Preventing an extinction event: Is New Zealand's management response enough to save the world's rarest marine dolphin?

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ABSTRACT

Maui's dolphins (*Cephalorhynchus hectori maui*), listed as critically endangered by the International Union for Conservation of Nature (IUCN), are only found in waters off the west coast of the North Island of New Zealand. They are one of the smallest and rarest cetaceans in the world. The latest population abundance estimate, based on surveys conducted in 2010-2011, suggests that only about 55 individuals over the age of one year remain (95% confidence interval range of 48-69). The dolphins have low fecundity—one female might have four calves in her average 26-year life span. Low abundance, slow breeding rates, and susceptibility to fisheries interactions make Maui's dolphins extremely vulnerable to extinction. These dolphins live and range alongshore in shallow coastal waters, out to the 100-metre depth contour. Entanglement in gillnets and capture by inshore trawl fisheries are the leading human-induced causes of their decline. Despite very limited observer coverage on these vessels, reported and estimated fatalities have amounted to unsustainable levels of mortality. Other lethal and sub-lethal threats include collision with vessels, habitat loss and degradation through coastal development and seabed mining, and acoustic disturbance from mining and oil and gas exploration. This paper provides an overview of recent research and existing protection measures for Maui's dolphins. We also assess whether the New Zealand Government has adequately responded to the 2012 International Whaling Commission (IWC) Scientific Committee recommendations for urgent action to halt their decline. Maui's dolphins are on the brink of extinction and effective management action and a precautionary approach is required to ensure all necessary steps are in place to avoid extinction whilst providing opportunity for population recovery.

KEYWORDS: Abundance, distribution, bycatch, protection, management, extinction.

INTRODUCTION

Cephalorhynchus hectori is a small and culturally significant dolphin, endemic to the inshore waters of New Zealand. They are revered as taonga, or treasures, by indigenous Māori. Genetic studies (using mtDNA and microsatellite variation) have revealed four distinct and geographically separate populations around the South Island (east, west, and south coasts) and on the west coast of the North Island (Pichler et al., 1998; Pichler and Baker, 2000). In 2002, the North Island population, Maui's dolphin (*Cephalorhynchus hectori maui*), was formally described as a separate subspecies from the South Island populations, Hector's dolphins (*Cephalorhynchus hectori hectori*), due to differences in skull morphology, haplotypes, and the absence of gene-flow between the populations (Baker et al., 2002). Evidence suggests that speciation of this west coast North Island population began as early as 16,000 years ago (Pichler et al., 2001), following their isolation from the South Island due to the post-glacial formation of Cook Strait (Pichler, 2002).

Historically, Maui's dolphins are believed to have ranged along the full extent of the North Island west coast (Russell, 1999) with numbers close to 2000 individuals as recently as 1970 (Slooten, 2007; Slooten and Dawson, 2010). The latest abundance estimate, based on biopsy and autopsy samples, indicates that only 55 individuals over the age of 1 year remain (95% Confidence Interval 48-69; Hamner et al., 2012). The current severely depleted population is estimated at less than 10% of the 1970s levels and Maui's dolphins are classified as Critically Endangered (IUCN, 2000). In comparison, the South Island populations of Hector's dolphins have also experienced a significant decline (about 70%) from an estimated 21,000-29,000 individuals in the 1970s to just 7,270 today (Slooten, 2007; Davies et al., 2008), and are classified as Endangered (IUCN, 2000).

Maui's dolphins have not only declined significantly in abundance, but have also contracted markedly in range and suffered a loss of diversity (Martien et al., 1999; Russell, 1999; Pichler and Baker, 2000; Dawson et al., 2001). Similar to the Vaquita (*Phoecoena sinus*) in the Gulf of California, Maui's have only one remaining maternal lineage (Rosel and Rojas-Bracho, 1999; Dawson et al., 2001). Like many other cetaceans, fecundity is low and their numbers are but a fraction of historical levels due largely to human-induced mortality.

LIFE HISTORY AND DISTRIBUTION

Hector's and Maui's dolphins are particularly vulnerable to decline from human-induced threats because they frequent shallow coastal waters less than 100 metres deep, their lifespan is relatively short–estimated at just 22-30 years (Gormley et al., 2012) and they are relatively late and slow breeders. Females mature at approximately 7-9 years of age and have one calf every 2-3 years (Slooten, 1991). This equates to about 4 calves total in the average life of a female dolphin, or a maximum population growth rate of 1.8-4.9% (Slooten and Lad 1991). An assessment of the latest abundance estimate suggests that Maui's can only sustain one human-induced mortality every 10 to 23 years, known as Potential Biological Removal (PBR), without impacting on the ability of the population to rebuild to or maintain its optimum sustainable size (Wade et al., 2012).

Aerial and boat surveys have revealed that Maui's dolphins range from Manganui Bluff in the north to Wanganui (river mouth) in the south, including harbours and out to the 100 m depth contour (Currey et al., 2012; Slooten et al., 2005; Slooten et al., 2006; Rayment et al., 2011). Most summer sightings (75%) during aerial surveys occurred within 1 nm of shore, compared to 33.3% in the winter (Slooten et al., 2005). The World Wide Fund for Nature (WWF) and the government's Department of Conservation (DOC) have also maintained independent databases of verified Maui's dolphin sightings. DOC's database includes staff, research and public sightings as well as strandings, between 1922-2012, and has been supplemented by WWF public sightings since 2003 (Figure 1). Maui's dolphins have been reported inside harbours, past 12 nautical miles (nm), and south of New Plymouth. Continued scientific research has also strengthened evidence that harbours are part of the Maui's dolphin range (Russell, 1999; Rayment et al., 2011).

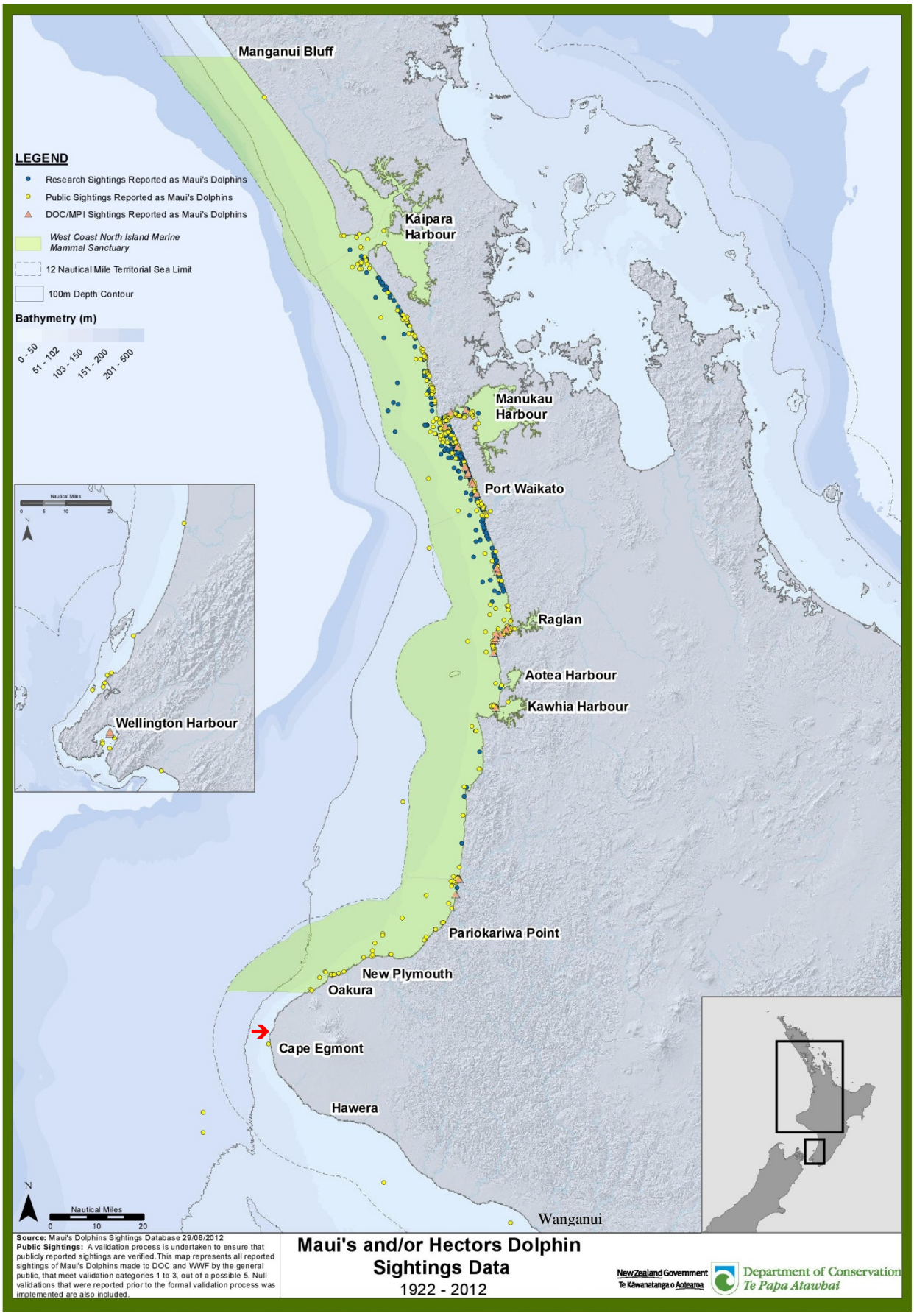

Figure 1. Maui's dolphin sightings (1922-2012). The public sightings around Wellington (small map) are likely to be migrant Hector's dolphins. The green zone represents the Marine Mammal Sanctuary which extends out to 12 nautical miles. The arrow indicates the approximate location of a gillnet bycatch incident on 02/01/2012. Source: Department of Conservation.

KEY THREATS

The New Zealand Government first formally acknowledged that Hector's dolphins were under threat in 1988 when the first protected area was created and in 1999 when the species was listed as threatened by New Zealand authorities. Entanglement in gillnets and capture by inshore trawl fisheries have been identified as the leading threat to their survival –estimated to be responsible for 95.5% of total Maui's dolphin mortalities (Currey et al., 2012), and genetic evidence suggests a demographic bottleneck has occurred within the past few generations (Hamner et al., 2012). As protection measures do not fully extend across their entire known range, both fishing methods (gillnetting and trawling) currently occur within Maui's dolphins habitat.

Commercial gillnetting has been in practice in New Zealand at low levels since 1930, however it was in the early 1970s that monofilament nylon fishing nets were introduced and fishing effort increased substantially (Martien et al., 1999). Evidence from 13 recorded entanglements of Hector's dolphins in this 40 year period suggests that Hector's and Maui's dolphin populations may have already declined below carrying capacity (Martien et al., 1999). Cause of death was also determined in 14 of 45 North Island dolphins from 1970-2000 stranding data, of which 7 individuals displayed clear gillnet entanglement marks and another 4 individuals had cut fins or slit abdomens, suggesting a fisheries interaction (Russell 1999).

In January 2012 a fisherman reported a Hector's dolphin caught in waters off Cape Egmont, Taranaki (see Figure 1), well beyond the southern boundary of the existing set net ban. The Government later reported that this was likely a Maui's dolphin due to its location. This area has long been cited as having the highest extinction risk to Maui's dolphins (Martien et al., 1999; Slooten et al., 2005), followed closely by harbours, particularly Manukau and Kaipara. Since 2002, a total of 12 Maui's dolphin mortalities have been recorded in the DOC incident database. Three were confirmed to be definite set net interactions, with the remaining deaths considered either natural or inconclusive (due to state of decay).

There have been several reports of Maui's dolphin captures by trawlers off the west coast of the North Island, in interviews with fishermen conducted by the Ministry of Fisheries. In addition, there are many reports of incidental catches of Common dolphins off the North Island west coast (e.g. Thompson et al. 2013; DOC and MFish 2007). Other dolphins, including Hector's, are also regularly caught in trawl fisheries, including on the east coast of the South Island (e.g. Baird and Bradford, 2000) and in Taranaki (Nordon and Fairfax, 2004). Additionally, the depletion of prey species through increased fishing effort has likely had an indirect effect on both the abundance and distribution of Maui's dolphins.

Other potential lethal and sub-lethal non-fishing-related threats include boat strike, pollution, mining, oil and gas exploration and activity, acoustic disturbance and coastal development –however these were estimated to cumulatively account for only 4.5% of all Maui's dolphin mortalities (Currey et al., 2012). It is likely that the habitat on the west coast of the North Island will be notably degraded through increases in acoustic and particulate pollution, benthic disturbance and vessel traffic (DOC and MFish 2007; Thompson, 2012) as a result of the increasing human demand for resources. It is not yet known what the implication of these activities will be on the dwindling population of Maui's dolphins, however, both direct and indirect effects are expected. Any large scale removal of sand from the seabed is likely to lead to relatively long term (3-10 year) changes to the benthic community composition, thereby altering prey availability, and to the benthic topography (Thompson, 2012). In addition, both the mobilisation and accidental spillage of contaminants and exposure to denser vessel traffic could lead to the bio-accumulation of toxins in tissue and associated collisions of Maui's dolphins respectively (Thompson, 2012). Acoustic noise in the marine environment (caused by anthropogenic sources such as seismic activity) is also a potential stressor to cetaceans which can cause negative physical and physiological effects, disruptions in behaviour, reduced foraging success, compromised health, and decreased well-being (Gordon et al., 2003).

IWC 64 RECOMMENDATIONS

In response to a World Wide Fund for Nature (WWF) working paper presented to the International Whaling Commission (IWC) Scientific Committee small cetacean working group in June 2012, the Committee recommended an immediate extension of the area protected from gillnet and trawl fisheries to approximately 80km south of the latest dolphin bycatch site (Maunganui Bluff to Hawera), and offshore to the 100m depth contour, including the harbours. The Committee also indicated that "adequate observer coverage across all inshore trawl and gillnet fisheries is important in order to obtain robust scientific data on continuing bycatch as a means of assessing the effectiveness of protection measures" and that "further population fragmentation could be avoided by also protecting the north coast of the South Island, providing safe 'corridors' between North and South Island populations".

Following IWC, the International Union for Conservation of Nature (IUCN) World Conservation Congress adopted a motion in September 2012 which urged the New Zealand government to "urgently extend the areas of protection from gillnetting and trawling to cover the entire range of Maui's and Hector's dolphins", out to the 100m depth contour (including harbours) and to "immediately increase the level of observer coverage on any

gillnet or trawling vessel allowed to operate in any part of the range of Hector's and Maui's dolphins until such bans can be implemented; and to report such action and monitoring and enforcement results". This Resolution passed with majority vote, despite the New Zealand Government putting forward the only two recorded votes *against* the motion. New Zealand's Ministry for Primary Industries (MPI) cited their rationale for the 'no' vote as being that in their assessment, banning gillnet fishing to 100-metres depth contour, as proposed in the IUCN motion, is not backed by scientific evidence. When challenged on this statement, MPI have made it clear that they do agree with the scientific evidence for the species as a whole (Hector's dolphin) ranging throughout waters out to 100m deep but they feel there is insufficient information specifically from the North Island subspecies (Maui's dolphin) to warrant banning gillnet and trawl fisheries in waters out to 100 m deep.

A more detailed explanation of the MPI position can now be found in the draft Maui's dolphin TMP (MPI and DOC, 2012), which states: "Research establishing that Hector's and Maui's dolphins prefer waters within the 100 m depth contour has only been undertaken for Hector's dolphins on the South Island, which has shown that dolphins can regularly be seen out to the 100 metre depth contour. It is, however, unknown how significant the 100 metre depth contour is to the distribution of Maui's dolphins" and "It is unknown what the offshore limit is of Maui's dolphins, and how often and how far they may travel offshore. The ability to detect these limits is difficult given their low abundance." These statements clearly acknowledge that for a population of 55 individuals it will be difficult to determine exactly how far offshore Maui's dolphins range. But the decision-making witnessed to-date fails to take the next logical step of implementing precautionary protection measures.

PROGRESS SINCE IWC 64

In response to the bycatch incident off the coast of Cape Egmont on 2 January 2012, the New Zealand government increased protection for Maui's dolphins on 28 June 2012 by implementing an interim set net ban between Pariokariwa Point and Hawera, out to 2nm. This announcement followed a 4-week public consultation and 11-week decision-making period which started 14March 2012, despite the Minister for Primary Industries having the option to immediately enact an emergency measure under NZ Fisheries Legislation (Section 16 of the *Fisheries Act* 1996).

Shortly after, the Maui's component of the New Zealand Hector's and Maui's draft Threat Management Plan (TMP) was brought forward for review. In order to inform the TMP review process, the Government convened a risk assessment workshop to allow the threats to be evaluated on the basis of all the available data by a panel of experts, consisting of local and international specialists in marine mammal science and ecological risk assessment (Currey et al., 2012). Several organisations, including WWF, were invited to attend and observe but not participate in the workshop. A draft review of the Maui's component of the TMP, including proposed management options, was subsequently released for public consultation on 24 September 2012 for a period of 7 weeks. Unfortunately the scope of the management options in the consultation paper were inconsistent with the outcomes of the risk assessment workshop report and the previously mentioned recommendations. There was an unprecedented response to the consultation with over 70,000 submissions received by 12 November 2012.

At the time this paper was being written, the Government had not yet announced any management decisions for increased protection of Maui's dolphins beyond the interim measures, nor released any analysis of the public submissions.

CURRENT PROTECTION

Current activity restrictions inside the Maui's habitat consist of a trawl ban out to 2 and 4 nm, a set net ban out to 7 nm (including harbour entrances), and a marine mammal sanctuary out to 12 nm with limits on certain types of mining and seismic activities (Figure 2)—which includes a mineral mining exclusion zone out to 2-4 nm not shown on the map. This area offers protection to Maui's where they are most abundant, but fails to secure their entire known range. In addition, an interim set net ban out to 2 nm (with 100% observer coverage on all remaining vessels out to 7 nm) has been put in place in part of their southern range (Pariokariwa Point to Hawera), to encompass the most recent bycatch incident, until a decision on permanent protection is made.

New Zealand marine mammal protection legislation attempts to reduce the number of deaths and other impacts from activities such as vessel collision, harassment, and deliberate injury, but does not address the negative effects from marine mining within their habitat (Thompson, 2012). Additionally, a newly improved code of conduct is has been developed and voluntarily implemented in New Zealand waters in an effort to minimise disturbance to marine mammals from seismic survey operations (DOC, 2012).

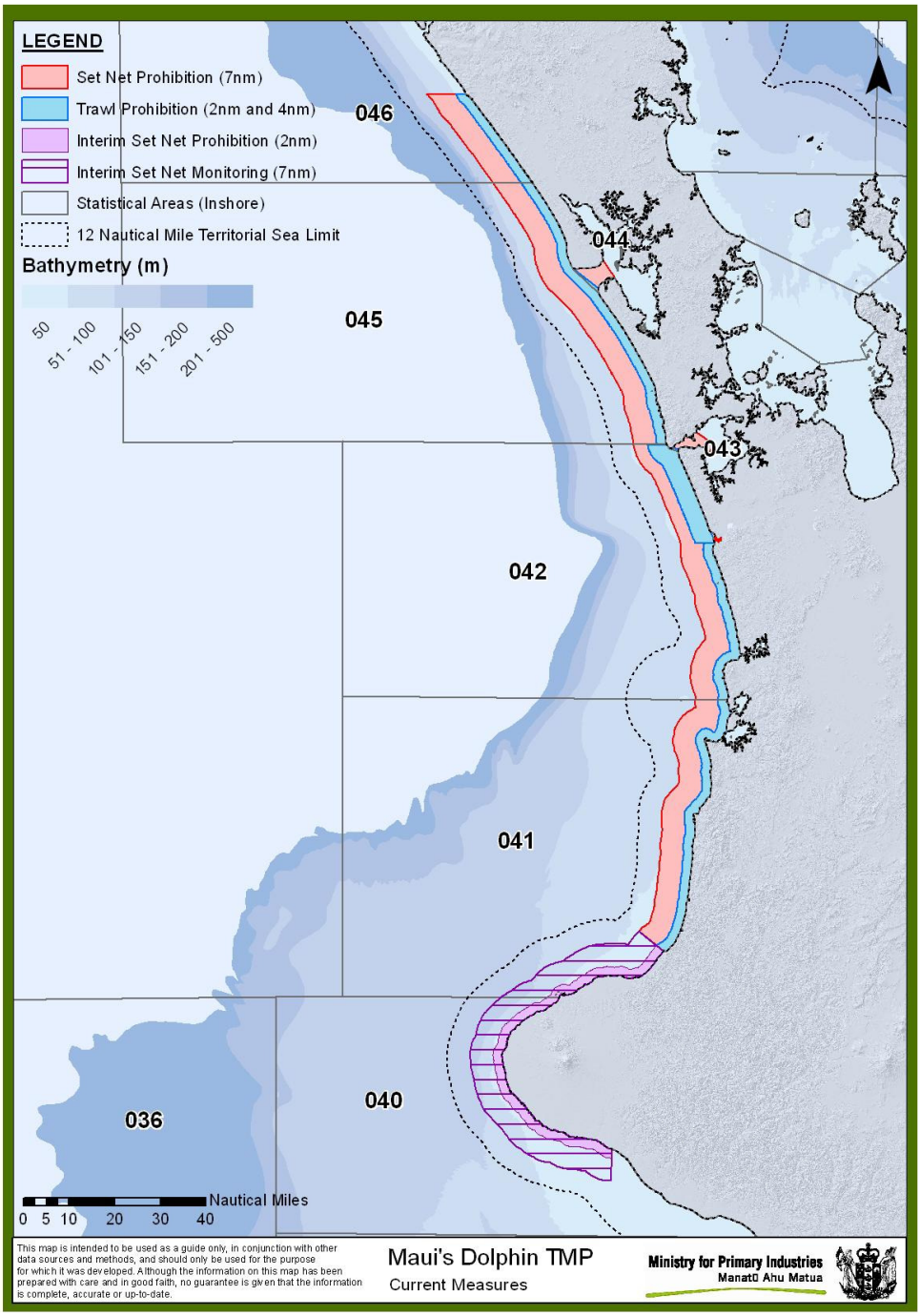

Figure 2. Current activity restrictions within the Maui's dolphin habitat. These consist of a trawl ban out to 2 and 4 nautical miles (nm), a set net ban out to 7 nm (including harbour entrances), and a marine mammal sanctuary out to 12 nm with limits on certain types of mining and seismic activities. An interim set net ban out to 2 nm (with 100% observer coverage on all remaining vessels out to 7 nm) has been placed in part of their southern range until a decision on permanent protection is made. Source: Ministry of Fisheries.

DISCUSSION POINTS and KEY QUESTIONS

Observer coverage, bycatch and compliance

Although the New Zealand Marine Mammal Protection Act (1978) legally requires reporting of fisheries-related mortalities, compliance is not closely monitored, and observer coverage in gillnetting and inshore trawl fisheries is particularly low. Specifically, on the west coast of the North Island, there has been less than 1% observer coverage on gillnet fishing vessels operating within the dolphin's habitat up until 2012 and severe under-reporting of bycatch is suspected (Table 1). No entangled Maui's dolphins have been voluntarily reported by fishers until recently, when the bycatch incident occurred off the North Island west coast in the waters off Taranaki. This region is recognised by the New Zealand government as having been a habitat commonly utilized by Maui's dolphins until recently, yet remains largely unprotected from fishing and other threats (DOC and MFish 2007).

Table 1. Observer coverage for gillnet fisheries within dolphin habitat on the west coast of the North Island, New Zealand. Source: Ministry of Fisheries.

Year	Percent observer coverage
2008-2009	0.6%
2009-2010	0.11%
2010-2011	0.0%
2011-2012	<1%
2012-2013	0-100%*

*this increase is only for the inshore gillnet fishery between Pariokariwa Point and Hawera and out to 7 nm.

There are currently no direct estimates of bycatch (through a credited observer program) available for the North Island population and the apparent lack of voluntary reporting is of concern. Commercial gillnet fishing effort is relatively high off the coast of Taranaki and in the harbours on the upper west coast (Figure 3a; Martien et al., 1999; Burkhart and Slooten, 2003). The very high level of fishing effort (both commercial and recreational) in west coast harbours, compared to the open coast, suggests that even infrequent use of the harbours by Maui's dolphins poses a very high entanglement risk (Slooten et al., 2005; Rayment et al., 2011). There is also very limited information on the level of fishing effort for recreational gillnetters or catch rate (per trawl) for the very high level of effort in the inshore trawling fishery (Figure 3b) for this area. To date, quantitative bycatch estimates only exist for the east coast South Island population based on observed captures. Hector's dolphins in South Island waters are known to be caught in gillnets (both commercial and amateur) and trawling operations (Dawson, 1991; Baird and Bradford, 2000; DOC and MFish 2007).

A 2008 risk analysis, by the National Institute for Water and Atmospheric Research, estimated the total death rate at 110-150 Hector's and Maui's dolphins nationally every year (Davies et al., 2008). The DOC Hector's dolphin incident database reports cause of death for a total of 41 known Maui's deaths in 1921-2008, of which 5 are identified as entanglement and an additional 2 as human-interaction. Recent data between 2008-2012 lists 3 Maui's dolphin mortalities, of which 1 is confirmed as gillnetting bycatch (identified as the January incident). Assessing the effects of the current protection measures (improved in 2008) is difficult, given the very small population size of Maui's dolphins. Scientifically robust bycatch data are available for Hector's dolphins living on the east coast of the South Island. From 2000-2006, an estimated 35-46 dolphins were caught (Davies et al., 2008). From May 2009-2010, an estimated 23 individuals were caught based on fisheries observer data (Slooten and Davies 2011). The Expert Panel convened by the New Zealand government in 2012 reviewed all of the available catch rate data, and the continued level of overlap between Maui's dolphins and fisheries known to cause dolphin mortality. On the basis of these data, the Panel estimated that around 5 Maui's dolphins are likely to be caught each year in gillnet and trawl fisheries, which is 75.5 times PBR or what the population can withstand (Currey et al., 2012).

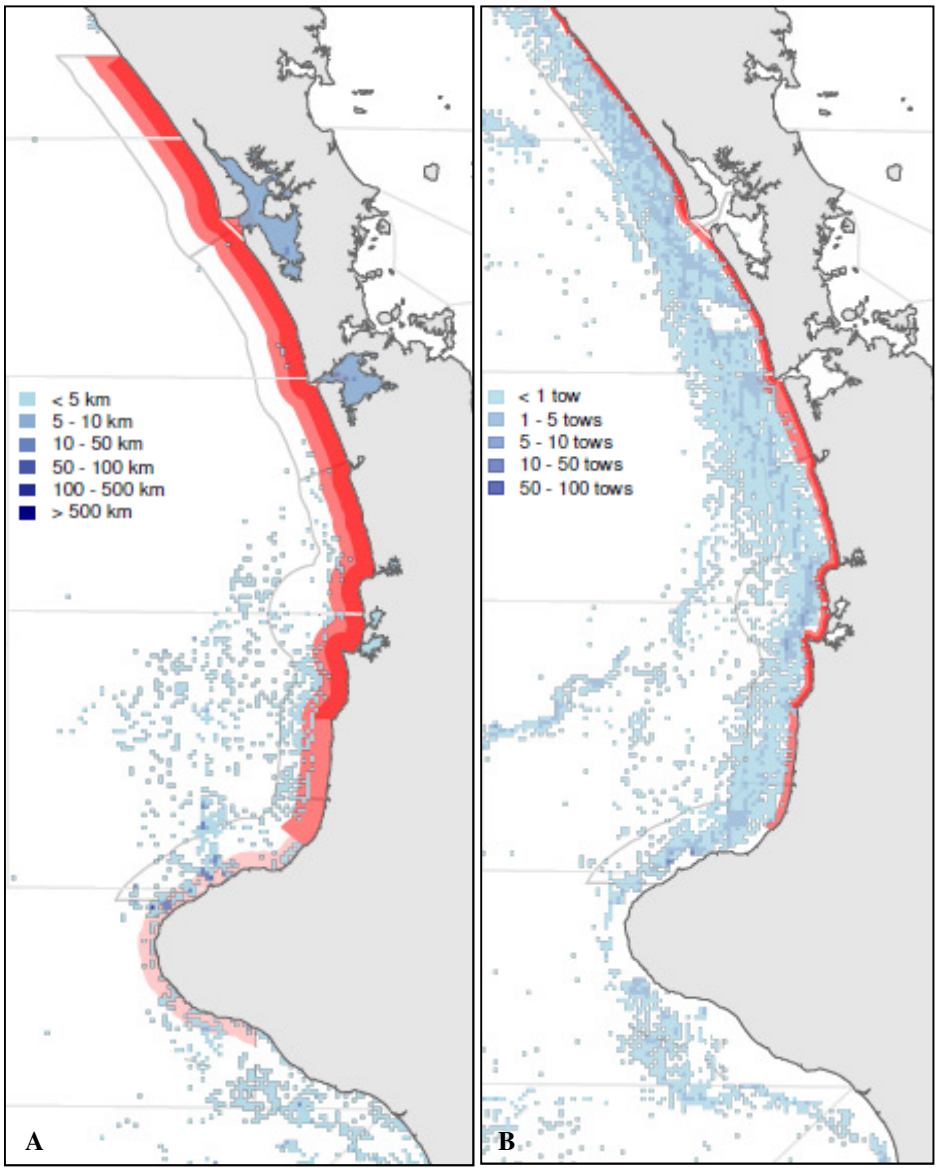

Figure 3. Set net effort, measured in kilometres of net set per year, per 1 square nautical mile, for the years 2008 to 2011 (A), and trawl effort from vessels less than 43m long, measured in tows per year, per square nautical mile, for the years 2006-2011 (B). The various existing and proposed areas closed to set net fishing (A) and the various existing areas closed to trawl fishing (B) are indicated in red. The grey outline marks the extent of the Marine Mammal Sanctuary. Adapted from Currey et al. 2012.

Current and recent range of Maui's dolphin

Although not directly comparable due to differences in methodologies used, the latest abundance estimate of approximately 55 individuals is considerably lower than previous estimates made between 1985 and 2004, which ranged between 75 to 140 individuals (Dawson and Slooten, 1988; Ferreira and Roberts, 2003; Martien et al., 1999; Russell, 1999; Slooten et al., 2006). It appears that Maui's dolphins are continuing to be lost at an unsustainable rate (Hamner et al., 2012).

Earlier this century, sightings and strandings data were distributed around most of the North Island (Figure 4; Russell, 1999), but in recent years their range appears to have contracted with very few recent sightings in the southern part of their former range. In particular, there is ongoing concern that the unprotected waters around Taranaki are continuing to act as a sink for the population (Martien et al., 1999; Hamner et al., 2012). The government acknowledges that Maui's dolphins were once common in this area (DOC and MFish, 2007), but has resisted the growing evidence that the Taranaki area is still an important part of their range. Dolphins can easily be missed in low-density areas and in areas with low survey effort (Slooten et al., 2005), however public sightings data has continued to indicate that these dolphins move beyond the boundaries of the protected area, as restrictions on gillnets and trawling only extend to Pariokariwa Point and do not include harbours (Figure 2).

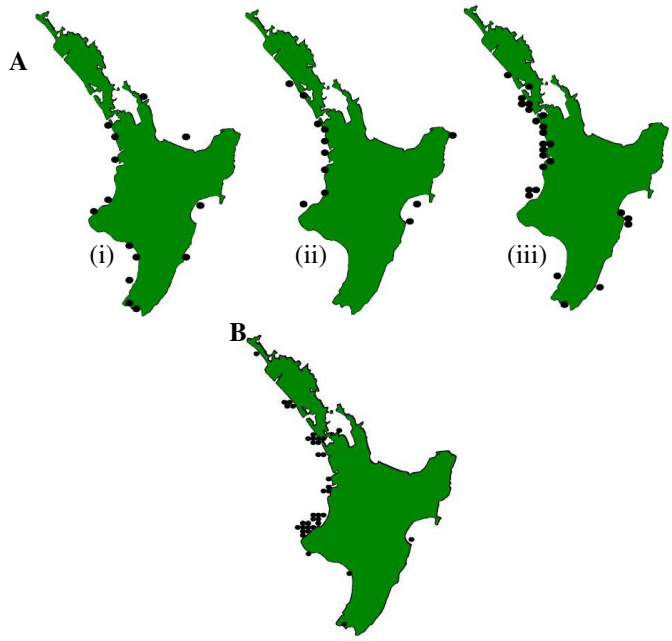

Figure 4. Public sightings data (A) from the 1970s (i), 1980s (ii), and 1990s (iii); and stranding locations (B) between 1970-2000 for the North Island Hector's dolphin (ie. Maui's dolphin), New Zealand. Adapted from Russell (1999).

With the recent discovery of 2 migrant female Hector's dolphins within the Maui's population (Hamner et al., 2012), the importance of the area south of Taranaki is further supported. Giving Hector's dolphins the ability to safely access the Maui's population, and vice versa, may be the key to ensuring their recovery. Maui's need to be protected across their entire historic range, not just in the limited habitat where most of the recent sightings have been made.

A viable future

Although Hamner et al. (2012) reveals a staggeringly low number of Maui's dolphins and suggests they may have been declining approximately 2.8% per year in the last decade, they present some key findings which suggest recovery is still possible. Overall, the level of genetic diversity, albeit low, has been retained. The sex ratio is close to even (if not slightly biased to females), the number of pregnant females is within expected range, and the dolphins are travelling considerable distances (eg. one female travelled 79 km within 19 days), which may help prevent further fragmentation and group isolation, and thus gives the population the best chance of recovery. Unexpectedly, the study also found the presence of 2 migrant female Hector's dolphins within the Maui's range, which would have travelled ≥400 km– the first documented contact between these two subspecies. Although interbreeding has not been confirmed, the potential for this exists and could lead to an enhancement of the genetic diversity of the Maui's population.

There is no reason to believe that the Maui's dolphin population is no longer viable, or that there is no point trying to save them. The number one threat is easily avoidable by switching to more selective, sustainable fishing methods–especially in areas where the dolphins are currently found. With appropriate protection, it is reasonable to believe that Maui's can survive and recover their numbers (Currey et al., 2012).

PRIORITISING MANAGEMENT MEASURES TO ENSURE THE DOLPHINS' RECOVERY

When the first west coast North Island protected area was created in 2003, the Minister of Fisheries at the time was lobbied by the fishing industry to exclude the southern boundary of their range and the harbours. This exemption was granted, leaving substantial overlap between the dolphins and fishing nets. Gillnet fishing effort in this southern part of the range of Maui's dolphin has always been relatively high. Continued research, public sightings of dolphins and the confirmed January 2012 death of a dolphin in a commercial net off the Taranaki coast, all reinforce the need for the southern boundary of the protected area to be extended. A precautionary approach would extend it at least to Wanganui (Currey et al., 2012), given recent research has demonstrated that Maui's are capable of travelling significant alongshore distances. Protection should ban gillnets and trawl fisheries from within the area (including harbours) and restrict oil and gas activities where Maui's dolphins are found. Strong evidence suggests that if a marine mammal protected area is made large enough, this species is capable of reversing its decline (Slooten, 2013).

In the 2012 paper we presented to IWC SC 64, we concluded that strong conservation action was necessary, particularly the immediate reduction of all fisheries-related mortality to zero. Delaying precautionary management will very likely lead to the extinction of Maui's dolphin. Currently, the areas with the highest bycatch risk are the harbours, the area south of the protected area and offshore past restriction boundaries. In addition, there is a continuing risk from illegal fishing activities within the protected area, as policing and monitoring have been minimal. The top of the South Island and interisland corridor continue to have no protection at all. This is a serious risk for Maui's dolphins as there is evidence that Hector's travel north and could potentially help the Maui's dolphin population persist. Protecting Hector's and Maui's dolphins so that they can recover to 1970s numbers means preventing further fragmentation by developing one coherent and comprehensive protection package that matches the dolphins' distribution, current and former. In conclusion, the current interim extension of protection for Maui's dolphins south to Hawera simply doesn't match the scientific evidence and is an insufficient response to a very serious situation.

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