Occurrence of *Cephalorhynchus hectori* in coastal waters of Manukau and Taranaki, New Zealand;

Deployment Two

Identifying temporal and spatial information for review of the 2012 Threat Management Plan

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Abstract

Cephalorhynchus hectori (Hectors dolphin) are an endangered species that are only found in New Zealand waters (Reeves et al., 2013). *Cephalorhynchus hectori maui* (Māui dolphin) are a subspecies of Hectors dolphin that inhabit the west coast of the North Island and are currently listed as critically endangered on the International Union for Conservation of Nature red list (Reeves et al., 2013). Much of their population decline is a result of human activity. To improve existing knowledge on the distribution of Māui and Hectors dolphin, spatial information was gathered using click detector devices called C-POD's. These were deployed at various locations along the West Coast of the North Island. This report summaries data from the second deployment offshore from Manukau Harbour and Taranaki regions. The location with the greatest number of high quality narrow-band high frequency (NBHF) detections was found at Mooring 3 / POD 1534 located 5.4 nautical miles (nm) offshore from Manukau coastline. Most of these detections were at the C-PODs located closer to the shore. This included 5 DPM recorded at Mooring 2 during December and then a total of 8 DPM at M3 and M4 during January. There were no detections made on the C-POD deployed at Motunui / POD 2718. A total of 11 detective positive minutes (DPM) were made at Tongaporutu on POD 2720 during the month of April and July. The data suggests that Māui dolphins tend inhabit waters closer into shore and venture as far south as Taranaki. There was also a general trend that the detections were made during night time hours. Further research is required to increase understanding of the distribution of this species.

Introduction

The coastal waters of New Zealand are home to many marine mammal species, including *Cephalorhynchus hectori* (Hectors dolphin) which inhabit the coastal waters around the South Island of New Zealand (Dawson et al., 2004: Slooten et al., 2004, 2005). A small population of this species has been isolated in the west coast region of the North Island, having now evolved slightly different physiology and genetic makeup to the main southern population. This population is *Cephalorhynchus hectori maui* (Māui dolphin) and has been recognised as a subspecies of Hectors dolphin since 2002 (Baker et al., 2002, 2012). Māui dolphin are the smallest and rarest dolphin subspecies in the world and are listed as Nationally Critical under the NZ Threat Classification System and as Critically Endangered under the International Union for the Conservation of Nature Red List Categories and Criteria (Baker et al. 2016; Reeves et al. 2013). Estimates have suggested that 95.5% of human-induced mortality in Māui dolphins is due to trawling and by-catch from gillnetting (Calderwood, 2014). Since the introduction of gill nets into New Zealand waters in the 1960's, there has been a significant population decline from an estimated 1500 to the current estimate of 63 (95% CI 57 – 75) individuals (Baker et al. 2016). Their home range used to be anywhere from Cook Strait to Ninety Mile Beach but are today only found from Maunganui bluff to New Plymouth (Slooten et al., 2005). Māui dolphin are slow breeders, with each female giving birth to one calf every 2-4 years, resulting in a low population growth of 2% per year (Department of Conservation, 2017a). They are in need of conservation intervention in order to avoid their expected extinction in the next 20-26 years (Burkhart and Slooten, 2003).

The first Threat Management Plan for Hector's and Māui dolphins was implemented in 2008 to ensure the long-term survival of their population by reducing impacts from human activity (Currey et al. 2012). The Māui dolphin portion of the Threat Management Plan was later reviewed in 2012 after four public sightings of these dolphins in the Taranaki coastal area. In the 2012 review, the updated Potential Biological Removal analysis estimated that Māui dolphin population could only sustain one human-induced mortality every 10 - 23 years without affecting the population's ability to rebuild to a sustainable level (Hamner et al. 2014). The current restrictions and prohibitions in the Taranaki coastal area is enforced under the Fisheries Act 1996 and the Marine Mammals Protection Act 1978. The Marine Mammal Sanctuary extends out to 12 nautical miles offshore from Maunganui Bluff to Oakura Beach (Parliamentary Counsel Office, 2018; see *Appendix A*). This sanctuary includes restrictions on mining, with prohibition out to 2 nautical miles along the length of the Marine Mammal Sanctuary and out to 4 nautical miles from Manuka harbour to south of Raglan Harbour (New Zealand Gazette, 2012: Fisheries New Zealand, 2018: see *Appendix A*). Acoustic seismic surveying in this area is also restricted and must abide by the Code of conduct for minimising acoustic disturbance to marine mammals (New Zealand Gazette, 2012: Department of Conservation, 2017b: see *Appendix A*). Along the west coast, there are also restrictions on set netting. From Maunganui Bluff to Waiwhakaiho River commercial and recreational set netting is prohibited out to 7 nautical miles (Parliamentary Counsel Office, 2018; see *Appendix A* and *B*). From Waiwhakaiho River to Hawera commercial set netting is also prohibited out to 7 nautical miles unless an MPI observer is onboard (New Zealand Gazette, 2012: see *Appendix A* and *B)*.

In order to understand how we can best protect Māui dolphin, and increase their population to a sustainable level, more long-term and extensive information must be gathered. This helps maintain evidence for the current protection measures under the Threat Management Plan. Visual sightings of Māui are rare due to the fact that these dolphins themselves are rare and that there are fewer visitors to these remote and rough areas of coastline. Therefore, there is a need for a more reliable way of detecting them. Underwater acoustic devices called C-PODs detect odontocete click trains in the range of 20 – 160 kHz, which includes the high frequency (120 – 125 kHz) echolocation clicks that Māui dolphin emit when foraging. This bioacoustic data is logged through all hours of the day and night, and across long time periods. This gathers a much more extensive and informative data set as compared to aerial surveys which are limited to short term collection and are financially expensive and labour intensive. Information from this underwater acoustic technology can be used to determine the extent of Māui dolphin occurrence and about the temporal and spatial distribution of these mammals within their home range.

Aim

To investigate the spatial and temporal distribution of Māui dolphin in the Manukau and Taranaki coastal areas using C-POD technology.

Methods

To investigate the occurrence of Māui dolphin along the West Coast of the North Island, C-PODs devices were deployed at various sites. Each C-POD sits one to two meters above an attached float, anchored by a 30 – 35 kilogram weight at the base (Fig. 1). This positions the C-POD approximately three to four metres above the seabed.

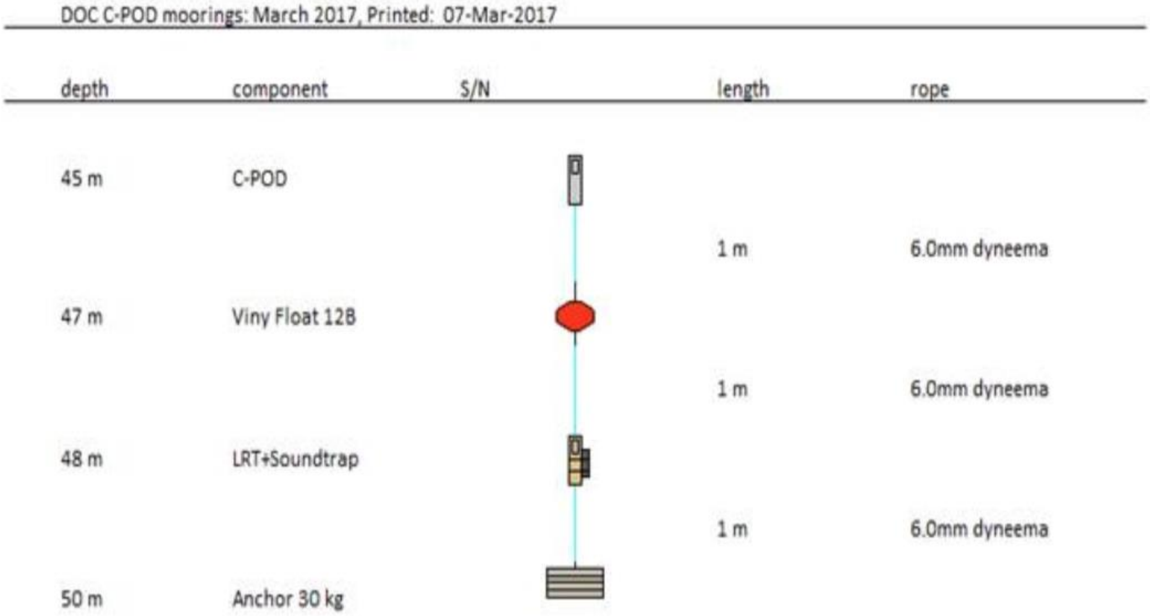

Fig. 1: Set-up of an underwater bioacoustic C-POD device with anchor placed on seabed (NIWA, 2018).

For the second deployment operation, a total of five C-PODs were placed at increasing distances offshore from Manukau coastline, south of Manukau Harbour entrance, on the 15th of November 2017 (Fig. 2). C-POD 1533 was placed at Mooring 2, located 4.32nm (8.0km) offshore. C-POD 1534 was placed at Mooring 3, located 5.45nm (10.1km) offshore. C-POD 1560 was placed at Mooring 4, located 6.53nm (12.1km) offshore. C-POD 1559 was placed at Mooring 6, located 8.7nm (16.1km) offshore. C-POD 1298 was placed at Mooring 7, located 9.83nm (18.2km) offshore. Further details are presented in *Appendix C.*

Two C-PODs were placed offshore of Taranaki region (Fig. 3). C-POD 2720 was placed 1.03nm (1.9km) offshore from Tongaporutu. C-POD 2718 was placed 1.12nm (2km) offshore from Motunui. Both C-PODs were deployed on the 15th of February 2018 and collected on the 3rd of July 2018. Further details are presented in *Appendix C.*

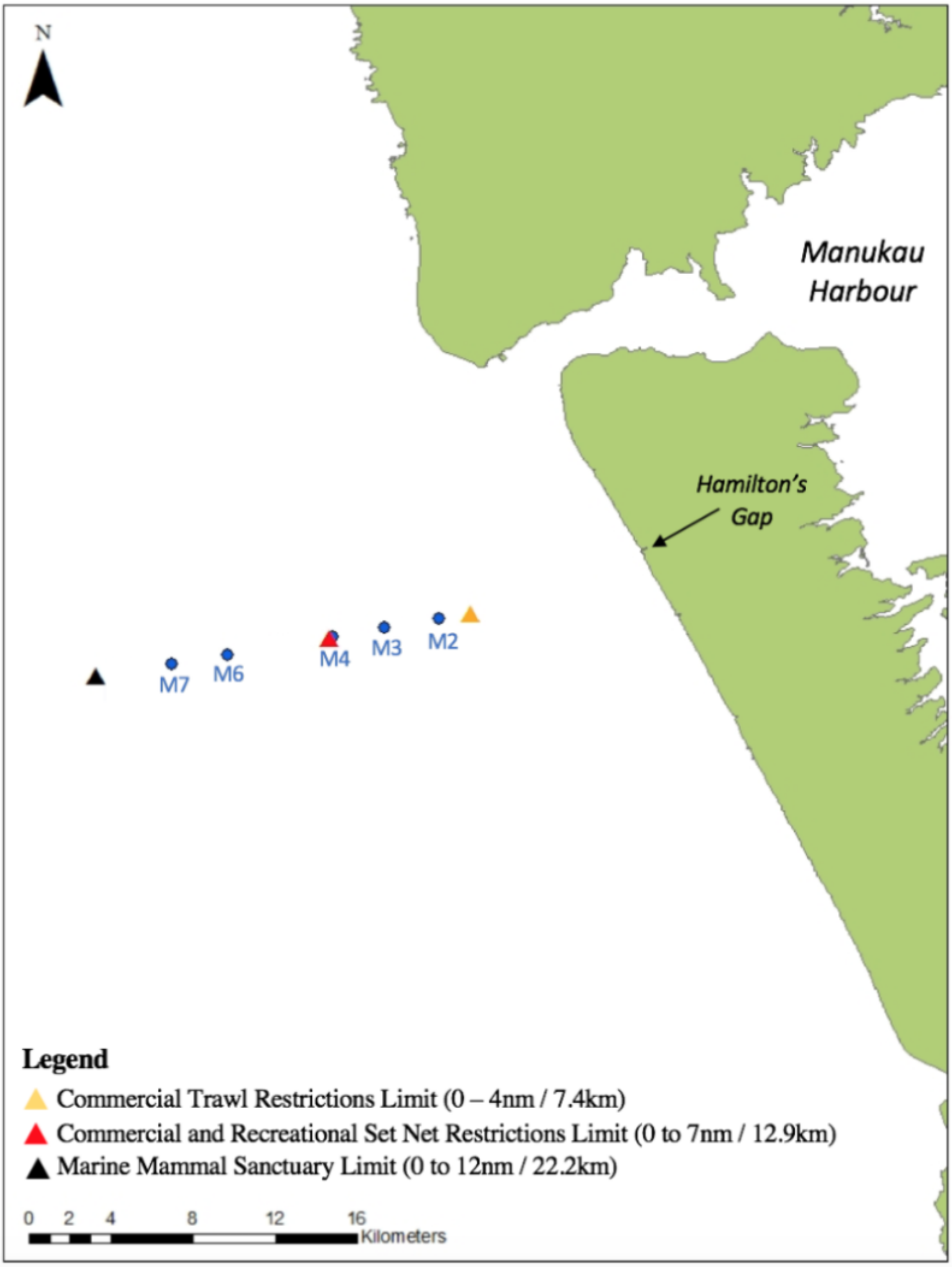

Fig. 2: Locations of C-POD's placed offshore from the Manukau coastline: M2; 4.32nm (8.0km), M3; 5.45nnm (10.1km), M4; 6.53nm (12.1km), M6; 8.7nm (16.1km), M7; 9.83nm (18.2km), with limits of protection zones displayed in relation to C-POD locations (ESRI ArcMAP Software, 2017).

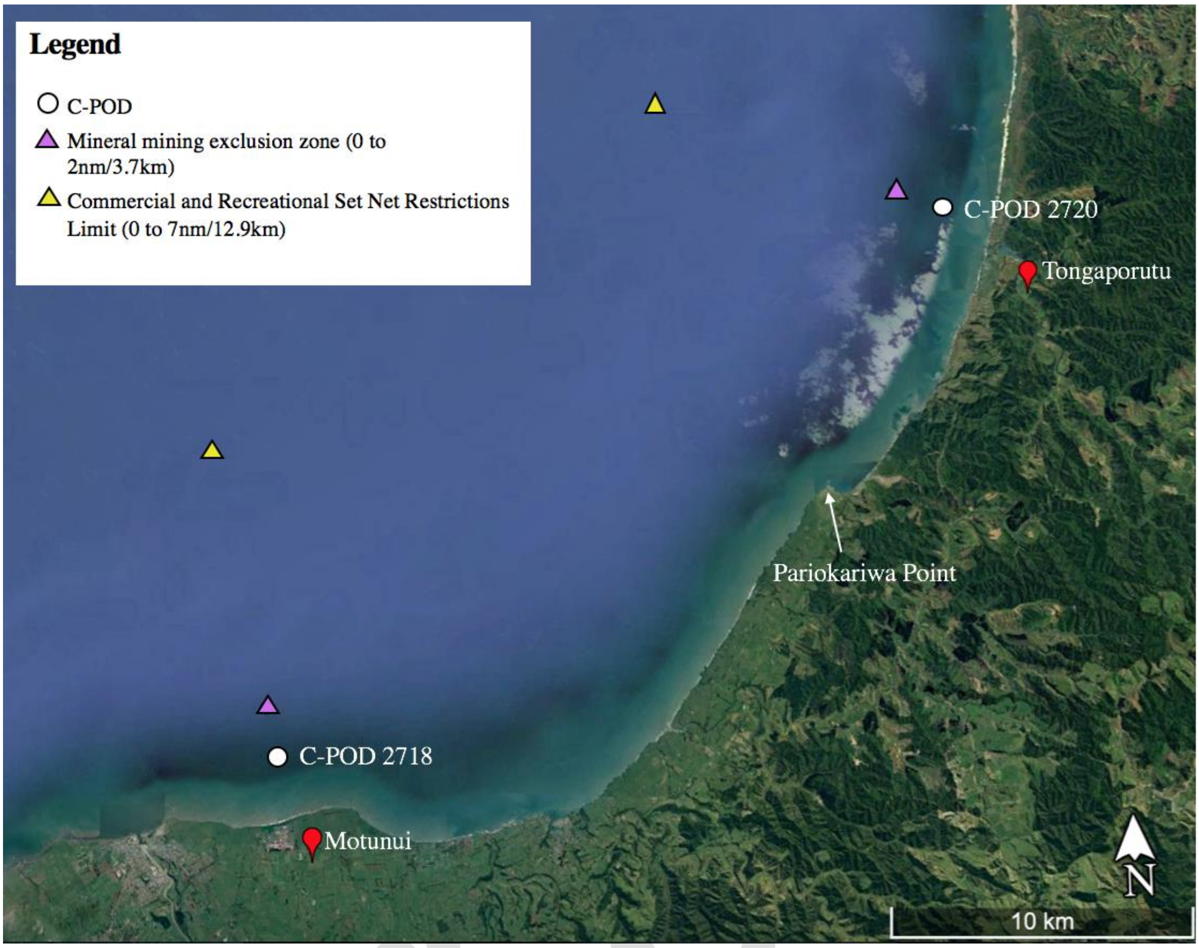

Fig. 3: Locations of C-PODs placed offshore from Tongaparoutu; C-POD 2720 at 1.03nm (1.9km), and offshore from Motunui; C-POD 2718 at 1.12nm (2km) in the Taranaki coastal area with limits of protection zones displayed in relation to C-POD location (Google Earth Pro, 2018).

Data Analysis

The data from each C-POD was downloaded and verified using C-POD.exe 2.064 software. The data was processed using the KERNO classifier and the train filter set to high quality. These filters improve the classification of detections and allow discrimination between species based on their click parameters. The KERNO classifier groups the data into four categories; Narrow Band High Frequency clicks (NBHF), Other cetaceans, Sonar, and Unclassified source (e.g. Weak Unknown Train Sources). Māui dolphin have high frequency, narrow-band clicks (NBHF) with frequencies of between 120 - 125 kHz (Thorpe & Dawson, 1990). It is likely that the NBHF clicks are Māui dolphin's echolocation clicks.

The data were then manually analysed by looking through the file and ensuring the classifications were correct with any false positives being re-classified. Through the verification process M4 had 32% of clicks removed from the total number of high quality NBHF clicks that were identified from the initial KERNO classification. M6 had 72% removed and M2, M3 and M7 had 0% removed. The verified data from all C-PODs was exported as detection positive minutes (DPM). The verified data was then run through Matlab software to produce click plots.

Results

Summary of Manukau Coastline C-PODs

The highest amount of detections was recorded on the C-POD located at M3, with a total of seven DPM (Fig. 4). The C-PODs at M6 and M7 where located the furthest offshore and had the lowest amount of detections, with a total of one DPM on each (Fig. 4).

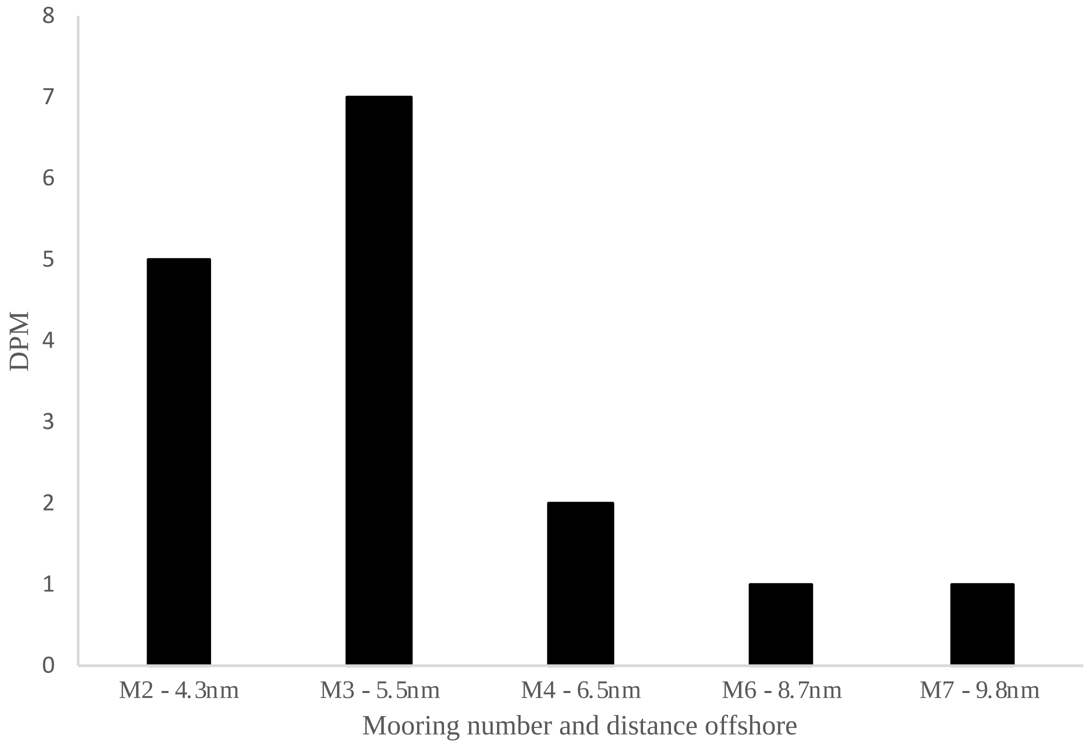

Fig. 4: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring locations (Mooring 2, M3, M4, M6 and M7) with increasing distance offshore (nautical miles).

The highest total number of detection positive minutes (DPM) per month was made during January, with a total of 8 detected positive minutes recording on the C-PODs at M3 and M4 (Table 1; Fig. 5). There was at least one DPM made each month from November to March across all C-POD locations (Table 1; Fig. 5).

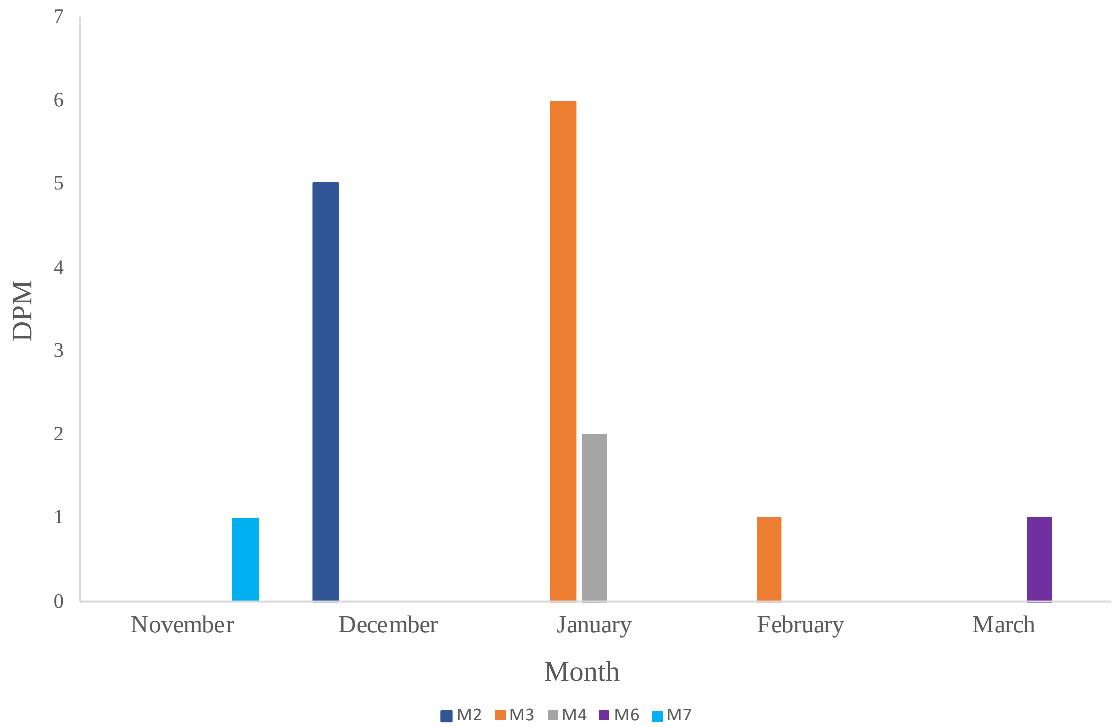

Fig. 5: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring locations (Mooring 2, M3, M4, M6 and M7) from November 2017 to March 2018.

Table 1: Number of high quality NBHF detection positive minutes (DPM) for each month at Manukau coastline CPOD locations from November 2017 to march 2018.

CPOD/Location	November 2017	December 2017	January 2018	February 2018	March 2018
M2	0	5	0	0	0
M3	0	0	6	1	0
M4	0	0	2	0	0
M6	0	0	0	0	1
M7	1	0	0	0	0

Manukau Coastal Area

M2 / Mooring Two:

A total of five detection positive minutes (DPM) of high quality NBHF click trains were detected during the middle of December 2017 at mooring two (Fig. 6). These detections were recorded spaning across sunset time (Fig. 6). There were no other Māui detections recorded on this C-POD.

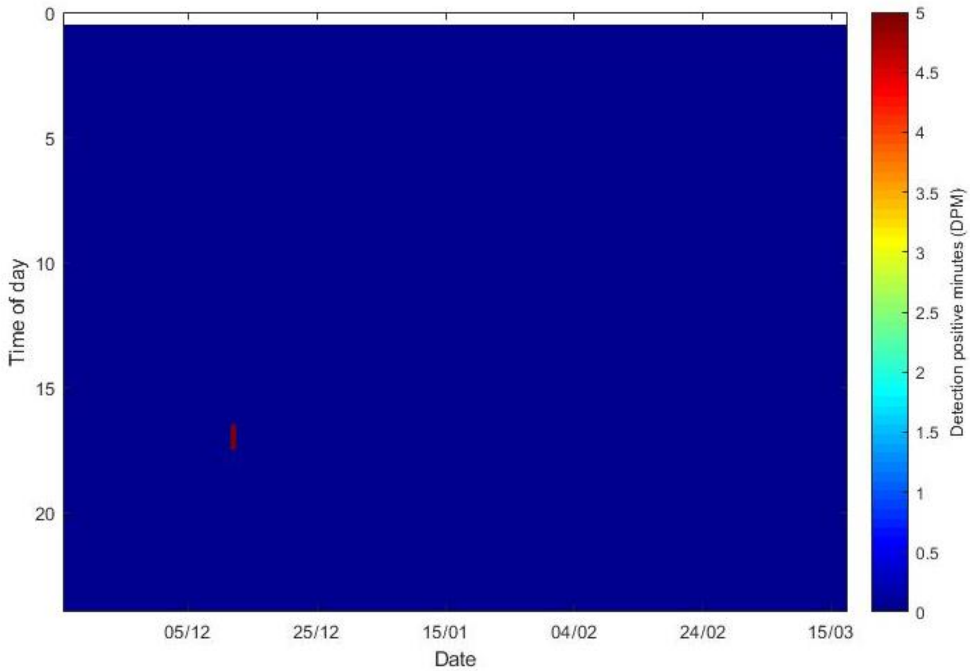

Fig. 6: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring two positioned 4.3 nautical miles (8.0 km) offshore from Manukau coastline C-PODs from the 15th November 2017 15:59 NZST to the 15th March 2018 23:59 NZST.

M3 / Mooring Three:

A total of seven DPM for high quality NBHF were recorded at Mooring three (Fig. 7). These detections were made during early January and early February (Fig. 7). Most of the detections were made during night time hours (Fig. 7).

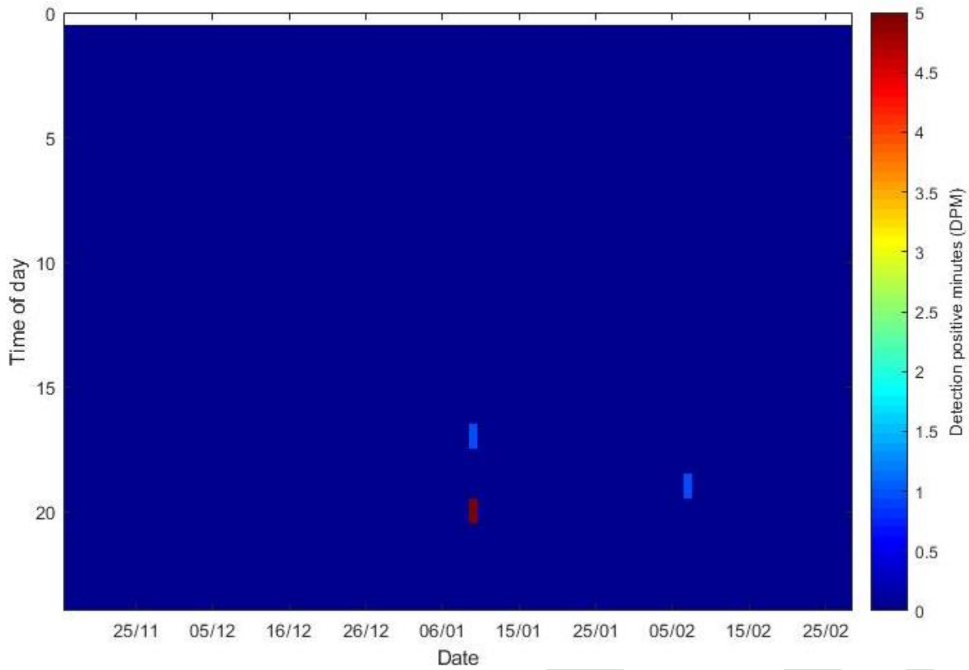

Fig. 7: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring three positioned 5.45 nautical miles (10.11 km) offshore from Manukau coastline C-PODs from the 15th November 2017 15:59 NZST to the 25th February 2018 15:59 NZST.

M4 / Mooring Four:

A total of two DPM for high quality NBHF were recorded at Mooring four, in early January (Fig. 8). This detection was made during night time hours (Fig. 8).

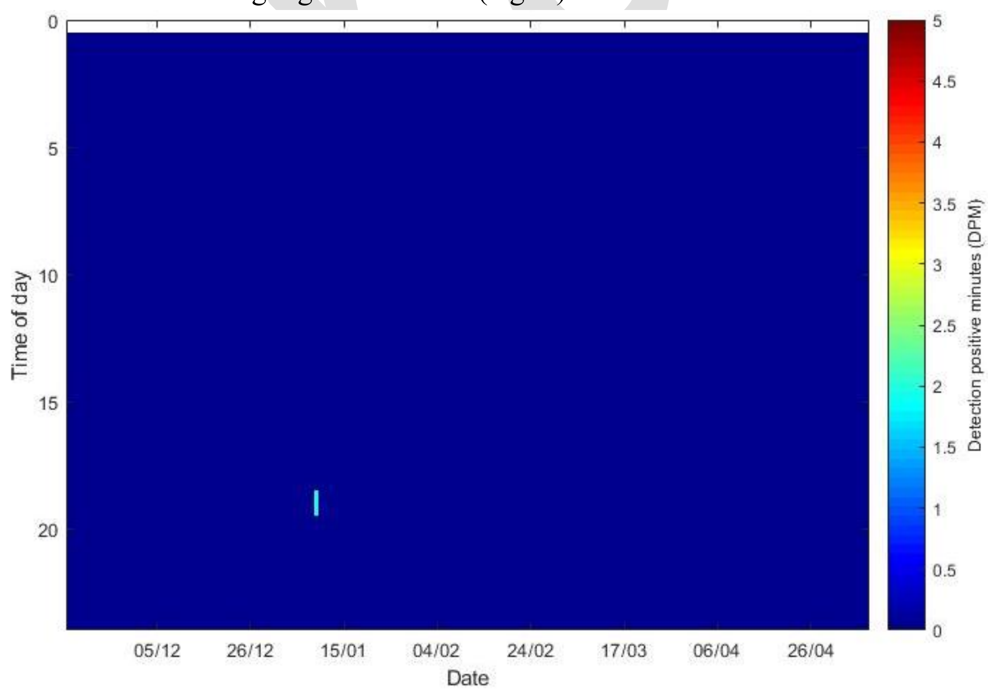

Fig. 8: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring four positioned 6.53 nautical miles (12.1 km) offshore from Manukau coastline C-PODs from the 15th November 2017 15:59 NZST to the 22nd May 2018 17:59 NZST.

M6 / Mooring Six:

A total of one DPM for high quality NBHF was recorded at Mooring six, in during mid-March (Fig. 9). This detection was made during day time hours (Fig. 9).

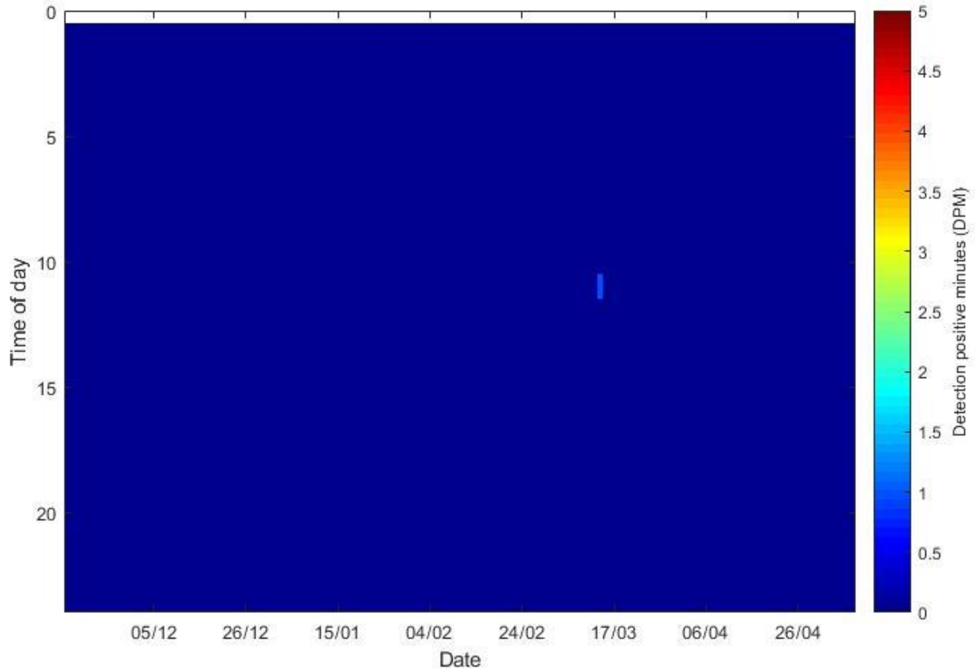

Fig. 9: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring six positioned 8.7 nautical miles (16.1 km) offshore from Manukau coastline C-PODs from the 15th November 2017 15:59 NZST to the 14th May 2018 17:59 NZST.

M7 / Mooring Seven:

A total of one DPM for high quality NBHF was recorded at Mooring six, in in late November (Fig. 10). This detection was made during day time hours (Fig. 10).

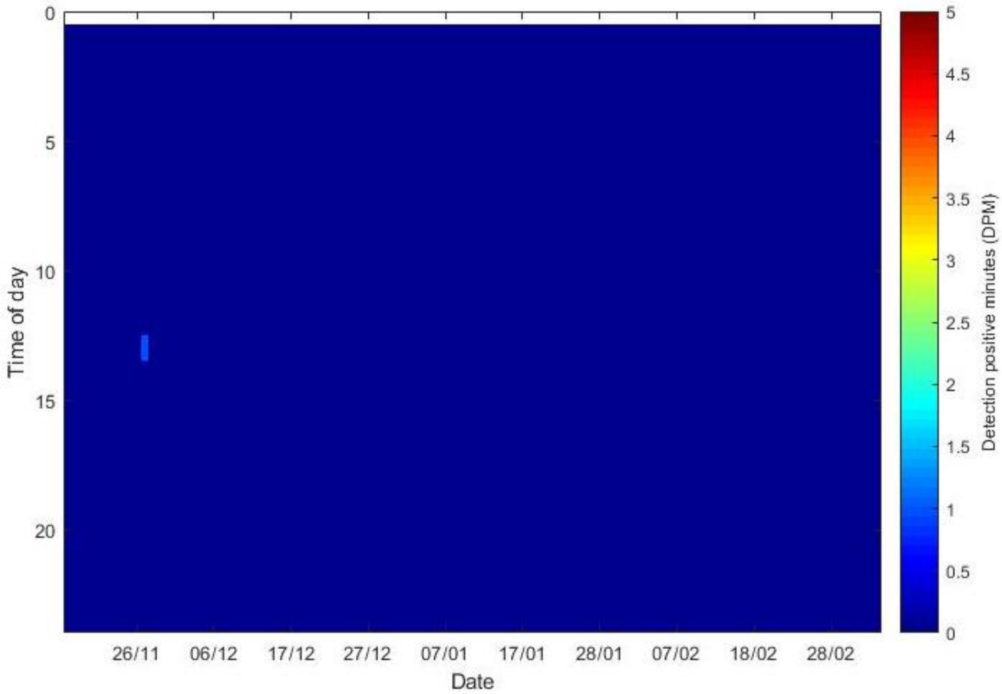

Fig. 10: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring six positioned 9.83 nautical miles (18.2 km) offshore from Manukau coastline C-PODs from the 15th November 2017 15:59 NZST to the 28th February 2018 14:59 NZST.

Taranaki Coastal Area

Tongaporutu

A total of 11 DPM for high quality NBHF were recorded on the C-POD deployed offshore from Tongaporutu (Fig. 11, Fig. 12). These detections were made during mid-April and late June, with all detections recorded during night time hours (Fig. 11, Fig. 12).

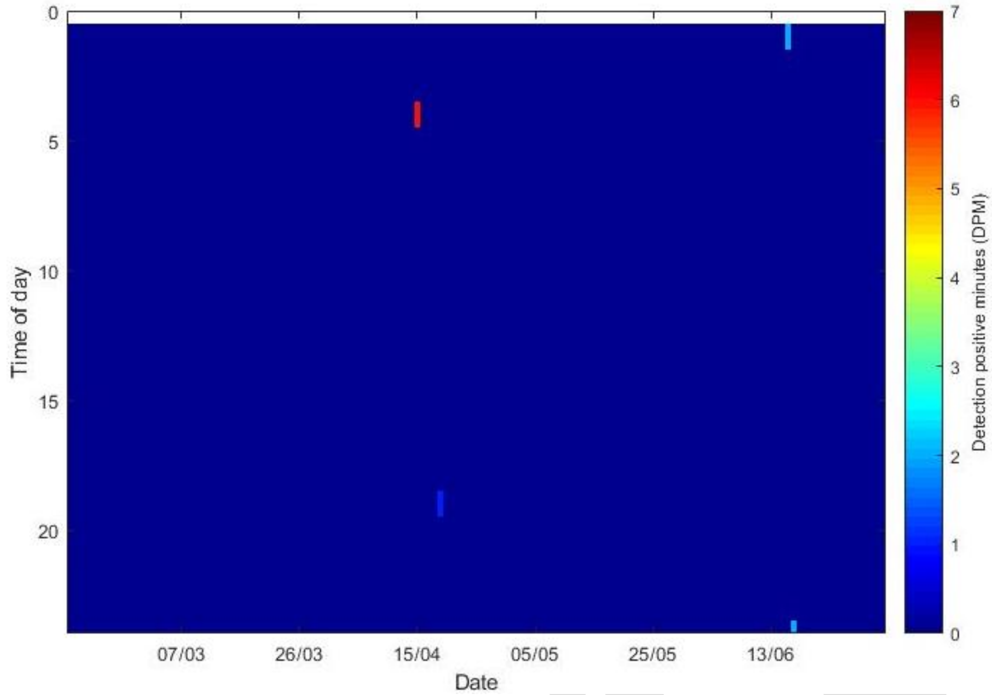

Fig. 11: Detection positive minutes (DPM) for high quality NBHF click trains detected at Tongaporutu C-POD positioned 1.03nm (1.9km) offshore from Manukau coastline C-PODs from the 15th January 2018 09:22 NZST to the 3rd July 2018 12:11 NZST.

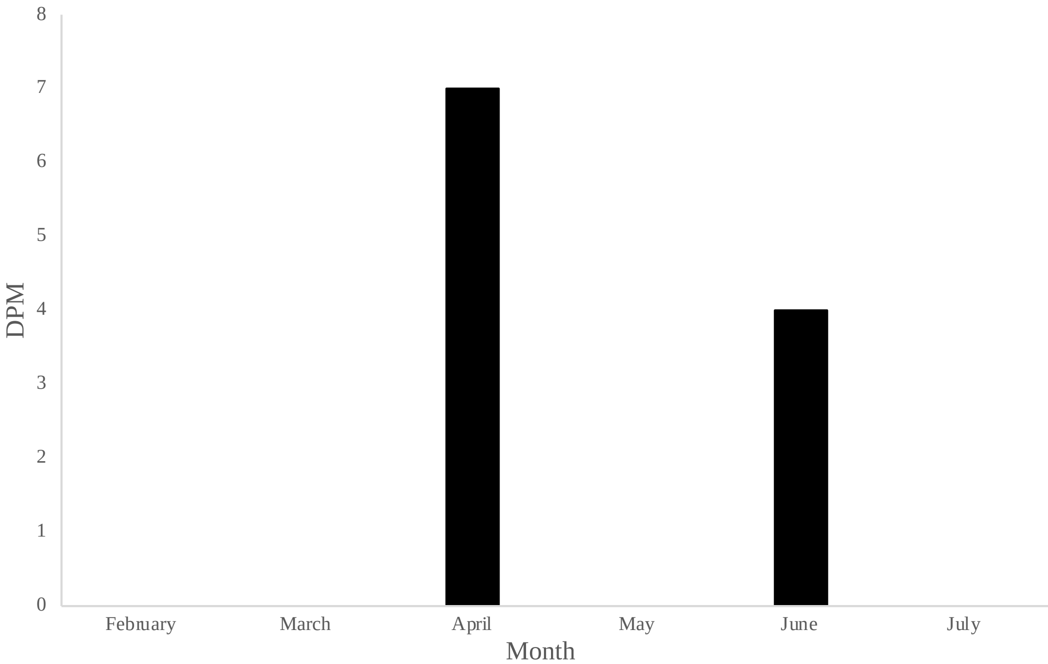

Fig. 12: Detection positive minutes (DPM) for high quality NBHF click trains detected offshore from Tongaporutu (C-POD 2720) from February to July 2018.

Motunui

There were no high quality NBHF detections recorded on the C-POD located offshore from Motunui.

Discussion

Current research is largely focused on Māui dolphin distribution within their core range. However, previous studies have given some insight into the overall distribution of this small population. For example, Oremus (2012) concludes that for the summer months of February and March, Māui dolphin have a small frequently used core area including two areas of high density; south of Manukau Harbour, offshore from Hamilton's Gap and south of the Waikato River mouth. Results gained from the first deployment report agree with Oremus's (2012) results, showing higher densities of detections recorded at the Hamilton's Gap C-POD from the first deployment data and at M2 and M3 from both deployment one and two data. However, the first deployment had much higher DPM values in the C-PODs closer in to shore than in the second deployment. These higher amounts of detections may indicate higher numbers of Māui dolphin in these regions closer to the coastline.

One aim of this research was to determine the extent that Māui dolphin occur offshore. The first deployment found this offshore extent to be 14km, whereas this report for the second deployment finds evidence for detections as far as 18km offshore. Data from the second deployment found detections at M6 and M7, whereas deployment one found none at these moorings.

The first deployment also found no detections on the C-PODs deployed in Taranaki coastal area. However, data from the second deployment shows a reasonable number of detections (11 DPM) at the C-POD placed offshore from Tongaporutu. These detections were found from April to June, with no detections from January to March. In the Manukau C-PODs, the highest amount of detections was recorded in the month of January. This may indicate a seasonal movement of Māui at the end of summer, down to the area of Taranaki. However, current data from the Department of Conservation sightings database shows no such trend, with a biased towards summer months across all regions due to more people being out on the water (Department of Conservation, 2018). In order to better understand whether these movements are significant, more research is required to be carried out over longer periods of time.

As consistent with the first deployment, there if a general trend that detections from all C-PODs were made during night time hours. This may indicate a behavioural diurnal pattern, where Māui dolphin inhabit more coastal waters (e.g. Hamilton's Gap) during day time hours and move out towards slightly more offshore locations during night time hours. More research is needed in this area to better understand this pattern to determine whether it is significant and the possible reasons for this behaviour.

Limitations:

The main limitation to this research is that we cannot differentiate between Māui and Hector's dolphin with sound data alone, as both emit similar eco-location clicks. Genetic sampling needs to be taken alongside this data in order to determine this. The results of this study are dependent on all these NBHF detections being Māui/Hectors dolphin. Given that there are no other marine mammals in New Zealand waters that emit such high frequency sound, it is safe to assume this. C-POD detections are also unreliable if the C-POD is not orientated in an upright position (see *Appendix C*). The C-PODs that had NBHF detections all were in various states of being off the vertical axis, due to wave action. When taking into consideration the angle of the C-POD, this decreases the reliability of the data gained in this study. All detections presented in this report have been verified through critical analysis of the C-POD angle and physical characteristics of the click data (including frequency, bandwidth, inter click rate, envelope etc.). High quality NBHF detections from the KERNO classification process that did not confidently satisfy all the critical factors required were removed from the data.

Another limitation was the fact that not all C-PODs were able to be collected on the same date, and therefore each have a slightly different time period of data recordings, making comparisons between mooring locations difficult. This was unavoidable due to weather conditions affecting planned C-POD retrieval dates.

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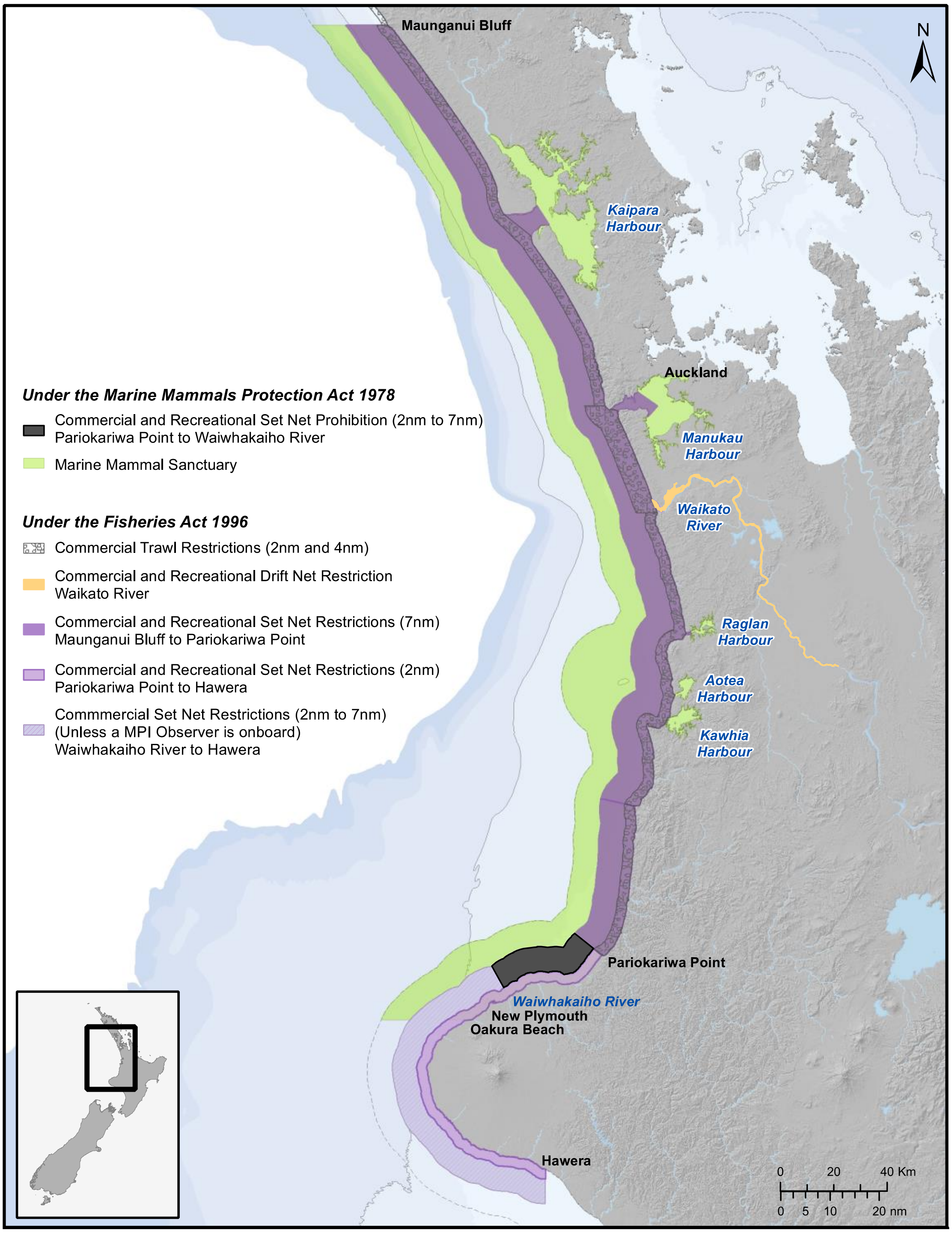
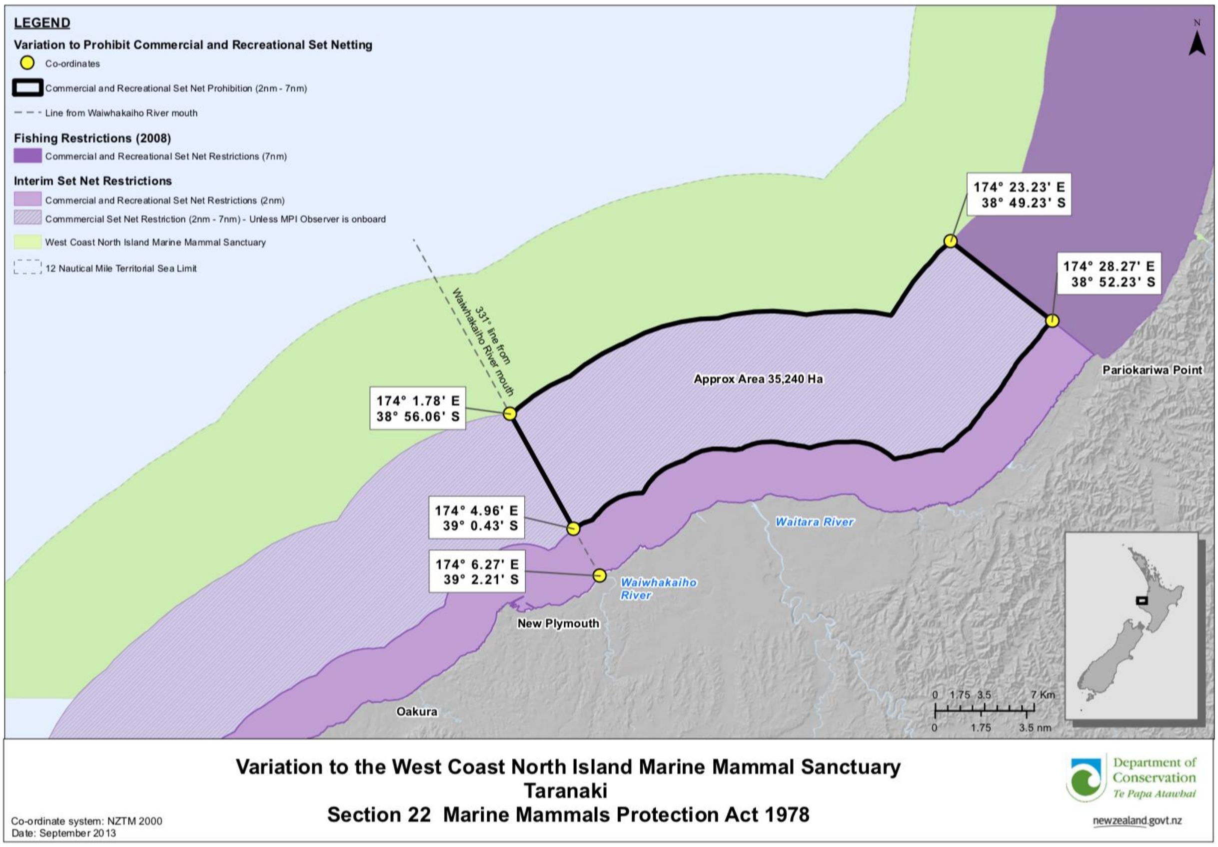
Appendix A: Protection measures under the Marine Mammals Protection Act 1978 and the Fisheries Act 1996 along the West Coast of the North Island, New Zealand (Department of Conservation 2017b).



Appendix B: Details of commercial and recreational set net restrictions in the Taranaki Coastal area (Department of Conservation, 2013).



Appendix C: Summary data for Manukau Coastline and Taranaki C-PODs, Second Deployment.

C-POD Mooring & Approx. distance offshore	Name	Deployment Latitude	Deployment Longitude	Total NBHF clicks found	Total Clicks in CP1 file	Clicks per hour (NBHF)	Clicks per day (NBHF)	DPM per day (NBHF)	File duration analysed (days/hours/ minutes)	Acoustic duration (days/hours/ minutes)	Mean Temp (degrees Celsius)	Mean Angle	N
2 (8.0km)	M2 / POD1533	-37.161	174.483	354	44,199,805	0.06	1.55	0.02	227d 19h 27m	227d 19h 26m (99%)	1	1	8
3 (10.1km)	M3 / POD1534	-37.165	174.459	378	5,153,743	0.15	3.70	0.07	102d 2h 3m	102d 2h 2m (99%)	12	6	13
4 (12.1km)	M4 / POD1560	-37.169	174.436	150	32,771,702	0.03	0.78	0.02	193d 2h 24m	193d 2h 23m (99%)	16	30	3
6 (16.1km)	M6 / POD1559	-37.177	174.390	41	107,017,429	0.01	0.23	0.01	180d 3h 38m	180d 3h 37m (99%)	15	9	0
7 (18.2km)	M7 / POD1298	-37.181	174.366	14	31,912338	0.01	0.13	0.01	104d 23h 36m	104d 23h 35m (99%)	11	2	0
Tongaporutu	POD 2720	38º48’0.146”S	174º34’0.063”E	1,169	8,502,305	0.43	10.25	0.10	138d 2h 22m	114d 44m (82%)	18	5	44
Motunui	POD2718	38º58’0.146”S	174º17’0.814”E	0	77,406,789	0	0	0	138d 2h 39m	113d 23h 54m (82%)	18	2	0