, plans and applications for resource consents under the Resource Management Act 1991 (RMA).

4 Background

4.1 CONTEXT

Hector's and Māui dolphins are only found in New Zealand. Hector's dolphins were gazetted in 1999 as a threatened species under the Marine Mammals Protection Act 1978 (MMP Act) and Māui dolphins were recognised as a separate (and significantly less abundant) subspecies in 2002. Together, they are one of the world's rarest dolphins.

In response to public and government concern about the effect of human-induced mortality, including the impacts of fishing on these dolphins, the Hector's and Māui dolphin Threat Management Plan (TMP) was developed in 2008.

The TMP is led by the Department of Conservation (DOC) and Fisheries New Zealand. The partnership between these agencies reflects their respective roles and responsibilities. It is DOC's role and responsibility to manage the populations overall. It is Fisheries New Zealand's role and responsibility to manage fishing.

The TMP includes a guiding vision, goals and objectives, as well as specific measures under relevant legislation to address threats to the dolphins.

4.2 REVIEW OF THE THREAT MANAGEMENT PLAN

4.2.1 Purpose of the review

The TMP is intended as a medium-term planning document, subject to review approximately every five years. The first review was undertaken in 2012 and targeted the Māui dolphin part of the TMP. The current process is the first complete review of the TMP since it was established. The review allows the Government to consider the appropriateness of the core components of the plan (vision, goals and objectives) and the effectiveness of measures implemented to achieve the TMP in light of new information. In particular, the review allows the Government to consider whether the current plan and associated measures reflect their view of the acceptable level of risk from human-induced mortality to the dolphins.

Specifically, Ministers have signalled their desire for a review of the TMP to:

- continue engagement with iwi in shaping the successful management of this taonga species;
- ensure the TMP goals remain relevant and effective;
- assess new information and the performance of existing protection and monitoring measures to ensure the measures are effective;
- provide direction on future research and monitoring needs to improve future assessments on performance;
- explore new opportunities to progress the recovery of the species.

Agencies consider an important aim of this review is to better define outcomes for successfully managing threats to the dolphins. This aim will need to be supported with clear goals, specific objectives and performance measures that will ensure progress in achieving the outcome is clearly defined, measurable and transparent.

4.2.2 Process for the review

Consistent with the development of the previous TMP, the current review is being undertaken jointly by DOC and Fisheries New Zealand.

To better support the review and improve the information available for decision-making, agencies developed an extensive independent research, risk assessment and evaluation process. The process involved contributions from a range of scientific experts from New Zealand and overseas, as well as opportunities for tangata whenua and stakeholder input. The science work that was undertaken is outlined in the next section.

North Island (Māui) and South Island (Hector's) Stakeholder Forums comprised of experts from environmental non-government organisations (ENGOs), non-commercial fishers, commercial fishing representatives, and tourism operators were established to provide input into the management aspects of the review. Initial engagement has also taken place directly with iwi, and through iwi fisheries forums in both the North Island and South Island. Feedback from this process has been incorporated into the discussion document for wider consultation.

Consultation allows those with an interest to have their say on the proposed plan and measures. As noted earlier, DOC and Fisheries New Zealand's ongoing engagement with whānau, hapū and iwi is happening alongside the wider public consultation process for the TMP.

Agencies will prepare final advice to Ministers incorporating the views of whānau, hapū and iwi, and the public and agencies. Ministers will then make decisions on the plan and associated management measures. A process to implement the agreed measures will then occur. It is expected that any revised measures will be implemented in early 2020.

4.3 INFORMATION ABOUT HECTOR'S AND MĀUI DOLPHINS

The Hector's dolphin (mainly South Island) is ranked as nationally vulnerable in the New Zealand Threat Classification System and is estimated to consist of around 15,700 individual dolphins. Population trends are uncertain. The Māui dolphin (found on the west coast of the North Island), is estimated to have a population of around 63 individuals above one year of age and is ranked as nationally critical in the New Zealand Threat Classification System. Population trends are uncertain, but due to its very low population size it remains vulnerable to any human-induced deaths.

4.3.1 New information

The review of the TMP has been guided by new scientific information that greatly improves our understanding of the spatial distribution, biology, and population abundance of Māui and Hector's dolphins, and the threats affecting the dolphins. A multi-threat spatial risk assessment has been developed that combines all the new information and applies novel methods to estimate impacts on different dolphin subpopulations. Details about the new information and spatial risk assessment method used to inform the TMP review can be found in Appendices 1 and 2 and are summarised here. Population models specific to the Māui dolphin population were also used to estimate the effects of different threats including fishing and disease. The full scientific documents describing this research are available online[2].

New information and data to inform this review of the TMP include:

- new aerial surveys to estimate the spatial distribution and population abundance of Hector's dolphins;
- new genetic analyses to estimate the population size and trend of Māui dolphins;
- updated fishing effort data and observations from fisheries observers, to estimate fisheries capture rates;
- use of fisher survey data to estimate relative levels of recreational set-net fishing effort in different parts of New Zealand;
- new use of public sightings and fisheries observer sightings data to understand the spatial distribution of the dolphins, including in locations outside their normally recognised range;
- acoustic sensor data to detect the presence of dolphins in different parts of the historical range of Māui dolphins;
- updated necropsy information to identify the cause of death of beachcast dolphin carcasses;
- new means of understanding the biology of the dolphins to estimate the response of the dolphin populations to different threat levels;
- a spatial risk assessment that combines all of these new data and methods to estimate impacts on different dolphin subpopulations based on the spatial distribution of the dolphins and the spatial distribution of threats that may affect them;
- Māui dolphin population models that estimate the effects of fisheries and disease (toxoplasmosis) on future population trends.

[2] https://www.fisheries.govt.nz/dolphintmp

4.3.2 Population size and trend

The most recent available information on the abundance and distribution of Hector's dolphins[3] shows that, in the South Island, there are approximately 9,700 dolphins on the east coast, 5,500 on the west coast and 317 on the south coast. The north coast subpopulation, if indeed it is a distinct subpopulation, is poorly understood. There are no reliable data to estimate population trends for Hector's dolphins at the scale of these subpopulations.

An abundance survey of Māui dolphins in 2015/16 estimated that there were between 57 and 75 individuals aged one year and older. This estimate is slightly higher than the previous estimate of between 48 and 69 individuals from five years earlier. It is not possible to tell from these results whether the population has increased, stabilised or declined in recent years. However, reflecting the low population size, Māui dolphins remain highly vulnerable to any human-induced mortality.

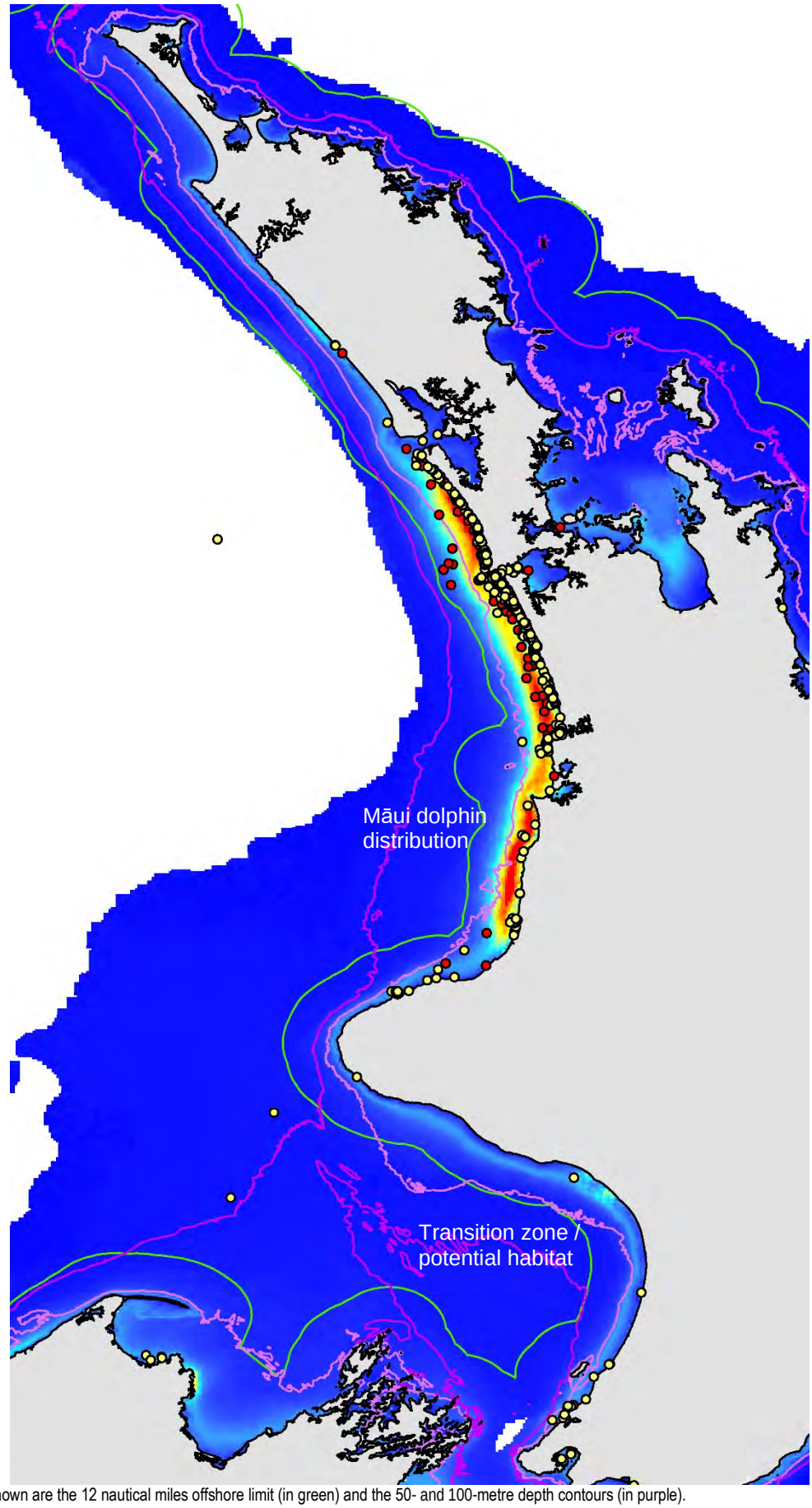
4.3.3 Spatial distribution

4.3.3.1 West coast North Island

The seasonal (summer and winter) density of Hector's and Māui dolphins on the west coast of the North Island was estimated and mapped using spatial habitat models, fitted to data from aerial dolphin surveys and public sightings. Māui and Hector's dolphins show a strong preference for high-turbidity water (which occurs out to around the 50-metre depth contour in most locations) and for locations where prey availability is higher. In summer, dolphin densities are highest in locations closest to shore; in winter the distribution shifts slightly further offshore (see Figure 1).

[3] MacKenzie, D. L. and Clement D.M. (2016) Cawthron Institute.

Figure 1: Estimated (winter) spatial distribution of **Māui dolphins, including validated public sightings (summer sightings in yellow, winter sightings in red)**



Note: Also shown are the 12 nautical miles offshore limit (in green) and the 50- and 100-metre depth contours (in purple).

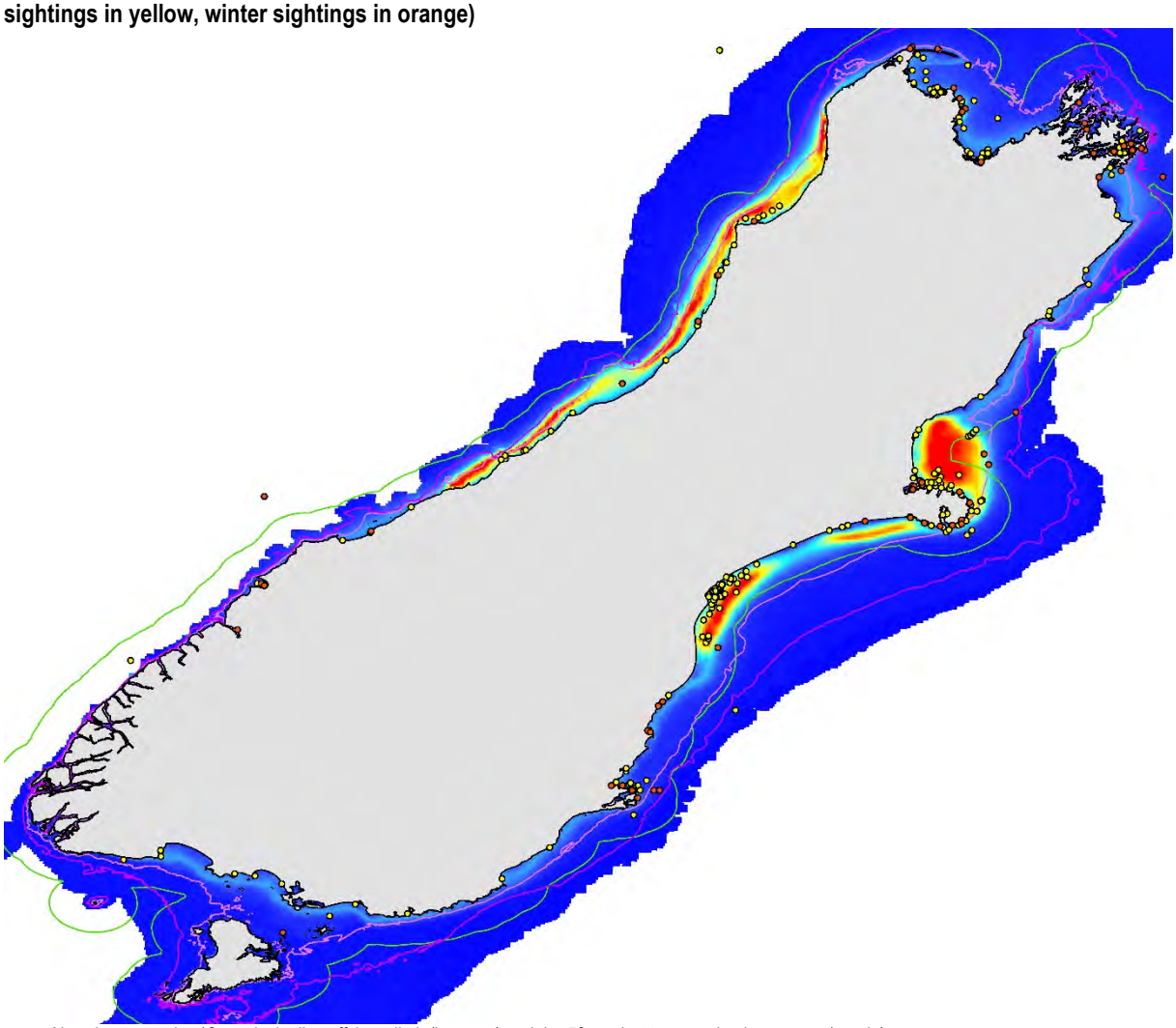
4.3.3.2 South Island

The spatial distribution of Hector's dolphins in the South Island was estimated using the same spatial habitat models described for Māui dolphins (above) except that public sightings were used only subjectively for model validation. Figure 2 shows the estimated distribution of Hector's dolphins, including public sightings.

Dolphin densities are highest in areas close to shore where the water is highly turbid from sediments originating in terrestrial rivers. The offshore limit of higher dolphin-density areas corresponds most closely to the 50-metre depth contour (shown in light purple).

Figure 2 reflects high numbers of dolphins in the east coast and west coast South Island subpopulations, and relatively small subpopulations on the north and south coasts of the South Island. Distinguishing these four subpopulations is supported by genetic evidence, although knowledge of the north coast subpopulation is poor.

Figure 2**: Estimated (winter) spatial distribution of Hector's dolphins, including validated public s**ightings (summer **sightings in yellow, winter sightings in orange)**



Note: Also shown are the 12 nautical miles offshore limit (in green) and the 50- and 100-metre depth contours (purple).

4.4 ASSESSMENT OF THREATS TO HECTOR'**S AND MĀUI DOLPHINS**

The update of the TMP is informed by the new information described above, and a novel, spatially explicit multi-threat risk assessment. The risk assessment estimates the spatial distribution of the dolphins and the spatial distribution of the threats that may that affect them. The rate that dolphins encounter a threat is estimated by the level of spatial overlap between the dolphin distribution and the threat distribution. The probability of death per encounter is estimated from fisheries observer data (for commercial fishery threats) or from cause of death identified by necropsy for beachcast bodies (for lethal non-fisheries threats).

The advantage of this spatial risk assessment is that managers can estimate how many dolphins are dying from each threat and where those deaths are occurring, noting that different subpopulations of dolphins will be exposed to different combinations of threats. It is also possible to estimate the cumulative effects of multiple threats affecting the dolphins simultaneously. The risk assessment also identifies levels of statistical uncertainty in estimating the effects of different threats to the dolphins. Further information on the risk assessment methodology and outputs is included in Appendix 2.

There are a number of threats facing the dolphins including fishing-related threats and non-fishing-related threats. Some of these threats are a direct cause of dolphin deaths (see Table 1). Other non-lethal threats may have a more indirect negative impact on the population (for example, by reducing reproductive success).

Estimates of annual deaths and subpopulation-level risk are available for three main human-caused lethal threats: commercial set-net fisheries, commercial trawl fisheries, and toxoplasmosis (a parasitic disease originating in cats, which spreads to the sea in terrestrial run-off). Estimates of annual deaths for each subspecies are provided in Table 1 below.

Table 1: Estimated annual deaths of Hector's and Māui dolphins from commercial set-net, inshore trawl and toxoplasmosis

	Mean annual mortalities (5th to 95th percentile estimates)		
	Commercial Set-Net	Inshore Trawl	Toxoplasmosis*
Māui	0.10 (0 – 0.25)	0.02 (0 – 0.05)	1.9 (1.1 – 3.0)
Hector's	44 (21 – 80)	14 (1 – 43)	334 (132 – 625)

* Data to estimate non-fishery deaths rely on necropsies from recovered dolphin carcasses. These estimates are much more uncertain than the estimates of commercial fisheries deaths, which use data from fisheries observers.

For these lethal human-caused threats and for natural causes of death that can be mapped in space, the risk assessment estimates different levels of risk for different subpopulations. Data to estimate non-fishery deaths rely on necropsies from recovered dolphin carcasses. These estimates are much more uncertain than the estimates of commercial fisheries deaths, which use data from fisheries observers.

The risk assessment also estimates relative exposure levels of the different subpopulations to recreational set-net fishing. The risk assessment was able to provide some spatial information on threats from oil spills and noise disturbance, including noise from seismic surveying and vessel traffic. Other activities, including seabed mining, vessel strike, tourism, coastal development, pollution, and climate change effects were limited to a review of the available literature to assess the potential threat to the dolphins.

Where the risk from human threats is judged to be too high, spatially resolved risk estimates can be used to design effective risk management responses to reduce those risks. This approach was used as one tool to evaluate different spatial management options for the management of fisheries. This approach is described later in this document. The risk assessment is a tool which helps inform the TMP review process; however, the risk assessment does not direct the outcomes of the TMP.

5 Proposals for the guiding vision and objectives

5.1 INTRODUCTION

The existing TMP provides a vision statement, high-level goals and objectives to guide management.

As part of the review, we propose updating the vision and revising the existing objectives to provide a clear link between the vision, objectives and management actions. This approach will support more accurate and transparent monitoring of the performance of the plan, help to inform responses to events that may occur, and identify whether any additional action is needed.

5.2 VISION

The vision statement is intended to state what success will look like. The vision statement used in previous iterations of the TMP was "Hector's and Māui dolphins should be managed for their long-term viability and recovery throughout their natural range".

The proposed new vision statement is:

New Zealand's Hector's and Māui dolphin populations are resilient and thriving throughout their natural range

This new vision statement better specifies the desired outcome of the plan.

5.3 GOALS

5.3.1 Long-term goal

Since 2002, Hector's and Māui dolphins have been designated as separate subspecies in recognition of the genetic differences between the population found on the west coast of the North Island *Cephalorhynchus hectori maui* and the population found primarily in the South Island *Cephalorhynchus hectori hectori*.

The Government has previously supported separate management of these subspecies to reflect this difference, and in particular the different population sizes and corresponding differences in resilience to human threats. Agencies do not propose any change to this approach.

The existing management plan operates on a "subpopulation" scale. This differentiates between the two subspecies and recognises the east, west and south coasts of the South Island as separate Hector's dolphin biological subpopulations, consistent with genetic evidence. For the purposes of the TMP, we also propose to recognise a distinct subpopulation on the north coast of the South Island.

We propose to continue to manage at a subpopulation scale, in recognition of the:

- genetic diversity that occurs between subpopulations is a consideration to support overall viability of the species;
- nature and level of human activities and other threats varies between areas;
- interests of tangata whenua and local communities in how activities and risks are managed at the local level in their particular locations, including at scales that are smaller than the recognised populations.

The goals in the initial TMP were to: ensure that the long-term viability of Hector's and Māui dolphins is not threatened by human activities; further reduce impacts of human activities as far as possible, taking into account advances in technology and knowledge, and, financial, social and cultural implications.

To better reflect the scale of management, the proposed long-term goal for the plan seeks to ensure that:

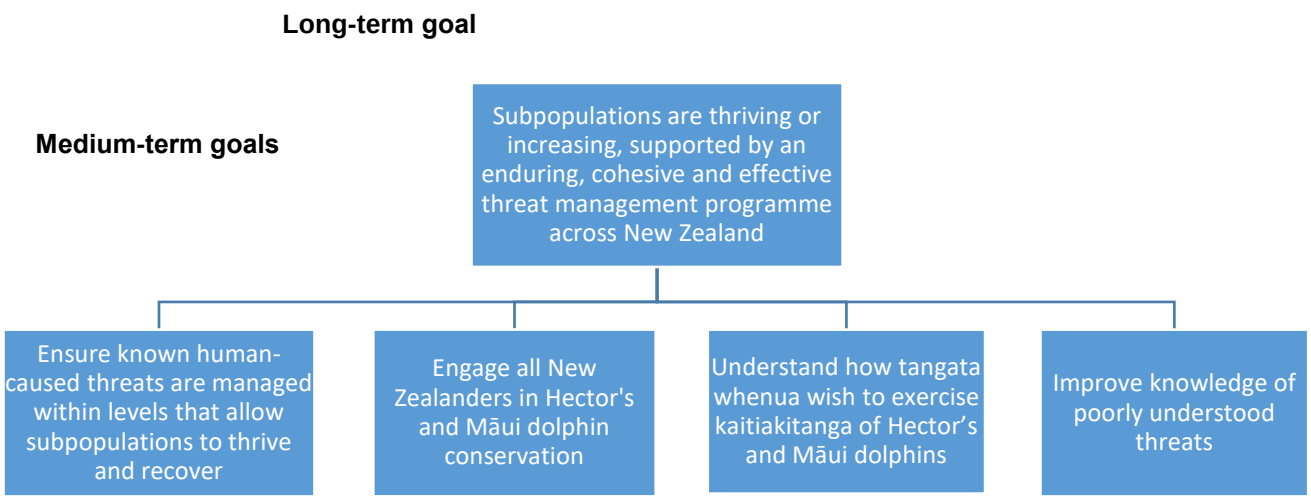
Hector's and Māui subpopulations are thriving or increasing, supported by an enduring, cohesive and effective threat management programme across New Zealand.

Possible adjustments to subpopulation boundary definitions are discussed in the more detailed sections of this document. This discussion acknowledges the possibility of a separate north coast South Island subpopulation.

5.3.2 Medium-term goals

Beneath the long-term goal, four medium-term goals have been identified[4]:

Figure 3: Long-term goal and four medium-term goals for the TMP



***Ensure known human-caused threats are managed within levels that allow subpopulations to thrive and recover*:** There is a range of threats that may result in human-induced adverse effects to the dolphins. This goal is intended to ensure that those threats are managed at levels that allow the subpopulations to collectively achieve the overall desired outcome outlined in the vision statement.

Engage all New Zealanders in Hector's and Māui dolphin conservation: There is a need to engage the public of New Zealand in understanding and, where required and possible, supporting the management of human-induced threats to the dolphins. This goal will drive objectives around the ongoing use of stakeholder forums, transparency and accessibility to information on the plan and its performance, education about the dolphins, the threats facing them and what the public can do to support threat management.

Understand how tangata whenua wish to exercise kaitiakitanga of Hector's and Māui dolphins: Feedback to agencies reflects that there is need to understand whānau, hapū and iwi expectations on exercising kaitiakitanga for the dolphins. DOC and Fisheries New Zealand seek to continue discussions with tangata whenua to further improve awareness and understanding of the perspectives of Māori in relation to the dolphins, including how kaitiakitanga can be best exercised. In continuing discussions, both agencies hope to hear about how they can work with tangata whenua to enable them to strengthen their participation in efforts to understand the threats to the dolphins and better protect them, based on mātauranga Māori values and concepts.

[4] The goals in the 2007 plan were to: ensure that the long-term viability of Hector's and Māui dolphins is not threatened by human activities; further reduce impacts of human activities as far as possible, taking into account advances in technology and knowledge, and, financial, social and cultural implications.

Improve knowledge of poorly understood threats: There are some human-induced threats to the dolphins that are poorly understood. The intent of this goal is to identify the need to resource new research and monitoring to improve our understanding of the nature and extent of those threats.

5.3.3 Desired population outcomes

Setting desired population outcomes helps to further define the goal "*Ensure known human-caused threats are managed within levels that allow subpopulations to thrive and recover"* by setting the level at which management will aim to keep impacts below for each population. The outcomes will help to define specific objectives to reduce the impact of particular threats.

A range of population outcomes could be chosen. Managing human-induced mortality with a high level of certainty at or below a level sufficient to ensure the population is maintained at 50 percent of the maximum number of dolphins the environment can support would ensure the population remains above a viable level (that is, avoids extinction). Further reductions in human-induced mortality, to allow populations to increase or remain closer toward their maximum number, would be a better reflection of the vision and goals of the plan, but will increase the socioeconomic impacts due to the greater number of restrictions required on some activities.

We propose setting a very high population outcome as an objective to guide management of impacts on Māui dolphins, to reflect the importance of the species to New Zealanders and the very small current population size.

The following population outcome for Māui dolphins is proposed:

- **Māui dolphins: Human impacts are managed to allow the population to increase to a level at or above 95 percent of the maximum number of dolphins the environment can support.**

A population outcome of 95 percent means the human-induced deaths need to be as near as practicable to zero.

The population of Hector's dolphin is much larger than the Māui dolphin population. Therefore, the acceptable level of impact on the population can be larger while still allowing the population to be managed at very high proportion of the maximum number of dolphins the environment can sustain. This provides an opportunity to seek a different balance between rebuilding Hector's dolphin populations and the socioeconomic impacts of measures that need to be put in place to do so.

The following population outcome for Hector's dolphins is proposed:

- **Hector's dolphins: Human impacts are managed to allow each subpopulation to increase to a level at or above 90 percent of the maximum number of dolphins the environment can support.**

5.4 OBJECTIVES

Agencies propose that, where possible, the plan contains detailed objectives that are specific, measurable and time-bound in relation to each of the work areas linked to the goals. Performance measures are proposed where appropriate for each objective.

The objectives and performance measures are new aspects of the TMP. They are intended to ensure the effective delivery of the TMP vision and goals. The objectives and performance measures will:

- support more transparent monitoring of the TMP and associated management measures;
- provide more context about any human-induced adverse effects (including deaths) that may occur during the lifetime of the TMP and whether any additional action is needed.

Monitoring information associated with these objectives will be publicly accessible and reported to tangata whenua and stakeholder advisory groups at regular intervals. Together, the plan and measures are intended to reduce the time and cost for stakeholders and the Government associated

with debate regarding individual mortality events. There is a focus on the longer-term management framework and whether it is designed to achieve the desired results.

5.4.1 Fisheries management objectives

Historically, fishing has been regarded as the greatest human-induced threat of deaths of Māui and Hector's dolphins. To address this threat, the proposed overarching objective is to:

Ensure that dolphin deaths arising from fisheries threats do not:

- *exceed population sustainability thresholds set to achieve the applicable population outcome, with 95 percent certainty;*
- *cause localised depletion;*
- *create substantial barriers to dispersal or connectivity between subpopulations.*

For the first time, the proposed fisheries-related objectives include quantitative targets. Further explanation of these targets and how they relate to the desired population outcomes is provided below.

Population sustainability threshold

The population sustainability threshold is the maximum number of dolphin deaths per year that can occur while still allowing that the population objective can be achieved. To ensure that the required level of risk reduction occurs with high probability, fisheries risk reduction targets are defined with reference to the upper 95th percentile estimate of current impact, rather than the median (most likely) estimate of current impact.

For dolphin populations to recover to the level reflected in the definition of the population sustainability threshold relative to the maximum level that the environment can support (i.e. 'carrying capacity'), all other human-induced deaths will also need to be effectively managed to close to zero. If other human impacts are ongoing, then fisheries impacts will affect the population by the same amount but relative to a lower baseline, reflecting the cumulative effect of other human threats. In this way, fisheries impacts can be evaluated empirically against quantitative targets even if the effect of non-fishery threats on current population status is unknown. This means that effects of fishing can confidently be managed to ensure long-term viability of the dolphin population, but the overall level to which the dolphin population recovers relies on how other human-induced deaths are managed.

Risk ratio

The risk ratio is the ratio between the estimated actual number of fisheries deaths (as estimated by the risk assessment) and the population sustainability threshold. A risk ratio exceeding one indicates that the population sustainability threshold is being exceeded and that management action to reduce risk should be considered. Table 2 shows the risk ratio under different examples of desired population outcomes, including those that have been proposed in Section 6.2 (95 percent carrying capacity for the Māui dolphin population and 90 percent carrying capacity for Hector's subpopulations).

Level of certainty

Because the estimated impacts (fisheries deaths) are themselves uncertain, a level of "certainty" has been included within the fisheries objective. To illustrate how the level of certainty affects the threshold, Table 2 shows the risk ratio for both the mean (average estimate) and the 95th percentile estimate of current deaths, as proposed in the objectives. We propose the 95th percentile estimate to provide a high level of certainty that the actual impact will be at or below the chosen threshold.

The implication of choosing a high level of certainty is that the actual population outcome is likely to be considerably higher than what is specified in the objective. To illustrate, if decision-makers choose to aim for a population objective of 95 percent of carrying capacity with 95 percent certainty, then the median (that is, most likely) population outcome will be higher, likely very close to 100 percent of carrying capacity (that is, no discernible impact). Defining performance measures with reference to the 95th percentile means that performance targets are likely to be met even if other information is uncertain (for example, if spatial distributions or biological variables are poorly estimated).

Table 2: Fisheries risk assessed against examples of desired population outcomes for the Māui dolphin population and Hector's dolphin subpopulations and local populations

Subpopulation	Population size (mean estimate)	Current annual commercial fisheries deaths (mean estimate)	Risk ratio (95th percentile in brackets)		
			Desired outcome of 80% carrying capacity	Desired outcome of 90% carrying capacity	Desired outcome of 95% carrying capacity
Māui (west coast North Island)	63	0.11	0.14 (0.32)	0.34 (0.81)	0.69 (1.62)
Hector's					
east coast	9728	51.0	0.36 (0.86)	0.90 (2.16)	1.80 (4.31)
west coast	5482	5.5	0.05 (0.24)	0.14 (0.60)	0.27 (1.21)
south coast	332	1.2	0.24 (0.62)	0.60 (1.55)	1.20 (3.09)
north coast	214	1.0	0.31 (0.83)	0.78 (2.07)	1.56 (4.14)
east coast South Island – local populations					
Kaikōura	*757*	11.0	1.04 (2.18)	2.60 (5.44)	5.20 (10.88)
Banks Peninsula	*4505*	17.3	0.27 (0.59)	0.67 (1.48)	1.34 (2.97)
Timaru	*2725*	19.7	0.48 (1.24)	1.21 (3.10)	2.42 (6.20)

Note: Where risk ratios exceed one (shown at the mean and 95th percentile level) then the population objective will not be achieved.

5.4.2 Toxoplasmosis management objectives

Toxoplasmosis is a parasitic disease that is spread by cat faeces and transported into the coastal environment through runoff from land. It can infect dolphins when they ingest contaminated food or water and is a confirmed cause of death in Hector's and Māui dolphins.

Although there is some uncertainty in the estimated number of toxoplasmosis-related deaths, the risk assessment indicates that this disease is a significant human-caused threat to Māui dolphins and to some subpopulations of Hector's dolphins.

Mitigating the threat of toxoplasmosis will require a multidisciplinary and collaborative approach, working with a range of agencies and organisations. DOC proposes the development of a Toxoplasmosis Action Plan with the following objectives:

- *Reduce the number of dolphin deaths caused by toxoplasmosis to near zero.*
- *Improve knowledge on toxoplasmosis to increase ability to take actions to reduce this threat.*

DOC will co-ordinate a workshop focused on toxoplasmosis, involving relevant national and international experts, to refine and prioritise research identified in the Toxoplasmosis Action Plan, within six months of the TMP being updated.

Performance plans are proposed to measure progress towards achieving the two objectives. These will include:

- Monitoring of causes of death to Māui and Hector's dolphins through DOC's necropsy contract with Massey University. All dolphin carcasses will be tested for toxoplasmosis, even if it wasn't the primary cause of death.
- Reporting on research results through existing science working groups and providing opportunities for stakeholders to engage.
- Re-evaluation of the Toxoplasmosis Action Plan against the above two objectives within five years of the TMP being updated.

5.4.3 Management objectives for other non-fishing threats

The proposed overarching objective for the management of other non-fishing threats is:

Ensure adverse effects on dolphins from other anthropogenic threats are avoided or minimised.

Other threats may affect Hector's and Māui dolphins through various overlapping direct and indirect mechanisms. These threats include injury, disease, disturbance, noise, habitat modification, impacts on prey distribution and abundance, reduced foraging success, displacement, and habitat fragmentation.

This objective may be met through, among other things:
- direct management changes under the MMP Act as outlined in this document; for example, any changes to marine mammal sanctuary boundaries and restrictions;
- ongoing management under the Marine Mammals Protection Regulations 1992 (MMPR);
- ongoing engagement through existing statutory processes under the Resource Management Act 1991 (RMA) and the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012 (EEZ Act) to ensure effects on Hector's and Māui dolphins are appropriately avoided, remedied or mitigated.

Changes under the MMP Act must meet the statutory requirements of that Act. They must also comply with the Crown's Treaty obligations including under Section 4 of the Conservation Act, the Marine and Coastal Area (Takutai Moana) Act 2011, and Treaty settlements. It is, therefore, not possible to fix a timeframe for these aspects of the TMP.

The remaining work is ongoing and, therefore, not time bound.

5.4.4 Engagement objectives

The goal to engage New Zealanders in Hector's and Māui dolphin conservation recognises the opportunities for tangata whenua and local communities to contribute information and support initiatives proposed in other parts of the TMP.

The specific objectives proposed under this section are to ensure:
- New Zealanders are aware of, and can identify Hector's and Māui dolphins;
- improved public understanding of the reasons and processes to report dolphin sightings;
- improved public understanding of the reasons and processes to report live strandings and beachcast dolphin carcasses;
- improved public understanding of how threats from activities that can cause human-induced effects on the dolphins are being managed.

The performance measures are:

- high rates of reporting by the public of beachcast dolphin carcasses, and where possible these are recovered in fresh condition leading to successful necropsy;
- regularly published fisheries compliance statistics, especially when set-netting is involved;
- regular standardised reporting of fisheries capture events;
- regular standardised reporting of dolphin sightings;
- stakeholder advisory group operating from 2020.

5.4.5 Research objectives

Gathering more information on Hector's and Māui dolphins and the threats impacting on them will be critical to ensuring that all subpopulations are able to recover to, and remain at, the desired population levels. To improve co-ordination of research activities, we propose a national research co-ordination process based on an agreed five-year research programme.

The draft research objectives proposed are to:
- improve information on cause of death of beachcast dolphins;

- improve understanding of diseases impacting Hector's and Māui dolphins;
- improve information on dolphin distribution and movements;
- improve information on composition and distribution of dolphin prey;
- continue monitoring population size and trend of Hector's and Māui dolphins;
- investigate monitoring of other biological factors important to population growth;
- improve information on fisheries impacts;
- improve estimation of dolphin subpopulation status and trends.

These objectives and associated measures will be further developed by a tangata whenua and stakeholder research advisory group that will provide input into research objectives, research planning and prioritisation. Likely priority research projects have been included in Appendix 4 but would be subject to further discussion and analysis through this planning process.

6 Proposed measures under the Fisheries Act 1996

6.1 CONTEXT

Historically, fishing has been regarded as the greatest threat of human-induced mortality of Māui and Hector's dolphins. In particular, set-nets are not visible in the water and dolphins can get caught in them and drown. Hector's dolphins have also been reported caught in trawl nets[5].

In recognition of the threat from these fishing methods, area-based restrictions have been put in place. The area covered by restrictions has increased over time reflecting improved information on the nature and extent of the risks.

- Restrictions on set-netting were introduced in Banks Peninsula in 1988.
- Restrictions on set-netting were introduced between Maunganui Bluff and Pariokariwa Point on the west coast of the North Island, implemented from 2003.
- Broader ranging measures introduced in 2008 in association with the development of the original TMP, this included:
  - extending the west coast North Island set-net measures further offshore and into the mouth of the Kaipara and Manukau harbours;
  - prohibiting trawling in part of the areas covered by the west coast North Island set-net restrictions;
  - introducing set-net and trawl restrictions on the east and south coasts of the South Island, and a seasonal set-net prohibition on the west coast of the South Island.
- Further restrictions were introduced on set-netting south from Pariokariwa Point to Hawera, following a reported capture at Cape Egmont in 2012.

Alongside other fisheries restrictions shown in Figures 4 and 5 below, over 7,000 square kilometres are closed to trawling and 20,000 square kilometres are closed to set-netting (not including the east coast of the North Island). In addition, there are voluntary protocols in place in the trawl fishery off the east coast of the South Island, designed to reduce the risk of mortality in that fishery.

[5] Records of observed or reported fishing-related mortalities of Hector's and Māui dolphins (dating from 1921) are included within a public database of all recorded mortalities https://www.doc.govt.nz/our-work/hectors-and-Māui-dolphin-incident-database/

Figure 4: Current restrictions on trawl and set-net fishing in North Island

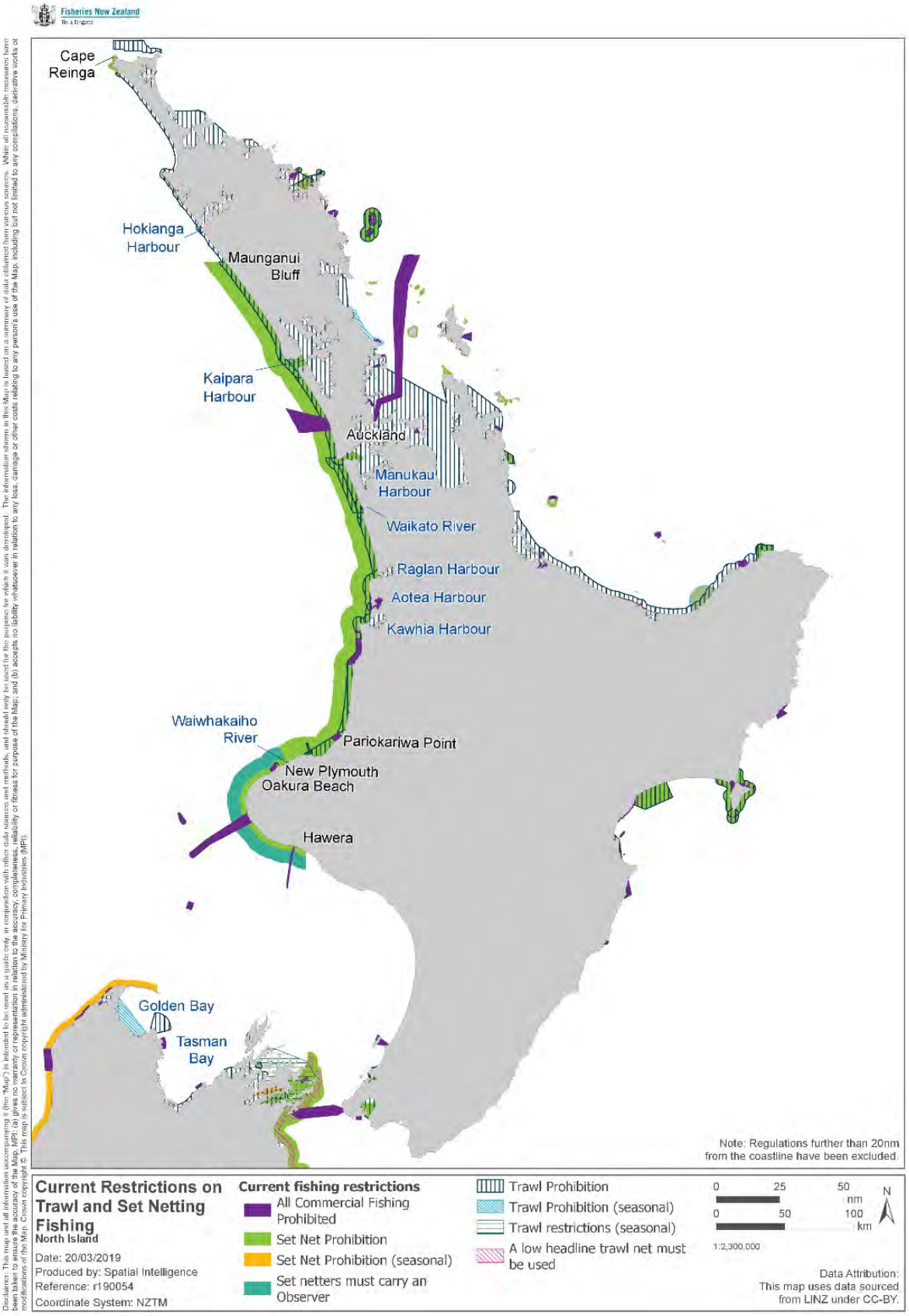
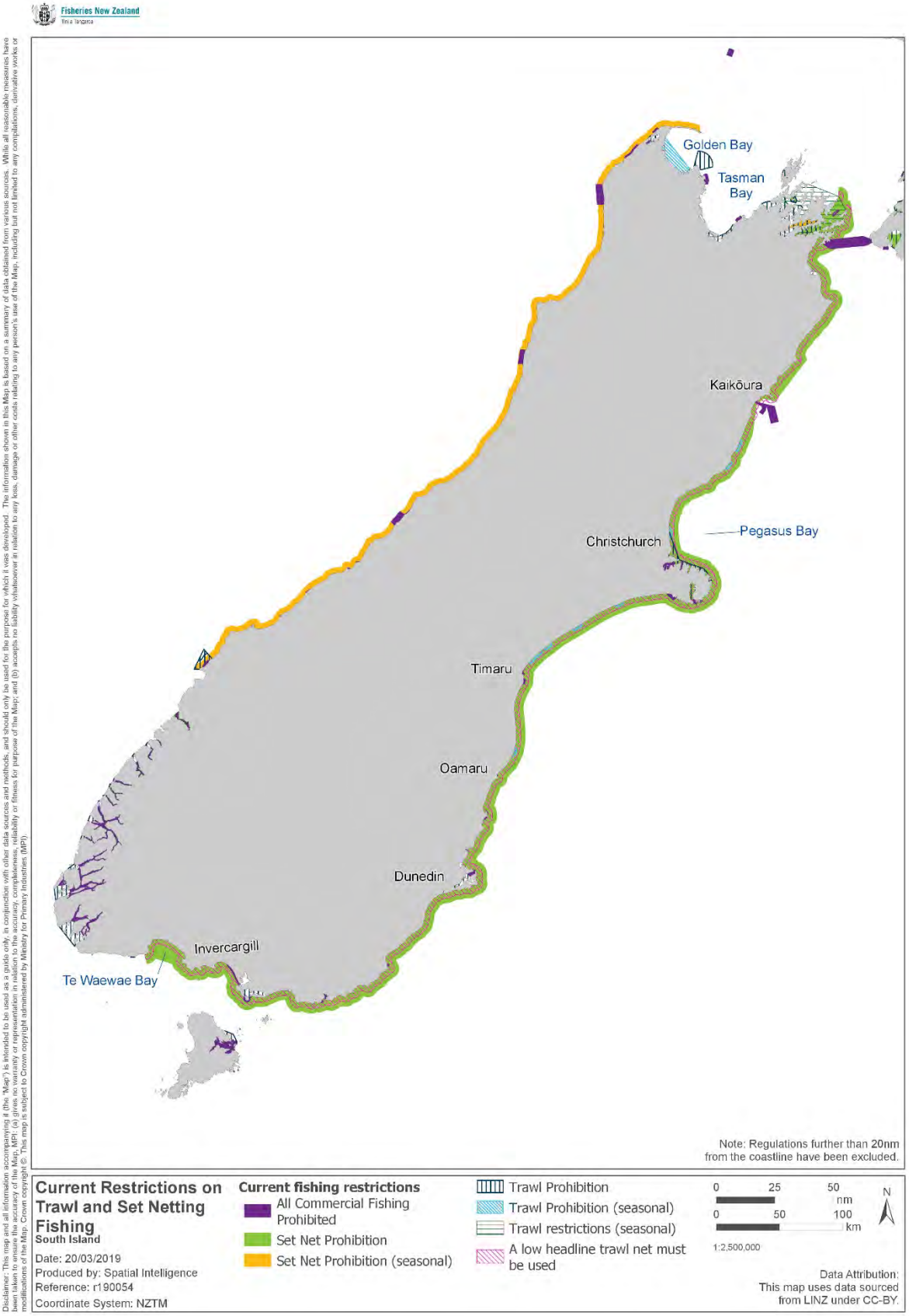


Figure 5: Current restrictions on trawl and set-net fishing in South Island



In general, commercial set-net fisheries have been assessed as posing a substantially greater risk to dolphins than trawl fisheries. In the fisheries where most set-net deaths occur, a typical set-net is estimated to be 20 to 30 times more likely to capture or kill a dolphin than a single trawl.

Recreational set-net fishing is also a known threat, but available information is insufficient to inform quantitative estimates of risk in recreational set-nets (because there are no independent fisheries observers). Instead, the encounter rate between dolphins and recreational set nets is estimated on a relative scale of each subpopulation, by mapping recreational set-net effort and calculating the level of spatial overlap with the dolphin distribution. Relative recreational set-net risk is summarised, along with relative exposure to spatially resolved non-lethal threats, in Appendix 2.

Set-net fishing can also occur under customary fishing authorisation.

6.1.1 Residual risk

The level of residual risk of fisheries-related mortality (the risk remaining after protection measures have been applied) to a particular population of dolphins depends on a combination of factors, including:

- the nature and intensity of fishing effort;
- the level of spatial overlap between the dolphin distribution and fishing effort distributions;
- to a lesser extent, the number of dolphins in the subpopulation (or local population) of interest.

Since the TMP was established in 2008, 22 commercial fisheries mortalities (one possible Māui dolphin) have been reported. Because there may be incentives not to report every capture; however, it cannot be assumed that fisher-reported capture rates are representative of actual capture rates.

The TMP risk assessment estimates that commercial fishing currently accounts for approximately:

- one Māui dolphin death every 9 years[6] from a population of approximately 63 animals;
- 59 Hector's dolphins' deaths per year[7] from a population of roughly 15,700 animals.

The large majority of fishing-related deaths of Hector's dolphins occur on the east coast of the South Island. Set-netting is thought to account for approximately 80 percent of fishing-related deaths, despite lower fishing effort levels and larger spatial closures. However, the TMP risk assessment also identifies specific locations of elevated risk from trawl fishing[8].

6.2 PROPOSALS TO REDUCE RESIDUAL RISK

Agencies propose to address the risk of mortality from fishing through the Fisheries Act 1996 (Fisheries Act). Although the option of managing the risk through the MMP Act is available, agencies consider the Fisheries Act the most appropriate tool to manage fisheries-related risk because it is focused on the management of fishing and its impacts. Fisheries New Zealand and the Ministry of Primary Industries also have appropriate resources to manage fishing related activities and ensure compliance with regulatory controls.

6.3 MANAGEMENT APPROACH

The desired population outcome for Hector's and Māui dolphins, and the level by which the population can be acceptably reduced as a consequence of fisheries impacts in the long term, determines the "population sustainability threshold" – the maximum number of dolphin deaths possible per year from fishing-related activities while still rebuilding populations to the desired level. By comparing this with the number of actual dolphin deaths from fishing-related activities per year, we can represent the magnitude of the fisheries risk we need to manage and identify appropriate risk-reduction measures.

For protected species like Hector's and Māui dolphins, the Fisheries Act requires that populations are maintained above their long-term viability. The outcomes proposed in this document are much higher – close to the maximum number of dolphins the environment can sustain.

[6] Range: one death per three to 50 years.
[7] Range: 23 to 122 deaths per year.
[8] Trawl catchability is estimated with less precision than set-net catchability, due to fewer observed capture events.

Because of the importance of Māui dolphins to New Zealanders, we consider a population outcome of 95 percent of carrying capacity with 95 percent certainty is appropriate. This means the limit of human-induced mortality effectively needs to be near as practicable to zero. Agencies consider this outcome provides the Māui dolphin population with the best possible opportunity to increase in size. However, a range of other population outcomes are also outlined (80 percent and 90 percent) for stakeholder comment.

In the case of Hector's dolphins, the population is much larger (approximately 15,700). The necessity for additional measures depends very much on the decision regarding what long-term population outcome is desired, therefore what level of impact is acceptable.

On the east coast South Island, the decision on whether additional measures are necessary is further complicated by the likelihood that some local populations are being impacted much more heavily than others. ENGOs have called for greater consideration of managing risk to those populations to maintain their role in local ecosystems and connectivity (and therefore genetic diversity) between the populations as a whole. Local communities are also keen to protect "their" local populations of dolphins. The stakeholder working group that has supported the development of the TMP also supported the need for better management of local populations.

Fisheries New Zealand note the "charismatic mega fauna" description associated with Hector's dolphins and the reputational and tourism benefits associated with ensuring that they survive and prosper long term. In line with the proposed vision and goals of the TMP, we consider that there is benefit in ensuring that fisheries impacts are low enough to allow populations to recover to levels closer to carrying capacity. However, we also note the cost implications associated with the decision to manage fisheries risks to lower levels, to ensure populations achieve and can be maintained at these levels.

For the purposes of consultation, given the larger current population size of Hector's dolphins when compared to Māui dolphins, Fisheries New Zealand considers that at the subpopulation scale, achieving population sizes at or above 90 percent of carrying capacity, with 95 percent certainty, is an appropriate population outcome. However, a lower population outcome (such as, 80 percent of carrying capacity) could also be chosen. This outcome would result in the need for less stringent measures to manage risk of fishing-related mortality.

In this context, at the local population level, Fisheries New Zealand considers that an objective of maintaining or increasing populations to levels at or above 80 percent of carrying capacity best reflects the relative importance of maintaining local populations relative to ensuring the sub-population and overall population is maintained at desired levels.

To achieve the proposed population outcomes for a subpopulation or local population, we propose a range of options to reduce the risk of human-induced mortality. Options can be combined to reduce risks by the desired amount, while minimising socioeconomic and other impacts.

The sections below outline the range, and some potential combinations of options, that will reduce risk to the desired level. The socioeconomic impact of each of the measures has also been assessed.

6.4 SOCIOECONOMIC IMPACTS

Explanation of the methods used to calculate economic impacts of options in this supporting document are described in Appendix 5. The impacts calculated are estimates, and also will not fall equally on all parts of the fishing industry or take account of the wider impacts on small communities. More informed and detailed economic analyses are underway for the final advice for Ministers.

While some transitional adjustments to current fishing practices have been identified for the options proposed,[9] it is impossible to predict exactly how the fishing industry will respond. Some fishers may be able to adjust better than others. The methodology is a starting point for calculating the potential forgone benefits associated with commercial fishing restrictions. The preliminary analysis assumes revenue is lost and cannot be regained by catches elsewhere in the relevant quota management areas (QMAs). The preliminary analysis does not extend to potential quota value losses if this occurs

[9] *Transitioning to alternative fishing methods off New Zealand's West Coast North Island: A response to the threat to Māui dolphin*. BERL April 2017 A report for WWF.

and, therefore, cannot necessarily be considered the worst-case scenario. Submissions are sought to address these issues.

The analysis also does not take account of the socioeconomic impacts of restricting recreational fishing. Information is sought on these socioeconomic impacts through the consultation process.

6.5 **MĀUI DOLPHIN**: WEST COAST NORTH ISLAND – CONTEXT

The overall proposed Māui population objective is:

Reduce fisheries risks to very low levels, sufficient (with 95 percent certainty) to allow the Māui dolphin population to recover to and remain at or above 95 percent of carrying capacity.

Pursuant of that objective:

- *manage commercial fishing to ensure (with high confidence) that the combined estimate of mortality from set-netting and trawling is below the population sustainability threshold of 0.14 per year;*
- *reduce current commercial fisheries risk by at least 50 percent (from the current mean estimate of one death per nine years to a mean estimate of no more than one death per 18 years);*
- *provide consistency between commercial and recreational set-netting restrictions in acknowledgement of the similar risk factors between fishing types, as well as the potential for recreational gear to be lost and become a drifting risk to dolphins;*
- *introduce management measures along the west coast of the North Island in areas outside the known core range of Māui dolphins, to address risks of Hector's or Māui dolphins being caught while moving outside of their core distribution areas;*
- *continue data collection programmes to increase the precision of estimates of fisheries risk.*

6.5.1 Need for management action

The risk assessment estimates:

- for the Māui dolphin population to recover, there needs to be no more than 0.14 Māui dolphin deaths per year (equivalent to no more than one death every 7 years) to achieve the objective;
- the mean estimate of current fisheries impact is 0.11 deaths per year (one death every nine years);
- the upper 95th percentile estimate of current fisheries impact is 0.30 deaths per year (one death every four to five years);
- to achieve the proposed objective with high certainty, the residual risk needs to be reduced by at least half (reduced mean estimate of 0.056 deaths per year).

Agencies note that although there is uncertainty in the information, the TMP risk assessment estimates that the number of deaths attributable to commercial fishing is low relative to those attributed to toxoplasmosis. However, because the population of Māui dolphins is very small, there is rationale to reduce the risk of all human-induced mortality to as close as possible to zero. This provides the best chance of preventing further population decline and allowing the population to increase in size as rapidly as possible.

6.5.2 Current measures

The first measure taken to address fisheries risks to Māui dolphins was a prohibition on set-netting between Maunganui Bluff and Pariokariwa Point out to four nautical miles (excluding harbours). This regulation came into effect in 2003.

Following the development of the TMP, this restriction was extended to seven nautical miles, and also into the mouths of the Kaipara, Manukau and Raglan harbours in 2008. A trawl prohibition out to two nautical miles between Maunganui Bluff and Pariokariwa Point (and out to four nautical miles in the stretch between Manukau Harbour and Port Waikato) was also introduced at this time.

As part of the review of the TMP in 2012, the seven nautical miles set-net closure was extended to New Plymouth and a closure out to two nautical miles was put in place from New Plymouth to Hawera

(with no commercial set-net fishing without an observer between two nautical miles and seven nautical miles).

6.5.3 Current impact and risk

6.5.3.1 Spatial overlap

New spatial habitat models delivered as part of the TMP risk assessment constitute a very substantial improvement in our scientific understanding of the spatial distribution of Hector's and Māui dolphins.

Patterns of Māui dolphin density in the core of their range as illustrated in Figure 1 have been validated using independent data, for example, public sightings. Where uncertainty remains, it is primarily in the low dolphin density areas, for example, regarding the frequency with which dolphins visit the northern and southern tails of the predicted distribution, or the extent to which they go into harbours, or the offshore limits of their movements.

Comparison of the modelled spatial distribution with existing management boundaries suggests that the existing spatial closures for set-netting correspond well with the areas of highest dolphin density. The dolphins are considered likely to spend most of their time inside the bounds of the existing seven nautical miles set-net closure between Maunganui Bluff and Pariokariwa Point. While trawling is permitted in part of this area (two to seven nautical miles or four to seven nautical miles between Manukau Harbour and Port Waikato) it has been subject to a targeted observer programme since 2014. The observer coverage in this target zone has increased from six percent coverage in 2013/14 to 97 percent coverage in 2017/18. No dolphins have been observed interacting with fishing vessels or fishing gear during this period in this zone or other areas of the coast.

As reflected in the sightings data discussed earlier in this document, the dolphins are known to go further offshore in the core area, particularly in winter, and there is suitable habitat elsewhere on the coast. The risk assessment identifies specific locations in the core zone and the rest of the coastline where commercial fishing overlaps with possible dolphin distribution, resulting in a low but non-zero risk of fisheries captures if similar fishing patterns persist.

6.5.3.2 Direct observations of fisheries deaths

There are very few recorded fishing-related deaths of Māui dolphins. However, because there have not been strong incentives for recreational and commercial fishers to report captures of Māui dolphins in the past, the number of recorded fishing-related deaths is not likely to accurately reflect the total number of fishing-related deaths.

In total, there are five records of fishing-related dolphin deaths within the known range of Māui dolphins. Two dolphins were found in a single abandoned set-net inside the entrance to Manukau Harbour in 2002, and two others were found washed up on the beach on the open coast in 2001, with injuries consistent with set-net entanglement. It was not possible to determine whether these deaths occurred in commercial or in recreational set-nets. These locations were subsequently closed to set-net fishing, to seven nautical miles offshore. More recently, a fisher reported a commercial set-net capture near Cape Egmont (south of the southern extent of the closure at the time) in 2011. This location was subsequently closed to set-net fishing, to two nautical miles offshore.

The use of beachcast or recovered carcasses to estimate impacts at the population level is subject to assumptions about carcass detectability and changing relative threat intensity over time, both of which are uncertain. For fisheries deaths, use of these data is further complicated by the inability to distinguish between commercial or recreational fisheries deaths, and the absence of reliable effort data for recreational set-net fishing prior to the implementation of the closures in 2003. For these reasons, the estimation of fisheries risk uses fisheries observer data rather than beachcast carcasses.

6.5.3.3 Level of impact and risk

The risk assessment suggests that under the current fisheries restrictions, commercial fishing is responsible for approximately one Māui dolphin death per nine years[10], from a population of 63 animals. Of these, set-net fisheries are responsible for 84 percent of the current risk (approximately one death per 10 to 11 years) and commercial trawls are responsible for 16 percent of the risk.

[10] Range: 1 per 4 to 50 years.

6.6 **MĀUI DOLPHIN**: WEST COAST NORTH ISLAND – PROPOSALS TO REDUCE FISHERIES RISK

6.6.1 Overview

A range of options have been developed to reduce the remaining risk from both set-netting and trawling. The options are designed to successively reduce the risk to the dolphins from commercial set-nets and trawls, but they also successively increase socioeconomic impacts, reducing the benefits that are currently derived from those methods of fishing.

Potential set-net and trawl restrictions are identified in different locations. There is scope to vary the details of each option by selecting different combinations of set-net and trawl restrictions. Because the risk assessment estimates not only the number but also the location of fisheries deaths, the effects of imposing new restrictions in each area are additive, both in terms of benefits (fisheries deaths prevented) and costs (socioeconomic impacts on fishers and economic benefit).

Of particular interest, the risk assessment indicates that trawling is responsible for substantially less risk than set-netting (although the trawl estimates are also more uncertain). This conclusion is supported by historical information on mortalities of Hector's and Māui dolphins that suggests that set-netting is the substantially greater threat. However, agencies note that although observed and reported mortalities are lower, there is no doubt that trawling does pose a non-zero level of risk to dolphins.

Seven recent mortalities have been recorded in the Banks Peninsula area from trawl vessels. Although there are different circumstances in the South Island (much higher densities of dolphins in particular), it does not alter the fact that the method poses a threat which should be considered given the small Māui population size. The socioeconomic cost of new trawl restrictions relative to benefit (amount of risk reduction) is substantially greater for trawl than for set-net, reflecting that dolphin catchability is higher in set-nets than in trawls, and there are greater socioeconomic benefits currently being obtained by use of this method relative to set-nets.

6.6.2 Options

Four options for managing the residual risk of fishing have been developed for the purposes of consultation. These options are outlined in the consultation document and again in Table 3 of this supporting information and rationale document. This section provides more context for the options' development, a comparison of the options, and more detailed analysis of the options by area.

Understanding how potential fisheries management measures might contribute to the population recovery objectives for Māui dolphins requires an understanding of the spatial distribution of Māui dolphins and an analysis of what fishing effort occurs within that distribution. Areas along the west coast of the North Island (alongshore and offshore) have been separated based on known current dolphin presence and/or likely prey/habitat in areas adjacent to where dolphins are known to be found either commonly or occasionally. Table 3 proposes four options for how fisheries management measures might be applied across these alongshore and offshore distances. The options are presented geographically in Figure 6 (set-net) and Figure 7 (trawl).

As stated above, the options are designed to successively reduce the risk to the dolphins from commercial set-nets and trawls, but they also successively increase socioeconomic impacts, reducing the benefits that are currently derived from those methods of fishing. Estimated socioeconomic impacts on commercial fishing are presented in Table 4.

Fisheries New Zealand notes that these discrete options are offered as a guide, but that fisheries management measures could be proposed and evaluated for any combination of the smaller closure zones evaluated below or within alternate boundary definitions.

6.6.2.1 Context for options

The offshore extent of the distribution of Māui dolphins, and the need for corresponding fisheries restrictions, has been the subject of considerable discussion. This document includes options to extend fisheries management measures to seven, 10, and 12 nautical miles offshore, and further to the 100-metre depth contour, within the core alongshore range. Evidence to support these different options is discussed in the relevant section later in this document.

We note that a definition of "Māui dolphin habitat" extending to 20 nautical miles offshore has been advanced by some stakeholders. As illustrated in Figure 1, this definition has little support from habitat modelling or direct observations. Fisheries management options extending this far offshore have not been included in this consultation document on the basis that there is very little evidence to support them.

A range of options have also been put forward to cover potential alongshore distribution. Fisheries closures are currently in place from Maunganui Bluff to Hawera. Dolphin densities are highest in the "core area" between Maunganui Bluff and Pariokariwa Point; however, dolphins are also sighted infrequently further south near New Plymouth, and a set-net capture was reported by a fisher operating the Cape Egmont area in 2011.

The range of options also includes measures to extend set-net closures further inside harbours (trawling is already prohibited in these areas). Dolphins are known to occasionally enter the mouth of the Manukau and Kaipara harbours, but public sightings are few despite high levels of fisher and general activity on the harbour.

There have been two verified sightings and one possible acoustic detection of dolphins further inside the harbours beyond the extent of current closures. Extension of the closures to include the locations where these sightings occurred are included under Option 3. At locations still deeper inside the harbours, habitat models predict very low dolphin densities (such as rare intermittent presence), but they overlap with very high fishing effort, so the resulting estimates of fisheries deaths and risk are moderate. Because they rely on extrapolated estimates of dolphin density, these estimates are more uncertain than in other locations.

Considered collectively, these proposed measures are a significant extension relative to the current situation. Adoption of these measures would represent a precautionary approach. Feedback and input through this consultation will help to inform further development of a final set of options from within a matrix of possible choices.

6.6.2.2 Other important context

The public consultation document contains proposals for additional measures restricting trawl and set-net fisheries northward to Cape Reinga and southward to Wellington. The northern measures are designed to protect areas of suitable dolphin habit. There have been no recent dolphin sightings north of Dargaville. However, the DOC incident database includes a reported beachcast dolphin on Ninety Mile Beach. Agencies consider there is potential for occasional dolphin movement and also increased use of this area and also areas further south of the current dolphin distribution, if and when the dolphin population expands.

<u>Cape Egmont to Wellington risk management options</u>

Management options south of Cape Egmont propose to extend fisheries restrictions into an area where there is no evidence of a current resident population, but where it is confirmed that Hector's or Māui dolphins are present at least intermittently. There are areas where there is suitable dolphin habitat, and where there is historical evidence of a likely resident dolphin population in the past, suggesting that this area may allow important connectivity between the South Island Hector's population and the Māui dolphin population, or may allow for recolonisation of historically occupied areas, as the population expands.

The coastline from Hawera to Wellington is an area of very high recreational set-net effort. While it is not possible to estimate recreational set-net risk in an absolute sense, the TMP risk assessment estimates that in a relative sense, a dolphin resident in this area would be 27 times more likely to

encounter a recreational set-net than a dolphin on the east coast South Island, suggesting that recreational fisheries risk may constitute a barrier to dispersal through, or recolonisation of, this area.

Maunganui Bluff to Cape Reinga risk management options

Management options north of Maunganui Bluff propose to extend fisheries restrictions as far as Cape Reinga based off habitat model predictions that this area has suitable habitat for Māui dolphins. The actual frequency with which dolphins may use these habitats is unknown. There have been verified sightings as far north as Dargaville, and a beachcast carcass has been recovered at Ninety Mile Beach.

Trigger point(s)

Depending on whether additional measures are chosen, and the extent of those measures, agencies consider that implementation of regulatory trigger points should be considered. As an alternative to zero-risk reduction measures, a mix of measures could be introduced to reduce risk to levels that Ministers consider acceptable, but which still provide for a reasonable level of use. Alongside these measures a regulatory framework could be put in place that immediately halted all fishing activity by set-net or trawl vessels operating within a defined area (potentially the same as the most risk averse option proposed in this document) for a period until notified of the ability to fish again or further controls were implemented, including a full closure of the area if determined appropriate. This option would require 100% monitoring of vessels fishing using trawl or set net in areas of risk.

Table 3: West coast North Island (Māui dolphin) proposed method restrictions by fishing type

Location		Proposed area where fishing method would be prohibited							
		Set-net (commercial and recreational)				Trawl			
		Option 1 (status quo)	Option 2	Option 3	Option 4	Option 1 (status quo)	Option 2	Option 3	Option 4
Coast between Cape Reinga and Maunganui Bluff *(potential habitat)*	0-2 nautical miles offshore	-	✓	✓	✓	Closure to 1 nautical mile	No change	✓	✓
	2-4 nautical miles offshore	-	✓	✓	✓	-	-	-	-
Coast between Maunganui Bluff and New Plymouth *(core area of distribution)*	0-4 nautical miles offshore	✓	✓	✓	✓	Closure varies between 2 and 4 nautical miles	✓	✓	✓
	4-7 nautical miles offshore	✓	✓	✓	✓	-	-	✓	✓
	7-10 nautical miles offshore	-	✓	✓	✓	-	-	✓	✓
	10-12 nautical miles offshore	-	-	✓	✓	-	-	-	✓
	12 nautical miles – 100-metre depth	-	-	-	✓	-	-	-	✓
Harbours *(Potential habitat – low number of sightings)*	Partial extension (refer to map)	-	-	✓	✓	✓	✓	✓	✓
	Remaining harbours	-	-	-	✓	✓	✓	✓	✓
Coast between New Plymouth and Cape Egmont *(southern tail of distribution – low number of sightings)*	0-2 nautical miles offshore	✓	✓	✓	✓	-	-	✓	✓
	2-4 nautical miles offshore	Mandatory observer	✓	✓	✓	-	-	✓	✓
	4-7 nautical miles offshore	Mandatory observer	✓	✓	✓	-	-	-	-
Coast between Cape Egmont and Hawera *(Hector's moving north may transit through this area)*	0-2 nautical miles offshore	✓	✓	✓	✓	-	-	✓	✓
	2-4 nautical miles offshore	Mandatory observer	✓	✓	✓	-	-	✓	✓
	4-7 nautical miles offshore	Mandatory observer	✓	✓	✓	-	-	-	-
Coast between Hawera and Wellington *(potential habitat)*	0-2 nautical miles	-	-	✓	✓	-	-	✓	✓
	2-4 nautical miles offshore	-	-	✓	✓	-	-	-	-

Proposals for restricting commercial and recreational set-netting under the Fisheries Act – west coast North Island

Figure 6: Map showing proposed boundaries of commercial and set-net closures

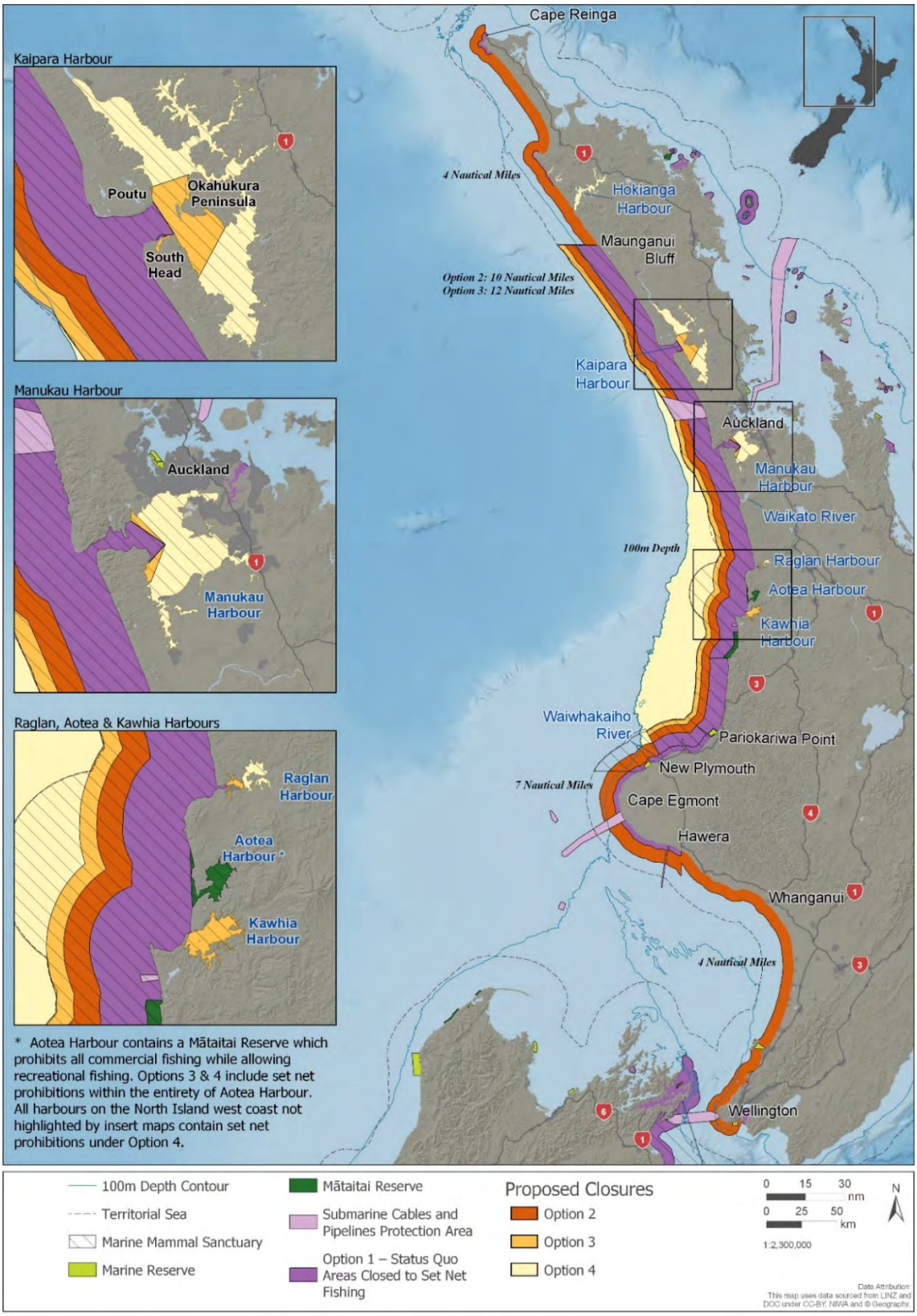


Figure 7: Map showing proposed boundaries of trawl closures

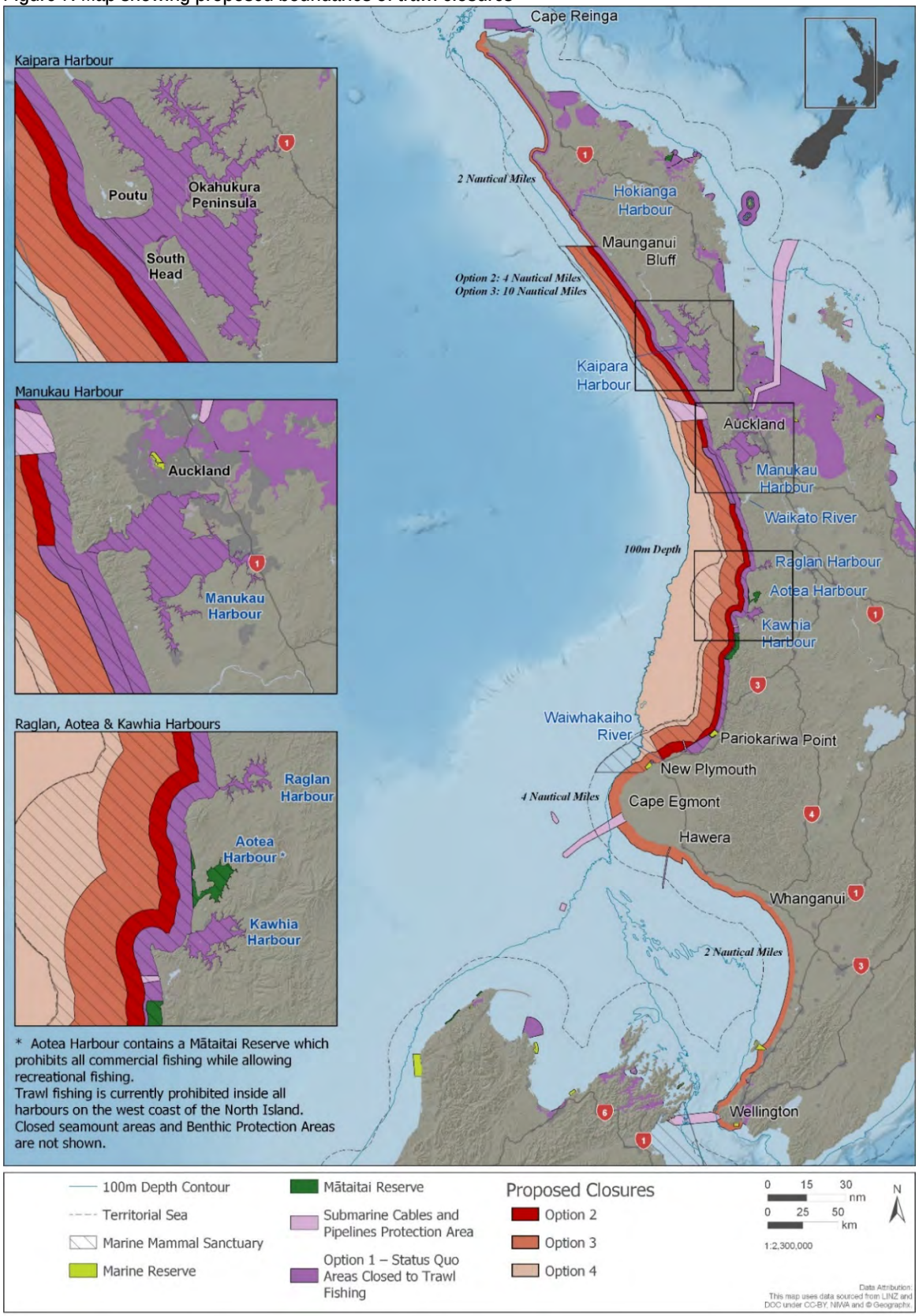
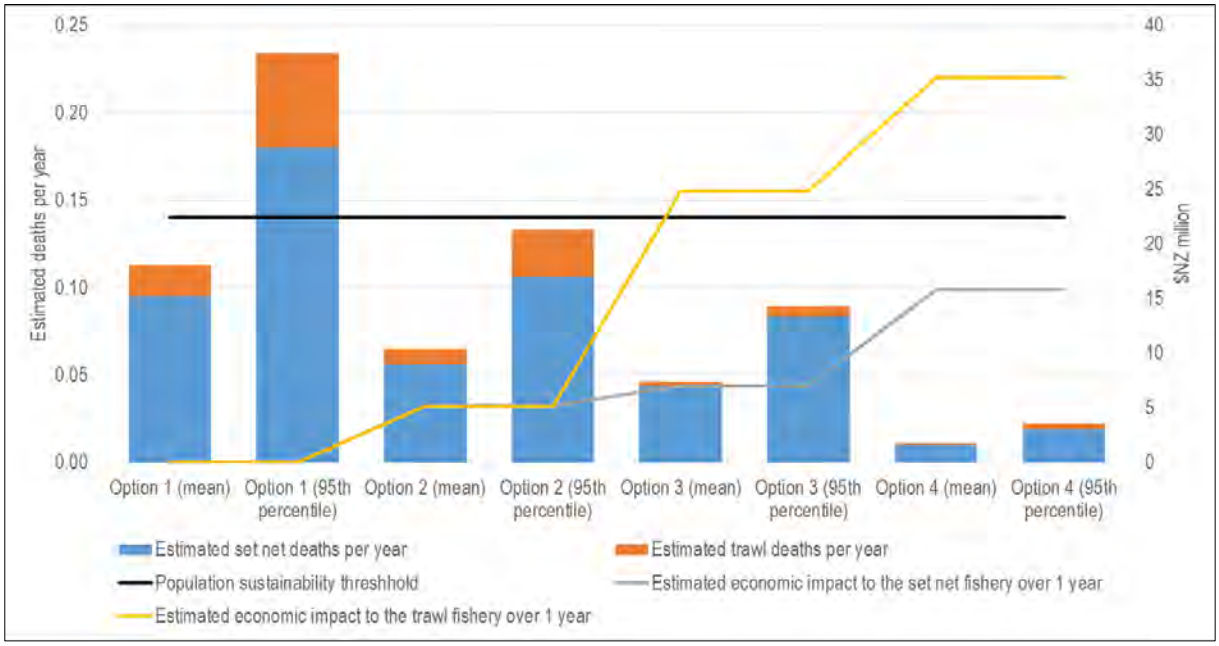


Table 4: Estimated socioeconomic impacts on commercial fishing from proposals for set-net and trawling closures off the west coast of the North Island

		Set-net			Trawl		
		Option 2	**Option 3**	**Option 4**	**Option 2**	**Option 3**	**Option 4**
Additional area closed		6700 km^2	8400 km^2	14,600 km^2	1400 km^2	8100 km^2	14,500 km^2
No. of fishing permit holders with:	>10% landings affected	78	112	160	8	15	18
	≥70% landings affected	28	30	96	0 (2>50%)	3	6
Landings of Quota Management Stocks currently taken in proposed closed area (highest impacts listed only)		Approx 40% SPO8 *(rig)* and WAR8 *(blue warehou)*	43% SPO8 *(rig)*, 40% WAR8, 32% WAR1 *(blue warehou)*	41% SPO1, 38% FLA1 *(flatfish)* 69% WAR8, 50% WAR1 *(blue warehou)*	8% TRE7 *(trevally)*, GUR1 *(gurnard)*, SNA8 *(snapper)*	60% TRE7*(trevally)* & SNA8 *(snapper)*, 45% GUR8 *(gurnard)*,	60% TRE7 *(trevally)* & SNA8 *(snapper)*, 50% GUR8 *(gurnard)*,
Estimate of total annual revenue		↓$1.8mil	↓$2.5mil	↓$5.6 mil	↓$1.8 mil	↓$8 mil	↓$12.5 mil
Total Economic Value Year 1		↓$5.2 mil	↓$7 mil	↓$15.8 mil	↓$5.1mil	↓$24.8 mil	↓$35.2 mil
Total Economic Value 3 years		↓$13.7 mil	↓$18.5mil	↓$41.5 mil	↓$13.5.5mil	↓$65.1mil	↓$92.5. mil
Total Economic Value 5 years		↓$21.2mil	↓$28.7mil	↓$64.4 mil	↓$20.9mil	↓$101mil	↓$143.5mil

6.6.3 Comparison of options

Figure 8: Estimated dolphin deaths by year and economic impact under each proposed option for west coast North Island



Note: Population sustainability threshold = the maximum number of dolphin deaths possible per year from fishing-related activities while still achieving the desired population objective.

Figure 8 shows the outcome of each option at the mean level of estimated set-net deaths (blue) and trawl deaths (orange) and at the upper 95th percentile. Making a decision based on the 95th percentile is the most precautionary approach.

The black line shows the population sustainability threshold to achieve population recovery to 95 percent of the unimpacted level (0.14 deaths per year). The number of deaths caused by fishing need to be below this line to ensure populations can rebuild to the desired level.

The economic impacts on set-netting and trawling are similar for Option 2. For Options 3 and 4, the economic impacts become much higher for trawling, even though the estimated number of deaths that can be prevented by managing trawling under these options is much lower compared to the estimated number of set-net deaths prevented.

It should be noted that there is uncertainty in the information used to assess reduction in risk. The graph should be considered as broadly indicative of outcomes. When considering which option might be preferred, the relative cost and benefits of each option should be considered, that is the socioeconomic impact of Option 3 for set-net is similar to Option 2 but results in a greater level of risk reduction. If implemented, Option 3 for set-net would result in measures extending further into harbours to cover areas where sightings and dolphin detections have occurred. It would also extend measures south from Hawera to Wellington, which sightings data suggests Hector's dolphins may use to traverse from South Island populations.

6.7 **MĀUI DOLPHIN**: WEST COAST NORTH ISLAND OPTIONS – SUPPORTING INFORMATION AND ANALYSIS

6.7.1 Proposed options for west coast North Island set-net

Four risk-reduction options with progressively larger spatial set-net fishery closures have been developed for west coast North Island. This section describes the options and analysis of the corresponding effects in terms of benefits (reduced risk to dolphins) and cost (socioeconomic impacts on fishers) for the west coast North Island as a whole, and also for each area along the west coast.

The proposed options apply to set-net fishing under both the commercial and amateur fishing regulations. However, the quantitative estimates of risk and economic cost refer to commercial set-nets only. As part of the TMP consultation, further information is sought on the level of current recreational set-net effort within the Māui dolphin distribution (best available information suggests that this is low) and the potential socioeconomic impacts of restrictions (which may be high for individuals who rely on set-netting for food).

6.7.1.1 Analysis of options – all of west coast North Island areas combined for set-net

Dolphin density: The estimated spatial distribution of Māui/Hector's dolphins in this area is shown in Figure 1. Dolphin densities are highest between Maunganui Bluff and Cape Egmont and within the 50-metre depth contour. Dolphin densities are low inside harbours.

Current fishing effort and number of permit holders: An estimated 78 permit holders report landings within the areas proposed for closure across Option 2. Options 3 and 4 would increase potential economic impacts, with twice as many permit holders affected by Option 4. The proposals to close areas off the coast would significantly reduce the fishing grounds for rig, school shark and warehou, which are all primarily taken using set-net. The harbour proposals would have a significant impact on flatfish and grey mullet fisheries. The closure of fishing grounds impacts both displaced fishers and quota holders.

Options

- Option 1: This option would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable or can be reduced in ways other than spatial closures. This option has the least amount of direct socioeconomic impact on the fishing industry.
- Option 2: This option reduces total commercial fisheries risk by approximately 35 percent through increased set-net closures between New Plymouth and Cape Egmont. Option 2 also proposes to extend set-net closures into the area between Cape Egmont and Hawera, which is part of a transition area between Māui and Hector's populations.
- Option 3: This option is similar to Option 2, but it proposes larger closures between Maunganui Bluff and New Plymouth, including to 12 nautical miles offshore; increased closures of the harbours, to include all locations at which dolphins have been sighted; and the full transition area from Cape Egmont through to Wellington. Option 3 is estimated to reduce total commercial

fisheries risk by 46 percent, which is very close to proposed total risk reduction objective for the Māui population (risk reduction of 50 percent).

- Option 4: This option is similar to Option 3, but it proposes larger closures between Maunganui Bluff and New Plymouth, including extending measures further off the coast to 100-metre depth and increased closures of the harbours.

Table 5: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting on west coast North Island

West coast North Island – set-net					
		Option 1 (status quo)	Option 2	Option 3	Option 4
Estimated mortalities % reduction from current estimate of 0.11 deaths/y for set-net and trawl combined		0.095 (0.05-0.18)	↓ 0.0391 (35%)	↓ 0.0513 (46%)	↓ 0.085 (77%)
Mean estimate		1 death/10–11 years	1 death/18 years	1 death/20 years	1 death/100 years
Estimate of total annual revenue			↓$1.8mil	↓$2.5mil	↓$5.6 mil
No. of fishing permit holders with:	>10% landings affected		78	112	160
	>=70% landings affected		28	30	96

6.7.1.2 Analysis of options – Coast between Cape Reinga and Maunganui Bluff

Dolphin density: There have been no recent sightings of dolphins in this area. However, habitat modelling indicates that the area north of Maunganui Bluff may be suitable for Māui dolphins. There is also a record of a beachcast dolphin found on Ninety Mile Beach (north of Kaitaia) in the DOC incident database. Anecdotal information from tangata whenua indicate that dolphins were seen in this area historically.

Current fishing effort and number of permit holders: Approximately four permit holders currently report set-net catches within this region. The main species caught are rig, school shark, flatfish and gurnard. The cost of this prohibition would be a reduction in annual total revenue of $350,000.

Options

- Option 1 (status quo): This option would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable or can be reduced in ways other than spatial closures.
- Options 2, 3 and 4: These options propose prohibition on set-netting out to four nautical miles on this coastline, which is to the north of the core Māui dolphin distribution. The benefit of this prohibition is that it would reduce the risk to dolphins that may occasionally move into this area, given that it includes likely dolphin habitat. It would also provide protection for the Māui population if and when it expands. The amount of commercial set-net activity in the area is small (four permit holders) and the socioeconomic impact relatively low ($350 000).

Table 6: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting from Cape Reinga to Maunganui Bluff

		Option 1 (status quo)	Option 2	Option 3	Option 4
Cape Reinga to Maunganui Bluff	Restrictions on set-netting	Prohibitions in selected areas only (out to 1 nautical mile Cape Reinga to Scott Point and out to 0.5 nautical miles Tauroa Point to Whangape Harbour)	Prohibition out to 4 nautical miles		
	Estimated risk reduction (d/y, % of total)		↓ 0.015 (15%) *Reduction of 1 death every 66 years*		
	Estimate of annual revenue		↓$350,000		

6.7.1.3 Analysis of options – Coast between Maunganui Bluff and New Plymouth

Dolphin density: This area encompasses the core distribution of the dolphins and is already subject to restrictions. Dolphin densities are highest closer to shore and approach very low densities at variable distances offshore best approximated by the 50-metre depth contour (Figure 1).

Current fishing effort and number of permit holders: Approximately 25 permit holders regularly report set-net catches within this region. The main species caught are rig, school shark, blue warehou, snapper, trevally, flatfish and gurnard.

Options:

- Option 1 (status quo): This option would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable or can be reduced in ways other than spatial closures.
- Option 2: Extends the existing set-net closure from seven to 10 nautical miles. The benefit of this option would be an estimated 13 percent reduction in fisheries risk. The cost is estimated to be a reduction in total annual revenue of $370,000.
- Option 3: This option extends existing set-net closure to 12 nautical miles, which is sufficiently far offshore to include all but one verified public sighting. The benefit would be an estimated 15 percent reduction in fisheries risk. The cost is estimated to be a reduction in total annual revenue of $450,000.
- Option 4: This option would extend existing set-net closure to 100-metre depth contour. The benefit would be an estimated 18 percent reduction in fisheries risk. The cost is estimated to be a reduction in total annual revenue of $900,000.

Table 7: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting from Maunganui Bluff to New Plymouth (excluding harbours)

		Option 1 (status quo)	Option 2	Option 3	Option 4
Maunganui Bluff to New Plymouth (excluding harbours)	Restrictions on set-netting	Prohibition out to 7 nautical miles	Prohibition out to 10 nautical miles	Prohibition out to 12 nautical miles	Prohibition out to 100-metre depth contour
	Estimated risk reduction (d/y, % of total)		↓ 0.012 (13%)	↓ 0.014 (15%)	↓ 0.0170 (18%)
	Estimate of annual revenue		↓$ 370,000	↓$450,000	↓$900,000

6.7.1.4 Analysis of options – Harbours

Dolphin density: Estimated to be very low, suggesting dolphins enter the harbours very rarely.

Current fishing effort and number of permit holders: The locations of fishing effort inside harbours are reported with lower precision than elsewhere. Approximately 40 permit holders regularly report catch in the Kaipara Harbour and 20 within the Manukau Harbour. Several permit holders also operate in smaller harbours around the coast.

Level of uncertainty: Estimates of fisheries risk inside the harbours are more uncertain than corresponding estimates on the open coast.

Options

- Option 1: This option proposes no changes to spatial management boundaries in harbours.
- Option 2: This option proposes no changes to spatial management boundaries in harbours.
- Option 3: This option would extend existing closures further into harbours to include the locations of all verified public sightings and acoustic detections (see inset images in Figure 6). Option 3 is estimated to reduce total commercial fisheries risk by 11 percent. The cost is estimated to be a reduction in total annual revenue of $560,000.
- Option 4: This option eliminates set-net fishing in harbours completely. Option 4 is estimated to reduce total commercial fisheries risk by 44 percent. The estimates of risk and risk reduction for the harbour areas from the risk assessment are highly uncertain. The cost is estimated to be a reduction in total annual revenue of $3.2 million.

Table 8: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting in harbours

		Option 1 (status quo)	Option 2	Option 3	Option 4
Harbours	Restrictions on set-netting	Defined areas in Kaipara, Manukau and Raglan harbour mouths	No change – Left as option to align with other areas.	Closures as defined	All harbours
	Estimated risk reduction (d/y, % of total)			↓ *0.011 (10%)*	↓ *0.041 (37%)*
	Estimate of annual revenue			↓$560,000	↓$3.2mil

6.7.1.5 Analysis of options – Coast between New Plymouth and Cape Egmont

Dolphin density: This area constitutes the southern "tail" of the known Māui dolphin distribution, in which estimated densities decline from moderately low to very low levels (indicative of very intermittent occasional presence). Occasional dolphin presence in this location is confirmed by verified public sightings.

Current fishing effort and number of permit holders: There is currently limited commercial set-netting occurring within this area.

Options

- Option 1 (status quo): This option would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable or can be reduced in ways other than spatial closures.
- Options 2, 3 and 4 would extend the set-net closure between New Plymouth and Cape Egmont from two nautical miles to seven nautical miles. The benefit is estimated to be a reduction in fisheries risk of 13 percent. The cost is estimated to be a reduction in total annual revenue of $360,000.

Table 9: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting from New Plymouth to Cape Egmont

		Option 1 (status quo)	Option 2	Option 3	Option 4
New Plymouth to Cape Egmont	Restrictions on set-netting	Prohibition out to 2 nautical miles, prohibition unless observer on board 2 nautical miles to 7 nautical miles	Prohibition out to 7 nautical miles		
	Estimated risk reduction (d/y, % of total)		↓ 0.012 (11%) *Reduction of 1 death every 83 years*		
	Estimate of annual revenue		↓$360,000		

6.7.1.6 Analysis of options – Coast between Cape Egmont and Wellington

Dolphin density: There is no evidence of a resident population south of Cape Egmont, but public sightings and acoustic detections confirm that Hector's and/or Māui dolphins are infrequently present here, and historical evidence suggests that they were likely to have been more abundant here in the past. The estimation of fisheries risk shown here uses a habitat model to estimate what the risk would be if dolphins were present year-round at densities comparable to Māui dolphins in similar habitats.

Hector's dolphins may occasionally use this area when transiting between South Island populations and the area of known Māui dolphin habitat. The number of dolphins that undertake this movement is unknown. However, two Hector's dolphins have been genetically sampled in the Māui area. This interconnectivity between populations may be important to ensuring the future of the Māui population. Dolphins traversing this area are estimated to experience higher recreational set-net risk than anywhere else in New Zealand (but note recreational fisheries risk is estimated on a relative scale only and is not included in the quantitative estimates below).

Current fishing effort and number of permit holders: Approximately two to five permit holders report catches using the method of set-netting within the Taranaki area.

Options

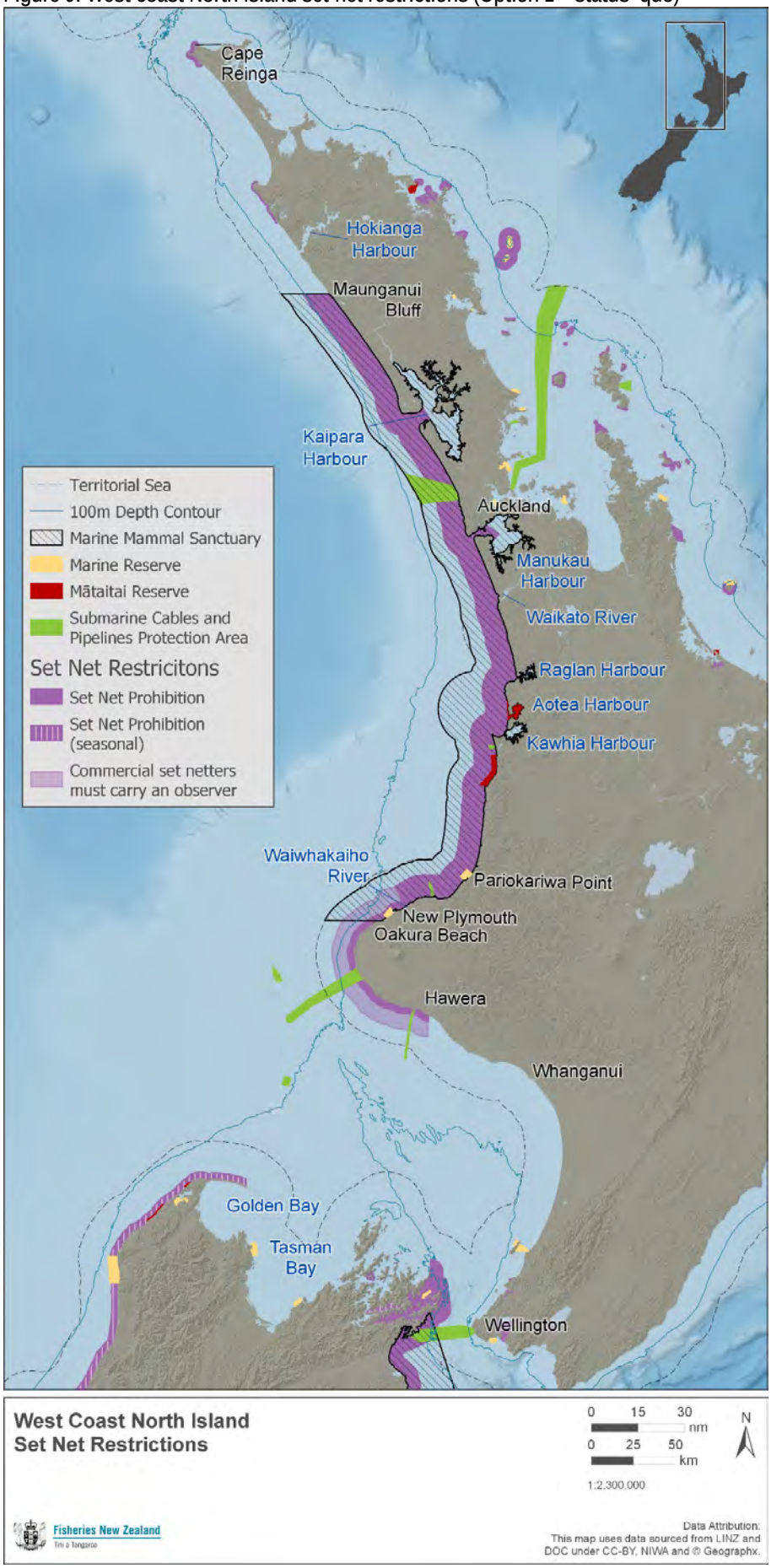
- Option 1 (status quo): This option would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable or can be reduced in ways other than spatial closures. This option has the least amount of direct socioeconomic impact on the fishing industry.
- Options 2, 3 and 4:
  - Would introduce a new four nautical mile closure from Hawera to Wellington. The benefit is estimated to be a 75 percent reduction in fisheries risk to dolphins in this "transition" area. It does not alter the fisheries risk in the areas north of Cape Egmont where the majority of Māui dolphin are found.
  - Would extend the existing two nautical mile closure to seven nautical miles from Cape Egmont through to Hawera. The benefit is estimated to be a two percent reduction in fisheries risk. The cost of closure of this area would be an estimated $125,000 reduction in total annual revenue.

Table 10: Estimated fisheries deaths (status quo) and deaths prevented under options for set-netting from Cape Egmont to Wellington (transition habitat area*)

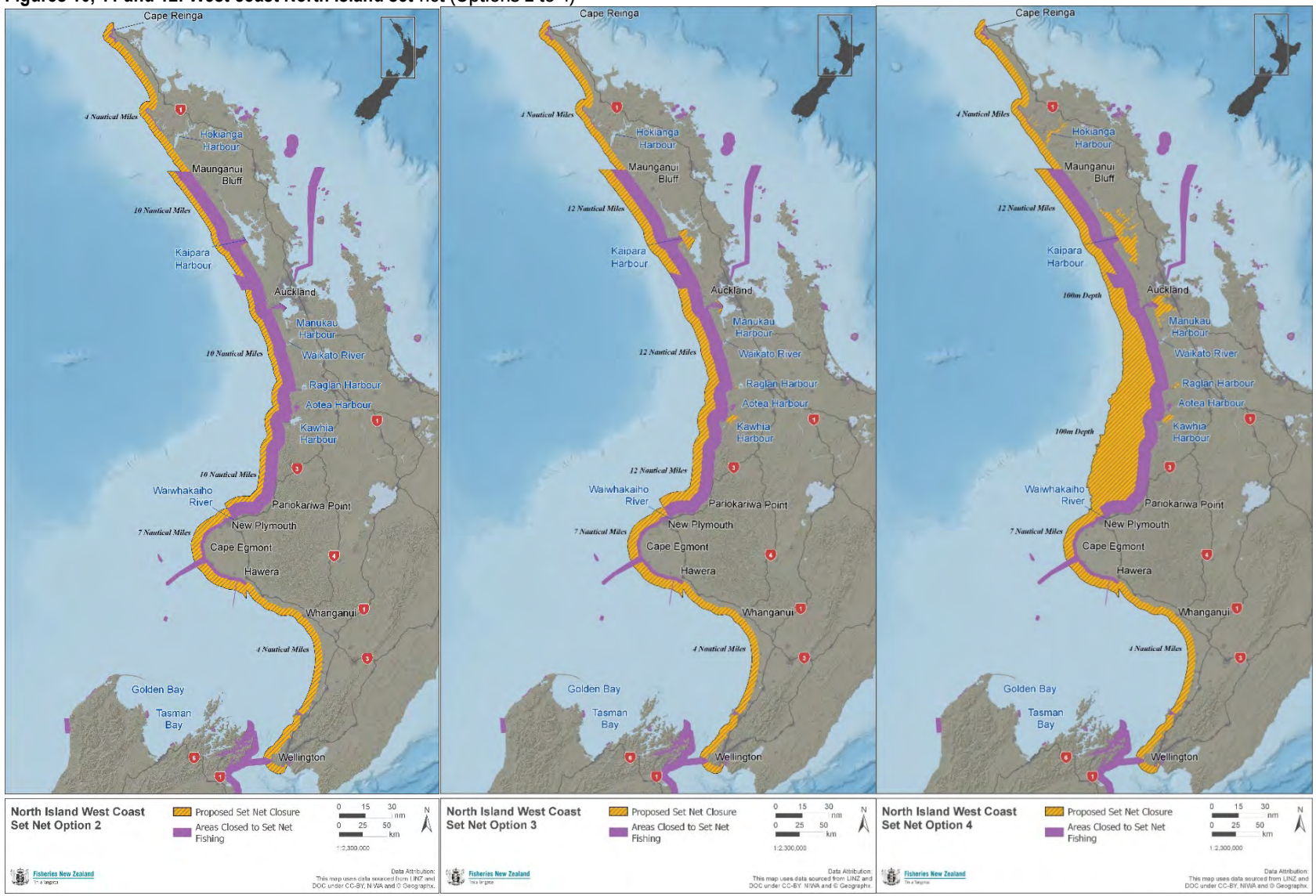
		Option 1 (status quo)	Option 2	Option 3	Option 4
Estimate of total annual set-net deaths*		0.063 (0.025-0.011)	↓ 0.049 deaths/y (77% for this transition area)		
		Options 1 (status quo)	Option 2	Option 3	Option 4
Cape Egmont to Hawera	Restrictions on set-netting	Prohibition out to 2 nautical miles, prohibition unless observer on board to 7 nautical miles	Prohibition out to 7 nautical miles		
	Estimated risk reduction (d/y, % of transition area total)		↓ 0.001% deaths/y (2%) *Reduction of 1 death every 1000 years*		
	Estimate of annual revenue		↓$125,000		
		Option 1 (status quo)	Option 2	Option 3	Option 4
Hawera to Wellington	Restrictions on set-netting	Prohibitions in reserve areas only	Prohibition out to 4 nautical miles		
	Estimated risk reduction (d/y, % of transition area total)		↓ 0.048 deaths/y (75%)		
	Estimate of annual revenue		↓$630,000		

* Estimates of annual deaths reflect the risk that would be faced by dolphins if they were resident year-round at equivalent densities to what occurs in comparable Māui dolphin habitats. Because there is no evidence of an actual resident population in the transition habitat, and the frequency with which dolphins transit this area is unknown, these figures represent potential risk to transiting or recolonising dolphins, not actual current deaths.

Figure 9: West coast North Island set-net restrictions (Option 1 – status quo)



Figures 10, 11 and 12: West coast North Island set-net (Options 2 to 4)



6.7.2 Proposed options for west coast North Island trawl

Four options for progressively larger trawl fishery closures have also been developed for the west coast of the North Island. The options are analysed for the west coast as a whole, though fisheries deaths are also estimated separately in each discrete area. The amount of risk reduction relative to the economic impact is significantly lower for trawl fishery closures than for set-net closures in the same locations. This reflects the higher profitability of trawl fisheries and much lower probability of capturing dolphins per unit effort. Alternate variations on these options could be chosen from within the range from Option 1 (status quo) to Option 4.

Note these options are proposed with reference to traditional trawl methods. If modified "dolphin-friendly" trawl methods can be developed and are shown to effectively mitigate trawl risk to dolphins then exemptions to these closures could be considered in future.

Table 11: Options for trawl for west coast North Island

West coast North Island – trawl					
		Option 1 (status quo)	Option 2	Option 3	Option 4
Estimate of total annual trawl mortalities and % change (note percent reductions are reported relative 0.11 deaths per year for set-net and trawl fisheries combined)		0.018 (0 – 0.054)	↓ 0.009 deaths/y (↓ 9%)	↓ 0.016 deaths/y (↓ 15%)	↓ 0.017 deaths/y (↓ 15%)
No. of fishing permit holders with:	>10% landings affected		8	15	18
	>=70% landings affected		0 (2 > 50%)	3	6
Quota stocks most affected			8% TRE7, GUR1, SNA1	60% TRE7 & SNA8, 45% GUR8	60% TRE7 & SNA8, 50% GUR8
Estimate of total annual revenue			↓$1.8 mil	↓$8 mil	↓$12.5 mil
Total Economic Value Year 1			↓$5.1mil	↓$24.8 mil	↓$35.2 mil
Total Economic Value 3 years			↓$13.5.5mil	↓$65.1mil	↓$92.5. mil
Total Economic Value 5 years			↓$20.9mil	↓$101mil	↓$143.5mil

Table 12: Analysis of options by area for west coast North Island trawl

Analysis by area					
		Option 1 (status quo)	Option 2	Option 3	Option 4
Cape Reinga to Maunganui Bluff	Restrictions on trawl		No change	Prohibit out to 2 nautical miles	
	Estimate of annual trawl mortalities			↓ 0.0004 deaths/y (↓ 0.4%)	
	Socioeconomic impacts			↓$450,820	
Maunganui Bluff to New Plymouth	Restrictions on trawl		Prohibition out to 4 nautical miles	Prohibition out to 7 or 10 nautical miles	Prohibition out to 100 metre contour
	Estimate of annual trawl mortalities		↓ 0.009 deaths/y (↓ 8%)	Note ↓ 0.0148 (↓ 13% out to 7 nautical miles)	(↓ 0.0160) deaths/y (↓ 14%)

				↓ 0.0157 (↓ 14% out to 10 nautical miles)	
	Socioeconomic impacts		↓$886,895	↓ $5,146,110 (out to 7 nautical miles) ↓$7,851,371 (out to 10 nautical miles)	↓$11,687,828

New Plymouth to Hawera	Restrictions on trawl			Prohibition out to 4 nautical miles
	Estimate of annual trawl mortalities			(↓ 0.00127 Māui) (↓ 0.1%)
	Socioeconomic impacts			↓ $283,845

Hawera to Wellington	Restrictions on trawl	Prohibitions in reserve areas only		Prohibition out to 2 nautical miles
	Estimate of annual trawl mortalities			(↓ 0.000194)
	Socioeconomic impacts			↓ $221,145

6.7.2.1 Analysis of options – west coast North Island trawl

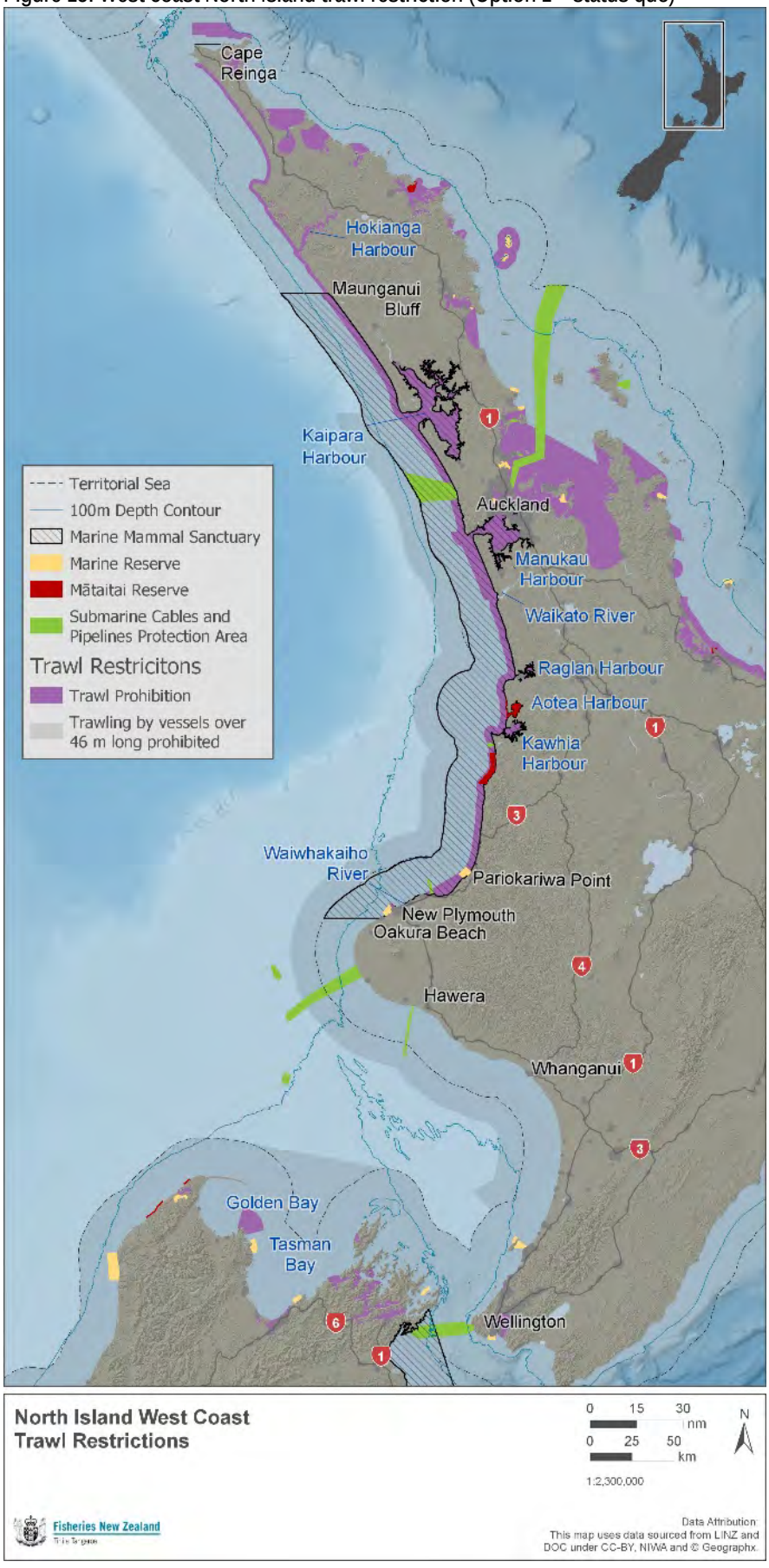
Dolphin density: See Figure 1 and Section 6.7.1.1 above.

Options

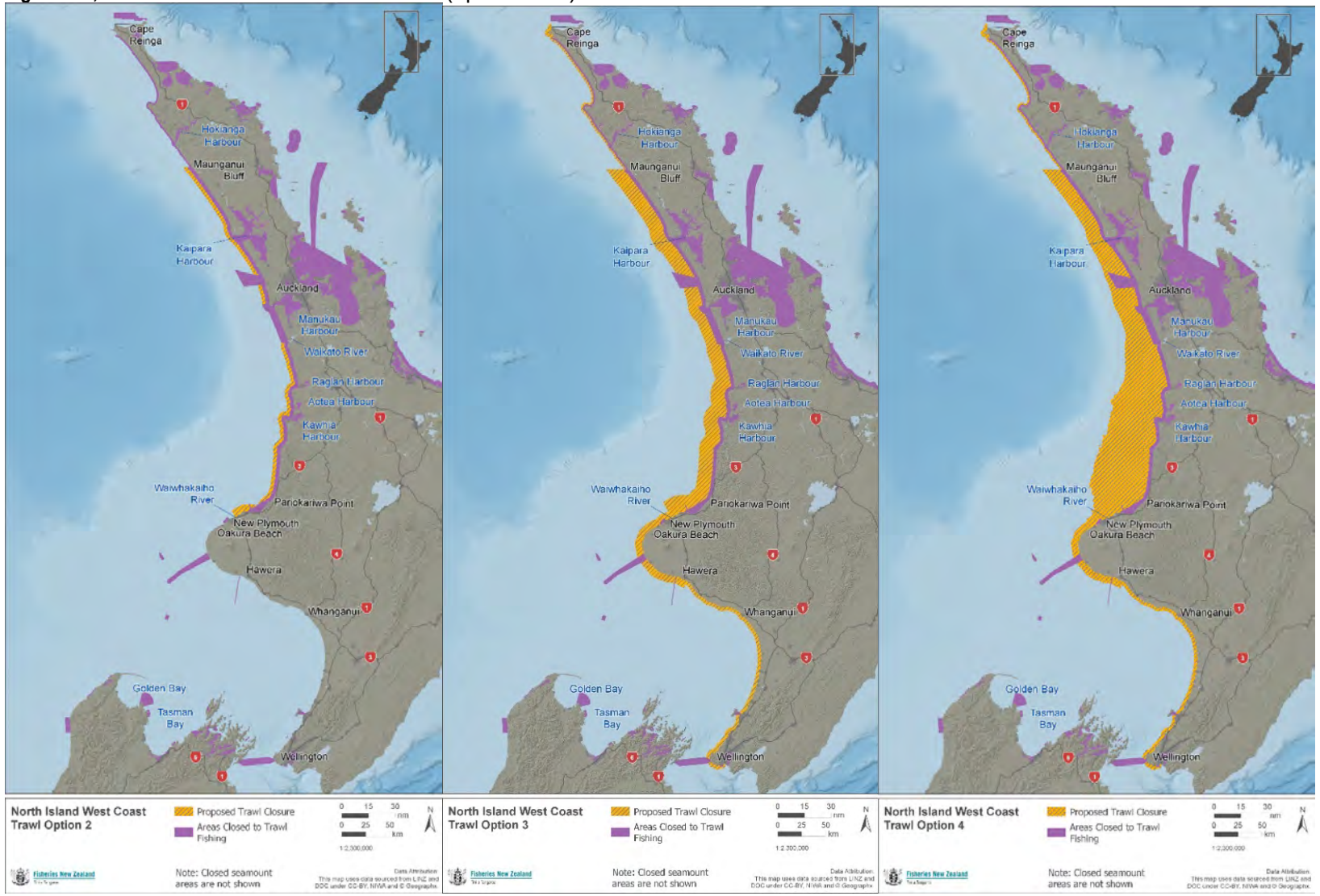
- Option 1: Independent monitoring of the trawl fleet operating in Māui dolphin habitat would be required under this option and a trigger point would also be implemented. If a Māui dolphin was reported killed in a trawl net, all fishing activity using this method would stop until the Minister made a determination about whether trawl fishing could recommence, subject to any conditions considered reasonable, such as those relating to time, area and method. This option recognises that trawl fisheries risk is lower than set-net fisheries risk, and that risk-reduction measures for trawling carry greater socioeconomic cost. The benefit is that it does not impact on existing use except in the event of a mortality. The cost of this option is that it does not reduce the current risk of a mortality from trawl vessels.
- Option 2: This option reduces the total commercial fisheries risk by approximately nine percent through trawl closures along the west coast of the North Island from Manganui Bluff to New Plymouth. The distance that the proposed closures extend offshore differs between sections of the coast. The benefit is that, in combination with Option 3 for set-netting, it would reduce fishing-related risk by a total of 55 percent, marginally exceeding the level of risk reduction considered necessary to achieve the desired outcomes with high certainty. The cost of this option is estimated to be $1.8 million in annual revenue.
- Option 3: This option extends trawl closures substantially to varying distances offshore, including to 10 nautical miles in the core habitat and establishing a new two nautical mile trawl closure in the "transition habitat" as far south as Wellington and as far north as Cape Reinga. Total commercial fisheries risk to Māui dolphins would be reduced by 15 percent. Relative to Option 2, the socioeconomic cost increases from $1.8 to $8 million total annual revenue for a relatively small reduction in overall risk.
- Option 4 is similar to Option 3 but extends trawl closures further off the coast to the 100-metre depth contour. Cost increases from $8 million to $12 million in total annual revenue, for a broadly

similar level of risk reduction relative to Option 3. Information indicating that the dolphin distribution extends to the 100-metre depth contour off this coast is very limited; benefits for the dolphins of extending the trawl closure to this distance are highly uncertain.

Figure 13: West coast North Island trawl restriction (Option 1 – status quo)



Figures 14, 15 and 16: West coast North Island trawl (Options 2 to 4)



6.8 HECTOR'S DOLPHIN: SOUTH ISLAND – CONTEXT

Two overall Hector's dolphin population objectives are proposed:

1. *For each Hector's dolphin subpopulation, reduce fisheries risks to very low levels, sufficient (with 95 percent certainty) to allow the population to recover to and remain at or above 90 percent of carrying capacity.*
2. *For each local population, reduce fisheries risks sufficient (with 95 percent certainty) to allow the population to recover to and remain at or above 80 percent of carrying capacity.*

Pursuant of those objectives:

- *manage commercial fishing to ensure that the combined estimate of mortality from set-netting and trawling is below the population sustainability threshold for each subpopulation and defined local populations;*
- *provide consistency between commercial and recreational set-netting restrictions in acknowledgement of the similar risk factors between fishing types, as well as the potential for recreational gear to be lost and become a drifting risk to dolphins;*
- *continue data collection programmes to increase the precision of estimates of fisheries risk.*

6.8.1 Need for management action

As the Hector's dolphins population is much larger than for Māui's, the necessity for additional measures depends very much on the decision regarding what long-term population outcome is desired, and therefore what level of impact is acceptable.

For the purposes of consultation, given the larger current population size of Hector's dolphins in comparison to Māui dolphins, Fisheries New Zealand considers that at the subpopulation scale, managing fisheries risk to achieve population sizes at or above 90 percent of their unimpacted status, with 95 percent certainty, is an appropriate population outcome. However, a lower population outcome (such as 80 percent of unimpacted status) could also be chosen. This outcome would result in the need for less stringent measures to manage risk of fishing-related mortality.

In this context, at the local population level, Fisheries New Zealand consider that an objective of maintaining or increasing populations to levels at or above 80 percent of carrying capacity best reflects the relative importance of maintaining local populations relative to ensuring the overall population is maintained at desired levels.

The full range of population outcomes considered is outlined in Table 13 below.

6.8.2 Current measures

Hector's dolphins occur around most of the South Island in three recognised subpopulations:

- east coast South Island;
- west coast South Island;
- south coast South Island.

North coast South Island Hector's dolphins may constitute a fourth subpopulation. Information on this possible subpopulation is limited and highly uncertain.

However, for the purposes of setting population objectives, the TMP assumes the three recognised subpopulations and the north coast South Island possible subpopulation are all biologically distinct. A map of subpopulation boundaries is included in Appendix 1.

The first spatial closure implemented to mitigate the risk of Hector's dolphin incidental capture was put in place around Banks Peninsula in 1988. Commercial set-netting was effectively prohibited out to four nautical miles from the coast and recreational set-netting was subject to seasonal restrictions.

In 2008, following the development of the TMP, a more extensive package of spatial closures was implemented by the Minister of Fisheries, providing some protection in most of the areas where

Hector's dolphins are found and largely superseding the existing discrete closures. On the east and south coasts of the South Island most set-netting was prohibited within four nautical miles of the coast (with an exemption near the mouth of Kaikōura Canyon, and in some estuarine areas to allow fishing for flatfish and a butterfish exclusion area north of Kaikōura).On the west coast of the South Island, recreational set-netting was banned within two nautical miles of the coast and commercial set-netting was subject to a seasonal restriction.

In 2008, on the east and south coasts of the South Island, trawling was subject to additional restrictions within two nautical miles. Within this area, trawlers were allowed to operate using low headline height trawl gear only.

6.8.3 Current impact and risk

6.8.3.1 Spatial overlap

Spatial patterns of Hector's dolphin density are estimated with high accuracy in the core areas of Hector's dolphin habitat on the east and west coasts of the South Island. Locations at which high dolphin densities are predicted in Figure 2 have been validated with reference to independent data (from fisheries observer and public sightings), and the captures estimation model does a good job of predicting the locations at which historical captures have occurred, and where captures continue to occur in recent years, based on overlap between the spatial distribution of the dolphins (in Figure 2) and known fishing effort locations.

Overlap with set-nets (hence residual risk) occurs in three main locations of the east coast of the South Island:

- in Pegasus Bay (north of Banks Peninsula) where high dolphin densities occur much further offshore (> 15 nautical miles) than the extent of the existing closure (four nautical miles);
- from Banks Peninsula to Timaru, in a narrow strip where high dolphin densities occur further offshore than the existing four nautical mile closure;
- near Kaikōura Canyon, where dolphin densities are low to moderate, but set-net fishing effort is extremely high in the area close to shore that was exempted from the four nautical mile closure in 2008.

Overlap with trawl fisheries on the east coast of the South Island occurs in roughly the same locations in Pegasus Bay and is highest near the port of Timaru, but trawl risk is substantially lower than set-net risk, reflecting the dolphins' much lower catchability in trawls.

On the west coast of the South Island, overlap (and risk) is very low from both fishing methods, reflecting low fishing effort in locations where dolphins occur. No further management is proposed for the west coast of the South Island.

Estimates of overlap and risk on the north and south coasts of the South Island are much less certain than elsewhere because the spatial habitat model (correctly) predicts very low densities of dolphins in these areas, reflecting that these subpopulations are small. But, because the reliability of the spatial model's predictions is lower in very low-density areas, the spatial patterns of dolphin distribution (and therefore overlap and risk) predicted in the north and south coasts of the South Island are more uncertain than for the high-density populations on the east and west coasts of the South Island. On the south coast of the South Island the spatial model lacked a key data layer (dolphin prey availability), so the map may be particularly uncertain for this subpopulation.

Reflecting this uncertainty, the risk management options proposed below for the south and north coasts of the South Island were designed with reference to actual observations (raw data from aerial and public sightings) and with less reliance on the predictions of the spatial habitat model. Risk ratio estimates derived from the habitat model (see Table 13) should be interpreted with appropriate caution, and alternate means of estimating the need for and effectiveness of these options are considered below. Further research to better understand the dolphins' spatial distributions in these subpopulations is a priority.

6.8.3.2 Estimation of catchability using fisheries observer data

There have been 15 observed set-net captures from 3009 observed kilometres of set-net fishing (from 1996-2017, excluding the North Island), and a single observed trawl capture from 3402 observed trawl events in the same period. Dolphin catchability is much higher in set-nets than in trawls. Because there are more observed set-net captures than trawl captures, set-net catchability (and risk) can be estimated with higher precision than the corresponding estimates for trawls (that is, trawl risk is much lower, but also more uncertain).

6.8.3.3 Use of fisher-reported (unobserved) captures data

There have been 90 captures of Hector's dolphins reported voluntarily by fishers (84 fishing events), 65 fisher-reported captures by set-net (in 52 capture events) and 25 fisher-reported trawl captures by trawl (in 13 capture events). Because fishers may not always voluntarily report their captures, these data are not used to estimate catchability in the spatial risk model, but the model does a good job of predicting the locations of both observed and self-reported capture events, lending confidence to the model's ability to estimate captures in other locations.

In early 2019, after the spatial risk assessment model had already been completed and reviewed, there were two fisher-reported capture events of Hector's dolphins that attracted considerable public attention because they both involved multiple dolphins captured in a single event. In light of this new information, Fisheries New Zealand via its science working groups reviewed the assumptions underlying the estimation of trawl fishery risk in the risk assessment model. The working group judged that the model correctly estimated the frequency with which captures occur (because more than three thousand fishing events have been observed in locations where dolphins may be present) but most likely underestimated the number of dolphin deaths per capture (because only a single capture trawl event has been observed). Fisher-reported captures data, including the new multiple captures, were then used to estimate that trawl capture events are likely to catch more than one dolphin (average two, range one to four). For this reason, trawl fisheries risk has been multiplied by two relative to what was initially estimated by the spatial risk assessment model before this correction was adopted[11].

6.8.3.4 Estimated commercial fisheries impact and risk

Risk scores have been calculated separately for each subpopulation.

Local population risk scores have also been calculated in the three locations of highest localised fisheries risk on the east coast of the South Island. Local populations are defined at spatial scales comparable to the distances over which individual dolphins are typically known to range in their lifetimes. There is no evidence that local populations are genetically distinct or otherwise isolated from neighbouring populations, but by managing risk also at the local scale (that is, estimated as if the populations were distinct), fisheries managers can be sure to avoid localised depletion.

Because there are no fisheries observers assigned to monitoring recreational set-net fishing, numerical estimates of risk in the tables below do not include recreational fisheries risk. In most locations set-net closures are already in place since at least 2008, meaning that recreational fisheries risk has been greatly reduced (because recreational fishers cannot operate at large distances offshore).This is true on the east and south coasts of the South Island, and on much of the west coast, although some recreational set-net fishing still occurs legally in harbours or estuaries, and recreational set-netting still occasionally occurs illegally in closed areas.

The notable exception is the north coast South Island, where relatively high levels of recreational set-net fishing occurs in Tasman Bay and Golden Bay. Risk associated with this fishing is not reflected in the numerical risk ratios but may be considerable.

[11] In the published risk assessment document, the updated (doubled) trawl estimates are reproduced in Appendix 17; these are the figures that are used to inform management advice under this update of the TMP.

Table 13: Population objectives and accompanying risk ratio estimates by subpopulation in the South Island

			Population objective		
Subpopulation	Population size (mean estimate)	Annual fisheries deaths (mean estimate)	Risk ratio → 80% carrying capacity (median and 95th percentile)	Risk ratio → 90% carrying capacity (median and 95th percentile)	Risk ratio → 95% carrying capacity (median and 95th percentile)
Hector's					
east coast	9728	51.2		0.90 (2.16)	1.80 (4.31)
west coast	5 482	5.5		0.14 (0.60)	0.27 (1.21)
south coast	332	1.2*		0.72 (1.53 – 3.35)**	1.44 (3.09 – 6.71)**
north coast	214*	1.0*		0.78 (2.07)	1.56 (4.14)
East coast South Island – local populations					
Kaikōura	*757*	11.0	1.04 (2.18)	2.60 (5.44)	5.20 (10.88)
Banks Peninsula	*4505*	17.4	0.27 (0.59)	0.67 (1.48)	1.34 (2.97)
Timaru	*2725*	19.8	0.48 (1.24)	1.21 (3.10)	2.42 (6.20)

* The south coast and north coast South Island estimates are uncertain, reflecting uncertain spatial distribution of the dolphins.
**On the south coast, the variable 95th percentile confidence interval estimates reflect alternate spatial distribution scenarios.

6.9 HECTOR'S DOLPHIN: SOUTH ISLAND – PROPOSALS TO REDUCE FISHERIES RISK

6.9.1 Overview

Population sustainability threshold

To achieve the proposed population outcome (populations maintained at or above 90 percent of the unimpacted population status) population models estimate that fisheries mortalities cannot exceed:

- 48.6 deaths from the east coast South Island subpopulation;
- 1.1 deaths from the north coast South Island subpopulation;
- 27.4 deaths from the west coast South Island subpopulation;
- 1.7 deaths from the south coast South Island subpopulation.

The risk ratios (that is, fisheries deaths divided by the population sustainability threshold) for the proposed population objective (recovery to 90 percent of unimpacted status), and for potential alternate population objectives (that is, 80 percent or 95 percent of unimpacted status) are outlined in Table 13. Risk ratios exceeding one (highlighted in red) indicate where the risk assessment estimates that current dolphin deaths (mean or 95th percentile) exceed the population sustainability threshold (allowable mortalities) such that risk reduction measures should be considered.

As shown in Table 13, the risk assessment indicates that fisheries risk is very low on the west coast of the South Island, due to very low fishing effort in locations where dolphins are present. This conclusion is strongly supported by anecdotal and reported information. No further reduction in risk is considered necessary for this dolphin population at this time. For other subpopulations, risk reduction measures are proposed in line with estimates from the risk assessment.

6.9.2 Options

Consistent with fisheries risk reduction objectives identified in Section 5.4 and Table 2, above, agencies identified a need to design spatial risk-reduction options for subpopulations of Hector's dolphins (on the east coast, north coast, and south coast of the South Island) and also within three local populations on the east coast where fisheries impacts are highest (Kaikōura, Banks Peninsula, and Timaru).

Three broad options for management response are discussed:

- Option 1 is to maintain the status quo for spatial management, but to require additional monitoring.
- Options 2 and 3 provide different combinations of set-net and trawl closures designed to eliminate fisheries risk in key areas where the remaining overlap and risk are highest.

Spatial risk estimates underpinning the design of new spatial management options reflect the updated spatial distribution of the dolphins; new closures are designed to displace fishing effort out of high dolphin density areas and into areas of much lower dolphin density. Each option builds upon the previous option to accomplish greater risk reduction, with a corresponding higher socioeconomic cost to fishers.

Alternatively, decision-makers may choose different combinations of specific area closures to generate intermediate options; the effects of specific area closures are additive (to dolphin deaths prevented and socioeconomic cost).

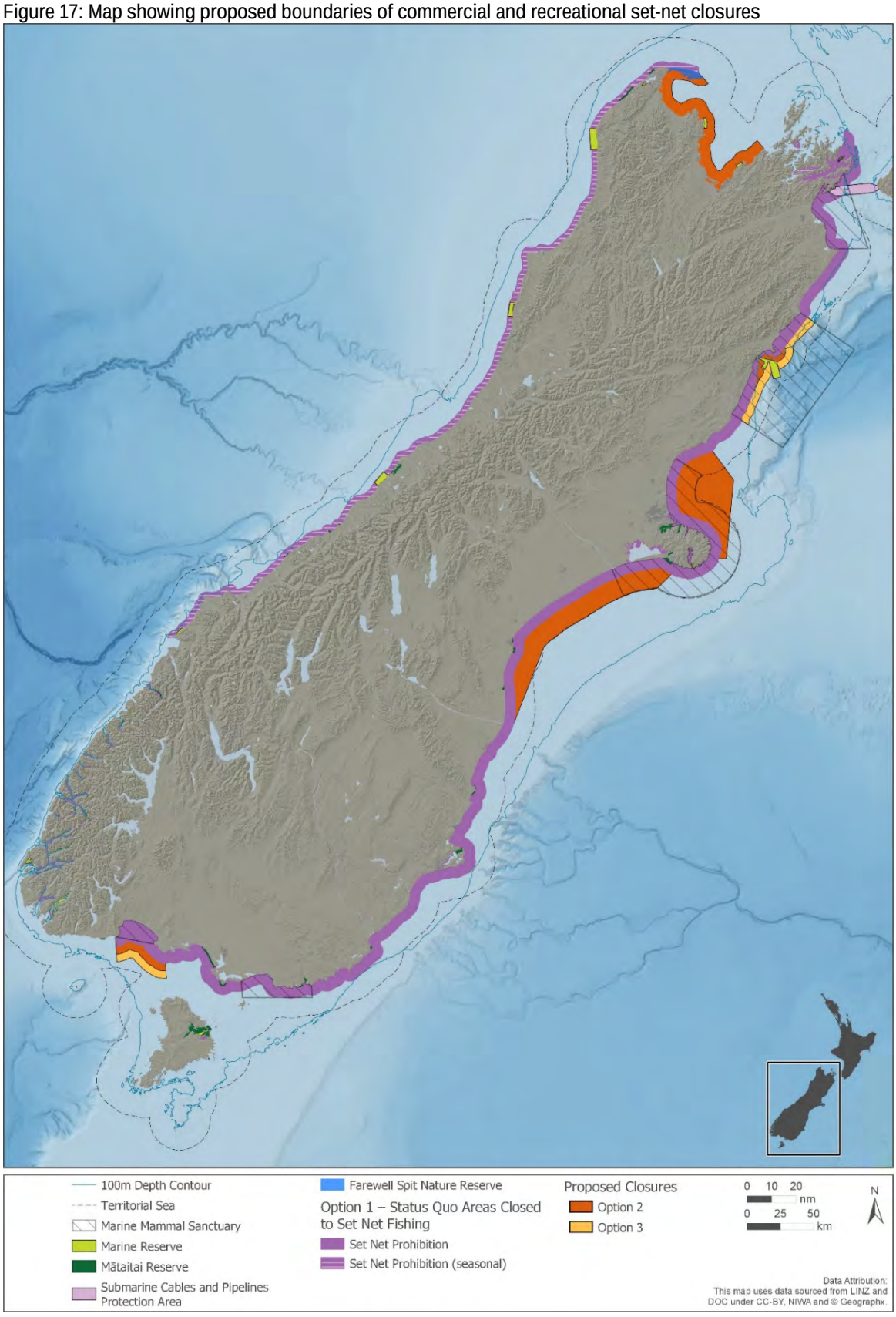
Within each of the subpopulations, three options for managing residual fisheries risk to Hector's dolphins have been developed for the purposes of consultation. These options are summarised in Table 14. The options are presented geographically in Figure 17 (set-net) and Figure 18 (trawl). Section 6.10 provides more detailed objectives and an analysis of the options by subpopulation and local population.

Table 14: South Island (Hector's dolphin) proposed method restrictions by fishing type

		Proposed method restrictions					
		Set-net (commercial and recreational)			Trawl		
		Option 1 (status quo)	Option 2	Option 3	Option 1 (status quo)	Option 2	Option 3
Kaikōura – refer to map *(east coast South Island)*	0-4 nautical mile	Exemption in Kaikōura Canyon	✓	✓	2 nautical miles with low headline height exemption	No change	No change
	4-7 nautical mile	-	-	✓	-	-	-
Pegasus Bay *(east coast South Island)*	0-2 nautical miles	✓	✓	✓	low headline height exemption	✓	✓
	2-4 nautical miles	✓	✓	✓	-	✓	✓
	Entire bay (refer to map)		✓	✓	-	✓	✓
south from Banks Peninsula to Timaru *(east coast South Island)*	0-2 nautical miles	✓	✓	✓	low headline height exemption	✓	✓
	2-4 nautical miles	✓	✓	✓	-	✓	✓
	Extended closures (refer to map)	-	Banks Peninsula – Waitaki River (refer to map)	Same as Option 2	-	southern closure only (refer to map)	closure from Banks Peninsula (refer to map)
Golden Bay and Tasman Bay *(north coast South Island)*	0-2 nautical miles	-	✓	✓	-	-	✓
	2-4 nautical miles	-	✓	✓	-	-	-
Te Waewae Bay *(south coast South Island)*	0-2 nautical miles	✓	✓	✓	low headline height exemption	✓	✓
	in bay (refer to map)	✓	✓	✓	-	✓	✓
	4 nautical miles offshore	✓	✓	✓	-	-	✓
	7 nautical miles offshore	-	✓	✓	-	-	-
	10 nautical miles offshore	-	-	✓	-	-	-

Proposals for restricting commercial and recreational set-netting under the Fisheries Act – South Island

Figure 17: Map showing proposed boundaries of commercial and recreational set-net closures



Proposals for restricting trawling under the Fisheries Act – South Island

Figure 18: Map showing proposed boundaries of trawl closures

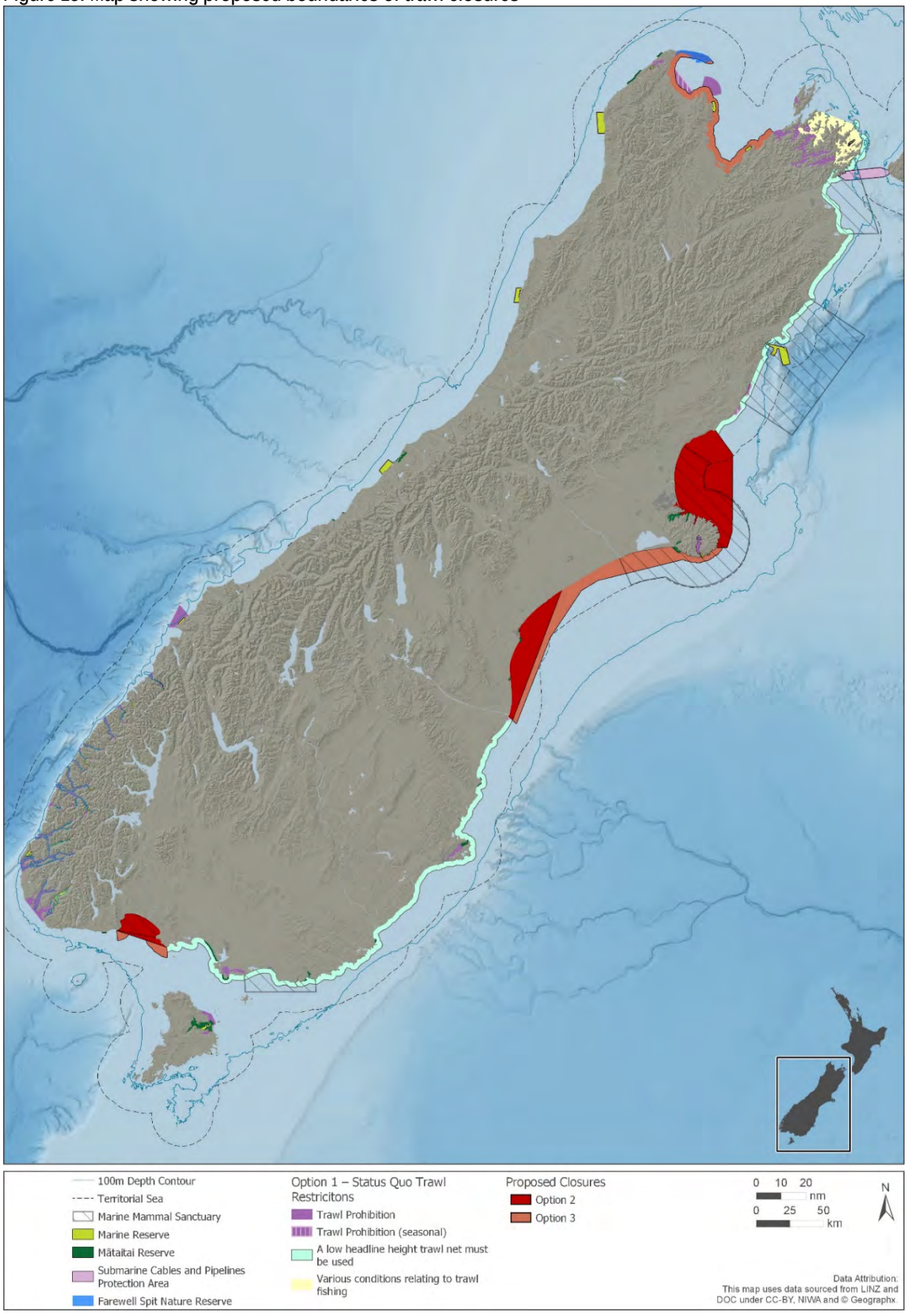
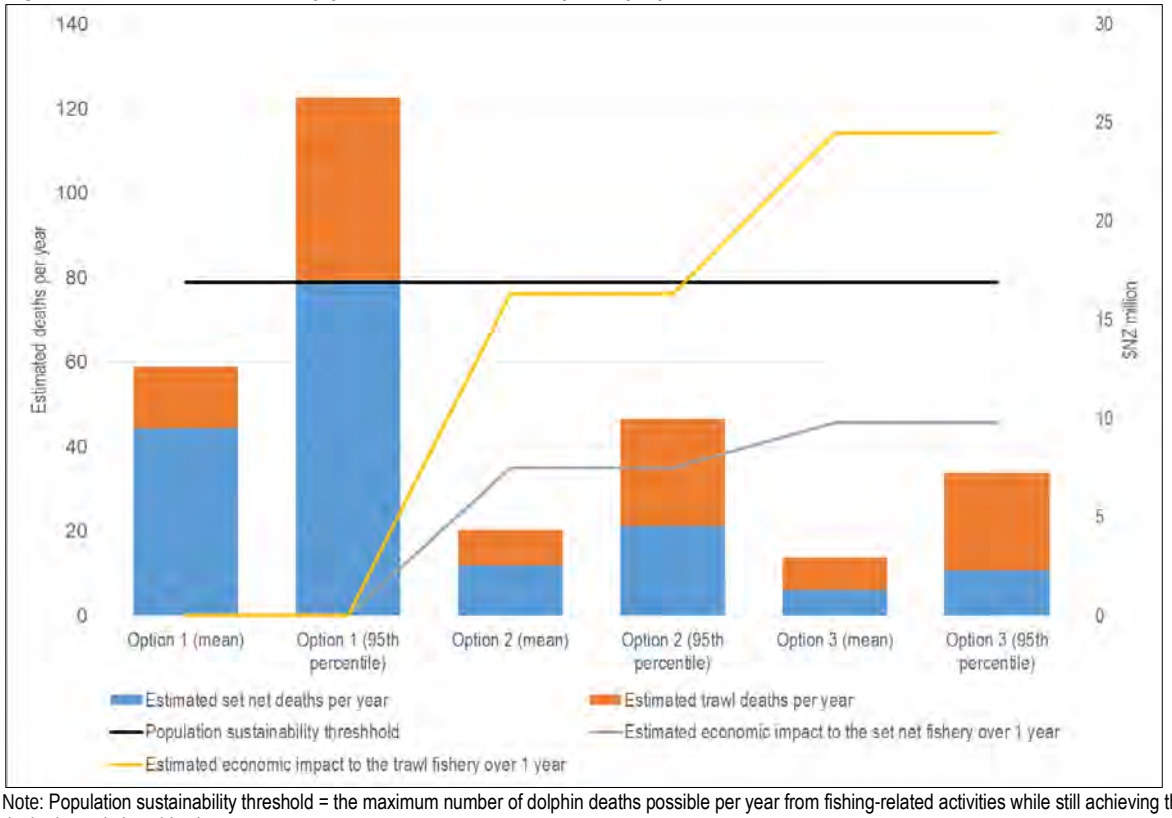


Table 15: Estimated socioeconomic impacts on commercial fishing from proposals for set-net and trawling closures in the South Island

		Set-net		Trawl	
		Option 2	**Option 3**	**Option 2**	**Option 3**
Additional area closed		6000 km^2	3600 km^2	6500 km^2	6300 km^2
No. of fishing permit holders with:	>10% landings affected	28	29	45	77
	≥70% landings affected	5	7	9	13
Landings of Quota Management Stocks currently taken in proposed closed area (highest impacts listed only)		Approx. 30% MOK3 *(moki)*, 20% SCH3 *(school shark)*, 18% SPO3 *(rig)*, HPB3 *(hapuku bass)*, 15% SPO7	Approx. 44% MOK3 *(moki)*,, 25% HPB3 *(hapuku bass)*, 24% SCH3 *(school shark)*, 20% SPO3,15% SPO7 *(rig)*	Approx. 28% ELE3 *(elephantfish)*, 20% RSK3 *(rough skate)*, 18% GUR3 *(gurnard)*, FLA3 *(flatfish)*, 9% RCO3 *(red cod)*	Approx. 42% ELE3 *(elephantfish)*,, 29% RSK3 *(rough skate)*, 25% GUR3 *(gurnard)*, FLA3*(flatfish)*, 16% RCO3, RCO7 *(red cod)*, 13% SNA7 *(snapper)*, SPO3 *(rig)*
Estimate of total annual revenue		$2.7mil	$3.5mil	$5.8mil	$8.7mil
Total Economic Value Year 1		$7.5mil	$9.8mil	$16.3mil	$24.48mil
Total Economic Value 3 years		$19.8mil	$25.7mil	$19.8mil	$64 mil
Total Economic Value 5 years		$30.7mil	$39.9mil	$30.7mil	$99.3mil

6.9.3 Comparison of options

Figure 19: Estimated deaths by year and economic impact by option for South Island



Note: Population sustainability threshold = the maximum number of dolphin deaths possible per year from fishing-related activities while still achieving the desired population objective.

Figure 19 shows the outcome of each option at the mean level of estimated set-net deaths (blue) and trawl deaths (orange) and at the upper 95th percentile for South Island. Making a decision at the 95th percentile is the most precautionary approach.

The black line shows the population sustainability threshold to achieve population recovery to 95 percent of the unimpacted level (79 deaths per year). Estimated deaths caused by fishing need to be below this line to ensure populations can rebuild to the desired level. This means the South Island Hector's dolphin population can sustain no more than 79 fisheries caused deaths each year. However, this broad geographical approach does not take into account subpopulation structure or the potential for localised depletion, which is shown above in Table 13. Finer-scale management approaches are appropriate to manage impacts within smaller areas.

Set-netting is considered to be a higher-risk fishing method than trawling. The economic impacts are much higher for trawling for Options 2 and 3.

6.10 HECTOR'S DOLPHIN: SOUTH ISLAND OPTIONS – SUPPORTING INFORMATION AND ANALYSIS

As outlined in Sections 6.3, 6.8, and 6.9.2, this section summarises risk-reduction options to achieve population objectives at both subpopulation and local population levels and provides analysis and supporting information for these options.

The proposed options apply to set-net fishing under both the commercial and amateur fishing regulations. However, the quantitative estimates of risk and economic cost refer to commercial set-nets only. As part of the TMP consultation, further information is sought on the level of current recreational set-net effort within the Hector's dolphin distribution, and the potential socioeconomic impacts of restrictions (which may be high for individuals that rely on set-netting for food).

6.10.1 Proposed management objectives for the east coast South Island

6.10.1.1 Subpopulation objective

The following population objective is proposed at the scale of the east coast South Island subpopulation:

Reduce fisheries deaths sufficient (with 95 percent certainty) to allow the east coast South Island subpopulation to achieve and remain at or above 90 percent of carrying capacity.

Pursuant of this objective:
- the population sustainability threshold is no more than 48.6 deaths per year;
- the current mean estimate of commercial fisheries impact is 51.0 deaths per year;
- the upper 95th percentile of impact is 105 deaths per year;
- to achieve the desired outcome residual risk needs to be reduced by at least 54 percent.

This implies that a combination of fishery closures should seek to prevent at least **27.4 deaths per year** (mean estimate).

6.10.1.2 Local population objective

Commercial fisheries risk on the east coast South Island is particularly concentrated in three locations where impacts on local populations are thought to be sufficiently high that risk reduction may be necessary if those populations are to increase or be maintained at or above 80 percent of carrying capacity (with 95 percent certainty) as is proposed. See local population objectives for these three areas below.

Kaikōura
Reduce fisheries deaths sufficient (with 95 percent certainty) to allow the Kaikōura local population to achieve and remain at or above 80 percent of carrying capacity.

Pursuant of this objective:
- the population sustainability threshold is no more than 9.5 deaths per year;

- the current mean estimate of commercial fisheries impact is 11.0 deaths per year (10.8 from set-net and 0.2 from trawl)
- the upper 95th percentile of impact is 20.6 deaths per year;
- to achieve the desired outcome residual risk needs to be reduced by at least 54 percent.

This implies that a combination of fishery closures should seek to prevent at least **5.1 deaths per year** (mean estimate).

Banks Peninsula
Reduce fisheries deaths sufficient (with 95 percent certainty) to allow the Banks Peninsula local population to achieve and remain at or above 80 percent of carrying capacity.

Pursuant to this objective:
- the population sustainability threshold is no more than 56.3 deaths per year;
- the current mean estimate of commercial fisheries impact is 17.4 deaths per year (15.2 from set-net and 2.1 from trawl)
- the upper 95th percentile of impact is 33.4 deaths per year;
- these estimates suggest that commercial fishery risk is already low enough to allow the Banks Peninsula population to achieve 80 percent of carrying capacity. Additional risk reduction proposed here is to meet the larger-scale subpopulation objective

Timaru
Reduce fisheries deaths sufficient (with 95 percent certainty) to allow the Timaru local population to achieve and remain at or above 80 percent of carrying capacity.

Pursuant to this objective:
- the population sustainability threshold is no more than 34.1 deaths per year;
- the current mean estimate of commercial fisheries impact is 19.8 deaths per year (14.6 from set-net and 5.2 from trawl);
- the upper 95th percentile of impact is 42.2 deaths per year;
- to achieve the desired outcome residual risk needs to be reduced by at least 19 percent.

This implies that a combination of fishery closures should seek to prevent at least **3.8 deaths per year.** Where risk reduction greater than this is proposed, it is to achieve the larger-scale subpopulation objective.

6.10.1.3 Options – east coast South Island set-net

Table 16: Options for set-net for the east coast South Island

East coast South Island – set-net				
		Option 1 (status quo)	Option 2	Option 3
Estimate of total annual set-net mortalities and % change (% reduction from current estimate of 51.2 death/y for set-net and trawl combined at the subpopulation scale)		42.4 set-net deaths/y (83% of total)	(↓32.3) deaths/y (↓ 63%)	(↓38.1) deaths/y (↓ 74%)
Estimate of total annual fishing revenue loss (?)			↓$2.3 mil	↓$3.1 mil
Analysis by local population (% reduction at the subpopulation scale in green) (% risk reduction at the local population scale in purple)				
Kaikōura	Restrictions on set-netting		4 nautical miles (eliminates previous exemption allowing set-netting around Kaikōura Canyon)	7 nautical miles (for the coastal length of the marine mammal sanctuary)
	Estimate of set-net mortalities	11.0	↓ 3.0 deaths/y (↓ 6% east coast South Island; ↓ 27% local)	↓ 8.3 deaths/y (↓ 15% east coast South Island; ↓ 75% local)
	Initial assessment of impacts		↓$1.3 mil	↓ 2 mil
Pegasus Bay	Restrictions on set-netting		Fishery closure approximately to the 50-metre depth contour (see map)	
	Estimate of set-net mortalities	17.4	(↓ 12.1 death /y (↓ 24% east coast South Island; ↓ 69% local)	
	Initial assessment of impacts		↓$170,000	
South Canterbury/ Timaru	Restrictions on set-netting			
	Estimate of set-net mortalities	19.8	(↓ 17.5) deaths/y (↓ 34% east coast South Island; ↓ 89% local)	
	Initial assessment of impacts		↓$870,000	

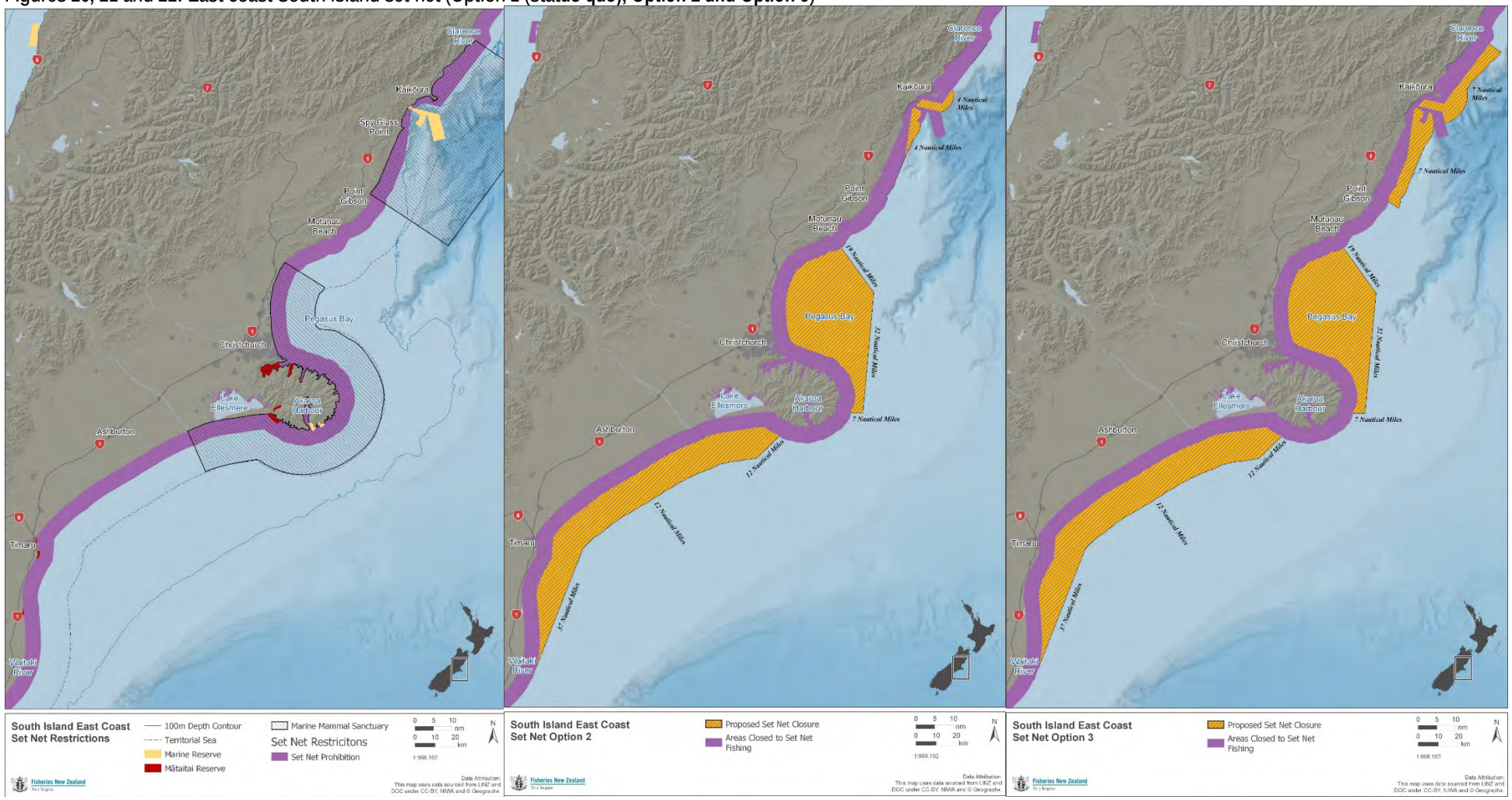
6.10.1.4 Analysis of options – east coast South Island set-net

Dolphin density: The estimated spatial distribution of Hector's dolphins in this area is shown in Figure 2. Dolphin densities are highest in Pegasus Bay (north of Banks Peninsula) and in the South Canterbury Bight between Banks Peninsula and Timaru, to variable distances offshore best approximated by the 50-metre depth contour. Lower dolphin densities occur along the coast southward to the Otago Peninsula and northward to Cloudy-Clifford Bay (where densities are moderate).

Options

- Option 1 would not introduce any additional spatial restrictions on set-netting, reflecting the large subpopulation size. If fisheries impacts reducing the subpopulation to levels lower than 90 percent of carrying capacity was considered appropriate (for example, if the population objective were 80 percent) then current levels of fisheries mortality would already be low enough to meet that objective. Under this option the only change would be to increase monitoring as outlined in the monitoring section later in this supporting document. If independent monitoring were in place across all, or a significant number of, vessels operating within the dolphin habitat then controls like Fisheries-Related Mortality Limits could be considered rather than spatial closures. Over time, improved monitoring would inform increased precision in the estimation of commercial fisheries risk.
- Option 2 would reduce total commercial fisheries risk by approximately 63 percent by expanding set-net closures in key locations where dolphin densities are highest. The distance that the proposed closures extend offshore is variable in different sections of the coast, to approximately the 50-metre depth contour in Pegasus Bay and in South Canterbury/Timaru. This option also eliminates the previous exemption to the four nautical miles closure around Kaikōura Canyon; this is an area of low-to-moderate dolphin density but very high commercial set-net effort. The expected benefit of this option is that it will reduce commercial fisheries deaths at the scale of the subpopulation (and of the local populations of Timaru and Banks Peninsula) to levels lower than the chosen population sustainability threshold. The cost of this option is an estimated reduction in total annual revenue of $2.3 million. In addition, the risk assessment suggests that under this option there remains a chance that commercial fisheries impacts on the local Kaikōura population could be high enough to suppress their local abundance.
- Option 3 extends the proposed closure around Kaikōura out to seven nautical miles. The benefit is that it reduces estimates of fishing-related mortality to below the level of population sustainability threshold for the subpopulation and each local area population. Cost of this option would result in an estimated $3.1 million reduction in total annual revenue.

Figures 20, **2**1 and 22: East coast South Island set-net (Option 1 (stat**us quo**), **Option 2 and Option 3**)



6.10.1.5 Options – east coast South Island trawl

Table 17: Options for trawl for the east coast South Island

East coast South Island – trawl				
		Option 1 (status quo)	Option 2	Option 3
Estimate of total annual trawl mortalities and % change (% reduction from current estimate of 51.2 death/y for set-net and trawl combined)		8.6 trawl deaths/y (17% of total)	(↓ 5.9) deaths/y (↓ 11%)	(↓ 6.7) deaths/y (↓ 13%)
Estimate of total annual revenue loss			↓$4.5 mil	↓$6.1 mil
Analysis by local population (% reduction at the subpopulation scale in green) (% risk reduction at the local population scale in purple)				
		Option 1	Option 2	Option 3
Pegasus Bay	Restrictions on trawling			
	Estimate of trawl mortalities		(↓ 1.45) deaths/y (↓ 3%; ↓ 8% local)	
	Initial assessment of impacts		↓$2.2 mil	
South Canterbury/Timaru	Restrictions on trawling			
	Estimate of trawl mortalities		(↓ 4.51) deaths/y (↓ 9% east coast South Island; ↓ 22% local)	(↓ 5.24) deaths/y (↓ 10% east coast South Island; ↓ 27% local)
	Initial assessment of impacts		↓$2.3 mil	↓$3.9 mil

Note: Proportional changes in death are as a percentage of mean total fisheries deaths at the subpopulation level across both methods, that is 51.2 deaths per year.

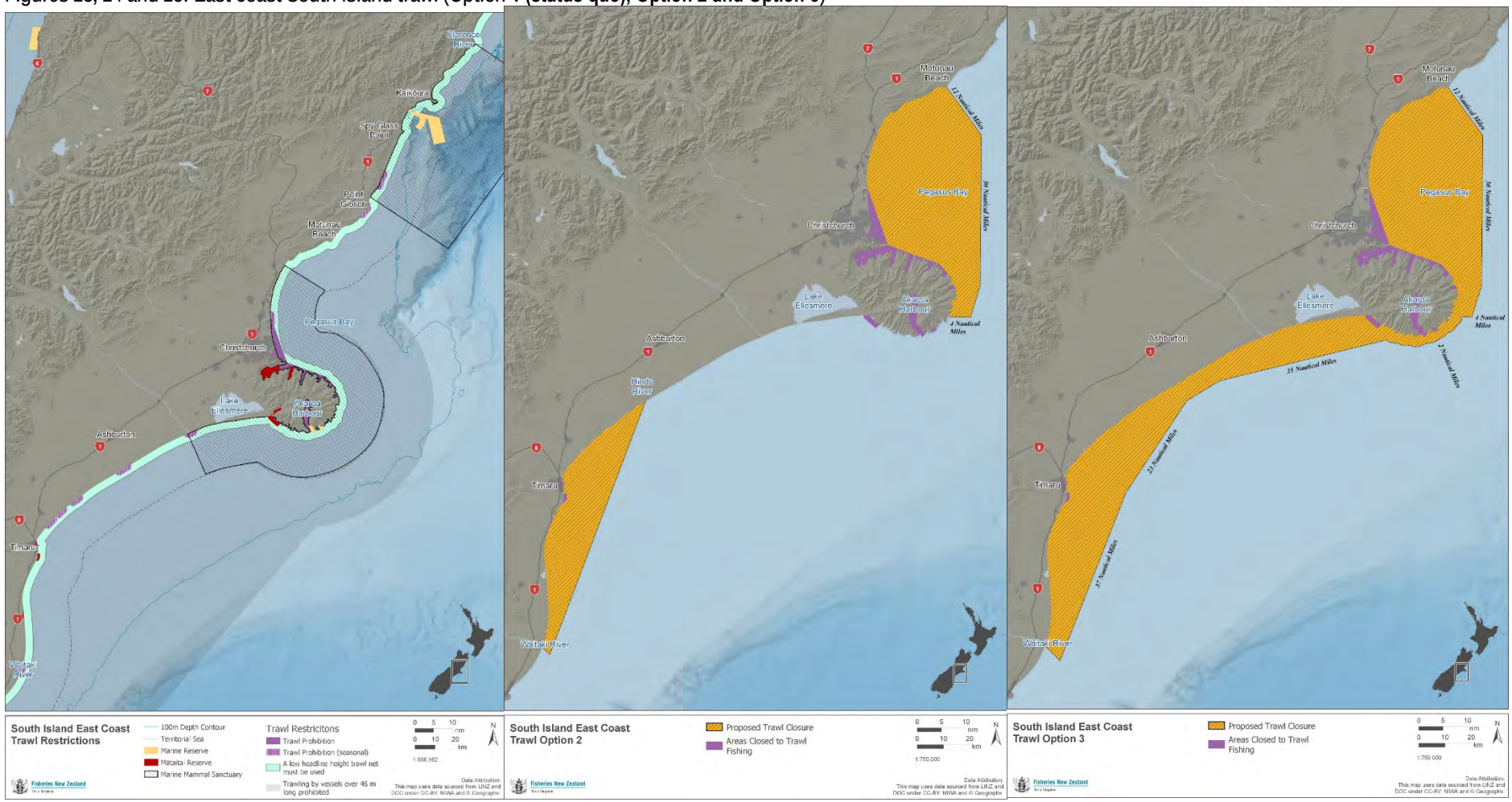
6.10.1.6 Analysis of options – east coast South Island trawl

Dolphin density: As discussed in Section 6.10.1.4 above.

Options

- Option 1 would not introduce any additional spatial restrictions on trawling, recognising that trawl risk is substantially lower than set-net risk and reflecting a view that the level of current risk is either acceptable or can be reduced in ways other than spatial closures.
- Option 2 reduces total commercial fisheries risk to the subpopulation by approximately 11 percent (5.9 deaths per year) by extending trawl closures in key high dolphin density locations on the east coast of the South Island. The size of the proposed closure is variable, extending to approximately the 50-metre depth contour in Pegasus Bay, and focused on core high-density locations out to around five nautical miles offshore in South Canterbury/Timaru. This option would result in an estimated reduction in total annual revenue of $4.5 million. All reported trawl captures in 2018/19 occurred in locations that are encompassed by the boundaries of this proposed closure.
- Option 3 differs from Option 2 by extending the proposed trawl closure to cover a larger area between Banks Peninsula and Timaru. The benefit of this option is that it would deliver a slightly higher level of risk reduction than does Option 2 (less than one percent at the scale of the subpopulation). The cost of this option is that it would reduce total annual revenue by an estimated $6.1 million.

Figures 23, **2**4 and 25: East coast South Island trawl (Option **1 (status quo), Option 2 and Option 3**)



6.10.2 Proposed management objectives for the north coast South Island subpopulation

In the north and south coast South Island subpopulations, the spatial habitat models (which estimate the relative density of dolphins in different locations) are more uncertain than elsewhere. This is because the relative densities of dolphins in these areas are much lower than on the east and west coasts of the South Island and because the model is missing key information. In the north and south coasts of the South Island, the habitat model appears to spread the dolphins more widely in space than is plausible (that is, the habitat model predicts that the dolphins occur evenly "everywhere", but this is not supported by actual observations).

In the north coast South Island, estimates of population size are highly uncertain (based only on observations in a single aerial survey stratum during a 2013 winter aerial survey). However, because risk can be estimated per individual dolphin as a function of spatial overlap, it is possible to estimate fisheries risk accurately even when population size is unknown. Because total fishing effort in this area is known with high accuracy and is not highly concentrated in particular locations, the subpopulation-level risk ratio estimated in Table 13 above provides a useful approximation of total risk (proportional to probability of death per individual) even though the number of animals (and therefore deaths) in Tables 18 and 19 below remain uncertain.

At the same time, the spatial patterns of dolphin distribution within this area may not be well estimated, meaning that the risk estimates are more uncertain than elsewhere, and we lack the spatial resolution to reliably estimate the relative efficacy of alternate spatial closures.

For these reasons, Fisheries New Zealand proposes risk reduction on the basis of the subpopulation-scale risk ratio estimated above, but the spatial design of the options proposed are based more on patterns evident in the raw data (dolphin sightings) and qualitative assessment of the dolphins' likely spatial distribution, rather than reliance on the predictions of the habitat models. Numerical estimates of the efficacy of the proposed measures to reduce dolphin deaths are unavailable at this time, but the magnitude of the closure options proposed is proportional to what would be required to achieve the desired risk reduction if we assume that the dolphin distribution is comparable to similar locations where available information is better.

6.10.2.1 Subpopulation objective

Reduce fisheries deaths sufficient to allow the north coast South Island subpopulation to achieve and remain at or above 90 percent of carrying capacity (with 95 percent certainty):

- assuming that the population size is estimated accurately[12], the population sustainability threshold is no more than 1.1 fisheries deaths per year, to achieve the objective;
- the current mean estimate of impact is 1.0 deaths per year, of which 70 percent of the risk is from commercial set-nets and 30 percent is from trawl;
- the upper 95th percentile of impact is 2.3 deaths per year.

To achieve the desired outcome with high certainty, residual risk needs to be **reduced by at least 52 percent.**

[12]The estimated number of deaths is estimated as a proportion of the population size, which is uncertain in this location. Therefore, if the population is estimated too high or too low, the number of estimated deaths will also change, but the *proportion* of the population being impacted, that is the annual fisheries risk, will be unchanged. For this reason, we can estimate the level of risk reduction required even where population size is small and uncertain.

6.10.2.2 Options – north coast South Island set-net

Table 18: Options for set-net north coast South Island

North coast South Island – set-net		
	Option 1 (status quo)	Option 2
Estimate of total annual set-net mortalities and % of total	0.70 set-net deaths/y* (70% of total)*	Numerical estimates unavailable; likely risk reduction is approximately one half to two thirds of residual commercial set-net risk
Estimate of total annual revenue		↓$280,000

*These estimates are uncertain, reflecting uncertain population size and spatial distribution.

6.10.2.3 Analysis of options – north coast South Island set-net

Options

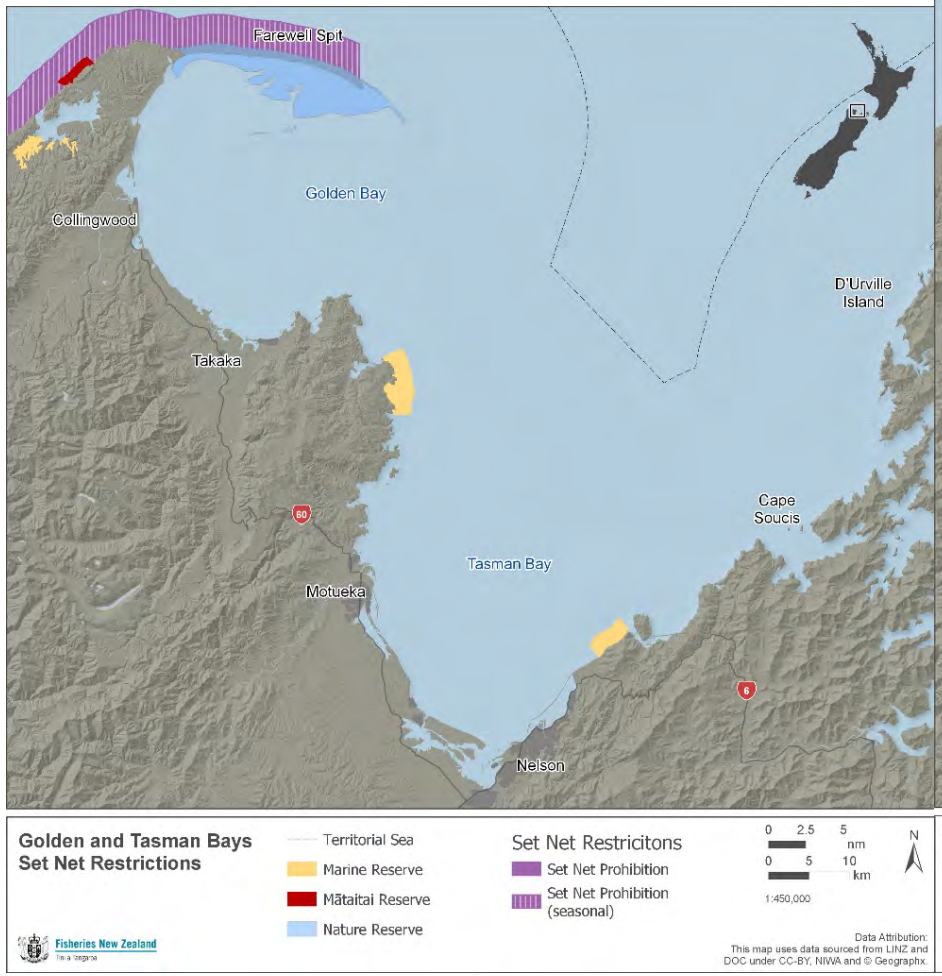
- Option 1: This option would not introduce any additional spatial restrictions on set-netting, on the basis that the current level of risk is either acceptable or can be reduced in ways other than spatial closures.

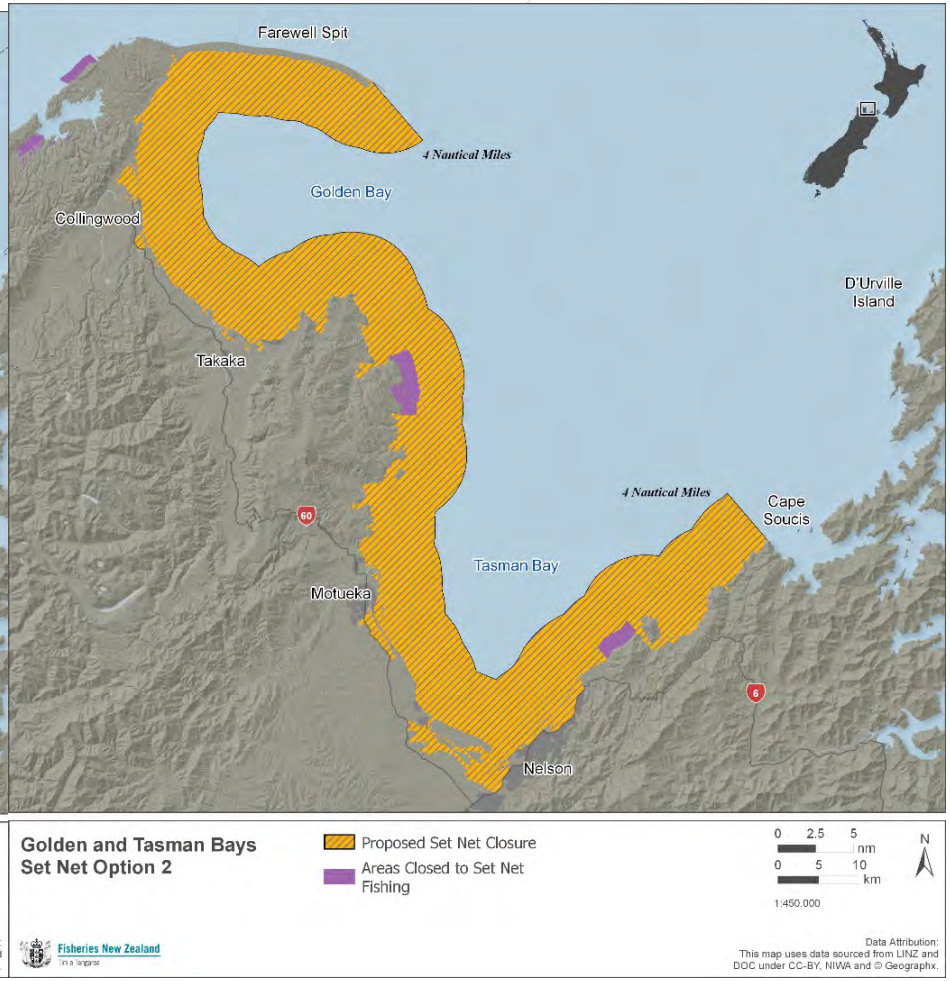
- Option 2: This option proposes introduction of a set-net prohibition out to four nautical miles from shore in Golden Bay and Tasman Bay. While numerical risk reduction estimates are unlikely to be reliable due to poorly estimated spatial densities at this scale, comparison with comparably small populations for which better spatial information are available (for example, Māui dolphins and south coast South Island Hector's dolphins) suggest that the dolphins are likely to spend more than two-thirds of their time within the boundaries of this proposed closure, and these measures may be expected to eliminate roughly one-half to two-thirds of the current commercial set-net risk.

  This option would also eliminate recreational set-netting in most of Golden Bay and Tasman Bay. The amount of risk reduction that this would achieve is unknown, as is the number of fishers it would affect, but it is likely that both figures are substantial (because the north coast is one of the last large areas of the South Island coastline where high levels of recreational set-netting occur).

  This option would close large areas of the fishing grounds for elephant fish, school shark and rig which are all primarily taken by set-nets. The closure of fishing grounds impacts both displaced fishers and quota holders. The cost of this option is estimated to be a reduction of $280,000 in total annual revenue.

Figures 26 and 27: North coast South Island set-net (Option 1 (status quo) and Option 2)





6.10.2.4 Options – north coast South Island trawl

Table 19: Options for trawl north coast South Island

North coast South Island – trawl			
	Option 1 (status quo)	Option 2	Option 3
Estimate of total annual trawl mortalities and % of total	0.30 trawl deaths/y (30% of total)*	No change	Numerical estimates unavailable; likely risk reduction is approximately one third to one half of residual trawl risk
Estimate of total annual revenue			↓$1 mil

*These estimates are uncertain, reflecting uncertain spatial distribution.

6.10.2.5 Analysis of options – north coast South Island trawl

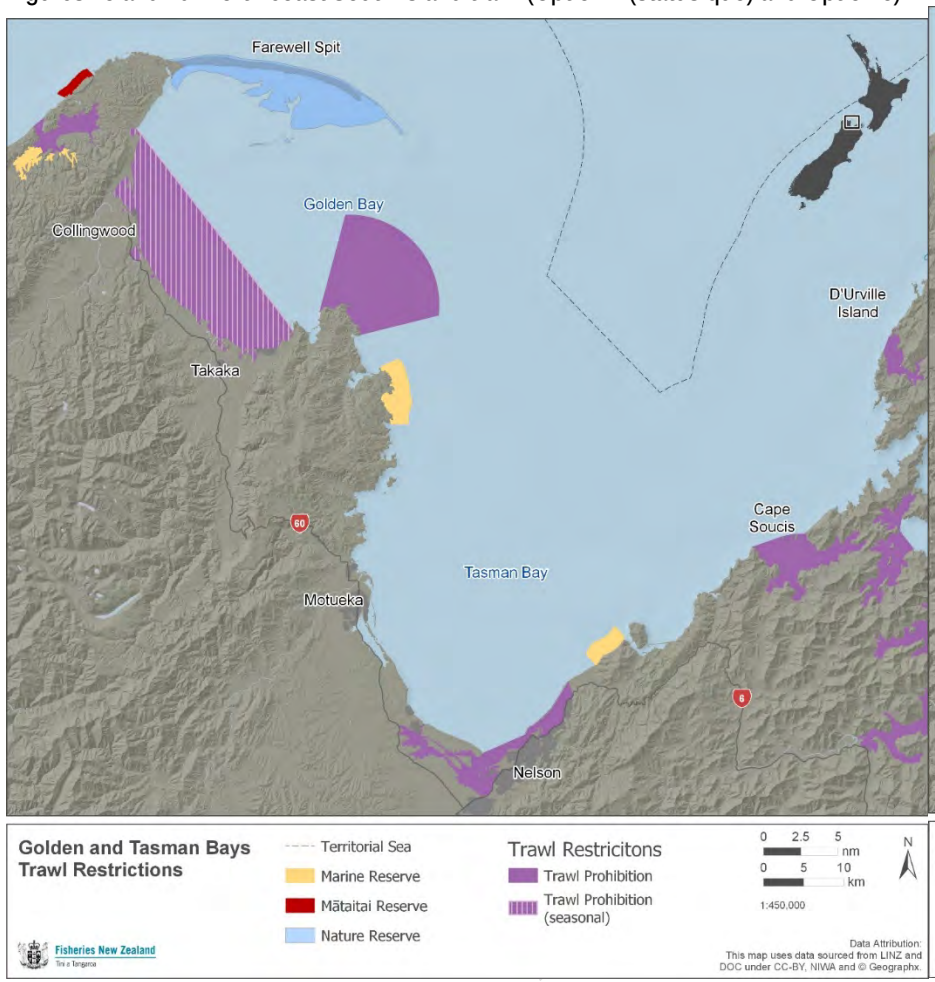
Options

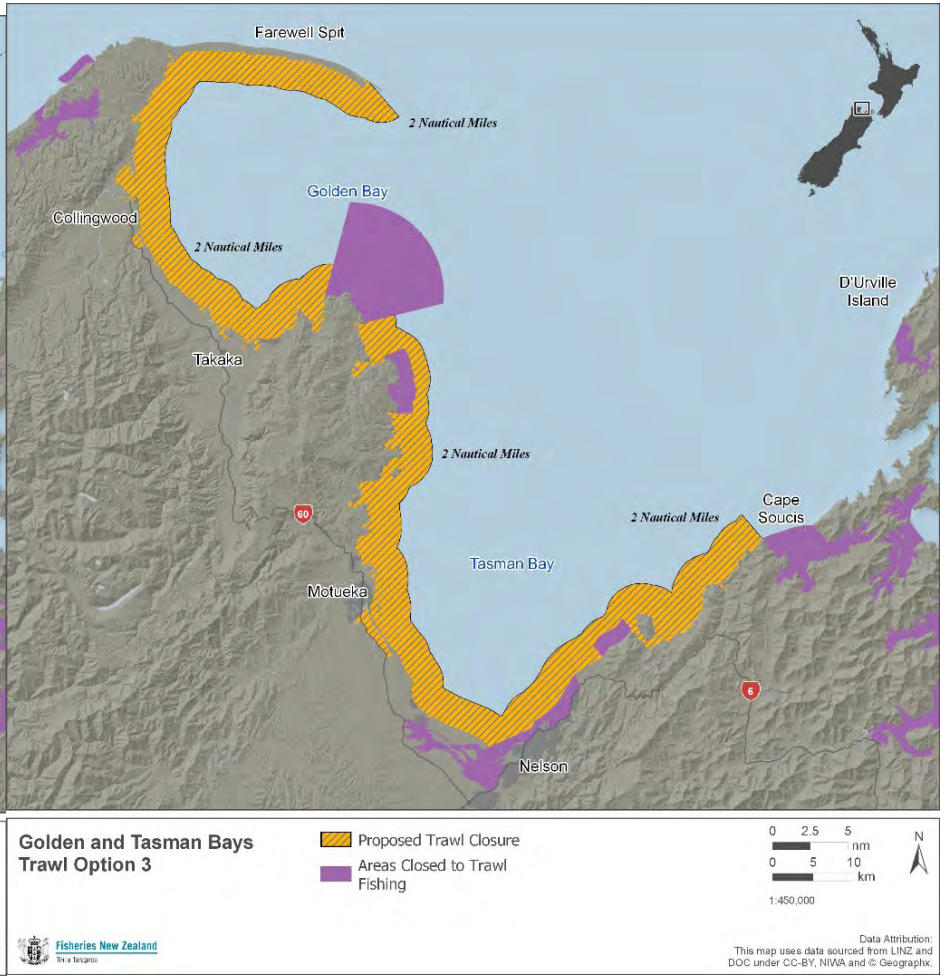
- Options 1 and 2: These options would not introduce any additional spatial restrictions on trawling recognising that the trawl fisheries are responsible for a smaller portion of the current risk than set-net fisheries such that risk reduction can more effectively be achieved by implementing set-net closures only. These options have the least amount of direct socioeconomic impact on the fishing industry.

- Option 3 proposes introducing a trawl prohibition out to two nautical miles in Golden Bay and Tasman Bay. While numerical risk reduction estimates are unlikely to be reliable due to poorly estimated spatial densities at this scale, it is likely that dolphins spend up to half of their time within two nautical miles of the coast, and comparable levels of protection in locations where dolphin distributions are better estimated suggest that these measures may be expected to eliminate roughly one-third to one-half of the current commercial trawl risk.

  An estimated 18 to 23 vessels would be affected by the proposals. The cost of the proposal is an estimated reduction in total annual revenue of $1 million. Option 3 would close large areas of the fishing grounds for flatfish, snapper and gurnard which are all primarily taken by trawl in this area. The closure of fishing grounds impacts both displaced fishers and quota holders.

Figures 28 and 29: North coast South Island trawl (Option 1 (status quo) and Option 3)





6.10.3 Proposed management objectives for the south coast South Island

Similar to the north coast, the spatial habitat model used to estimate the density of the south coast South Island subpopulation is much more uncertain than elsewhere, due to increased model uncertainty at very low dolphin densities. The habitat model in this location also lacked a key data layer that was used elsewhere to predict dolphin density (dolphin prey availability).

Like on the north coast, the habitat model appears to spread the dolphins more widely in space than is plausible. This mismatch is particularly evident in comparison with direct observations from two aerial surveys (one of which was not available at the time of the spatial habitat modelling) which provide reliable estimates of population size, and strongly suggest that the dolphins are highly concentrated in Te Waewae Bay, for much of the year. The habitat model estimates that only 20 percent of the dolphin distribution is inside Te Waewae Bay; but in the 2016 aerial survey, 74 percent of dolphins were estimated to occur in Te Waewae Bay; and in 2018, this figure was 99 percent.

This apparent spatial concentration of dolphins will have major implications for risk estimation if it coincides with similar patterns of high densities of fishing effort. This does not appear to be the case for set-net fisheries; set-net fishing on the south coast is dispersed widely with no areas of particular concentration (and Te Waewae Bay is closed to set-net fishing). However, trawl fisheries are highly concentrated in Te Waewae Bay. This implies that if the aerial survey observations are a better representation of year-round dolphin distribution, then the habitat model estimates of fisheries risk will slightly overestimate set-net fishery risk and may strongly under-estimate trawl fishery risk.

For this reason, we estimate fisheries risk, and the efficacy of risk reduction, options using three different spatial distribution scenarios:

- Scenario A: using the same habitat model as applied for all Hector's dolphins, 20 percent of dolphins are in Te Waewae Bay;
- Scenario B: using the 2016 aerial survey, 74 percent of dolphins are in Te Waewae Bay;
- Scenario C: using the 2018 aerial survey, 99 percent of dolphins are in Te Waewae Bay.

It is likely that the true annual distribution lies in the middle (for example, Scenario B), because the extreme spatial concentration of dolphins in Te Waewae Bay likely only occurs during a part of the year, and because aerial surveys are likely to "miss" some dolphins in lower-density locations.

Nonetheless, aerial survey observations strongly support the assertion that south coast South Island dolphins spend a much greater proportion of their time in Te Waewae Bay than is predicted by the habitat modelling. Management options are designed to reflect this reality, especially with reference to trawl fisheries, for which effort in Te Waewae Bay is high.

Higher resolution habitat modelling to better estimate the spatial distribution of south coast South Island dolphins, using all available data including the new aerial survey results, is a high priority.

6.10.3.1 Proposed management objective

Reduce fisheries deaths sufficient to allow the south coast South Island subpopulation to achieve and remain at or above 90 percent of carrying capacity (with 95 percent certainty):

- population sustainability threshold is no more than 1.7 deaths per year from all human-induced mortality to achieve the objective;
- the current mean estimate of impact from 1.2 deaths per year (but depending on which dolphin distribution is assumed, the attribution of this risk ranges from 70:30 set-net to trawl, to 100 percent trawl, if all dolphins are in Te Waewae Bay);
- the upper 95th percentile of estimated impact is 2.6 deaths per year (under Scenario A) to 5.7 deaths per year (under Scenario C).

To achieve the desired outcome residual risk needs to be reduced by a variable amount depending on which spatial distribution scenario is used.

6.10.3.2 Options – south coast South Island set-net

Table 20: Options for set-net south coast South Island

South coast South Island – set-net			
	Option 1	Option 2	Option 3
Estimate of total annual set-net mortalities and % change: Scenario A: using habitat model (20% of dolphin distribution inside Te Waewae Bay)	0.9 set-net deaths/y	(↓ 0.2) deaths/y (↓ 22%)	(↓ 0.2) deaths/y (↓ 23%)
Estimate of total annual set-net mortalities and % change: Scenario B: using 2016 aerial survey (70% of dolphin distribution inside Te Waewae Bay)	0.7 set-net deaths/y	(↓ 0.1) deaths/y (↓ 13%)	(↓ 0.1) deaths/y (↓ 14%)
Estimate of total annual set-net mortalities and % change: Scenario C: using 2018 aerial survey (100% of dolphin distribution inside Te Waewae Bay)	0 deaths /y* * this distribution scenario assumes all dolphins are inside an area already closed to set-nets therefore no further risk reduction is possible		
Estimate of total annual revenue		↓$50,000	↓$90,000

6.10.3.3 Analysis of options – south coast South Island set-net

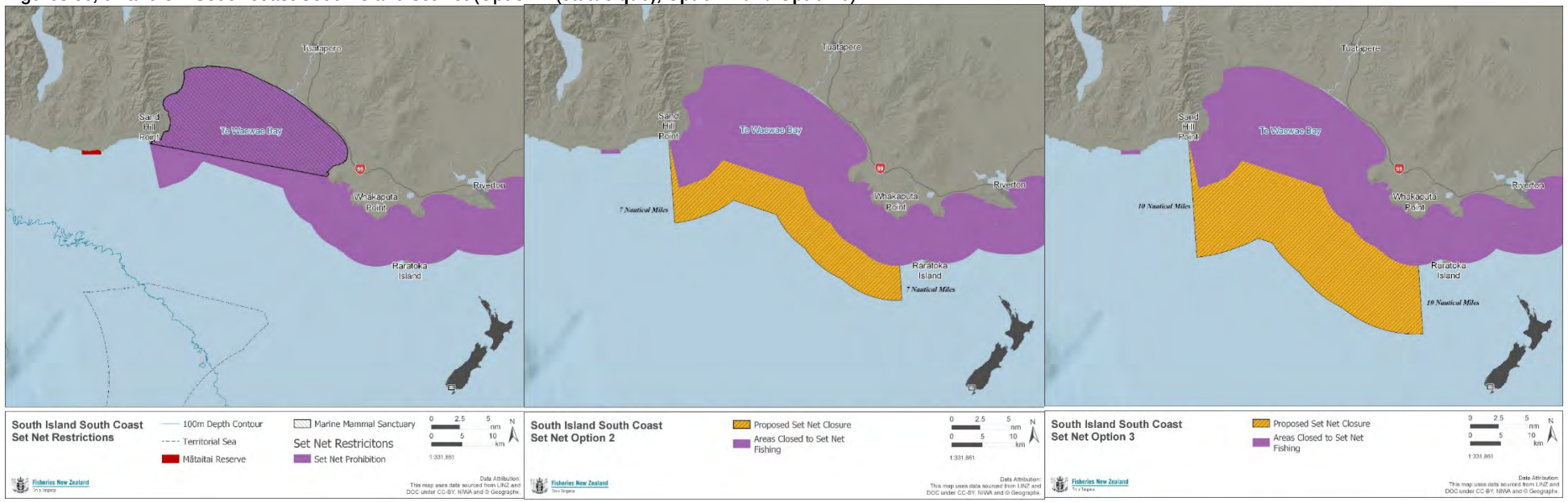
Dolphin density: three dolphin density scenarios are described above. Agencies consider that Scenario B is the most plausible representation of dolphin distribution.

Options

- Option 1 would not introduce any additional spatial restrictions on set-netting, confirming that the level of current risk is either acceptable, or can be reduced in ways other than spatial closures.
- Option 2 would reduce fisheries risk by approximately one death every five to ten years by extending set-net closures in the area of Te Waewae Bay to seven nautical miles offshore. The cost of this option is estimated to be a reduction in total annual revenue of $50,000.
- Option 3 would reduce the risk marginally by extending the set-net closure out to 10 nautical miles. The cost of this option is estimated to be a reduction of $90,000 in total annual revenue.

Both Option 2 and Option 3 would close further areas of the fishing grounds for rig and school shark, which are all primarily taken by set-net in this area. The closure of fishing grounds affects both displaced fishers and quota holders.

Figures 30, 31 and 32: South coast South Island set-net (Option 1 (**status quo**), **Option 2 and Option 3**)



6.10.3.4 Options – south coast South Island trawl

Table 21: Options trawl south coast South Island

South Coast South Island – trawl				
		Option 1	Option 2	Option 3
South coast	Restrictions on trawling		Prohibit trawling within Te Waewae Bay and 2 nautical miles outward	Prohibit trawling within Te Waewae Bay and 4 nautical miles outward
Estimate of total annual trawl mortalities and % change: Scenario A: using habitat model (10% of dolphin distribution inside Te Waewae Bay)		0.3 trawl deaths/y	(↓ 0.11) deaths/y (↓ 22%)	Numerical estimate currently unavailable
Estimate of total annual trawl mortalities and % change: Scenario B: using 2016 aerial survey (72% of dolphin distribution inside Te Waewae Bay)		0.95 trawl deaths/y	(↓ 0.85) deaths/y (↓ 53%) relative to total of 1.65 death/y including set-net	(↓ 0.89) deaths/y (↓ 55%) relative to total of 1.65 death/y including set-net
Estimate of total annual trawl mortalities and % change: Scenario C: using 2018 aerial survey (99% of dolphin distribution inside Te Waewae Bay)		1.2 trawl deaths/y	(↓ 1.2) deaths/y (↓ 100%) relative to total of 1.2 death/y including set-net	(↓ 1.2) deaths/y (↓ 100%) relative to total of 1.2 death/y including set-net
Landings from quota stocks affected				
Estimate of total annual revenue			↓$1.6 mil	↓$2.3 mil

Note: Quantitative estimates of risk and risk reduction in this table depend upon estimates of dolphin spatial distribution that may be unreliable at this scale. Additional analyses are pending.

6.10.3.5 Analysis of options – south coast South Island trawl

Dolphin density: three dolphin density scenarios are described above. Under Scenario A, additional set-net closures are justified, and trawl closures have a relatively minor effect. Under Scenarios B and C, trawl closures in Te Waewae Bay are supported due to high spatial overlap in this concentrated location.

These scenarios illustrate the effects of spatial uncertainty where both dolphins and fishing effort may be highly concentrated. Agencies consider that Scenario B is likely to be most accurate. That is, it is likely that dolphins are indeed highly concentrated in Te Waewae Bay for much of the year, but it is likely that they also disperse more widely especially in winter, and that lower densities occur elsewhere that were not observed in the aerial survey (as supported by public and fisheries observer sightings).

Options

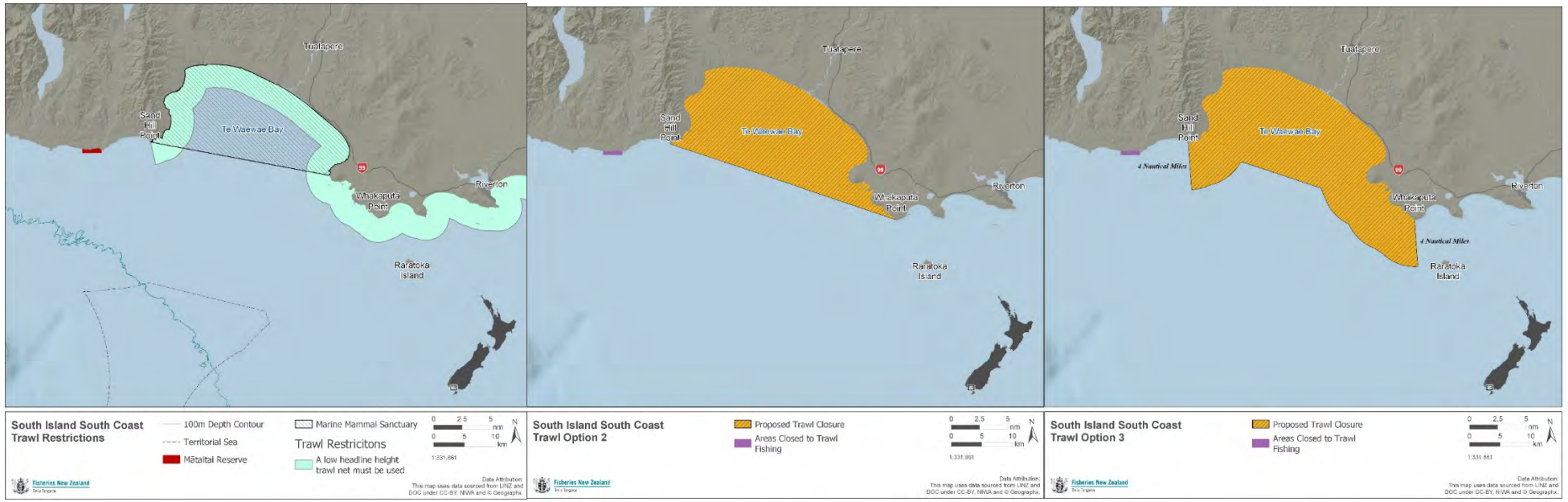
- Option 1: This option proposes no change to current restrictions.
- Option 2: This option would impose a trawl prohibition out to two nautical miles beyond Te Waewae Bay. The benefit of Option 2 would be to protect the subpopulation from the risk of trawl mortality in the area where they are most commonly found. Although there is an existing headline height restriction[13] in Te Waewae Bay, it is unclear whether this is effective. Given the small size of this population and the potentially higher risk posed by trawling if spatial overlap with dolphins is

[13] Low headline height trawl net means a trawl net that—
(a) has been manufactured or modified with the intention of having a net opening with a vertical height of no more than 1 m; and (b) is fitted with a device (for example, a spreader bar, rope, or wire) that is no more than 1 m long on the wing-end to constrain the wing-end height to below 1 m; and (c) has buoyancy on the headline that does not exceed 60 kg.

very high, this option would result in a potentially significant reduction in risk. The cost of this option is an estimated reduction in total annual revenue of $1.6 million.

- Option 3: Under Option 3, a trawl prohibition would be extended out to four nautical miles beyond the entrance to Te Waewae Bay. The benefit of this option would be further protection for dolphins that may venture further than two nautical miles outside Te Waewae Bay. The reduction of risk is not well estimated, but intuitively would be greater than under Option 2. The cost of this option is an estimated $2.3 million reduction in total annual revenue.

Figures 33, 34 and 35: **South coast South Island trawl (Option 1 (status quo), Option 2 and Option 3)**



6.11 MONITORING FISHERIES THREATS

Proposed fisheries monitoring objectives:

- Fishing activity using methods known to pose a risk to Māui and Hector's dolphins within the dolphin distribution range is monitored at a level sufficient to ensure robust information on total fisheries-related deaths.
    - Develop a five-year plan outlining priority areas for monitoring, coverage levels, tools and strategies to improve the effectiveness of monitoring by 1 December 2019.
- Monitoring information in aggregate form is available online as soon as possible after it has been collected.

Monitoring fishing-related impacts helps us understand whether measures to manage the risk of fisheries-related deaths are achieving the desired population outcomes. Fishers are legally required to report all captures of protected species.

The level of fisher-reported deaths of dolphins has significantly increased since 2008, following publicity around obligations and clarification of reporting requirements. However, there remains a strong likelihood of under-reporting. Independent monitoring remains the best source of data on total fishing-related deaths and the performance of management measures, and ultimately, whether the plan is on track to achieve the desired outcomes.

Government has recently announced a requirement for the use of on-board cameras for commercial fishing vessels using high-risk fishing methods in the inshore area between Whanganui and Kaitaia (Tauroa Point). This requirement comes into effect from 1 November 2019. The monitoring plan proposed above will incorporate this requirement for on-board cameras in the prescribed areas.

6.12 OTHER MATTERS

In addition to the spatial closures and trigger framework described in the previous sections, Fisheries New Zealand proposes two further regulatory changes to support implementation of the revised TMP.

6.12.1 Definition of set-net

The legal definition of a set-net in New Zealand is much broader than the common usage of the term "set-net". Under the Fisheries (Commercial Fishing) Regulations 2001 and the Fisheries (Amateur Fishing) Regulations 2013, the current definition of a set-net is "a gill net or any other sort of net which acts by enmeshing, entrapping, or entangling any fish".

Of the activities (that aren't further defined elsewhere) that fall within this definition, passive netting, (such as, nets that are left submerged for extended periods) are considered to pose the greatest risk of fishing-related mortality. Fisheries New Zealand proposes to provide more clarity about what type of fishing is restricted under set-net prohibitions and seeks views to help address any ambiguity about activities that are allowed to continue.

6.12.1.1 Ring netting

One example of a netting method that falls under the scope of legal definition of "set-net" is "ring-netting", and this issue has been raised in earlier iterations of the TMP. Ring netting is a common fishing method used to target mullet and kahawai in the Manukau and Kaipara harbours. ”

When ring netting, a fisher is actively involved throughout the fishing activity compared to a "passive" set-net, meaning they are more likely to see and avoid dolphin activity. We seek views of stakeholders on whether this method should be allowed to operate regardless of whether any area is closed to set-net more generally.

6.12.1.2 Driftnet fishing

While not known to be a common activity, we consider that driftnetting (including nets less than one kilometre in length) should be explicitly prohibited due to the limited ability to control and mitigate threats to Hector's and Māui dolphins. We propose to further specify that driftnetting (including nets less than one kilometre) cannot be used for fishing either:

a) in the areas subject to set-net prohibitions; or
b) in New Zealand.

We seek views from stakeholders on these two options.

A "driftnet" has been defined as a gillnet or other net that—

(a) either singly or tied or connected together in combination with other nets is more than 1 kilometre in length; and

(b) acts by enmeshing, entrapping, or entangling any fish or marine life; and

(c) acts by drifting in the water, or on the surface of the water; and

(d) does not have attached to it sufficient means of anchoring it to any point of land or the sea bed (irrespective of whether the net has attached to it any means of being attached to any vessel).

Under the Driftnet Prohibition Act 1991 (administered by the Ministry for Primary Industries) driftnet fishing fitting the description above is prohibited in New Zealand waters.

Following the establishment of the TMP it was further legislated that driftnets (including nets less than one kilometre) cannot be used for fishing in specified areas of the Port Waikato River.

7 Proposal for a Toxoplasmosis Action Plan

7.1 THE PROBLEM

Toxoplasmosis is a parasitic disease caused by infection with *Toxoplasmosis gondii* oocysts. Cats are the only animal in which the parasite can reproduce. The oocysts (eggs) are spread into the environment via cat faeces and can survive for many months. Rainwater and runoff transport the oocysts into the coastal environment through streams, rivers and stormwater drains. As they are ingested by other animals, they may accumulate up the food chain, ultimately infecting Hector's and Māui dolphins that have ingested contaminated prey or water. It only takes one oocyst to infect a dolphin, and the risk of infection increases where there are high levels of water runoff from land and high cat densities.

Carcasses of dead dolphins are examined for cause of death when in suitable condition. Of the deaths that were not fishing related, toxoplasmosis was identified as the cause in 29 percent of the non-calf dolphins examined (nine of 31 dolphins; seven of these were mature females). Two toxoplasmosis-related deaths were from carcasses reported on the west coast of the North Island (Māui dolphin habitat), five on the east coast of the South Island and two on the west coast of the South Island.

The estimates of mortality associated with toxoplasmosis rely on assumptions around the relative detectability of carcasses dying from different causes of death and reporting of dead dolphins by the public for subsequent necropsy. The number of necropsied carcasses is not high; as a result, there is substantial uncertainty around the estimated number of toxoplasmosis-related deaths, and these estimates may be biased either high or low. However, even though the estimates are highly uncertain, the risk to the dolphins is significant even at the lower bound of these estimates, and the potential threat of this disease must be taken seriously, especially for Māui dolphins which experience the highest estimated exposure levels.

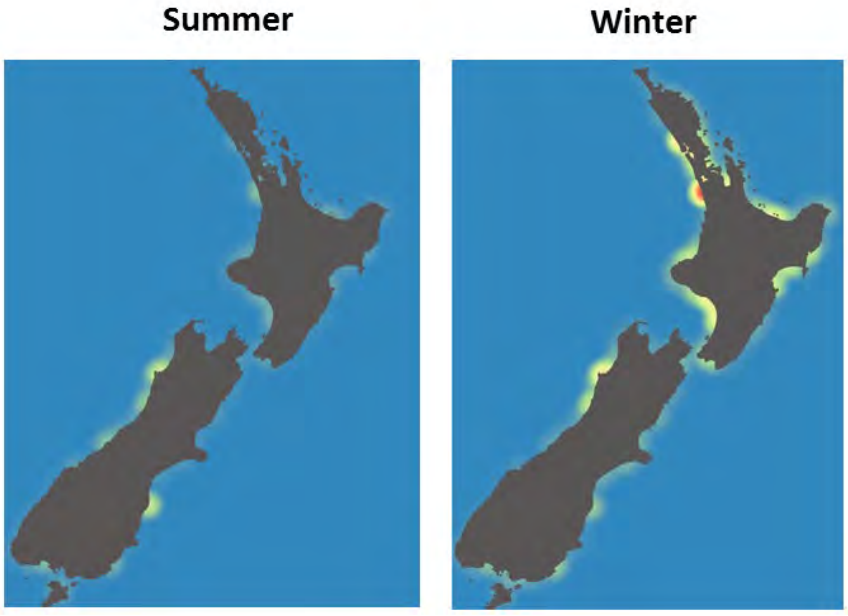
The risk assessment indicates that toxoplasmosis is a significant human-caused threat to Māui and Hector's dolphins as a species, but certain locations are of particular concern. The risk assessment estimates toxoplasmosis exposure in different locations by estimating cat densities as a function of human density and using a hydrological model to estimate the transport of oocysts to the sea via terrestrial runoff. A similar approach has been shown to accurately estimate toxoplasmosis exposure in Californian sea otters. Coastal areas adjacent to large river mouths and in close proximity to high-density cat areas (such as cities and large towns) are likely to be specific hot spots of high exposure to toxoplasmosis, for example, the Waikato River, and rivers on the west coast of the South Island (Figure 36).

Māui dolphins are the population most exposed to toxoplasmosis risk; it is estimated that toxoplasmosis is responsible for roughly two (probably ranging between 0.5 and 3.3) Māui dolphin deaths per year. Even at the lower end of this range, the risk assessment indicates that toxoplasmosis may kill more dolphins than any other human threat, by a wide margin. Māui dolphin population demographic models produced independently from the multi-threat risk assessment (Appendix 3) estimate that toxoplasmosis risk is sufficient to drive ongoing population decline even in the absence of any other human threat.

Hector's dolphins are also exposed to toxoplasmosis risk. At the scale of the whole South Island, the risk assessment estimates roughly 300 (probably ranging between 50 and 700) Hector's dolphin deaths per year, but the risk is not uniform across the four populations. The Hector's dolphin population likely to be most exposed to toxoplasmosis risk are on the west coast South Island.

The threat from toxoplasmosis may also have implications for other native wildlife, agriculture and human health.

Figure 36: Estimated relative coastal water densities of *Toxoplasma gondii* oocysts (eggs) in summer and in winter



7.2 PROPOSAL

DOC recognises that mitigating the threat of toxoplasmosis to Hector's and Māui dolphins covers terrestrial, freshwater and marine domains, as well as agriculture and human health. As such, it will require a multidisciplinary and collaborative approach, working with a range of agencies and organisations. DOC can build upon existing knowledge and align with existing work programmes (such as, the Essential Freshwater and Three Waters Review and Predator Free 2050) to reduce the threat of toxoplasmosis. However, these work programmes are not specifically aimed at reducing dolphin deaths from toxoplasmosis, and there is no one action that can immediately be undertaken to eliminate toxoplasmosis in the dolphins' habitat. Acknowledging the urgency for the Māui dolphin in particular, DOC proposes the development of a Toxoplasmosis Action Plan with the following objectives:

1) Reduce the number of dolphin deaths attributable to toxoplasmosis (determined through examination of carcasses) to near zero.
2) Improve knowledge on toxoplasmosis to increase ability to take actions to reduce this threat.

In assessing options to address the threat of toxoplasmosis DOC is considering:

- What knowledge can be built upon from overseas?
- What information gaps are critical to be able to act?
- What actions are available now?
- What actions could become available but require more work?
- How to ensure compliance with specific actions?
- How proposed actions will affect individuals or government agencies (such as councils)?
- What are the potential costs of the proposed actions to government, individuals and councils?
- How to monitor success?

The Toxoplasmosis Action Plan will include a range of workstreams, focused on targeted research, direct actions, improving awareness, and understanding the overall impacts of toxoplasmosis on New Zealand's native wildlife.

Research is required to determine where to target actions to be most effective. There is also a need to identify hot spots of toxoplasmosis contamination in the coastal environment and in freshwater catchments, to be able to prioritise and implement effective management actions. Other research could focus on identifying the pathway of infection for the dolphins and improving our understanding of the frequency of toxoplasmosis-related deaths.

Actions that can be taken now include feral cat control, wetland restoration, and domestic cat owner behaviour change. Actions that require more work include vaccine development to address risks originating from owned domestic cats, and genetic analyses to identify and trace particular strains of the disease, useful for targeting the source of the disease and determining if there are stormwater or wastewater treatment options to eliminate toxoplasmosis.

It is important to increase certainty in our assessment of non-fisheries-related threats, such as toxoplasmosis, which are currently reliant on necropsy data from a small number of dolphins. An awareness campaign around the importance of public reporting of beachcast dolphins would likely increase the necropsy data available. This would also improve our ability to assess whether actions taken have had a positive effect on the dolphin populations.

It is well known that cats impact on native bird populations. However, most people will be unaware that cats may also indirectly impact on Hector's and Māui dolphins. An awareness campaign could be undertaken to educate the general public, cat owners, veterinarians and conservation practitioners on how to contribute to the conservation of the dolphins.

Dolphins are not the only species impacted by toxoplasmosis. Toxoplasmosis is also known to have killed New Zealand native birds, but the full extent of this threat on New Zealand's conservation values, economic values, and human health remains unknown. There is a need to improve our understanding of toxoplasmosis in New Zealand, which may help to guide and prioritise actions and investment in the future. It is likely that New Zealand can benefit from the experience of overseas researchers; particularly in Hawaii, where toxoplasmosis has been identified as the main threat to the recovery of endangered Hawaiian monk seals and is known to also affect Hawaiian native birds.

Following the consultation process, DOC will develop a final Toxoplasmosis Action Plan, with associated costings and funding schemes; DOC will co-ordinate implementation of the Toxoplasmosis Action Plan across central and local government.

7.2.1 Threat-specific objectives and monitoring

Under the overarching vision, goal and objectives of the TMP, DOC and Fisheries New Zealand propose to have threat-specific objectives, whereby agencies can measure progress against mitigating or eliminating the threats. These objectives also act as decision trigger points at which time an additional action might be taken. Given the large amount of uncertainty that remains around the impact of toxoplasmosis on the dolphins, it is difficult to develop specific performance measures that are meaningful. Instead, performance plans are proposed to measure progress towards achieving the two objectives.

Performance plan: Reduce the number of dolphin deaths attributable to toxoplasmosis to near zero.

The monitoring of success related to this goal is dependent on examination of beachcast carcasses. Acknowledging that this is a long-term objective and the near-zero toxoplasmosis deaths is unlikely to be achieved immediately, DOC recommends a process to monitor progress and identify points where a change in approach might be made.

1. Given the highest risk of toxoplasmosis is on the west coast of the North Island in Māui dolphin habitat, implementation of the action plan will be prioritised here in the first instance and expanded to other areas as possible.
2. Causes of death to Māui and Hector's dolphins will continue to be monitored through DOC's necropsy contract with Massey University. All dolphin carcasses will be tested for toxoplasmosis, even if it wasn't the primary cause of death.
3. Should there be more than two deaths a year from toxoplasmosis on either the east or west coast of the South Island, we would evaluate what actions could be taken or re-prioritised for that area.
4. Should there be two or more deaths of a Māui dolphins, or five or more of Hector's dolphins, in a year from toxoplasmosis, then a re-evaluation of the whole action plan would be initiated.

Performance plan: Improve knowledge on toxoplasmosis to increase ability to take actions to reduce this threat

Research in the Toxoplasmosis Action Plan is intended to fill critical gaps and support the identification and prioritisation of effective action. Research results will be reported through existing science working groups, with opportunities for engagement by tangata whenua and stakeholders. As new information comes to light from any of the workstreams, actions may be adapted or re-prioritised.

The action plan would be evaluated against the above two objectives within five years of the TMP being updated.

7.3 COST AND TIMING OF THE WORK

DOC is working through a process to establish the costs of, and funding mechanisms to implement, the Toxoplasmosis Action Plan. There will not be one solution to reducing toxoplasmosis impacts on dolphins. Greater benefits will be realised by focusing management actions at points in the toxoplasmosis pathway (for example, at the cat) that will benefit other species in addition to the dolphins. Wetland restoration or riparian plantings may also reduce risks from toxoplasmosis. Where prioritisation of workstreams is required to meet financial demands, it is proposed that actions with a direct influence on Māui dolphin habitat take precedence.

DOC would like to hear from submitters on this proposal, including ideas on potential research or actions. Additionally, DOC is interested to hear of any other well-aligned work programmes, or funding mechanisms to support components of the work that may not be absorbed within DOCs current baseline. Following the consultation process, DOC will provide advice on a final Toxoplasmosis Action Plan, with associated costings and funding schemes.

8 Management of other non-fishing threats

8.1 RANGE OF THREATS

The risk assessment was undertaken to support the TMP review and improve the information available for decision-making. The risk assessment enabled more refined estimates of spatial overlap of dolphin distribution with fishing activity and some non-fishing threats. It was able to provide better information for fishing-related risks to dolphins, but risks from industrial activities and noise pollution are less well understood. Assumptions and uncertainties within the risk assessment remain, particularly on effects from non-fishing activities, including disease, seismic exploration and seabed mining.

The risk assessment was able to provide some spatial information on threats from oil spills and noise disturbance, including seismic surveying and vessel traffic. Other activities, including seabed mining, vessel strike, tourism, coastal development, pollution, and climate change effects were limited to a review of the available literature to assess the potential threat to the dolphins.

The assumptions, caveats and uncertainties within the risk assessment are acknowledged. In this regard, it is important to emphasise the risk assessment is a tool which helps inform but does not direct the outcomes of the TMP process.

In addition to fishing (set-netting and inshore trawling) and toxoplasmosis, both of which cause direct mortality of dolphins, the risk assessment identified several other threats to Hector's and Māui dolphins, notably:

- seismic surveying;
- seabed mining;
- dolphin watching and vessel traffic;
- oil spills;
- other pollution and sedimentation run-off;
- coastal development;
- infectious diseases other than toxoplasmosis; and
- climate change.

The threats listed above can affect Hector's and Māui dolphins through various overlapping direct and indirect mechanisms including injury, disease, disturbance, noise, habitat modification, impacts on prey distribution and abundance, reduced foraging success, displacement, and habitat fragmentation. The wide range and overlapping nature of these threats and effects, coupled with impacts from fishing and toxoplasmosis, means cumulative impacts are also highly relevant.

The range of threats and potential impacts means a broad management approach needs to be adopted to ensure subpopulations of Hector's and Māui dolphins recover and thrive, weighted towards those activities that are most likely to pose the greatest threat. The proposed management measures presented in the following sections follow this approach.

Reducing human-caused threats to levels which allow subpopulations to recover and thrive is one of the proposed medium-term goals of the TMP. The proposed overarching objective for managing threats other than fishing and toxoplasmosis is to *ensure adverse effects on dolphins from other threats are avoided or minimised.*

8.2 MARINE MAMMAL SANCTUARY EXTENSIONS

New Zealand has eight sanctuaries for protecting marine mammals – six marine mammal sanctuaries established under the Marine Mammals Protection Act 1978 and two sanctuaries created under the Kaikōura (Te Tai o Marokura) Marine Management Act 2014 (Figure 37).

The six marine mammal sanctuaries are:

- Auckland Islands (also a marine reserve)
- Banks Peninsula (also includes Akaroa and Pōhatu marine reserves)
- Catlins Coast

- Clifford and Cloudy Bay
- Te Waewae Bay
- West Coast North Island (also includes Tapuae and Parininihi marine reserves)

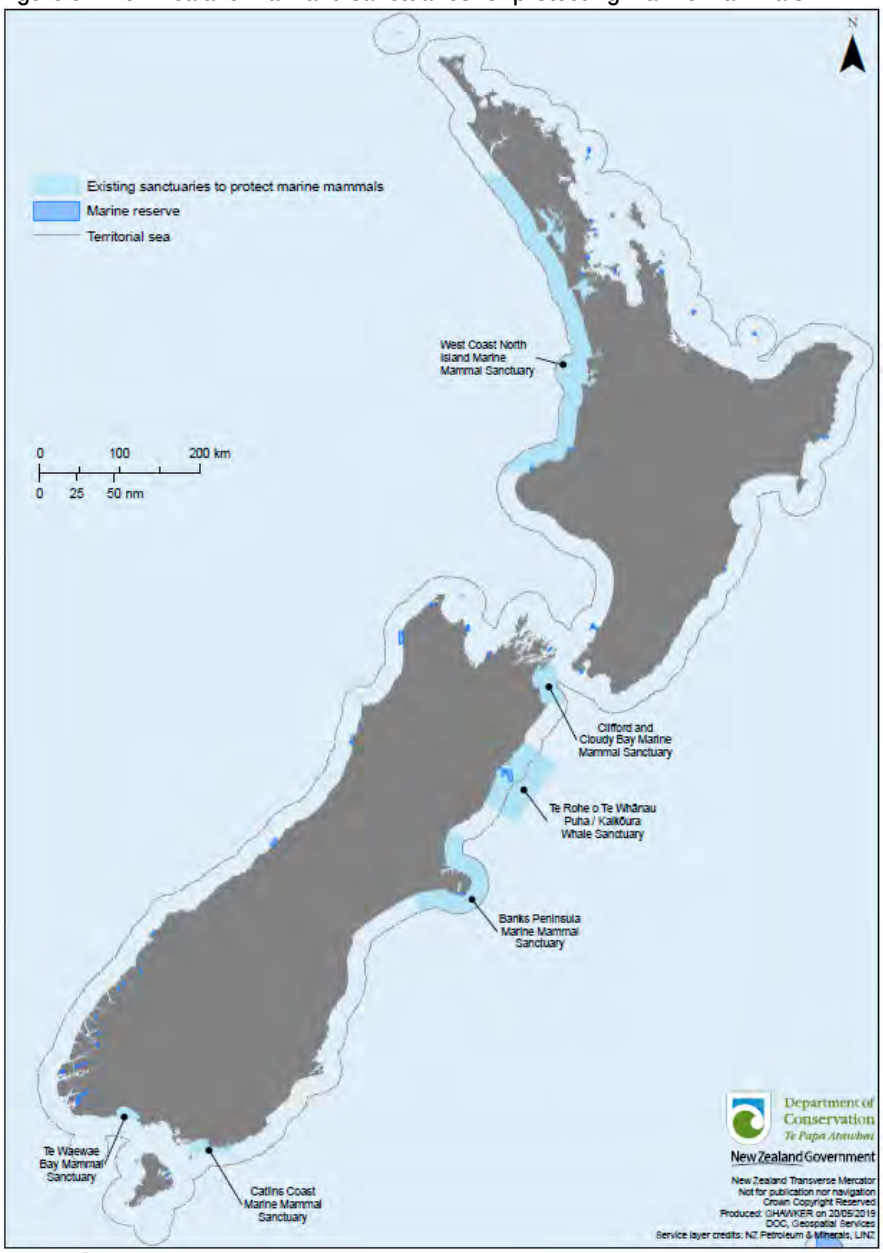
The two sanctuaries created under the Kaikōura (Te Tai o Marokura) Marine Management Act 2014 are:

- Te Rohe o Te Whānau Puha Whale Sanctuary (Kaikōura coast)
- Ōhau New Zealand Fur Seal Sanctuary (north of Kaikōura)

Specific details for each of these sanctuaries are available on the DOC website or using the individual links embedded above.

Five of these marine mammal sanctuaries (West Coast North Island, Clifford and Cloudy Bay, Banks Peninsula, Catlins Coast, and Te Waewae Bay) are relevant for the management of Hector's and Māui dolphins. Each have restrictions on seismic surveying whereas the West Coast North Island Marine Mammal Sanctuary also has specific restrictions on seabed mining and set-netting. Options to amend the restrictions in these five marine mammal sanctuaries are discussed below.

Figure 37: New Zealand mainland sanctuaries for protecting marine mammals



Note: The Ōhau New Zealand Fur Seal Sanctuary is too small to be seen at this scale.

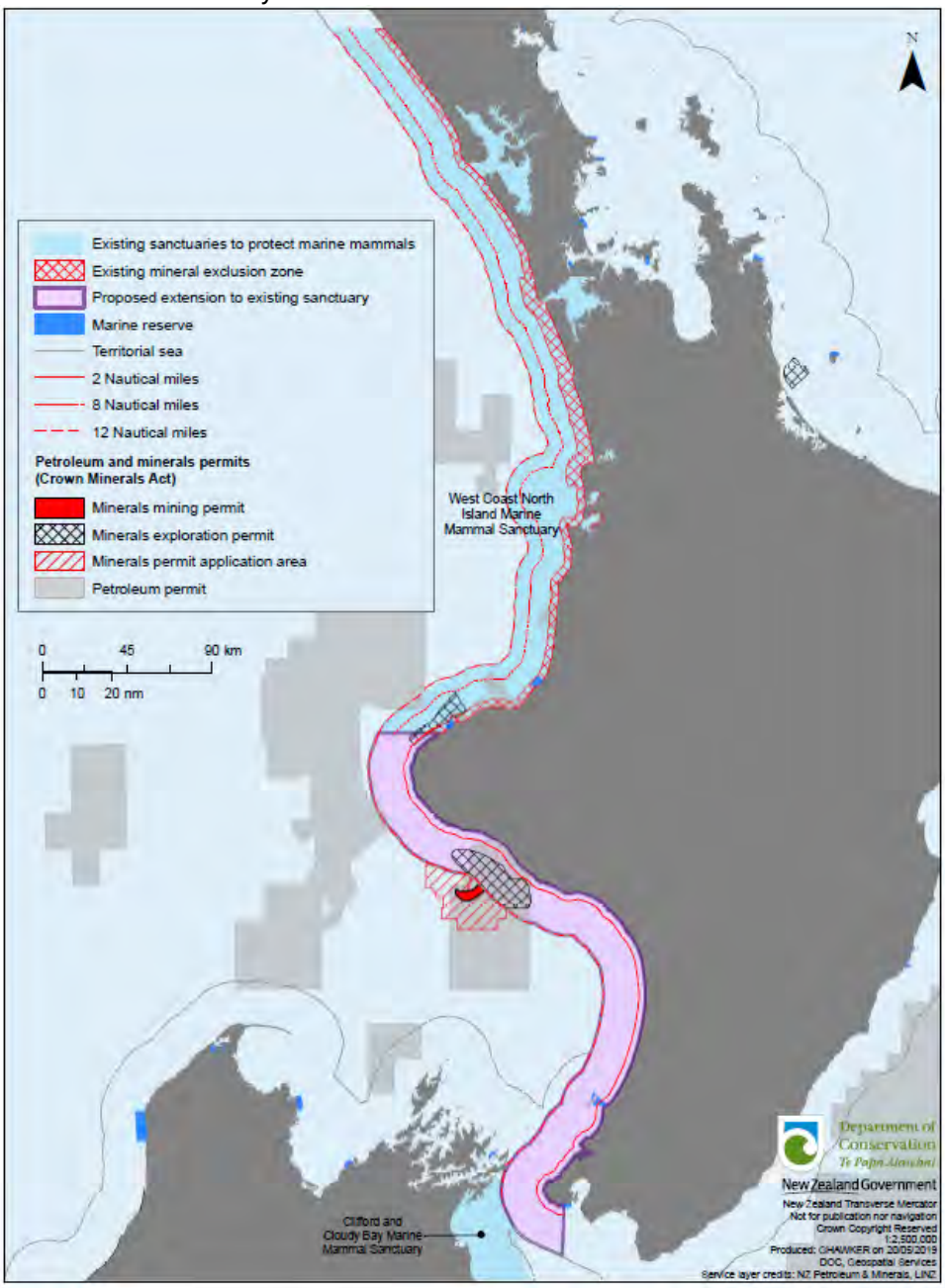
8.2.1 West Coast North Island Marine Mammal Sanctuary

The current West Coast North Island Marine Mammal Sanctuary, established in 2008 as a part of the TMP, extends from Maunganui Bluff in Northland to Oakura Beach, Taranaki, in the south (Figure 38). The sanctuary's offshore boundary extends from mean high water springs to the 12 nautical mile (territorial sea) limit, encompassing approximately 1,200,086 hectares and 2,164 kilometres of coastline.

There are restrictions on acoustic seismic surveying throughout the sanctuary (see Section 8.3.1). Seabed mining is prohibited out to two nautical miles along the full length of the sanctuary, and out to four nautical miles from south of Raglan Harbour to north of Manukau Harbour (Figure 38).

Commercial and recreational set-net fishing is prohibited in a portion of the sanctuary between two and seven nautical miles offshore between Pariokariwa Point and the Waiwhakaiho River; this set-netting restriction complements other fishing restrictions implemented along this coast under the Fisheries Act. More information on the existing sanctuary is available on the DOC website using this link: West Coast North Island Marine Mammal Sanctuary.

Figure 38: West Coast North Island Marine Mammal Sanctuary showing existing boundaries and proposed southern extension to the sanctuary



Māui dolphins are found only on the North Island's west coast and have a very small population size. While there is no evidence of a resident population south of Cape Egmont, public sightings and acoustic detections confirm Hector's and/or Māui dolphins are infrequently present there, and historical evidence suggests they were likely to have been more abundant in this area in the past. The risk assessment identified this southern area as a potential transitional area between Hector's and Māui dolphins and an area of suitable habitat for the dolphins. Therefore, risk reduction in this southern area may reduce barriers to population connectivity or facilitate recolonisation of previously occupied areas. It is proposed to extend the boundaries of the West Coast North Island Marine Mammal Sanctuary southwards to Wellington as depicted in Figure 38, with commensurate restrictions proposed for seismic surveying and seabed mining (see Sections 8.3 and 8.4, respectively, for details). The proposed southern boundary is at the western boundary of Taputeranga Marine Reserve and abuts the Clifford and Cloudy Bay Marine Mammal Sanctuary.

This proposed sanctuary extension would align with some of the fisheries proposals presented in the discussion document, and in Section 6 of this document.

8.2.2 Banks Peninsula Marine Mammal Sanctuary

The current Banks Peninsula Marine Mammal Sanctuary extends from the mouth of the Rakaia River to the mouth of the Waipara River and to 12 nautical miles offshore (Figure 39). This sanctuary encompasses approximately 413,000 hectares and covers 389 kilometres of coastline. There are restrictions on acoustic seismic surveying throughout the sanctuary.

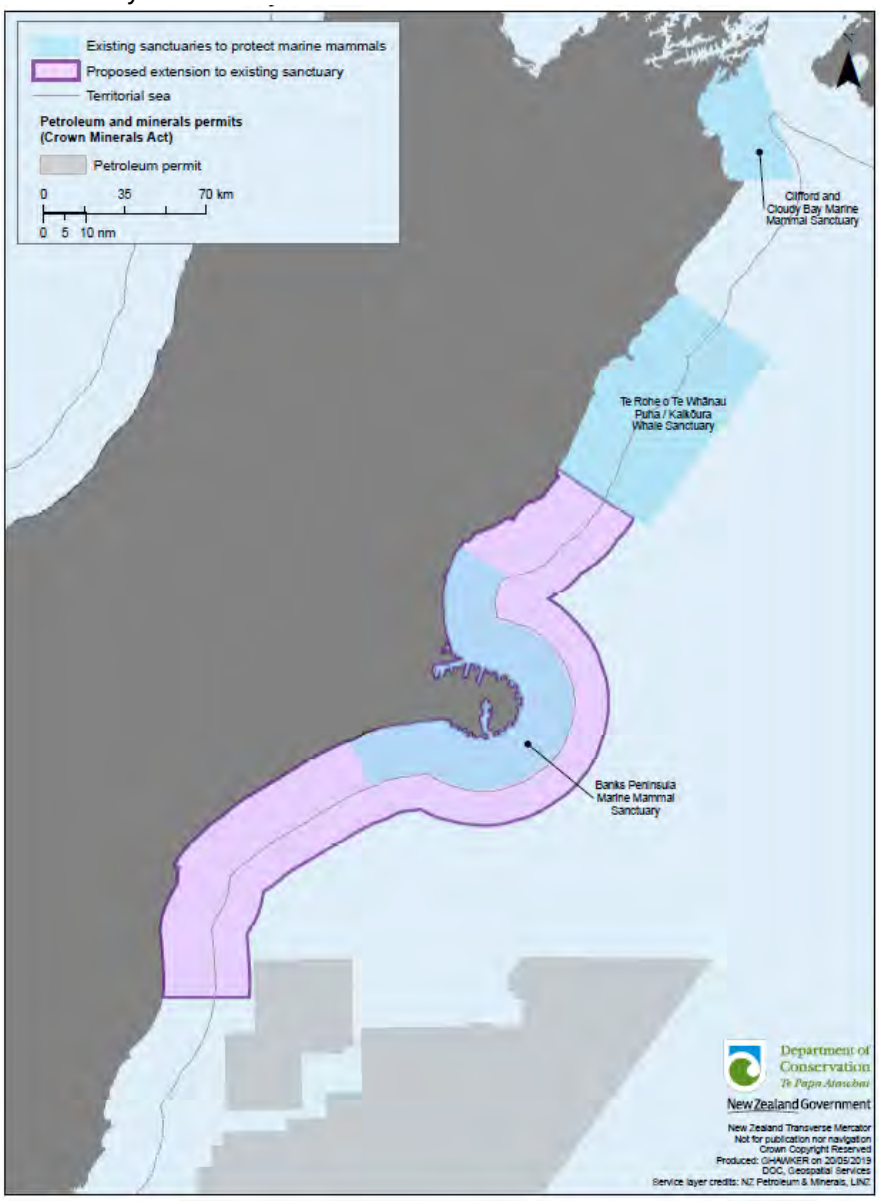
The risk assessment process identified Hector's dolphin distribution off the east coast of the South Island ranging well beyond the current boundaries of the Banks Peninsula Marine Mammal Sanctuary, with particularly high densities outside current protected areas north of Banks Peninsula and south toward Timaru (see Figure 2).

It is proposed to extend the Banks Peninsula Marine Mammal Sanctuary north to the southern boundary of the Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary, south to Timaru, and offshore to 20 nautical miles throughout (Figure 39). These extensions would allow for protection of Hector's dolphins across a greater portion of their distribution as identified by the spatial risk assessment. Proposed restrictions on seismic surveying and seabed mining within the sanctuary are outlined in Sections 8.3 and 8.4, respectively. This proposed sanctuary extension would align with some of the fisheries proposals presented earlier in this supporting document (see Section 6.10).

Effect of the proposals on existing users

The effect of the proposed sanctuary extensions on existing users (seismic surveying and seabed mining) will depend on what restrictions are implemented and where; please refer to Sections 8.3.4 and 8.4.3.

Figure 39: Banks Peninsula Marine Mammal Sanctuary showing existing boundaries and proposed extensions to the sanctuary



8.3 SEISMIC SURVEYING

Marine seismic surveying consists of using an acoustic source (usually an array of air guns) to send a controlled sound wave beneath the surface of the seabed. Reflections of the sound wave are picked up by sensors as the wave bounces off subsurface formations, generating an image of subsurface geological structures.

The TMP proposals focus on seismic surveys at sound levels that are typically used by the oil, gas and mining industry to assess the prospectivity of petroleum and mineral deposits. Seismic surveying of similar or lesser intensity can also be used for scientific research (for example, on fault lines to study earthquakes). Surveys may range in duration from a few days to many months.

Noise produced by seismic surveying is loud enough that it poses risks to marine life, and because marine mammals use sound to communicate, navigate, and find food, they are particularly sensitive to effects from noise. There is a substantial body of literature demonstrating that exposure to such noise may disturb important marine mammal behaviours, including breeding, feeding, and resting. Indirect effects may also result from changes in the distribution and abundance of their prey. Further information on seismic surveying and its effects on marine biodiversity is available on the DOC website (www.doc.govt.nz/tmp-review).

Effects on an animal will be influenced by a range of factors including the type and intensity of sound, what the animal is doing when it hears the sound, and whether the animal has been exposed to similar noises previously. Noise-induced effects range from mere perception, to acoustic masking and stress, through to behavioural and physiological or physical effects.

As part of the TMP review, DOC commissioned a review of the existing literature to assess potential impacts of petroleum and mineral exploration and production on the dolphins[14]. The literature review noted that, apart from theoretical or modelled assessments, no studies have been undertaken to assess the effects of seismic surveying on Hector's or Māui dolphins directly. Thus, there is no direct experimental or similar evidence that shows seismic surveying adversely affects Hector's or Māui dolphins. Such experimental research would require substantial funding and would necessitate intentional exposure of the dolphins to loud noise. The small number of Māui dolphins would also significantly hamper the ability to undertake such research.

Establishing (or disproving) a direct link between seismic surveying and population-level effects for Hector's or Māui dolphins is also hampered by the difficulty of undertaking research on long-lived, slowly reproducing animals, as such effects might take decades or more to be seen. These animals are also exposed to a variety of human activities and environmental variables over the course of their lives, which would make it difficult to attribute effects to a single activity.

Notwithstanding these limitations, other information about the biology and predicted hearing sensitivities of the species and the effects of seismic surveying on other cetaceans, means we can be confident seismic surveying poses a threat to the dolphins. The literature review concluded that behavioural reactions were the most likely effect of noise-producing activities, such as seismic surveying, but that there was no specific information available on behavioural responses of Hector's and Māui dolphins to noise. The authors concluded that the optimal techniques to reduce impacts on the dolphins would be a combination of noise-producing activities avoiding biologically important areas combined with strict restriction of any activities still permitted to occur.

Further information on seismic surveying and its effects on marine biodiversity is available on the DOC website (www.doc.govt.nz/tmp-review).

8.3.1 Current management

Seismic surveying and the effects of seismic surveying on marine biodiversity is currently managed through several regulatory and non-regulatory processes:

- Crown Minerals Act 1991 (CMA) for the allocation of rights to extract Crown-owned minerals;
- the Exclusive Economic Zone and Continental Shelf (Environmental Effects Act 2012 (EEZ Act)) and the Exclusive Economic and Continental Shelf (Environmental Effects—Permitted Activities) Regulations 2013 (the permitted activity regulations) for managing the effects of seismic surveying on the environment;
- the 2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveying Operations (the Code);
- restrictions in Marine Mammal Sanctuaries and the Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary;
- prohibitions in marine reserves under the Marine Reserves Act 1971;
- coastal plans created under the Resource Management Act 1991 (RMA).

The current management regime creates some tension between protecting and conserving biodiversity (which can include avoiding effects or mitigating risks), managing the environmental effects of activities, and allowing for sustainable use of resources. A more in-depth summary of the current regime is available on the DOC website (www.doc.govt.nz/tmp-review).

One important tool in the current regime is the *2013 Code of Conduct for Minimising Acoustic Disturbance to Marine Mammals from Seismic Surveying Operations* (the Code). It was developed by DOC, with stakeholder input, as a voluntary measure to apply throughout New Zealand continental waters[15]. The Code aims to minimise disturbance to marine mammals from seismic surveys and

[14] Lucke, K., D. Clement, V. Todd, L. Williamson, O. Johnston, L. Floerl, S. Cox, I. Todd, and C.R. McPherson. 2019. *Potential Impacts of Petroleum and Mineral Exploration and Production on Hector's and Māui Dolphins*. Document 01725, Version 1.0. Technical report by JASCO Applied Sciences, Cawthron Institute, and Ocean Science Consulting Ltd. for the Department of Conservation, New Zealand.

[15] New Zealand continental waters means the territorial sea; the waters of the exclusive economic zone; and, the waters beyond the outer limits of the exclusive economic zone but over the continental shelf, of New Zealand.

provides practical mitigation measures to manage the most significant effects of seismic surveying on marine mammals.

The Code was incorporated into the Exclusive Economic Zone and Continental Shelf (Environmental Effects – Permitted Activities) Regulations 2013. As a result, seismic surveying became a permitted activity in the exclusive economic zone provided it complied with the Code.

Most existing marine mammal sanctuaries, along with the Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary, have restrictions on seismic surveying which are different to the requirements of the Code. Seismic surveying was restricted in marine mammal sanctuaries before the Code was developed, and, in most cases, sanctuary restrictions provide less protection than the requirements of the Code. For example, in existing marine mammal sanctuaries, pre-survey consultation and assessment of potential impacts are not required, on-water monitoring and mitigation requirements are less rigorous, and reporting requirements are less robust. Additional monitoring and mitigation requirements cannot be added to reduce risks. Voluntary compliance with the Code within sanctuaries is also not universal and there is no ability to legally enforce compliance.

Thus, there is greater protection to Hector's and Māui dolphins from the effects of seismic surveying outside marine mammal sanctuaries than inside them. A comparison of the main requirements in each case is available on the DOC website (www.doc.govt.nz/tmp-review).

Recent research has also highlighted concerns that there are risks to marine mammals from seismic surveying that cannot be managed (see further information on the DOC website: www.doc.govt.nz/tmp-review).

There is complex propagation of airgun pulses, difficulty in monitoring smaller, cryptic, and/or deep-diving species (for example, Hector's and Māui dolphins, beaked whales, and sperm whales). There are also limitations to the effectiveness of at-sea monitoring, a lack of baseline data, and other biological and acoustical complications or unknowns.

The current regime provides limited powers for the Government to exercise discretion, particularly where greater protection may be appropriate due to the sensitivity of animals or habitats or where there is greater uncertainty around potential effects. For example, there is no ability in the existing marine mammal sanctuaries to require additional controls to reduce risk (for example, because of sensitivity of animals or habitats, or uncertainty around potential effects). Nor can a seismic survey be prevented in a sanctuary, or in a specific area within a sanctuary, when risks cannot be appropriately mitigated.

8.3.2 Future management

Several proposed options are presented below for managing the risk of seismic surveying to Hector's and Māui dolphins.

Retaining the current restrictions on seismic surveying in marine mammal sanctuaries is not proposed as an option given the anomalous situation of there being less protection for Hector's and Māui dolphins inside marine mammal sanctuaries than in places outside them. In addition, the residual risk resulting from the lower standard of protection in sanctuaries, difficulty in monitoring for small dolphins, and inability to impose additional controls on seismic surveys, has the potential to result in unacceptable risks to Māui and Hector's dolphins in marine mammal sanctuaries, which must be managed to achieve the vision and goals of the TMP.

While coastal plans developed under the RMA could be used to partly address some of these concerns, this approach would require multiple regional councils amending their plans over time, with inconsistent outcomes likely. Additionally, the scope and purpose of the RMA relates to the sustainable management of resources generally and is much broader than protecting a particular marine mammal (as enabled under the MMP Act).

The proposed options presented below would allow the Government to control potential effects of seismic surveys on Hector's and Māui dolphins in sanctuaries in a consistent manner and alleviate uncertainties for the industry, iwi and others.

All proposed options would apply equally to seismic surveying undertaken for commercial (petroleum and mining) purposes, as well as non-commercial (academic or other research) purposes. Surveys undertaken to fulfil requirements of existing permits issued under the Crown Minerals Act would be captured by requirements detailed in the proposed options.

8.3.3 Management Options

8.3.3.1 Option 1: Require compliance with the Code in marine mammal sanctuaries

Under this proposed option, restrictions in marine mammal sanctuaries would be revised to require compliance with the Code. DOC would continue to be responsible for compliance and enforcement of the sanctuary restrictions.

The Director-General of Conservation would be able to request additional conditions on any surveys being undertaken in sanctuaries, but not require them as conditions. This option would also not allow the Director-General to prevent a seismic survey happening in a sanctuary (in whole or in part) when risks cannot be appropriately mitigated.

Option 1 would result in a regime in sanctuaries consistent with the requirements in the EEZ, allowing surveys which cross between the two areas to operate under a common set of rules. However, it would not resolve the risk of proponents not agreeing to additional conditions in sanctuaries requested by the Director-General.

Costs associated with this change would be expected to be minimal. DOC already administers the Code and is responsible for enforcing restrictions in sanctuaries. Furthermore, industry already complies with the Code as a regulatory requirement in the EEZ and as a voluntary measure elsewhere.

8.3.3.2 Option 2: Require a permit under the MMP Act in marine mammal sanctuaries

Under proposed Option 2, seismic surveying would be prohibited in a sanctuary unless authorised by a permit issued by the Minister of Conservation or the Director-General of Conservation. The permitting regime would be established by regulations following standard processes for developing regulations, including consultation with iwi, the public and industry.

The permit regime is likely to include:

- a process for applying for a permit and for assessing the application;
- power to grant or decline a permit for seismic surveying;
- power to impose conditions;
- a process for public submissions (similar to the current permitting process for commercial marine mammal watching activities);
- criteria for granting or declining a permit.

The new regime would rely on the basic provisions of the Code as a foundation for management, with additional conditions applied if considered appropriate. It is also proposed to include “Level 3” surveys (that is those with the smallest acoustic source; as defined in the Code) for consistency with current protection in sanctuaries. Applicants would need to submit with their applications the same type of information currently required by the Code, and permits could be granted (with conditions) or declined.

Under the new regime, a written application (accompanied by the prescribed fee) would be required from every person wanting a permit to conduct a seismic survey in a marine mammal sanctuary. Information requirements for applications would be set out in the regulations and are likely to be similar to the marine mammal impact assessment and mitigation plans currently required by the Code.

Matters for assessment are likely to include:

- information submitted with the application (referred to above, and to be set out in the regulations);
- any additional information as to the potential effects on marine mammals notwithstanding the implementation of planned monitoring and mitigation measures;
- DOC’s assessment of potential risks associated with the application, considering geographic area, duration, intensity of noise produced, and so forth;
- any submissions received in relation to the application;
- relevant views of iwi, hapū or whānau, including under the Marine and Coastal Area (Takutai Moana) Act 2011 as appropriate.

The criteria for granting a permit are likely to include a requirement for the protection, conservation and management of marine mammals, reflecting the overall purpose of the MMP Act.

Revising the sanctuary restrictions to require a permit for seismic surveying would address the problems identified within the current regime by:

- providing a process whereby a decision-maker can consider any additional information about the effects on marine mammals notwithstanding the implementation of the monitoring and mitigation measures planned for a survey;
- providing a legal basis to impose additional conditions or prohibit seismic surveying in the sanctuary (in whole or in part) if supported by the evidence, to conserve or protect marine mammals;
- using the Code as the basis for management in a sanctuary, addressing the current geographic inconsistencies inside and outside sanctuaries.

DOC would incur some additional costs to implement this proposed option. These would depend upon the exact process for processing a permit application, including whether public submissions were required. If not, costs would be similar to those for processing other complex permit applications under the MMP Act.

Industry and researchers would incur costs in preparing an application, but these are expected to be similar to what is already required in the EEZ under the Code.

8.3.3.3 Option 3: Prohibition of seismic surveying in marine mammal sanctuaries

Under this proposed option, seismic surveying would be prohibited in marine mammal sanctuaries to eliminate risk to Hector's and Māui dolphins from this activity.

Exceptions to this prohibition would be included for urgent hazard assessments in sanctuaries similar to what is provided for in the Te Rohe o Te Whānau Puha / Kaikōura Whale Sanctuary.

Exceptions would also be included consistent with the Crown Minerals (Petroleum) Amendment Act 2018. The prohibition would not apply to existing Crown Minerals Act permit holders or any subsequent permits granted with respect to those existing permits. Any seismic survey undertaken in a sanctuary under these exceptions would be subject to the restrictions as defined by Option 1 or Option 2 above and DOC would engage with the proponent to ensure risks to dolphins were reduced as much as possible.

The proposed prohibition would address the problems identified with the current regime by minimising the potential for surveys to be undertaken that could not be managed to an appropriate level of risk to the dolphins.

8.3.4 Effect of the proposals on existing users

The effect of the proposed restrictions on seismic surveying operations will depend on what restrictions are implemented and where, including the extent of any sanctuary extensions. The bigger the area, the greater the likely effect, though this will also depend on location and the likelihood of seismic surveys being undertaken.

The proposal to require compliance with the Code in sanctuaries (Option 1) should have little impact on current operators because this approach mirrors what is currently required in the EEZ (where most seismic surveying has been carried out) and the Code is generally adopted voluntarily by operators in the territorial sea.

The proposed permitting regime (Option 2) adds the greatest uncertainty and economic risk for applicants especially as operations could be constrained through permit conditions or applications could potentially be declined. The amount of uncertainty and economic risk will change depending on the detail of the permit regime, including the assessment criteria.

Existing Crown Minerals Act permit holders are proposed to be exempted from the proposed prohibition on seismic surveying in sanctuaries (Option 3). However, if the permitting regime (Option 2) was used to manage any surveys undertaken under these exemptions, the same uncertainty and economic risk as described above would apply to them under this proposal.

8.4 SEABED MINING

Seabed mining (for minerals other than oil and gas) typically involves large processing ships using mechanical/suction dredges to extract and pump sediment and associated minerals from the seafloor to the surface for processing. Unwanted sediments are discharged back into the sea either at the surface or at depth.

The three main components of seabed mining with the potential to affect dolphins are underwater noise, direct seabed disturbance, and the discharge of sediments. Noise and sediment plume effects may extend kilometres from the source.

Hector's and Māui dolphins rely on sound for communication, sensing their environment and hunting prey. Noise from mining operations has the potential to limit the dolphins' ability to communicate, sense predators, and forage.

Prey may also alter their distribution in response to noise, sediment plumes, or altered seabed habitat. This has the potential to affect the ability of the dolphins to find food, with flow-on effects for the health of individual dolphins or dolphin populations in the area.

Collectively these effects, if sufficiently large, may result in the affected area becoming sub-optimal as Hector's or Māui dolphin habitat, or in extreme cases, lead to partial or full displacement.

The severity of these impacts, however, will be context and scale dependent and will vary depending on a range of interrelated factors including:

- location;
- spatial and temporal scale of the operation;
- the technology being used and methods for mitigating adverse effects;
- other activities occurring in the territory, for example, shipping and commercial fishing;
- the physical and biological characteristics of the environment, for example, depth/bathymetry, hydrodynamics, benthic habitats;
- the specific characteristics of the effects, for example, frequency-dependent noise levels, noise attenuation, sediment plume footprint;
- the area affected at any given point in time (noting the total operational area will be much larger than the area being mined on any day);
- which subspecies (Hector's or Māui dolphin) is present;
- the importance of the affected area for Hector's or Māui dolphins, for example, is the area core dolphin habitat or on the fringes of their distribution?

Apart from theoretical or modelled assessments for individual consent applications (for example, noise production and attenuation), no studies have been undertaken to assess the effects of seabed mining on Hector's or Māui dolphins. No seabed mining has been undertaken in an area where Hector's or Māui dolphins occur, meaning there has been no opportunity to monitor effects. Thus, there is no direct experimental or similar evidence that shows seabed mining adversely affects Hector's or Māui dolphins. Experimental research would require substantial funding and would necessitate intentional exposure of the dolphins to mining activity. The small number of Māui dolphin would also significantly hamper such research if undertaken along the west coast of the North Island.

Establishing (or disproving) a direct link between seabed mining and population-level effects for Hector's or Māui dolphins is also hampered by the difficulty of undertaking research on long-lived, slowly reproducing animals, as such effects might take decades or more to be seen. These animals are also exposed to a variety of human activities and environmental variables over the course of their lives, which would make it difficult to attribute effects to a single activity.

8.4.1 Current management

Seabed mining is currently managed through three principal statutes – the Crown Minerals Act for the allocation of rights to extract Crown-owned minerals; the EEZ Act for assessing the environmental effects of applications in the EEZ; and the RMA for mining applications in the territorial sea. Some

regional councils may have objectives, policies and methods included in their respective regional coastal plans relating to seabed mining.[16]

The exception to this approach is in the West Coast North Island Marine Mammal Sanctuary where seabed mining is prohibited out to two nautical miles along the full length of the sanctuary, and out to four nautical miles from south of Raglan Harbour to north of Manukau Harbour (Figure 38) pursuant to the restrictions established under the sanctuary[17].

The current regulatory approach means, in terms of environmental effects of seabed mining, each mining operation is assessed on a case by case basis under either the RMA or the EEZ Act (or potentially both Acts for operations straddling the boundary between the territorial sea and the EEZ).

Under both the RMA and EEZ Act, the effects on Māui and Hector's dolphins are considered alongside other environmental effects as well as economic matters in terms of managing the use, development, and protection of natural resources. Applications can be contentious, litigious and costly, and there is no certainty as to outcome.

Providing for additional controls to protect Hector's and Māui dolphins specifically (as opposed to managing adverse effects on the environment generally) is appropriate under the MMP Act given its purpose of protecting, conserving and managing marine mammals.

Two large offshore applications have been processed under the EEZ Act: Trans-Tasman Resources for iron sand in the South Taranaki Bight[18] and Chatham Rock Phosphate for phosphate nodules and minerals on the Chatham Rise[19]. Two minerals exploration permits have also been issued under the Crown Minerals Act off the west coast of the North Island (Figure 38). One permit (Ironsands Offshore Mining Limited) is within the existing West Coast North Island Marine Mammal Sanctuary. The second exploration permit (Trans-Tasman Resources Limited) is outside the existing sanctuary but within the range of Māui dolphin and within the proposed southern extension of the sanctuary.

Future management

Māui dolphins

The Māui dolphin population is very small (63 dolphins aged 1+ (95 percent CL 57-75)) and is classified as Nationally Critical under the New Zealand Threat Classification system. The current state of the population justifies the implementation of strong protection measures to ensure the subspecies recovers and thrives. Even small potential effects will need to be managed to achieve the goals of the TMP.

The current prohibition on seabed mining within the West Coast North Island Marine Mammal Sanctuary extends out to two and four nautical miles (Figure 38) but does not include the full range of Māui dolphins offshore or alongshore. Residual risks to Māui dolphins from the effects of seabed mining therefore remain in these unprotected waters.

Māui dolphin densities are highest closer to shore with most validated sightings within four nautical miles of the coast. Validated sightings and acoustic detections decrease with increasing distance offshore. The great majority of these records occur inside seven nautical miles from shore, but occasional records occur out to at least eight nautical miles off the Manukau coast. The MMP Act's purpose of protecting, conserving and managing marine mammals would support protection measures across this known range. Extending the seabed mining prohibition within the West Coast North Island Marine Mammal Sanctuary out to eight nautical miles would avoid any direct overlap between mining and this known range. A greater distance (for example, to 12 nautical miles) would add a greater degree of protection by creating a buffer for effects such as noise and sedimentation which may spread well beyond the immediate location of a mining operation. It would also account for any Māui dolphins venturing further offshore than eight nautical miles; the furthest acoustic detection of a Hector's or Māui dolphin is 9.8 nautical miles off the Manukau coast.

South of the existing West Coast North Island Marine Mammal Sanctuary, there is the risk of seabed mining acting as a barrier to Māui or Hector's dolphin movements up and down the coast, including connections with dolphin populations closer to Cook Strait. Having a protected near-shore corridor (for

[16] For example, see Section F2.6 of the Auckland Unitary Plan.
[17] See clause 6 of the Marine Mammals Protection (West Coast North Island Sanctuary) Notice 2008 which prohibits mining, as specified in the area described in Schedule 3, except for mining for petroleum or a minimum impact activity.
[18] Decision currently under appeal, Court of Appeal.
[19] Application declined. This area is not Hector's dolphin habitat.

example, two nautical miles from shore) along these southern shores would help reduce impediments to dolphin movements.

Hector's dolphins

Although the current regulatory approach may be sufficient for managing the effects of seabed mining on Hector's dolphins through much of their range, a greater degree of protection in the four existing South Island marine mammal sanctuaries (Clifford and Cloudy Bay, Banks Peninsula, Catlins Coast, and Te Waewae Bay) would be beneficial for the long-term welfare of this subspecies given the higher densities of dolphins in these core areas.

In this regard, ensuring there is a near-shore corridor with no significant impediments to dolphin movements up and down the coast would be beneficial for retaining connectivity between areas and reducing the risk of fragmentation of subpopulations. Prohibiting seabed mining within two nautical miles of the coast in the four South Island marine mammal sanctuaries (including the proposed extensions to the Banks Peninsula Marine Mammal Sanctuary outlined earlier) would help provide for such a corridor in these core dolphin areas.

8.4.2 Management options

Depending on the degree of protection sought, management options for seabed mining are proposed below. Some of these proposed options are not mutually exclusive and could be implemented as a package of changes.

The proposed prohibitions would not apply to existing Crown Minerals Act permit holders or any subsequent permits granted with respect to those existing permits. This approach would enable a transition to a new management regime for mining activities while providing greater protection for Hector's and Māui dolphins than exists under the status quo. Residual risks to dolphins from activities undertaken pursuant to existing Crown Minerals Act permits would remain. DOC will continue to engage in statutory processes under the RMA and the EEZ Act to help ensure risks to dolphins from seabed mining operations are considered and mitigated.

8.4.2.1 Option 1 (Hector's and Māui dolphins)

The status quo, including maintaining the current prohibition on mining (and maintaining the current exceptions for mining for petroleum[20] and minimum impact activities[21]) within the West Coast North Island Marine Mammal Sanctuary out to two and four nautical miles (see Figure 38).

8.4.2.2 Option 2 (Māui dolphins)

Reducing the risk to Māui dolphins from seabed mining by extending the existing prohibitions (and exceptions) on seabed mining within the existing West Coast North Island Marine Mammal Sanctuary out to (see Figure 38):

a) eight nautical miles; or
b) 12 nautical miles.

8.4.2.3 Option 3 (Hector's and Māui dolphins)

Reducing the risk to dolphins moving along the Wellington to south Taranaki coast by prohibiting seabed mining out to two nautical miles within an extended West Coast North Island Marine Mammal Sanctuary south to Wellington (see Figure 38).

8.4.2.4 Option 4 (Hector's dolphins)

Reducing risk to Hector's dolphins by prohibiting seabed mining within two nautical miles of the coast within the four South Island marine mammal sanctuaries (Clifford and Cloudy Bay, Catlins Coast, Te Waewae Bay, and Banks Peninsula including the proposed extensions noted earlier) (see Figure 39).

[20] The current exception for mining for petroleum means existing petroleum permit holders under the Crown Minerals Act 1991 won't be affected by the seabed mining prohibition.
[21] "Minimum impact activity" has the meaning given by section 2(1) of the Crown Minerals Act 1991.

8.4.3 Effect of the proposals on existing users

There are likely to be economic consequences for Option 2 and to a lesser extent Option 3 given the known interest in offshore mining for iron sand (and co-occurring vanadium) along the west coast of the North Island. These effects relate to lost economic development opportunities rather than effects on existing permitted activities. These costs will vary depending on how far offshore any additional seabed mining prohibition extends (for example, two, eight or 12 nautical miles), with costs generally increasing with distance offshore. Prospectivity (and therefore effects) is likely to decrease closer towards Wellington.

There is insufficient information on the mineral resources off the west coast of the North Island to be able to quantify the lost economic development opportunity costs for the different proposals in this region with any certainty. The "in situ" resource could be in the many millions of dollars, and potentially much more. No detailed assessments of these costs have been undertaken.

The economic consequences of Option 4 should be comparatively low considering the inshore locations of the sanctuaries along the South Island's eastern and southern coasts where mineral prospectivity is likely to be limited.

As noted above, the proposed prohibitions would not apply to existing Crown Minerals Act permit holders or any subsequent permits granted with respect to those existing permits (that is, the proposals would not affect these existing permit holders).

8.4.4 Measuring benefits to the dolphins from the above management options

It is not possible to quantify the predicted benefits of the sanctuary extension, seismic surveying and seabed mining restrictions proposals for the conservation and protection of Hector's and Māui dolphins. While improved levels of protection should be beneficial for the long-term welfare of both subspecies, population recovery will be influenced by multiple factors (including population biology, other human threats, environmental variables, and other management interventions) and could take many decades or longer. Particularly for Māui dolphins, population recovery is likely to be very slow because of the very small current population size; range extension south of Taranaki could take even longer.

Relative benefits for dolphins will depend on what restrictions are implemented and where, including any sanctuary extensions. The bigger the area protected, the greater the likely benefits, though this will also depend on location and the likelihood of seismic surveys or seabed mining being undertaken there.

However, not being able to quantify the predicted benefits is not considered a reason for doing nothing. Strong protection measures are considered necessary to ensure the subspecies recover and thrive, and to achieve the MMP Act's purpose of protecting, conserving and managing marine mammals. Even small potential effects across the full range of threats need to be managed if the goals of the TMP are to be achieved, particularly for the critically endangered Māui dolphins.

Because the proposals would not affect existing Crown Minerals Act permit holders, residual risks to Hector's and Māui dolphins would remain. DOC will continue to engage in statutory processes under the RMA and the EEZ Act to help ensure risks to dolphins from seabed mining operations are considered and mitigated.

8.5 DOLPHIN WATCHING AND VESSEL TRAFFIC

Vessel traffic potentially affects Hector's and Māui dolphins in two principle ways: through disturbance (including noise) and collisions causing injury or death.

DOC has only one known record of a Hector's dolphin mortality from a vessel collision – a single dolphin off the east coast of the South Island. While it is likely injuries or mortalities from vessel strike go unnoticed or unreported, this solitary record indicates such incidents are unlikely to be common or widespread. Greatest risk will be in hot spot areas where there is greatest overlap between vessel activity (commercial and recreational) and dolphin distribution (for example, Akaroa).

A considerable amount of research has investigated the impact of marine mammal watching on dolphin behaviour in New Zealand and overseas. While different taxa respond differently to different levels of dolphin watching pressure, virtually all species have been observed to change their

behaviour in response to vessels including changes to resting, milling, socialising, travelling, foraging/feeding and/or group cohesion. These behavioural changes may have flow-on effects for the welfare of individuals and local populations.

Research at Akaroa on Hector's dolphins has showed indications of both habituation (reduced reactions over time) and sensitisation (increased reactions over time) to tourism activities. Vessels significantly affected the overall activity budget and certain behaviours of dolphins including:

- decreased travelling and increased milling in the presence of vessels and swimmers;
- decreased diving/foraging in the presence of vessels;
- increased diving with larger groups of swimmers.

Several aspects of the ecology and behaviour of Hector's and Māui dolphins make them vulnerable to potential disturbance. They are coastal, frequenting near-shore waters over the summer months when and where boating activity is highest. The peak in tourism and recreational boating activity (December to February) also coincides with the known calving period. They are also a very small dolphin, are not strong or fast swimmers, and are mostly found in very small groups. In addition, Hector's dolphins show high site fidelity, with relatively small home ranges compared to other dolphins, and can be "boat positive" particularly with slower-moving vessels.

These attributes make Hector's dolphins an easy target for commercial and recreational vessels, with the possibility of the same small group/s of animals being approached repeatedly over the course of a day and over several days. Swimming interactions are considered more disruptive than viewing-only trips because they can involve more intrusive approaches and tend to have longer interaction times.

Current management

Vessel activity near marine mammals is managed under the MMPR through a permit regime for commercial marine mammal watching and rules governing people and vessel behaviour around marine mammals. Collectively, the permit regime and rules are intended to minimise the likelihood of both collisions and disturbance by vessels.

All tourism operators must have a commercial marine mammal watching permit issued by DOC under the MMPR. Permits include requirements governing matters such as species, area of operation, vessel type, type of interaction, duration of contact, and number and length of trips.

The MMPR impose a high degree of caution when considering whether to grant a commercial marine mammal watching permit; such as a permit cannot be issued unless the Director-General of Conservation is satisfied the proposed commercial operation will not have, or be likely to have, any adverse effect on the conservation, protection, or management of marine mammals. In addition, the Director-General must be satisfied the criteria in Regulation 6 of the MMPR have been substantially complied with. The MMPR also allow for moratoria to be declared on issuing new permits.

Part 3 of the regulations stipulate general and specific operating rules which all vessels must adhere to including maximum speeds, orientation of approach and numbers of vessels within 300 metres. These rules apply to all recreational and commercial vessels irrespective of whether they are engaged in dolphin watching (the only exception being vessels that are fishing commercially).

No commercial dolphin watching permits have been issued for viewing Māui dolphins. The Northland, Auckland and Waikato Conservation Management Strategies include the following policy:

> *Take a precautionary approach to the number of commercial operators involved in marine mammal operations, including seeking a moratorium on issuing of new permits if research and monitoring indicate that such a step is required*.

Hector's dolphins are viewed commercially in some locations including the Marlborough Sounds, Kaikōura and Banks Peninsula. Akaroa is the main viewing location and while swimming with Hector's dolphins is allowed on some Akaroa-based permits, it has not been permitted elsewhere. There is a moratorium on issuing any new commercial permits at Akaroa which expires in 2026; no additional commercial effort can be considered until then. Further research is planned on the impacts of dolphin watching at Akaroa.

In addition to the MMPR, vessels are also required to adhere to various maritime rules administered by regional councils and Maritime New Zealand. For example, vessels must not exceed five knots within 200 metres of the shore except in designated exclusion areas. Whilst for different purposes, these controls may provide indirect protection for marine mammals close to the shore or in certain controlled harbour areas.

Future management
The MMPR provide strong regulatory control of dolphin watching through the permit regime and the operating rules in Part 3 of the regulations. DOC considers the regulations generally provide an appropriate range and level of protection relative to the risk posed by vessel traffic.

Compliance/enforcement is an important part of the management of dolphin watching, though remains a significant challenge especially for recreational vessels. DOC intends to continue current advocacy and outreach programmes in areas of high overlap between dolphins and vessels, to help ensure skippers are aware of and comply with the regulations.

Despite the relative difficulty in locating Māui dolphins, their high public profile may encourage people to apply for a commercial viewing permit. Given the known effects of vessel interactions on Hector's dolphins, and other dolphin species, there is a high risk of Māui dolphins being disturbed by repeated interactions should commercial tourism vessels target them. DOC believes the Māui dolphin population is far too small to support any level of commercial marine mammal watching and, therefore, proposes to declare a moratorium on new permits under Regulation 15 of the MMPR (using the Director-General of Conservation's existing authority under this regulation).

No other changes are proposed to the current regulatory regime which otherwise is considered sufficient to ensure the goals of the TMP are achieved. A wider review of the MMPR, separate from this TMP review, is currently under consideration.

This proposed approach does not have any economic implications given it is continuing with the status quo.

8.6 OIL SPILLS

A large oil spill could present a catastrophic threat to Hector's and Māui dolphins should one occur in their habitat range. Dolphins have been shown to experience elevated mortality after large-scale oil spills (such as bottlenose dolphins in the Gulf of Mexico after the Deepwater Horizon incident), most likely from exposure to petroleum products and chemicals used to control the spill, or from ecosystem-scale changes in prey distribution and availability.

A spatial risk assessment for oil spills was undertaken in 2015 for Maritime New Zealand and estimated approximately 99 percent of the oil spill risk originated from oil tankers, passenger vessels and cargo vessels, with relatively little contribution to risk from drilling and extraction activities.

The TMP risk assessment compared those results with Hector's and Māui dolphin distribution and estimated the highest risk to dolphins to be on the north side of Banks Peninsula, with relatively lower risk elsewhere.

Current management
The national framework for marine oil spill prevention, preparedness and response spans statutes including the Maritime Transport Act 1994, the Resource Management Act 1991, the Health and Safety at Work Act (HSWA) 2015, the Hazardous Substances and New Organisms Act 1996, and the Exclusive Economic Zone and Continental Shelf (Environmental Effects) Act 2012.

New Zealand's oil spill response capability is maintained (and developed) through partnerships between Maritime New Zealand, Regional Councils, the oil industry, and overseas agencies. In line with international practice and as provided for in the Maritime Transport Act 1994, New Zealand has a three-tiered approach to managing all aspects of marine oil spill preparation and response:

- Tier 1 oil spills – industry responsibility (for example, ships and oil transfer sites);
- Tier 2 oil spills – regional councils' responsibility;
- Tier 3 oil spills – Maritime New Zealand responsibility.

Those responsible for each tier are required to prepare for and respond to an oil-spill appropriate to their level of responsibility. Each tier can be escalated to the next, depending on the scale of the event.

Future management
DOC considers the risk to Hector's and Māui dolphins from an oil spill, while potentially of high consequence, has a low likelihood of occurring and the overall risk is minimised by the existing response framework. A large-scale spill would present the biggest risk, but there are no obvious options to reduce this risk further. As such, it is considered the existing management regime and associated mitigation measures have reduced the risk to the dolphins as much as possible and to a

point where the goals of the TMP will be met. No additional measures are suggested for managing the risk of oil spills to Hector's and Māui dolphins.

This proposed approach does not have any economic implications given it is continuing with the status quo.

8.7 **COASTAL DEVELOPMENT, OTHER POLLUTION, AND** SEDIMENT RUN-OFF

The coastal distribution of Hector's and Māui dolphins means they are more likely to be influenced by coastal development, pollution and sedimentation run-off than other dolphins. Effects may be direct (for example, point source or diffuse pollution, and noise from port-related activities) or indirect (for example, excessive sedimentation affecting benthic habitats and prey availability). Disturbance may be short-term and/or episodic (for example, noise from pile driving) or cumulative due to ongoing exposure (for example, sedimentation and pollution).

Pollution from industrial activities and terrestrial run-off can pose a significant risk to marine mammals because they are apex predators. Bioaccumulation of contaminants may occur, resulting in reduced individual fitness through compromised immune response, failure to produce offspring successfully, and other indirect effects on health. Contaminant levels, including for significant ones such as DDT and PCBs, are fortunately low in marine mammals in New Zealand relative to most industrialised nations.

Sedimentation run-off may be accelerated by land use activities, notably forestry, agriculture and urbanisation. Excessive sedimentation presents a significant threat to coastal marine ecosystems generally, and especially to benthic habitats. While Hector's and Māui dolphins are tolerant of turbid conditions and may be attracted to these waters for other habitat requirements (for example, predator avoidance), excessive sedimentation may lead to negative effects on their prey and, therefore, foraging success.

Hector's dolphins may also be affected by some coastal infrastructure, notably port developments. For example, pile driving noise has been assessed as a threat to resident Hector's dolphins in Lyttelton Harbour and measures were implemented in relevant resource consents to manage these effects (for example, soft starts, shutdown procedures and monitoring zones).

Current and future management

The effects of coastal development, pollution and sedimentation run-off, including threats to Hector's and Māui dolphins, are currently managed by district and regional councils under the RMA through plans and regional policy statements and on a case-by-case basis through individual consents.

Activities and effects are highly variable depending on their type, location, intensity and spatial and temporal scale. Given this variability, effects on marine mammals can only be properly addressed through relevant RMA plans and consents and it is proposed DOC continue to engage in these RMA processes to ensure effects on Hector's and Māui dolphins are appropriately avoided, remedied or mitigated.

This proposed approach does not have any economic implications given it is continuing with the status quo.

8.8 INFECTIOUS DISEASES (OTHER THAN TOXOPLASMOSIS)

Infectious diseases, including toxoplasmosis, brucellosis, pneumonia and tuberculosis, were the cause of death for over half of the Hector's and Māui dolphins which have had necropsies undertaken and where cause of death could be determined. Toxoplasmosis is the main disease of concern and is addressed separately in this supporting document.

Current and future management

While the remaining diseases also cause dolphin mortality, levels are lower than for toxoplasmosis, and these diseases are widespread in the environment, meaning they cannot be realistically managed as part of a species focussed TMP. Furthermore, it is commonly the case that diseases of this kind primarily kill old or compromised or otherwise immune-suppressed animals, such that deaths arising from them may constitute "natural" mortality that serves to keep the population within its natural environmental carrying capacity, rather than external "human-caused" mortality that can be expected

to suppress populations to levels lower than the environmental carrying capacity. In contrast toxoplasmosis appears to often kill otherwise healthy animals and originates only from cats (a source that cannot be considered natural for New Zealand wildlife). Nevertheless, diseases other than toxoplasmosis add important context for considering cumulative effects and the resilience of Hector's and Māui dolphins to other environmental and anthropogenic pressures. For example, animals affected by other non-lethal threats such as pollution, climate change, or seismic disturbance may be more at risk of becoming sick and dying of diseases that are commonly present but generally non-lethal.

No management measures are proposed in the TMP to specifically address these other infectious diseases. DOC will continue to investigate and support research on diseases affecting Hector's and Māui dolphins.

This proposed approach does not have any economic implications given it is continuing with the status quo.

8.9 CLIMATE CHANGE

Ocean acidification (from increased levels of carbon dioxide in the atmosphere) and rising sea temperatures are very significant threats to marine ecosystems. Other climate-related threats include changes in ocean currents, increased storm activity and sea-level rise. Oceanic responses to climate change may cause widespread effects on ecosystems and food webs, with resulting impacts on apex predators including marine mammals. These effects may reduce the resilience of Hector's and Māui dolphins to cope with other anthropogenic pressures.

It is not proposed to address climate-related threats to Hector's and Māui dolphins through the TMP. Instead, DOC will continue to engage in the cross-government response to climate change.

Appendix 1: New information and spatial risk assessment

New science documents supporting this TMP

Since August 2017, the New Zealand government has led a major collaborative effort to improve scientific understanding of the biology and spatial distribution Māui and Hector's dolphins and the various threats that may be affecting their population status to inform the update of the TMP. Peer review occurred iteratively throughout this process via Fisheries New Zealand Aquatic Environment science working groups and the DOC Conservation Services Programme, with active participation by government and academic scientists, fishing industry representatives, ENGOs, and other interested members of the public. New science documents arising from this process constitute part of the material provided to the public to inform this consultation process and are available here: https://www.fisheries.govt.nz/dolphintmp

A summary of the spatial risk assessment is included in Appendix 2, from the abstract of the full publication (Roberts et al. 2019) available at the link above. Selected extracts in Appendices 1 and 2 highlight, but do not replace, the outputs of this full document.

Population trends

The most recent available information on the abundance and distribution of Hector's dolphins[22] shows that, in the South Island, there are approximately 9,700 dolphins on the east coast, 5,500 on the west coast and 332 on the south coast. The north coast subpopulation, if indeed it is a distinct subpopulation, is poorly understood. There are no reliable data to estimate population trends for Hector's dolphins at the scale of these subpopulations.

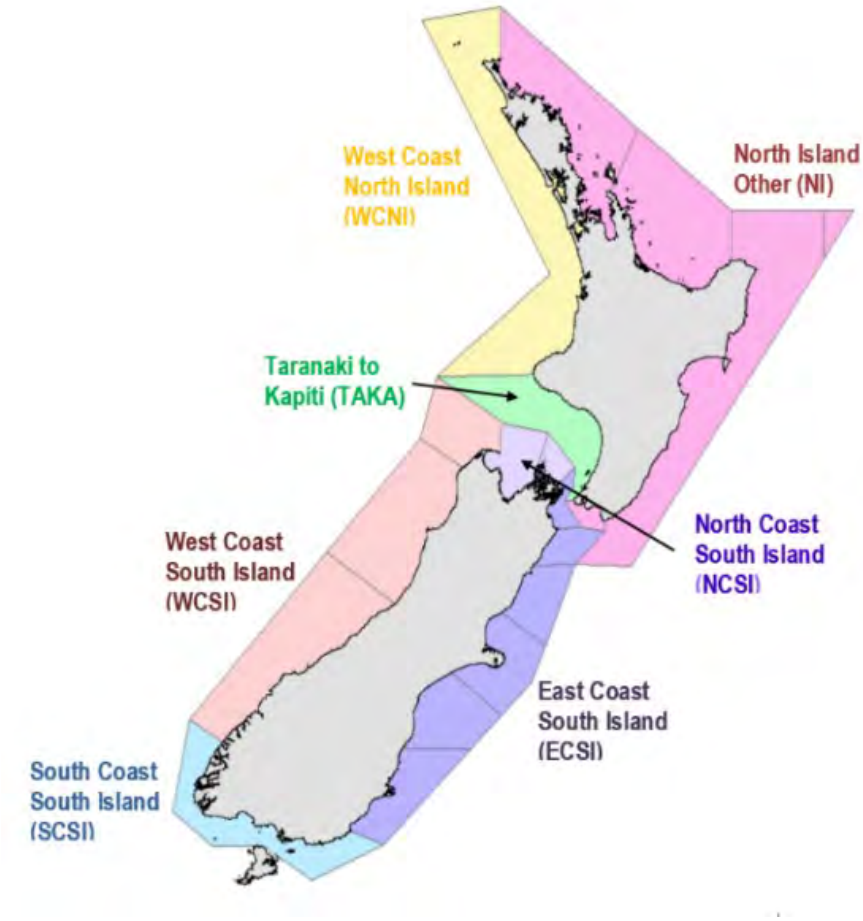
An abundance survey of Māui dolphins in 2015/16 estimated that there were 63 (57 – 75) individuals aged one year and older. This estimate is thought to be substantially lower than the population size two to three decades earlier but is slightly higher than the previous estimate of between 57 (48 – 69) individuals from only five years earlier. It is not possible to tell from these results whether the population has increased, stabilised or continued to decline. However, regardless of recent trends, Māui dolphins remain highly vulnerable to any human-induced mortality.

Subpopulation structure

The spatial risk assessment assumes four subpopulations of Hector's dolphins and a single population of Māui dolphins, and also estimates potential risk to dolphins in areas without permanent dolphin populations (including a "transition habitat" in the South Taranaki Bight where dolphins may occasionally move between Hector's and Māui dolphin subpopulations, and also the rest of the North Island, where individual dolphins are occasionally sighted by the public in locations far removed from any known population). The boundaries of these areas are shown below.

[22] MacKenzie, D. L. and Clement D.M. (2016) Cawthron Institute.

Figure A1.1: Spatial extent of subpopulation areas (discrete colours) and local population boundaries (black lines) **for Hector's and Māui dolphins**

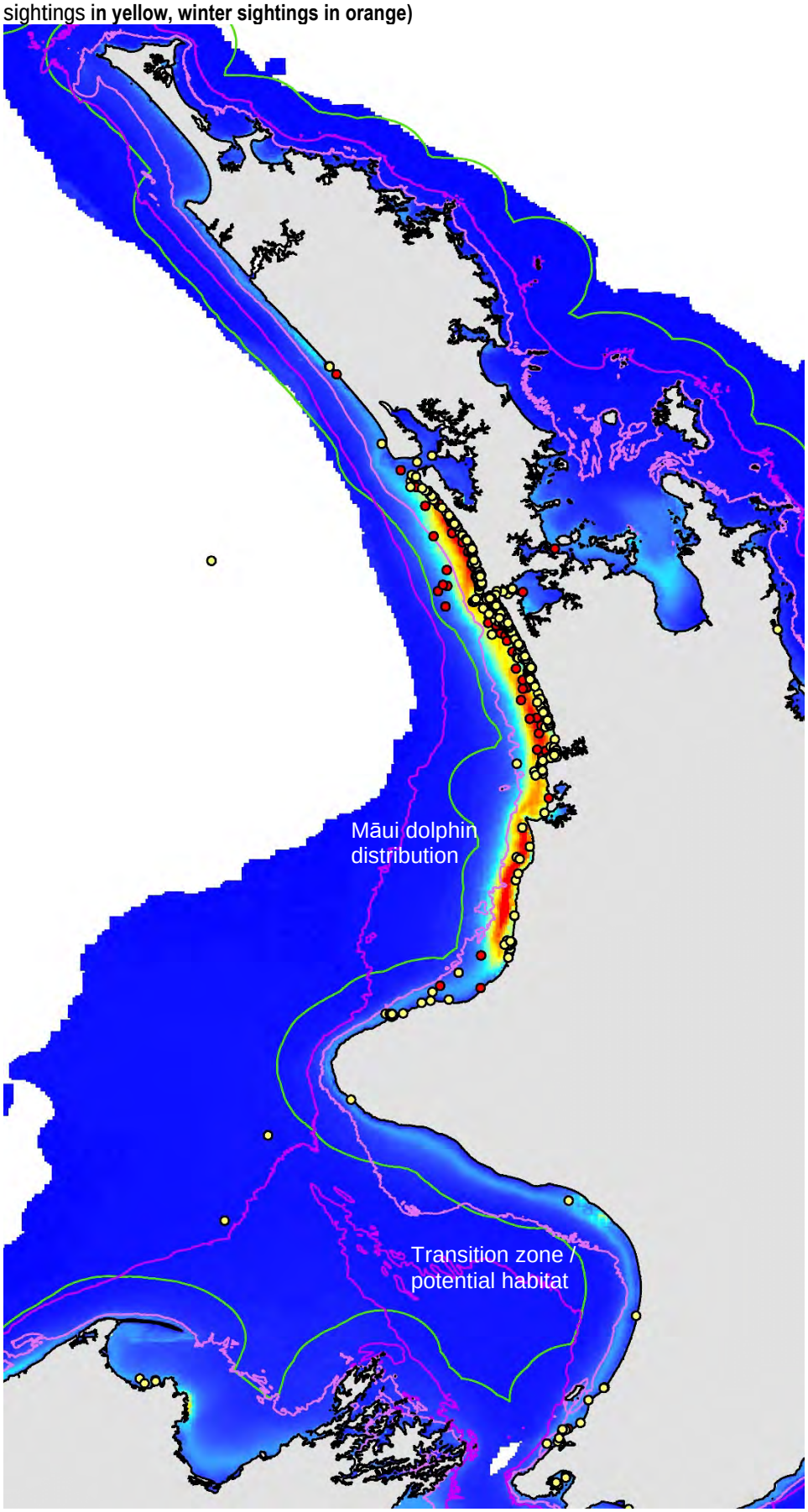


Spatial distribution

The seasonal (summer and winter) densities of Hector's and Māui dolphins were estimated and mapped using spatial habitat models, fitted to data from aerial dolphin surveys and public sightings. Māui and Hector's dolphins show a strong preference for high-turbidity water (which occurs out to around the 50-metre depth contour in most locations) and for locations where prey availability is higher. In summer, dolphin densities are highest in locations closest to shore; in winter the distribution shifts slightly further offshore.

North Island

Figure A1.2: **Estimated (winter) spatial distribution of Māui dolphins, including validated public sightings (summer** sightings **in yellow, winter sightings in orange)**



Note: Also shown are the 12 nautical miles offshore limit (in green) and the 50- and 100-metre depth contours (in purple).

Alongshore distribution

For purposes of estimating exposure to threats, the current distribution of Māui dolphins is defined between Cape Reinga in the north and Cape Egmont in the south. The northern extent of this distribution is unverified. There is suitable habitat for low densities of dolphins north of Kaipara Harbour to Cape Reinga, but the northernmost verified sightings have been near Dargaville.

In the southern tail of their current distribution, Māui dolphins are only rarely seen in the area around New Plymouth and their predicted density drops rapidly thereafter. There is no evidence of a resident population of Māui or Hector's south of Cape Egmont, but the habitat model predicts, and verified sightings and acoustic detections confirm, that Hector's and/or Māui dolphins are infrequently present here. Furthermore, DNA samples from historical strandings and museum specimens identify Māui dolphins as far south as Wellington.

Currently it is assumed that dolphins sighted south of Cape Egmont (and occasional sightings elsewhere around the North Island for example on the east coast) are more likely to be Hector's dolphins, and those to the north of Cape Egmont are predominantly Māui dolphins. However, two Hector's dolphins have been identified among the Māui dolphin subpopulation, suggesting that infrequent dispersal between subpopulations may occur.

In the estimation of risks, the area from Cape Egmont southward to Wellington is defined as a transition zone where non-resident or dispersing dolphins may be exposed to threats; risk management in this area may improve connectivity between subpopulations or allow dolphins to re-establish in the full extent of their former range.

While Māui have the more critical conservation status, Hector's that are found on the west coast of the North Island have their own special importance in maintaining the range of the dolphins. They also have the potential to breed with Māui, which could support both population growth and genetic diversity. Some may argue that this could put the uniqueness of Māui dolphin at risk; however, natural mixing between the subpopulations may be a better outcome than having Māui dolphin numbers decline further.

Harbours

Māui dolphin densities are estimated to be very low within west coast North Island harbours, based on very low numbers of public sightings despite high densities of recreational boat users. Existing fisheries closures include the harbour entrances and extend short distances into harbour mouths.

Sightings of Māui dolphins have been made in three North Island harbours (Kaipara, Manukau and Raglan). Passive acoustic monitoring of these three harbours, in addition to Kawhia Harbour, revealed a low level of intermittent dolphin presence in Kaipara and Manukau harbours. Dolphin densities at locations further from the harbour entrances are more uncertain; the habitat models predict that dolphins may occasionally venture into the upper reaches of these harbours, but there are no positive sightings to verify these predictions. Deployment of passive acoustic detectors in these harbours may be a high research priority to reduce this uncertainty.

Offshore distribution

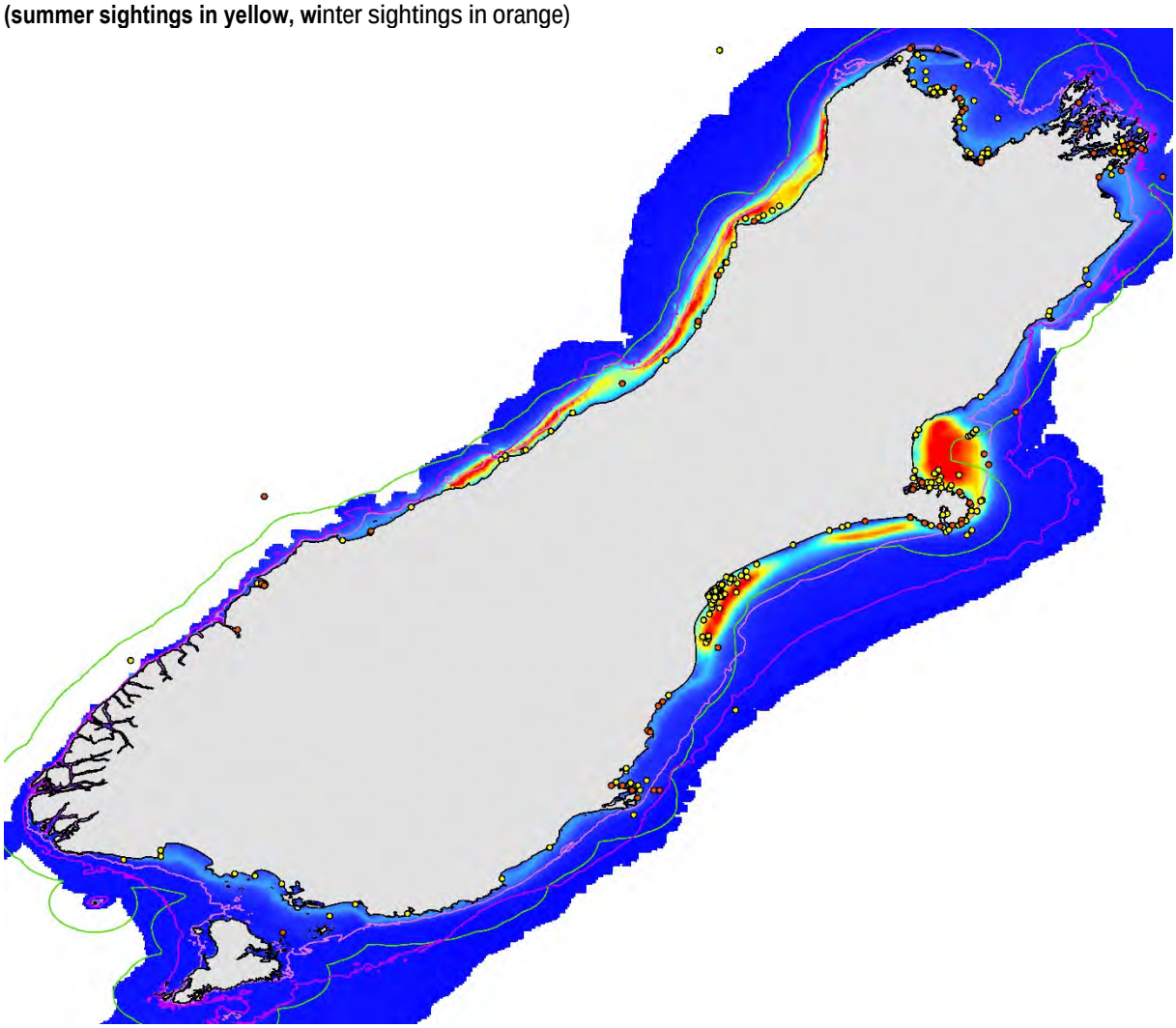
Māui dolphin densities are highest closer to shore. Within the core of their range between Manukau Harbour and Port Waikato, the highest density areas are confined within roughly four nautical miles of the coast, which is also where the vast majority of validated sightings occur.

Beyond four nautical miles from the coast, dolphin densities steadily decline, but occasional sightings are reported out to seven nautical miles offshore.

Dolphin densities beyond seven nautical miles are very low, but habitat models, validated sightings, and acoustic detections confirm that dolphins venture this far offshore at least occasionally. In the area between Maunganui Bluff and New Plymouth, there are five validated sighting events of Hector's or Māui dolphins beyond seven nautical miles offshore, compared with 983 validated sightings within seven nautical miles.

South Island

Figure A1.3: **Estimated (winter) spatial distribution of Hector's dolphins, including validated public sightings (summer sightings in yellow, w**inter sightings in orange)



Note: Also shown are the 12 nautical miles offshore limit (in green) and the 50- and 100-metre depth contours (in purple).

The spatial distribution of Hector's dolphins in the South Island was estimated using the same spatial habitat models described for Māui dolphins (above) except that public sightings were used only subjectively for model validation. Figure A1.3 shows the estimated distribution of Hector's dolphins, including public sightings.

Dolphin densities are highest in areas where the water is highly turbid from sediments originating in terrestrial rivers. The offshore limit of higher dolphin-density areas corresponds most closely to the 50-metre depth contour (light purple in the map above).

Figure A1.3 reflects high numbers of dolphins in the east coast and west coast South Island subpopulations, and relatively small subpopulations on the north and south coasts of the South Island. Distinguishing these four subpopulations is supported by genetic evidence, although knowledge of the north coast subpopulation is poor.

Risk assessment

The update of the TMP is informed by a novel, spatially explicit multi-threat risk assessment approach that combines new data and methods. The assessment was a joint effort led by NIWA in collaboration with numerous New Zealand and international scientists over 18 months.

The risk assessment estimates the spatial distribution of the dolphins and the spatial distribution of the threats that may affect them. The rate that dolphins encounter a threat is estimated by the level of

spatial overlap between the dolphin distribution and the threat distribution. The probability of death per encounter is estimated from fisheries observer data (for commercial fishery threats) or from cause of death identified by necropsy for beachcast bodies (for lethal non-fisheries threats).

The advantage of the spatially explicit risk assessment approach is that managers can estimate not only how many dolphins are dying from each threat, but also where those deaths are occurring, noting that different subpopulations of dolphins will be exposed to different combinations of threats. It is also possible to estimate the cumulative effects of multiple threats affecting the dolphins simultaneously.

Using an integrated Bayesian model, the risk assessment also identifies levels of statistical uncertainty in estimating the effects of different threats to the dolphins.

The risk assessment utilises an integrated Bayesian model to estimate the effects of different threats that may be affecting the dolphins. “Bayesian” refers to a type of statistical model that is clear about statistical uncertainty. In a Bayesian model, instead of requiring precise estimates of important variables (for example, how many dolphins there are), we can instead provide imprecise estimates that reflect the true uncertainty, and this uncertainty is carried through and reflected in model outputs.

The usefulness of a Bayesian risk model is that it doesn’t only answer the questions “How many dolphins are being killed?” and “What is the effect on the population?”; it also allows us to explore the questions “How sure are we about that answer?”, “What is the probability that we are wrong?” and “What kind of information do we need to collect in order to be more certain about our answers?”.

Model outputs that include uncertainty are inherently more useful for decision-makers, but also more difficult to describe in words. In this supporting document, where we summarise risk assessment outputs using a single number, it is the mean (average) estimate, but decision-makers also use the uncertainty to inform their choices. Where ranges are shown, they are the mean and 5^{th}-95^{th} percentile estimates, so that where decision-makers wish to be precautionary, they can use the high (for example, 95^{th}) percentile estimate rather than the mean estimate when evaluating performance against management objectives.

In this way, much of the uncertainty inherent in the risk assessment is shown explicitly in the outputs. However, we have also identified where the structure of the model itself is uncertain, or where the uncertainty cannot be expressed statistically, this needs to be identified separately, so that decision-makers can be appropriately cautious. Uncertainties are described in the relevant areas of this supporting document, and also summarised alongside potential research projects in Appendix 4.

Appendix 2: Risk assessment technical summary and key areas of uncertainty

TECHNICAL SUMMARY

The following technical method summary is reproduced from the full spatial risk assessment publication (Roberts et al. 2019). The full scientific reference is as follows, and is available online.

> *Roberts, J.O.; Webber, D.N.; Roe, W.T.; Edwards, C.T.T.; Doonan, I.J. (2019). Spatial risk assessment of threats to Hector's/Māui dolphins (Cephalorhynchus hectori). Fisheries New Zealand Aquatic Environment and Biodiversity Report No. 214. 168 p.*

Risk assessment methodology

A spatial risk assessment of threats was undertaken for Hector's dolphins (*Cephalorhynchus hectori*) and their closely related subspecies Māui dolphins (*Cephalorhynchus hectori maui*), to inform a revised TMP for the species. A Bayesian spatial risk model was developed using the spatially explicit fisheries risk assessment (SEFRA) approach. Under this approach, encounters between animals and lethal threats, such as fishing, are estimated as a function of their overlap in space, and the probability of death per encounter is estimated from fisheries observer data or other observations of deaths.

The SEFRA risk assessment model for Hector's and Māui dolphins estimated annual deaths (D), the population sustainability threshold (PST) (akin to the PBR), and the annual risk ratio (R) (D/PST) for commercial set-net and inshore trawl fisheries (fitting to fishery data) and lethal non-fishery threats (fitting to necropsy observations). Bayesian inference was used to propagate uncertainty with respect to model parameters through to posteriors of D, *PST* and R.

The SEFRA model estimation of D attempts to account for potential differences in the spatial overlap of total fishing effort and the observed portion of that effort with the estimated spatial density of Hector's and Māui dolphins, which can occur when observer coverage is low.

The SEFRA model *PST* assumed a calibration coefficient (ϕ) value of 0.2, a tuning factor chosen such that $R = 1$ would be consistent with population recovery to and/or stabilisation at an equilibrium population size at approximately 90 percent of the unimpacted level. Annual deaths and risk were explored for all around New Zealand and within several smaller subpopulations.

Spatial density of Hector's and Māui dolphins

As an input to the SEFRA model, the summer and winter spatial densities of Hector's and Māui dolphins were estimated using a habitat model fitted to Hector's dolphin aerial survey observations and using turbidity and prey species presence as habitat-based predictors. Spatial predictions arising from the habitat model were independently validated using public and commercial fisheries observer sightings (that is, the public sightings of Māui dolphins and fishery observer sightings of Hector's dolphins almost perfectly matched the Hector's dolphin habitat model spatial prediction). Boat-based public sightings were also used to estimate the relative density of Māui dolphins in harbours of the west coast North Island; these estimates were low, consistent with prior information from acoustic monitoring devices.

Population growth potential

This assessment updated the estimate of intrinsic rate of population growth ($r^{\max}$) for Hector's dolphins, based on an invariant with optimal generation time observed across vertebrate species including other cetaceans. The revised estimate for Hector's dolphins ($r^{\max}$ = 0.050; 95% CI = 0.029–0.071) is consistent with their estimated age at maturity of 6.9 (95% CI = 5.8 – 8.2), given the relationship observed across other mammals. A slightly lower $r^{\max}$ was estimated for the small population of Māui dolphins (median of 0.045), using an individual-based simulation modelling approach that accounted for demographic stochasticity and lethal alleles. Lower values of $r^{\max}$ may result from increased environmental variability and social Allee mechanisms, though were not included in this risk assessment.

Commercial fisheries deaths and risk

Annual deaths and risk were estimated quantitatively for commercial fisheries only, owing to data limitations with respect to capture rates in recreational fishing. For commercial fisheries, capture event observability priors increased the estimate of deaths that would have been obtained from observed captures only (effectively doubled for set-nets). When accounting for this cryptic mortality, model estimates of commercial fishery annual deaths were consistent with previous spatial risk assessment model estimates for this species. For commercial set-net fisheries, the upper 95 percent credible interval of the risk ratio was above one for all subpopulations, except the west coast South Island. However, the median value of risk ratio was below one for all except for the east and north coasts of the North Island (risk ratio of 1.61) and was 0.28 for the extent of the west coast of the North Island where Māui dolphins occur.

As such, the best estimates of commercial fishery deaths for all subpopulations would be insufficient to prevent population recovery to 90 percent of the unimpacted level. However, uncertainty in model inputs, including capture observability rate, pushed the upper estimate of annual deaths above this threshold. Also, greater levels of risk from commercial set-netting may be experienced by smaller local populations (that is, at scales smaller than the identified subpopulations) on the east coast of the South Island, including: the Kaikōura coast, Pegasus Bay north of Banks Peninsula, and the southern Canterbury Bight. For inshore trawl fisheries, the upper 95 percent credible interval of the risk ratio was below one for all subpopulations.

Options for increasing the precision of commercial set-net and trawl fisheries risk estimates are discussed, including the development of more informative priors for the probability that capture events were observable, and targeted increases in fishery observer coverage.

Non-fishery deaths and risk

A summary of necropsy records found that toxoplasmosis, caused by infection with *Toxoplasma gondii* oocysts, was the primary non-fishery cause of death for the recovered sample of 55 Hector's and Māui dolphins and seven out of nine cases were mature females. Other non-fishery causes of death included non-infectious diseases, brucellosis, predation and maternal separation. With the exceptions of toxoplasmosis and fishery bycatch, no other anthropogenic causes of death were identified in necropsied individuals.

The SEFRA modelling approach was extended to estimate non-fishery deaths. The model first estimated annual non-fishery deaths based on estimates of population size and non-calf survival. The model then partitioned these based on the proportional causes of death of necropsied individuals. One model run assumed that all non-fishery causes of death had an equal detection probability, whereas the "predation sensitivity" run assumed a 10-fold reduction in the detection probability of predation deaths, reducing the proportion of non-fishery deaths that were attributed to toxoplasmosis. The coastal spatial density of *Toxoplasma gondii* oocysts was estimated and used to partition toxoplasmosis deaths by subpopulation, based on the degree of spatial overlap with Hector's and Māui dolphins.

The median risk ratios for toxoplasmosis exceeded one for all subpopulations including Māui dolphins. This was also true for all assessment areas except the North Coast of the South Island for the predation sensitivity run. This suggests that toxoplasmosis has impacted on the status of Māui dolphin and South Island Hector's dolphin populations. However, we stress that model risk ratio estimates for toxoplasmosis and other non-fishery causes of death will be biased if the proportional causes of death of necropsied individuals are not representative of deaths in the wider population. An assessment of potential sources of bias would be informed by increased carcass recovery rate for this species, that would also allow more precise estimates of non-fisheries risks.

Assessment of other threats

Spatial threat intensity was estimated for other anthropogenic threats including recreational netting, oil spill risk and aquaculture. Recreational netting had greatest overlap with Hector's/Māui dolphins along the Taranaki/Kapiti coast; oil spill risk overlap was greatest north of Banks Peninsula; aquaculture overlap was greatest on the north coast of the South Island; and the estimated overlap with *T. gondii* cysts was greatest near to the Waikato River on the west coast of the North Island, overlapping with the known range of Māui dolphins.

Data limitations meant that some potentially key threats, such as the effects of seismic disturbance, and climate change effects on physical habitat and prey availability, were not addressed quantitatively. Future research can address these limitations and others identified by this assessment report.

Key Spatial Risk Assessment Outputs

The following key outputs are extracted from the full spatial risk assessment publication Roberts et al. (2019) summarising:

- estimated cause of death by subpopulation (expressed as numbers of deaths, for commercial fisheries and lethal non-fishery threats combined);
- commercial fisheries and toxoplasmosis risk by subpopulation (expressed as risk ratios); and
- recreational set-net fisheries threat exposure and non-fishery threat exposure by subpopulation (expressed as a relative index).

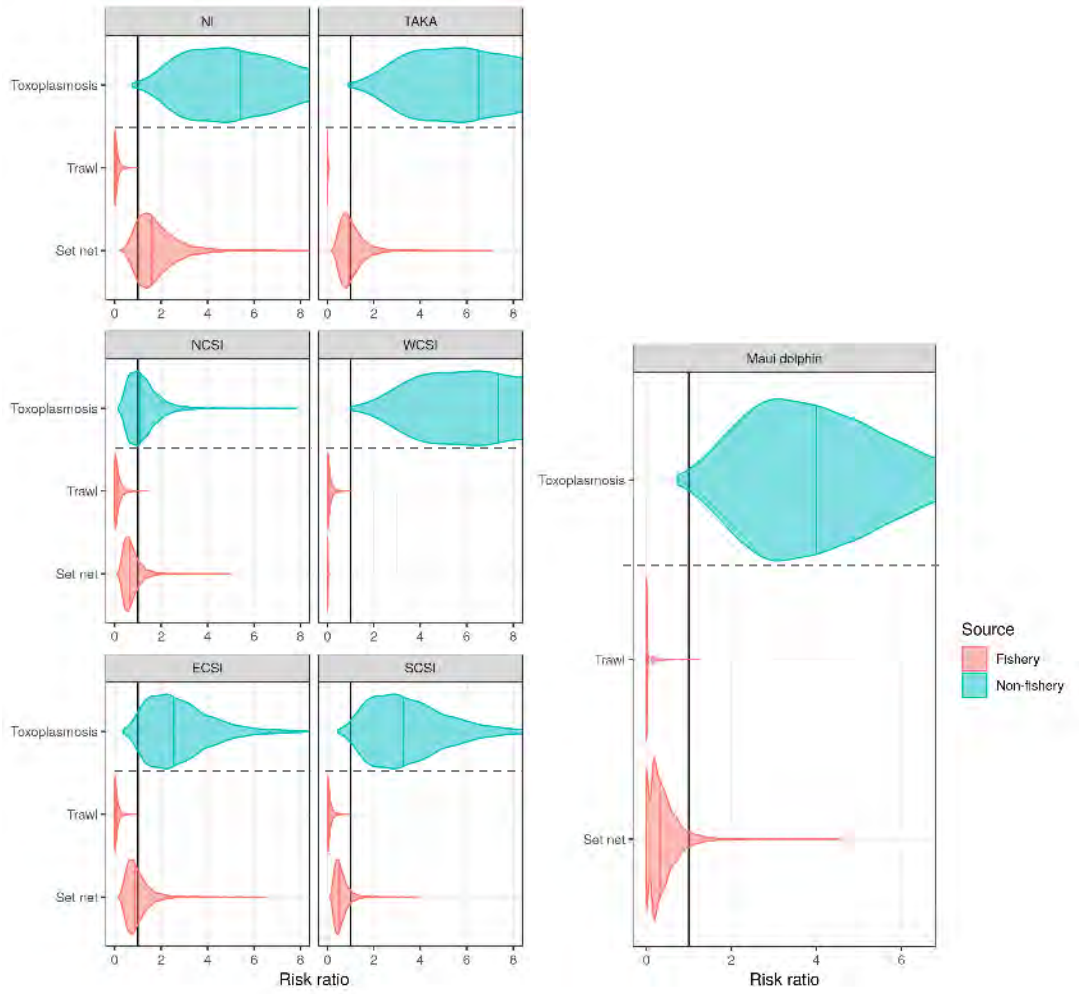
See Roberts et al. (2019) for a full description.

Extracted from Roberts et al. (2019) Table 3: Risk model estimates of annual deaths for commercial fisheries, toxoplasmosis, predation and other non-fishery causes by sub-population), showing the median and 95% credible intervals.

		Deaths (base case estimate)		
Cause of death	**Sub-population**	**50.0%**	**2.5%**	**97.5%**
Set net	MĀUI	0.10	0.00	0.30
Set net	NI*	0.07	0.04	0.17
Set net	TAKA	0.06	0.03	0.13
Set net	NCSI	0.65	0.31	1.47
Set net	WCSI	0.32	0.15	0.74
Set net	ECSI	38.86	18.57	88.25
Set net	SCSI	0.80	0.38	1.81
Inshore trawl	MĀUI	0.00	0.00	0.05
Inshore trawl	NI*	0.00	0.00	0.02
Inshore trawl	TAKA	0.00	0.00	0.00
Inshore trawl	NCSI	0.10	0.00	0.54
Inshore trawl	WCSI	1.84	0.08	9.40
Inshore trawl	ECSI	3.04	0.14	15.56
Inshore trawl	SCSI	0.11	0.00	0.56
Toxoplasmosis	MĀUI	1.90	0.96	3.27
Toxoplasmosis	NI*	0.25	0.09	0.58
Toxoplasmosis	TAKA	0.40	0.15	0.93
Toxoplasmosis	NCSI	1.10	0.40	2.54
Toxoplasmosis	WCSI	187.03	67.86	432.09
Toxoplasmosis	ECSI	115.06	41.75	265.81
Toxoplasmosis	SCSI	5.05	1.83	11.67
Predation	MĀUI	0.53	0.11	1.42
Predation	NI*	0.00	0.00	0.00
Predation	TAKA	0.03	0.01	0.11
Predation	NCSI	0.77	0.16	2.63
Predation	WCSI	62.64	12.72	214.41
Predation	ECSI	17.64	3.58	60.37
Predation	SCSI	2.63	0.53	9.00
Other	MĀUI	4.06	2.65	5.99
Other	NI*	0.42	0.17	0.88
Other	TAKA	0.56	0.23	1.16
Other	NCSI	9.06	3.69	18.78
Other	WCSI	232.05	94.49	480.99
Other	ECSI	411.79	167.67	853.54
Other	SCSI	14.05	5.72	29.13

*The “NI” area is a hypothetical distribution and much of the overlap is in the Hauraki Gulf where there have been no sightings, thus these numbers are not meaningful.

Extracted from Roberts et al. (2019) Figures 22 and 1: Annual commercial fishery (set net and inshore trawl) and **toxoplasmosis risk ratios for Hector's dolphins by subpopulation area, under the base case (equal detection** probability) scenario for non-fishery causes of death. The median and 97.5% quantile are indicated as vertical lines within each density. Dashed lines delineate threats for which differing methods were used to estimate annual risk ratio (above the line = based on proportions in the necropsied sample; below the line = using fisheries observer data).



Reproduced from Roberts et al (2019) Table 4: Relative exposure of Maui or Hector's dolphins to various non-commercial-fishery threats, by subpopulation and season. Rescaled as a proportion of the maximum value for a respective threat across all sub-populations and both seasons. Colours range from dark green (lowest exposure) to red (greatest exposure).

Sub-population	Toxoplasmosis	Predation	Recreational netting	Oil spill risk	Aquaculture
					Summer
ECSI	0.15	0.16	0.04	0.95	0.12
SCSI	0.19	0.69	0.21	0.36	0.02
WCNI	0.20	0.23	0.16	0.08	0.00
TAKA	0.24	0.20	1.00	0.30	0.00
WCSI	0.48	1.00	0.02	0.01	0.00
NI	0.14	0.01	0.41	0.77	0.20
NCSI	0.06	0.29	0.29	0.19	1.00
					Winter
ECSI	0.26	0.15	0.01	1.00	0.17
SCSI	0.34	0.68	0.02	0.38	0.01
WCNI	1.00	0.20	0.02	0.10	0.00
TAKA	0.82	0.22	0.09	0.34	0.00
WCSI	0.71	0.98	0.01	0.01	0.00
NI	0.73	0.01	0.05	0.67	0.20
NCSI	0.12	0.33	0.05	0.18	0.80

Key Areas of Uncertainty

Spatial uncertainty

The following are identified as areas where the outputs of the TMP risk assessment may be particularly uncertain.

- *Low dolphin density areas of Māui dolphin habitat*: The spatial estimates of dolphin density are most accurate in locations with more dolphins and become less reliable (in a proportional sense not an absolute sense) in locations with very low dolphin densities. For this reason, fisheries risk estimates may be more uncertain in the following locations:
  - *inside west coast North Island harbours*: the models estimate that dolphins enter the harbours very infrequently, but it's possible that these estimates are wrong in either direction, including the possibility that dolphins never penetrate the interior of these harbours;
  - *the northern and southern extreme of the Māui dolphin distribution:* The southern extreme is verified by actual data; the northern extreme is unverified.
  - *The extreme offshore distribution of the Māui dolphin distribution:* The habitat is well-specified and verified by actual data out to around 10 to 12 nautical miles offshore, but at further ranges it predicts a uniformly low "background" density that never drops to zero even at very far distances offshore. It is likely that the model is overestimating the numbers of dolphins (thus the presence of residual risk) at distances far offshore.
- *The Cape Egmont to Wellington "transition" zone*: Dolphin density estimates (and hence numbers of deaths) are assigned arbitrarily to illustrate what risk dolphins would face if they were resident in this area. It appears instead that dolphin sightings in this area are of transient or dispersing dolphins; actual densities are unknown.
- *North coast South Island:* The estimated spatial distribution here is more uncertain than the east and west coast South Island subpopulation distributions, due to very few aerial survey observations.
- *South coast South Island:* The estimated spatial distribution here is more uncertain than the east and west coast South Island subpopulation distributions, due to the absence of a key data layer in the spatial model (representing availability of dolphin prey).

In contrast, spatial dolphin population size and density estimates on the west and east coast South Island and in the core of the Māui dolphin habitat, are well specified and well supported by independent data.

Population uncertainty

The size of the west, east and south coast South Island subpopulations and Māui dolphin populations are estimated reliably. However:

- *North coast South Island population size:* Very little is known about how many dolphins there are in the north coast South Island subpopulation. Uncertainty about population size means that estimates of total deaths are also uncertain but estimates of risk (that is, probability of death per individual animal) are unaffected.

Fisheries risk uncertainty

Set-net catchability (probability of capture per encounter) is well estimated. Trawl catchability is estimated with less precision but is known to be much lower than for set-nets in an absolute sense. However:

- *Cryptic mortalities (*bodies that are lost without being seen by fisheries observers) are uncertain for set-net fisheries.
- *The number of animals dying per trawl event* is not well estimated. Evidence suggests that trawl captures may arise from social interactions that sometimes involve more than one dolphin. We currently assume that each capture event kills two dolphins on average, but this multiplier is uncertain.
- *Fishery groups*: All set-net fisheries are treated as a single group, and all inshore trawl fisheries are treated as a single group, for purposes of estimating catchability (that is, the likelihood of a dolphin being captured in an encounter with a net). If some fishers use different gear, or have consistently different behaviour, that affects dolphin catchability, then this contrast will not be reflected in the estimates. However, unless fisheries observer coverage is also biased, the result will be increased uncertainty but not less accurate.
- *Harbour set-nets*: The risk assessment model treats harbour set-nets as if they have the same probability of catching a dolphin as do set-nets in offshore areas. This approximation may not be valid, so the estimate of risk in harbours is more uncertain than reflected numerically.
- *Recreational fisheries risk* is not estimated quantitatively. In areas where recreational fishing is still permitted, this could be a substantial but unquantified cause of death. In areas where recreational fisheries previously occurred but were subsequently eliminated, this could cause a major historical change in threat level that the model is unable to estimate.

Non-fisheries risk uncertainty

The use of beachcast dolphin carcasses to estimate rates of death relies on assumptions about the rate that carcasses are recovered for necropsy and may be biased. As a consequence:

- *Toxoplasmosis death estimates* are more uncertain that represented in the numerical estimates and could be biased either high or low.
- *A possible sex bias in toxoplasmosis deaths* (if more females are dying) may have important implications, if the sex bias is real, then toxoplasmosis risk is higher than estimated here.

Non-lethal threats cannot be quantified:

- *Seismic risks* from underwater sound are estimates in a relative sense only, and only for Māui dolphins. While the level of sound the dolphins' experience has been estimated quantitatively, it is unknown how this level of sound may affect dolphins, or how much sound is too much.

Appendix 3: **Māui dolphin demographics models**

Reflecting their urgent conservation status, agencies commissioned two separate population modelling research projects for Maui dolphins. Full scientific references are as follows:

> *Cooke, J.; Constantine, R.; Hamner, R.M.; Steele, D.; Baker, C.S. (2019). Population dynamics modelling of the Māui dolphin based on genotype capture-recapture with projections involving bycatch and disease risk. Fisheries New Zealand Aquatic Environment and Biodiversity Report No. 216.*

> *Roberts, J.; Constantine, R.; Baker, C.S. (2019). Population effects of commercial fishery and non-fishery threats on Māui dolphins. Fisheries New Zealand Aquatic Environment and Biodiversity Report No. 215. 18 p.*

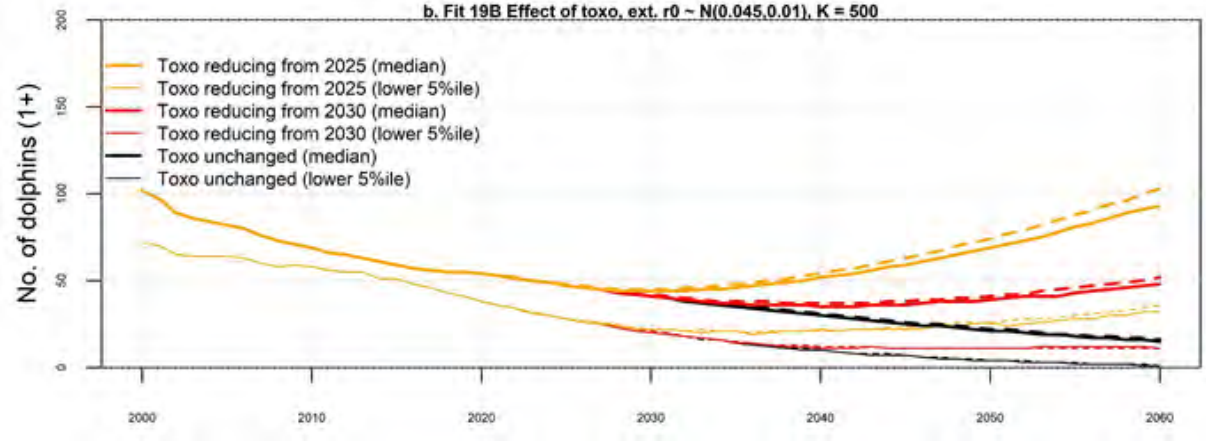
Both models used genetic population census and monitoring data, and estimates of fishery and non-fisheries threats from the spatial risk assessment described above, to estimate current impacts on Māui dolphin population growth rates, and to investigate the likely effect and efficacy of risk reduction measures on future population trends.

Both Māui dolphin models yielded broadly similar predictions. The models indicate that commercial fisheries deaths alone (as estimated by the spatial risk assessment) are not sufficient to explain the estimated decline of the Māui dolphin population. The model of Cooke et al. (2019) estimates that roughly 3-4 additional human-caused deaths per year are necessarily occurring, in order to account for the observed rate of decline.

The spatial risk assessment of Roberts et al. (2019) and the Māui demographic model of Cooke et al. (2019) each suggest that toxoplasmosis is the threat that could most likely account for this level of annual mortality. The likely impact of toxoplasmosis on the population, and the urgency and efficacy of risk management responses to reduce that impact, are illustrated below (from Cooke et al. 2019).

In these simulations, toxoplasmosis risk is assumed to be constant in time beginning in 2000 and continuing until such time as risk reduction efforts begin to take effect, in either 2025 or 2030. The black line assumes no reduction in toxoplasmosis risk; the lower confidence interval for this scenario indicates that with no reduction in risk, the Māui population could face extinction by 2050. The red and orange lines assume that toxoplasmosis risk is reduced by half each decade, beginning either in 2030 or 2025, respectively. The lower confidence intervals for these scenarios suggest that further declines are possible but that the species would likely avoid the risk of extinction if toxoplasmosis mitigation can be effective on this timeframe.

Reproduced from Cooke et al. (2019) Figure 6. Forward projections with toxoplasmosis (median and lower fifth **percentile), various scenarios.** Solid trajectories: bycatch continues. Dashed trajectories: bycatch eliminated.



The difference between the solid lines and the dashed lines illustrate the relative effect of commercial fisheries in each scenario (in the solid lines, fisheries impacts continue at the current level; in the dashed lines fisheries impacts are reduced to zero from 2019). These results suggest that unless

toxoplasmosis deaths are also addressed, reducing fisheries deaths to zero will not be sufficient to avoid the risk of Māui dolphin extinction.
In the interpretation of these model outputs it is important to note that recreational set-net fishing is likely to have had a substantial but un-quantified impact on Māui dolphins up until 2003, when a set-net closure was imposed for the alongshore extent of the core Māui dolphin habitat, out to 4 nm. It is likely that recreational fisheries risk was dramatically reduced at this time, because recreational fishers lack the ability to operate at such large distances offshore. However, because Māui dolphins take 7-8 years to reach maturity, the corresponding effect on observed population growth rates would be delayed.

In this context, the 3-4 'additional' deaths per year estimated by Cooke et al. (2019) may actually represent the combined impact of recreational fishing and toxoplasmosis. If this is the case, then the model projections above (which assume that all 'additional' deaths are due to toxoplasmosis alone) will be overly pessimistic (because a large part of the impact attributable to recreational fishing will have already been managed). The population demographic model of Roberts et al. (2018) lends some support to this interpretation, because it estimated that adult survival rates had improved in the second half of this period, consistent with census results that estimated a higher population in 2015/16 than in 2010/11, but these results are highly uncertain until the results of another census are available.

Priority research projects to improve our understanding of different threats affecting Māui dolphins, and to improve the design of risk reduction actions (including for toxoplasmosis) are identified in Appendix 4 below.

Appendix 4: Priority research projects

Cause of death of beachcast dolphins

Increasing the number of beachcast dolphin carcasses recovered for necropsy is a high priority. Expanded resourcing for the necropsy programme to handle increased volume and an increased range of diagnostic tests (antibody presence, expanded tissue sampling for potential pathogens, disease culturing, gene-sequencing pathogens to identify and track different strains, liaison with overseas disease pathologists) is a high priority.

Use of beachcast dolphin carcasses to estimate the number of deaths from different threats relies upon untested assumptions about carcass detectability, which may be affected by factors such as:

- spatial and seasonal patterns of death (relative the presence of people on beaches or on the water to report a carcass);
- body condition, affecting carcass buoyancy (hence the probability of a carcass becoming beachcast); or
- the likelihood of carcasses being scavenged or predated.

Research to explore the likely nature and magnitude of these effects is a high priority, so as to estimate the potential for bias arising from different assumptions implicit in using necropsy data for these purposes.

Disease impacts

Toxoplasmosis may be the single largest human-caused threat to Māui and Hector's dolphins. New research is required to better understand this threat. Priorities for further research include:

- A literature review of toxoplasmosis effects on marine wildlife in other countries, and liaison with overseas wildlife disease experts, to see what information can usefully be applied in the New Zealand context to better understand the mechanism by which toxoplasmosis is infecting and killing Māui and Hector's dolphins. Of particular interest are the apparent seasonal patterns of dolphin deaths (peaking in October) and the apparent sex bias (toward mature females) but both of these potential patterns are based on low sample sizes and difficult to interpret in isolation.
- Improved hydrological modelling of the spread of toxoplasmosis oocysts from land to sea, at higher spatial resolution (for example, at the scale of the Waikato River catchment) to inform spatial prioritisation of cat-focused research and controls.
- Genetic sequencing of different strains of toxoplasmosis recovered from dolphin carcasses, including carriers for which toxoplasmosis was not the cause of death, to identify – and track the spread of – distinct lethal vs non-lethal strains.
- Sampling and gene-sequencing of toxoplasmosis recovered from domestic and feral cats, and matching to strains recovered from dolphins, to inform the choice between non-lethal controls in domestic cats (such as vaccines) vs lethal controls in high-priority feral cat populations.
- Testing the ability to use filter-feeding marine or aquatic organisms (for example, mussels) as bio-assays to monitor toxoplasmosis oocyst densities in riverine and marine environments, and to look for seasonal or temporal patterns.
- Initiating a monitoring programme to detect the presence of toxoplasmosis in intermediate hosts in marine food chains potentially linking terrestrial run-off to the dolphins.

Toxoplasmosis may not be the only disease threat to Māui and Hector's dolphins. In 2018, a pregnant female Māui dolphin died as a consequence of carrying a strain of Brucellosis that originates in fur seals. It is possible that the northward expansion of the fur seal population will increase the level of disease risk faced by Māui dolphins. Depending on what is observed by the ongoing necropsy programme (as discussed above) focused research on Brucellosis or other diseases may be warranted.

Dolphin distribution

The spatial habitat models underpinning the estimation of the dolphin density in the TMP risk assessment constitute a substantial improvement in our scientific understanding. These models have been shown to accurately predict the dolphins' distribution at the scale of each subspecies, and for location-specific patterns match actual observations in core or high-dolphin-density areas, but the predictions are more uncertain in the low-density tails of the distribution. Where management of residual risk relies upon reliable estimates at smaller scales and in low-density areas, additional

research is warranted to improve our understanding of dolphin distribution and movement at smaller scales.

- *West coast North Island harbours:* Current estimates of the extent to which Māui dolphins may venture into harbours are uncertain. New spatial habitat models using higher resolution input layers (for example, a bathymetry layer that resolves the location and depth of channels and sandbars), and continued spatial monitoring of fishing effort locations, would improve the estimation of fisheries risk in these locations. Deployment of passive acoustic monitoring devices to detect dolphin presence in different parts of the west coast North Island harbours is a high priority.
- *Southern tail of Māui distribution (near New Plymouth) and Cape Egmont to Wellington transition/dispersal zone:* The actual extent/frequency with which dolphins utilise these areas is uncertain. Passive acoustic monitoring to detect dolphin presence, and encouraging the public to report sightings, is a high priority.
- *South coast South Island:* Hector's dolphin spatial density estimates are less certain than elsewhere. This is in part because only low dolphin densities are estimated and in part because the habitat model in this location lacked a key input (unlike elsewhere in the South Island, there were no inshore trawl survey data to inform a prey distribution layer). Reliable observations of the dolphins' presence are available from the new south coast South Island aerial survey (delivered in 2018), but these data were not available at the time that the habitat models were generated. For these reasons, new spatial distribution models fitted at the scale of the south coast South Island are expected to yield improved predictions. An inshore trawl survey to map the distribution of dolphin prey species would be valuable to inform this work. North coast South Island: Hector's dolphin spatial density estimates are uncertain. This is in part because only low densities are predicted there and in part because there are few observations of north coast South Island dolphins to test model predictions. Options for dedicated research to collect these data include:
  - encouraging the public to report sightings;
  - boat-based surveys in key locations;
  - repeat aerial surveys.

  Once improved data are available, spatial distribution modelling focused at the scale of the North Coast South Island subpopulation would be valuable.

Dolphin movements

The spatial scale at which dolphins disperse laterally along the coast and the frequency with which they undertake long distance migration affect our understanding of the scale at which we need to manage impacts. At smaller and shorter scales, the daily movements and foraging behaviours of the dolphins affects our understanding of how and where they are likely to encounter fisheries and other threats. If they can be implemented safely, electronic tag programmes (archival tags or satellite telemetry) could address these questions.

When the core of a population's range is already protected, managing residual risks requires understanding the frequency with which dolphins access marginal habitats at the extremes of their range. This is especially important for small populations such as Māui dolphins or in the north coast South Island. Moored acoustic detectors have been used successfully to monitor dolphin presence in low-density areas. Expanded deployment of acoustic detectors in key longshore locations of the North Island (for example, inside harbours, New Plymouth to Wellington, north of Kaipara Harbour) and in transects to validate the extent and pattern of the dolphins' offshore movements (including daily and seasonal patterns) is a priority.

Distribution of dolphin prey

The spatial estimates of the presence of the dolphins' preferred prey species proved valuable to estimate the dolphins' distribution. Updating these estimates to account for prey abundance rather than only presence and to reflect prey size rather than only species identity, would improve the power of these predictions, especially in Māui dolphin habitat, where prey abundance is thought to be very low.

Inshore trawl surveys focused on dolphin prey species, especially in the south coast South Island subpopulation and within the core of Māui dolphin habitat, would improve our understanding of dolphin prey, with benefits for both spatial distribution monitoring and understanding dolphin biology.

Population size and trends, along with monitoring other factors important to population growth

For Māui dolphins, continuation of the genetic mark-recapture census (currently planned every five years) is a high priority. Expansion of this programme to include new analyses addressing more than just population abundance (for example, monitoring pregnancy rates and calving success using biopsies and/or photo-ID, testing blood or tissue samples for the presence of disease antibodies, toxins or pollutants) should be considered.

For Hector's dolphins, establishment of one or more population monitoring programmes comparable to the existing Māui dolphin programme should be considered for the small, vulnerable north and south coast South Island subpopulations, including genetic analyses to understand population size and structure, and monitoring key demographic rates.

In the longer term, if monitoring potentially sensitive demographic parameters becomes feasible using routine biopsies, then comparing these times series with patterns of potential environmental drivers (for example, climatic variation) may prove valuable.

Fisheries impacts

Where spatial overlap remains between fishing effort and dolphins, increased fisheries observer coverage or the use of novel technologies (such as, electronic vessel monitoring and cameras) may be useful to improve estimates of fisheries catchability. Where overlap with fisheries is already low, capture events are expected to be rare. In these cases, observing the fishery may be useful to verify that captures have or have not occurred (see monitoring section below), but will not result in improved estimates, due to low statistical power.

Where different fishing gears or fisheries targeting different fish species can be expected to catch dolphins at different rates, it may be possible with increased observer coverage to model the effects of these gears separately. A candidate area for this research would be Kaikōura Canyon, where there is speculation that set-nets at different depths will pose different levels of risk to dolphins; currently there is insufficient observed fishing data to test to what extent this may be true.

Camera monitoring of fishing vessels during gear deployments may also improve our understanding of cryptic mortality (such as, carcasses that are lost without being seen even in the presence of a fisheries observer).

Dolphin subpopulation status and trend

The TMP risk assessment identifies threats and estimates the levels of associated impact that are thought to be occurring in the present, without reference to historical impacts, or to the conservation status of the dolphins. However, the urgency to manage human threats, and the expected population response as impact levels are reduced, depends on the current status of the population (that is, to what extent the dolphin population is currently depleted as a consequence of historical impacts).

The very small population size and apparently shrinking geographic range suggests that Māui dolphins are much reduced from their historical population size, but actual carrying capacity is unknown. For Hector's dolphins, estimates of historical population size (and current status) are based on limited observations in geographically limited locations, extrapolated to the rest of the subspecies without reference to local data. These estimates are therefore uncertain. Understanding of historical population size and historical impacts helps to put our estimates of current risk in context.

The spatial risk assessment method for fisheries can be extended back in time to any time period for which spatially resolved fishing effort data are available. The fishing effort database informing the current risk assessment begins in 1992. However, it is known that the highest fisheries impacts occurred earlier than this, from the 1960s and 1970s. Reconstructing historical fishing effort patterns in space and time, as well as accessing historical captures data to estimate potential changes in dolphin catchability as fishing practices changed, will allow estimation of historical impacts at finer scales, and inform more robust estimates of current population status. Planning to deliver this research is underway.

Appendix 5: Methodology for calculating socioeconomic impacts on commercial fishing

The revenue losses by fishing method and area were used to estimate income effects of the various area-based fishing restrictions.

Fisheries New Zealand has developed estimates of lost income using value-added estimates from an input-output model of the economy. Input-output models enable estimation of how a change in output of one industry will affect value added in that industry and more broadly in the economy. This method was first used as part of the 2012 Māui dolphin Threat Management Plan; however, the most recent ratios available from 2016 for use in the input-output model were used.

The method calculates the (forgone) values of commercial fishing as follows:

1. Extract the estimated commercial tonnage catch records (based on the average yearly landings of the last 10 fishing years).

2. Estimate the prices per tonne of fish (the figures presented in the options have used revenue estimates from BERL that may better reflect the impact of export earnings than the Fisheries New Zealand survey of port price, which has also been included in this appendix).

3. Calculate the revenue from that commercial catch, and differentiate according to:

- Direct harvesting income – value added lost in the harvesting sector and calculated as 0.24 times the gross revenue from fish landed.
- Direct processing income – value added lost in the processing sector and calculated as 0.57 times the gross revenue from fish landed.
- Indirect income in supply sectors – indirect value added lost in sectors that supply harvesting and processing calculated as 1.69 times the gross revenue from fish landed. The sectors supplying the fishing and processing sectors also supply very similar products to the broader boating and food processing industries. There may be one-time inventory losses if highly specialised inventories, such as set-nets, become obsolete because of the restrictions.
- Induced income in broader economy – induced value added lost in the broader economy and calculated as 0.32 times the gross revenue from fish landed. When income is lost in harvesting, processing, and fishing supply sectors, the broader economy will see reduced economic activity because of reduced consumption by those who earn income in the directly affected sectors.

In this document, we have calculated present values of the income effects over short (one year), medium (three years) and longer-term (five years) time frames which accounts for different rates for labour and capital resources to be redirected within the economy.

Throughout the Treasury discount rate of six percent was used.

While some transitional adjustments to current fishing practises have been identified with regard to the options proposed[23] it is impossible to predict exactly how the fishing industry will respond. Some fishers may be able to adjust better than others. The methodology is a starting point for calculating the potential forgone benefits associated with commercial fishing restrictions. The preliminary analysis assumes revenue is lost and cannot be regained by catches elsewhere in the relevant quota management areas (QMAs). The preliminary analysis does not extend to potential quota value losses if this occurs and therefore cannot necessarily be considered the worst-case scenario.

Submissions are eagerly sought to address these issues. Estimates presented are based on preliminary analyses, and more informed and detailed economic analyses will be required for the final advice.

[23] *Transitioning to alternative fishing methods off New Zealand's West Coast North Island: A response to the threat to Māui dolphin*. BERL April 2017 A report for WWF.