Occurrence of *Cephalorhynchus hectori* in the coastal areas of Hamilton's Gap, Manukau Harbour, Taranaki and Wanganui River;

Deployment One

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 deployment one offshore from Hamilton's Gap, Manukau Harbour, Taranaki airport and Wanganui river. The location with the highest amount of high frequency click detections was offshore from Hamilton's Gap. A large amount of detections was also found at the M2 C-POD located 2.8km kilometres offshore from Manukau Harbour. Detections then decreased with increasing distance offshore from the M2 site until there were no detections from M5 (14.2km offshore) onwards. There were also no detections made at the C-POD's located offshore from Taranaki and Wanganui river. These data suggest that Māui do not venture very far from shore and like to spend the majority of their time around the Manukau harbour region during July and October.

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, 2018b; 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, 2018b; see *Appendix A*). 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).*

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.

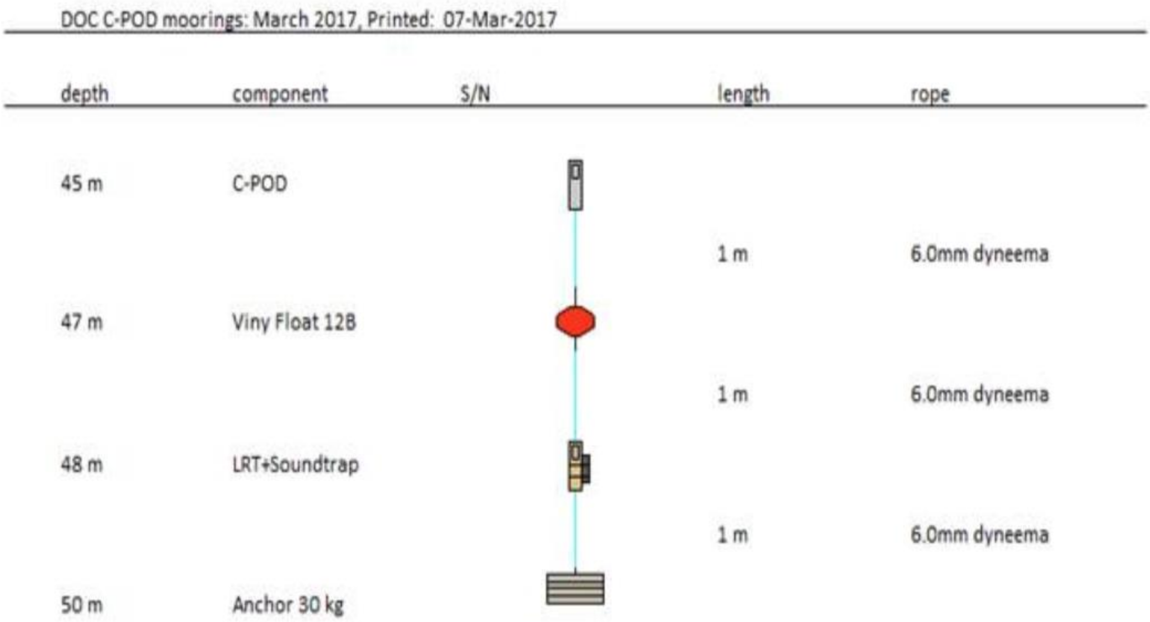

Fig. 1: Set-up of an underwater bioacoustic C-POD device with anchor placed on seabed (NIWA, 2018).

One C-POD was placed north of Hamilton's Gap at approximately 0.9km offshore (Fig. 2) on the 10th of February 2016 and retrieved on the 7th March 2016. Nine C-PODs were deployed in straight line off shore from Hamilton's Gap, south of Manukau Harbour entrance. These CPOD's were deployed on the 28/06/2017 from 08:50 to 10:23 NZST. A high frequency sound trap device was also deployed at M2 as a reference to check the ability of the C-POD to pick up bioacoustics sound. They were collected on the 15/11/2017. All data presented in this report has been taken from the time period of 29/06/2017 00:59 NZST to 14/11/2017 24:59 NZST to ensure accuracy in data analysis. See Fig. 2 for locations of C-POD deployments.
CPODs at mooring one and nine were lost due to strong tidal flows and sediment movement. The C-POD at Mooring 8 had technical difficulties, therefore there was no accurate data to analyse.

Two C-POD's were deployed offshore from Taranaki on the 18/11/2016 at 09:03 NZST. The final C-POD was deployed offshore near Wanganui river on the 21/12/2016 at 17:47 NZST.

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 was then manually analysed by looking through the file and ensuring the classifications were correct and re-classifying any false positives. The verified data from all C-PODs was exported as Detections Per Minute (DPM) and then run through Matlab software to produce click plots. Monthly graphs displaying the sound data in relation to moon phases were produced using Excel.

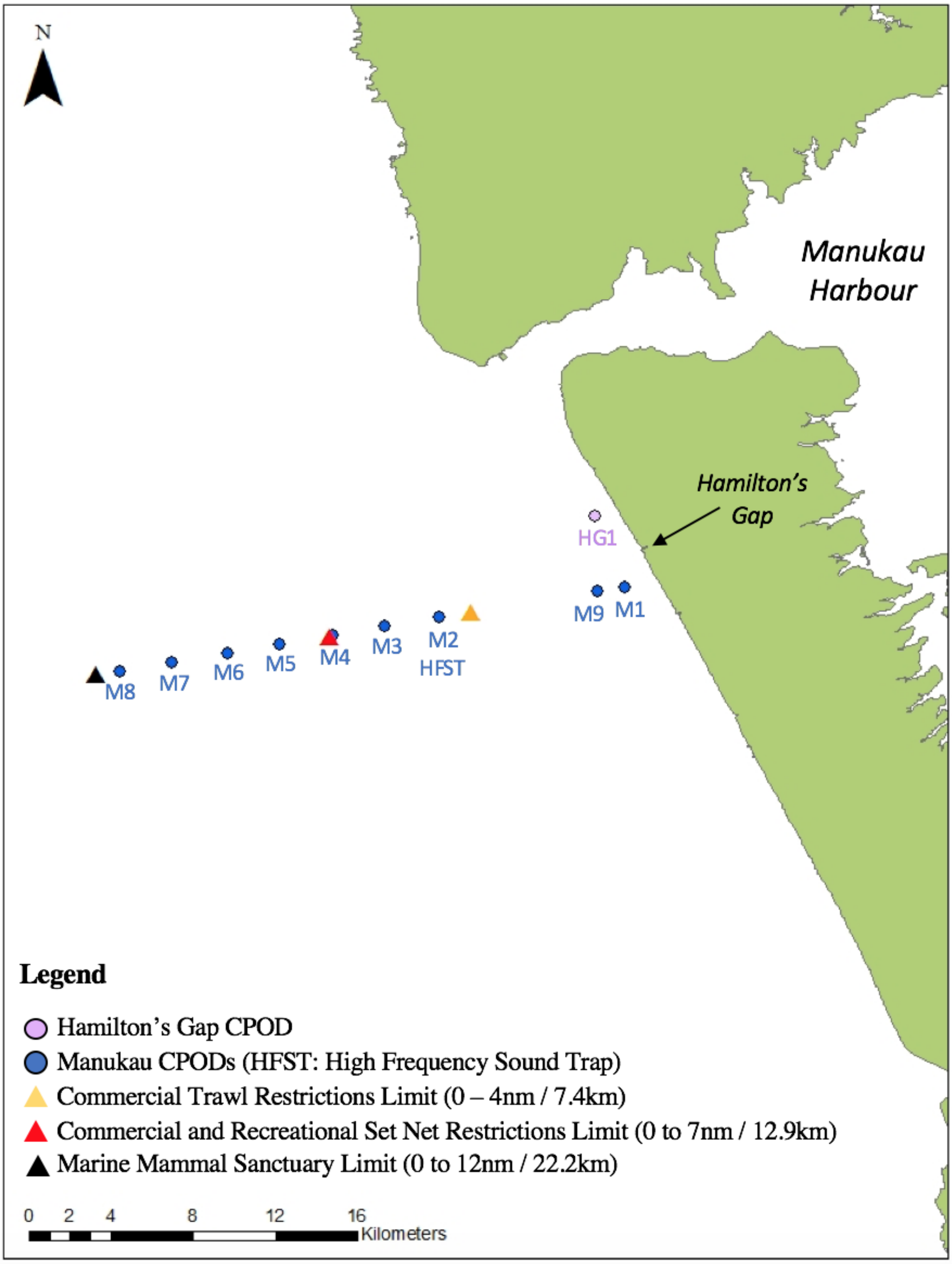

Fig. 2: Locations of CPOD's placed offshore from and Hamilton's Gap: HG1, 0.91km and from Manukau Harbour: M1; 1.9km offshore (lost), M9; 2.8km (lost) M2; 8.0km, M3; 10.1km, M4; 12.1km, M5; 14.1km, M6; 16.1km, M7; 18.2km, M8; 19.9km (technical difficulties) with limits of protection zones displayed in relation to CPOD locations.

Results

Summary of Manukau Deployments:

The highest total number of detections per month was made during October, with a total of 66 detection positive minutes (Table 1). Detections were made at M2, M3 and M4 C-PODs during the months of October and November (Fig. 3). During the month of August, detections were made only at M2 C-POD (Fig. 3). M4 C-POD recorded detections only during the months of October and November (Fig. 3).

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

CPOD/Location	July 2017	August 2017	September 2017	October 2017	November 2017
M1	-	-	-	-	-
M2	64	17	21	66	26
M3	6	0	6	22	5
M4	0	0	0	2	2
M5	0	0	0	0	0
M6	0	0	0	0	0
M7	0	0	0	-	-
M8	-	-	-	-	-
M9	-	-	-	-	-

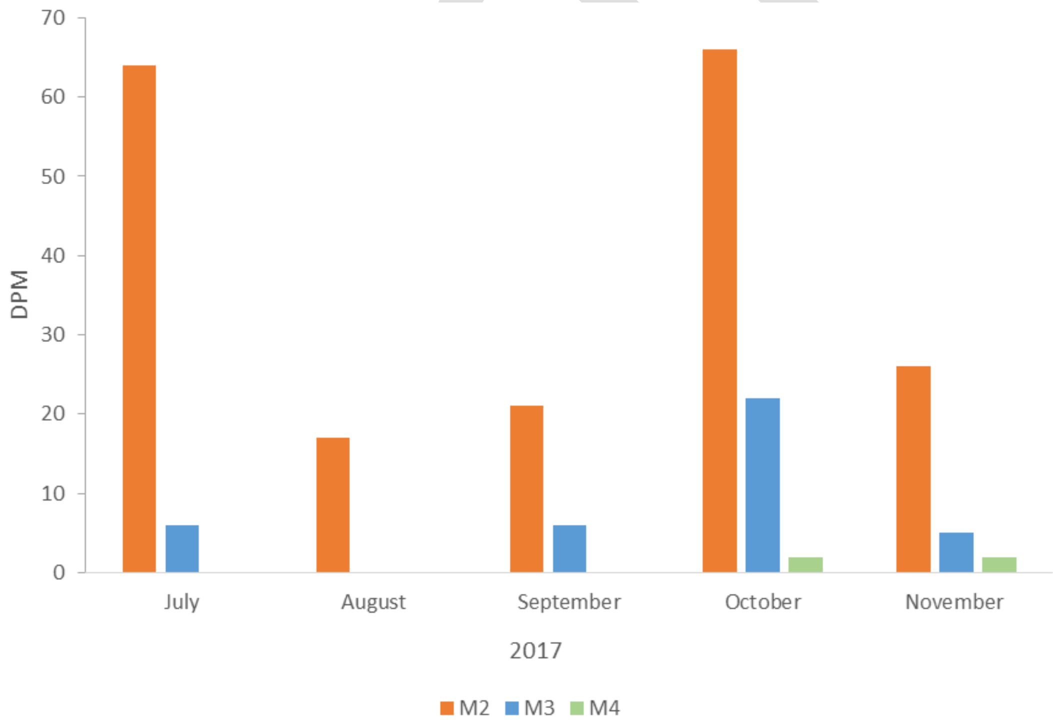

Fig. 3: Total detection positive minutes (DPM) per month for Manukau Harbour C-PODs M2, M3 and M4 from July 2017 to November 2017

Hamilton's Gap

Overall, Hamiltons Gap had the highest amount of high quality NBHF detections. The large majority of the detections occur during daylight hours, where there was a big cluster of detections occurring during the middle of February to the beginning of March 2016 (Fig. 4).

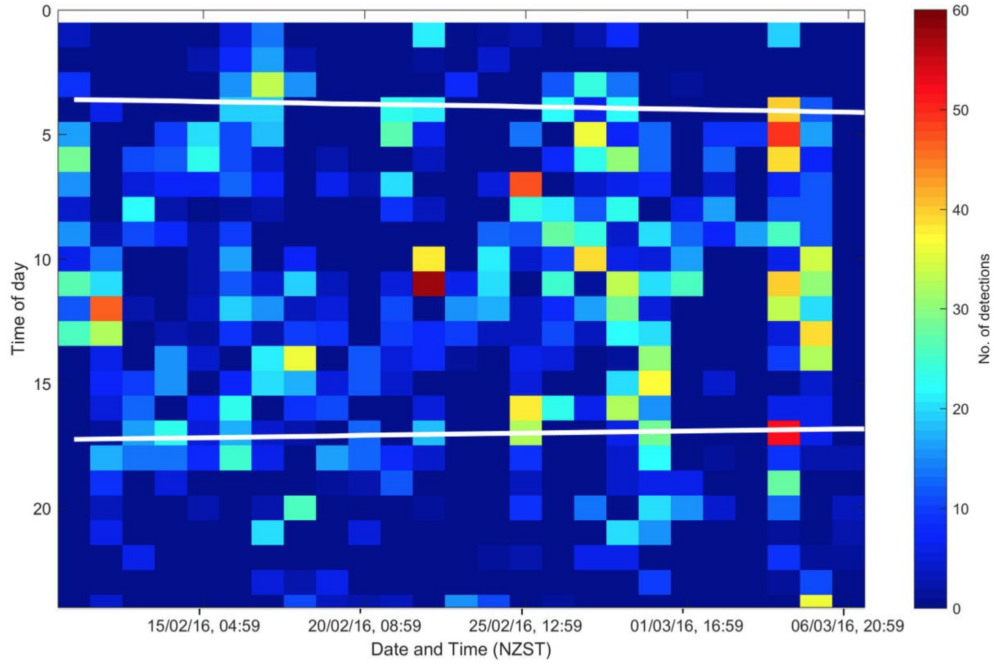

Fig. 4: Detection positive minutes (DPM) for high quality NBHF clicks from the 10/02/2016 00:59 NZST to the 06/03/2016 23:59 NZST at Hamilton's Gap C-POD (HG1). Upper white line represents sunrise time and lower white line represents sunset time over the study period.

The highest daily total of detected positive minutes of NBHF was on the 03/03/16, with over 400 detections (Fig. 5). The amount of detections appears to increase gradually during the study period; from February to early March 2016 (Fig. 5). There was also no apparent relationship between moon phase and NBHF detections.

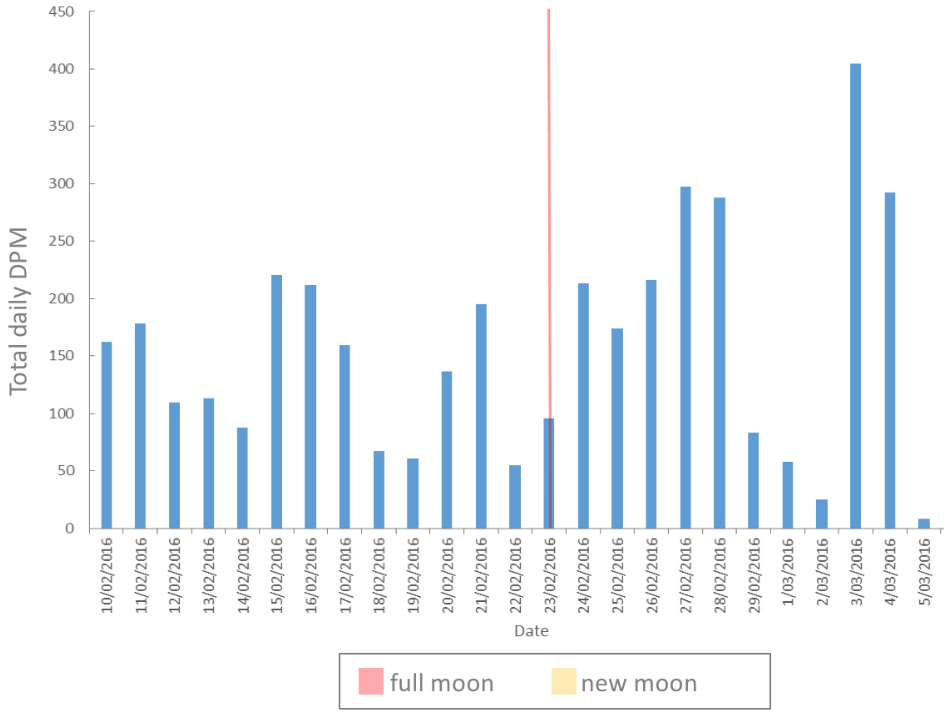

Fig. 5: Total amount of daily NHBF detection positive minutes (DPM) at the Hamilton's Gap CPOD location from 10/02/2016 00.59 NZST to 05/03/2016 24:0023:59 NZST.

Manukau Harbour

M2 / Mooring Two:

Overall, the M2 C-POD had the greatest number of detection positive minutes. The highest single detection positive minutes was 8 DPM, which was recorded on the 31/07/17 at 22:59 NZST and also on the 03/08/2017 at 04:59 NZST (Fig. 6). These values contribute to a cluster of high number of detections from the middle of July to early August (Fig. 6 and 7). From the middle of August to early October there were very low numbers of detections (Fig. 6 and 7). Also, most of the detections were recorded during the night (Fig. 6).

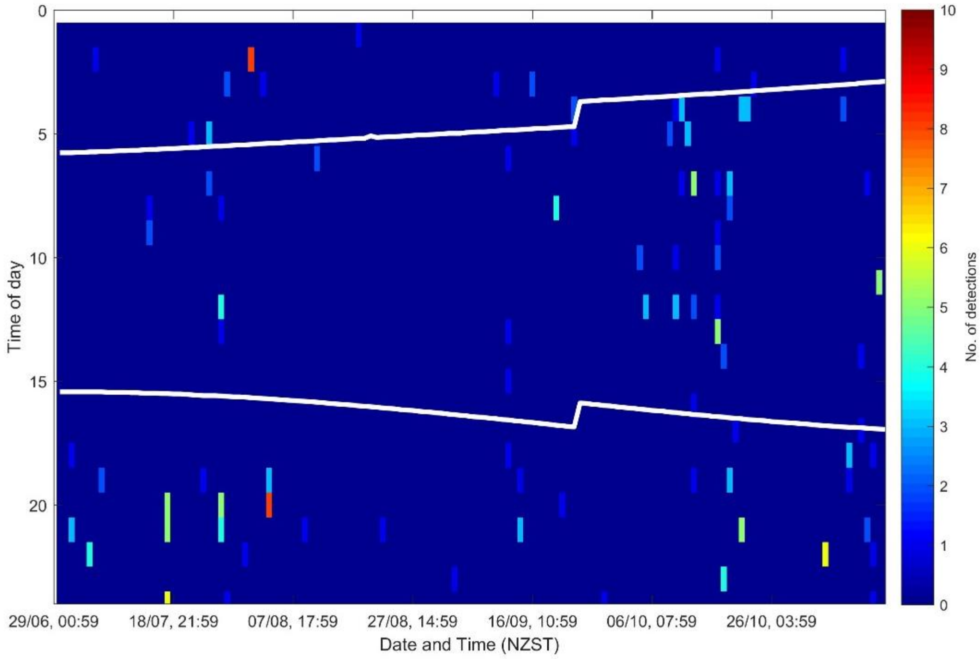

Fig. 6: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring two of Manukau Harbour C-PODs from the 29/06/2017 00:59 NZST to the 14/11/2017 23:59 NZST. Upper white line represents sunrise time and lower white line represents sunset time.

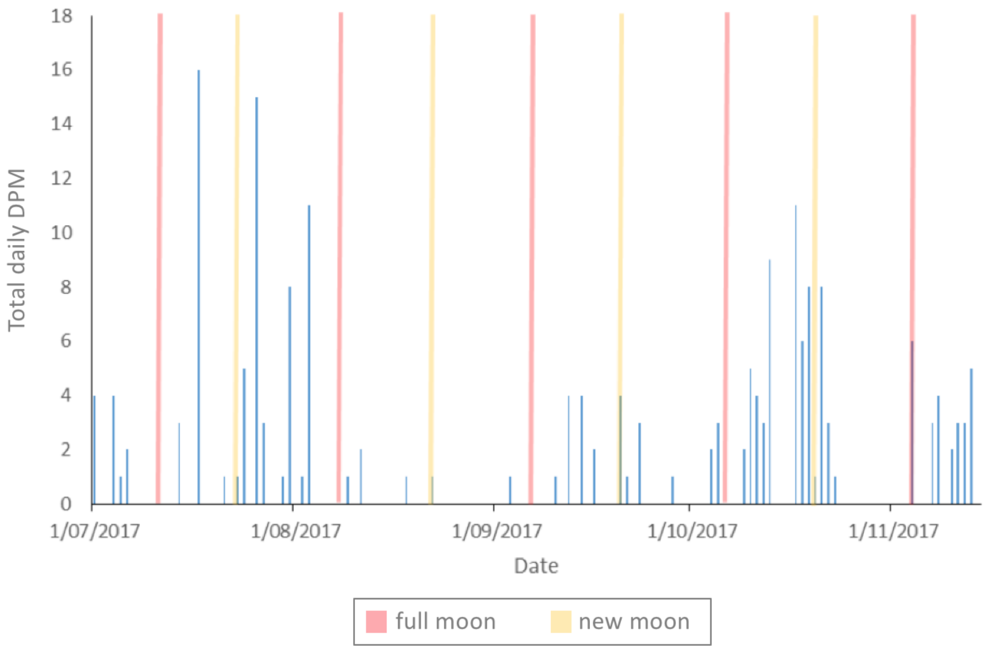

Fig. 7: Total amount of daily high quality NHBF detection positive minutes (DPM) at mooring location number two dating from 01/07/2017 00.00 NZST to 14/11/2017 23:59 NZST.

M3 / Mooring Three:

The highest detection positive minutes was recorded on the 19/10/2017 at 20:59 NZST (Fig. 8). There were no detections made from early August to early September (Fig. 8 and 9). Like site M2, the majority of the detections were recorded during the night (Fig. 8).

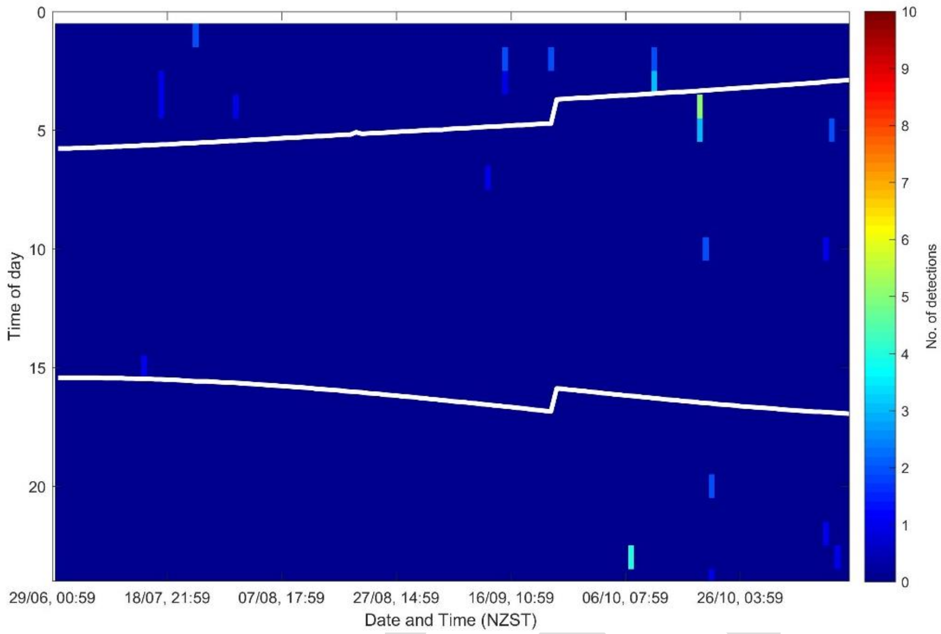

Fig. 8: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring three of Manukau Harbour C-PODs from the 29/06/2017 00:00 NZST to the 14/11/2017 23:59 NZST. Upper white line represents the sunrise time and lower white line represents sunset time.

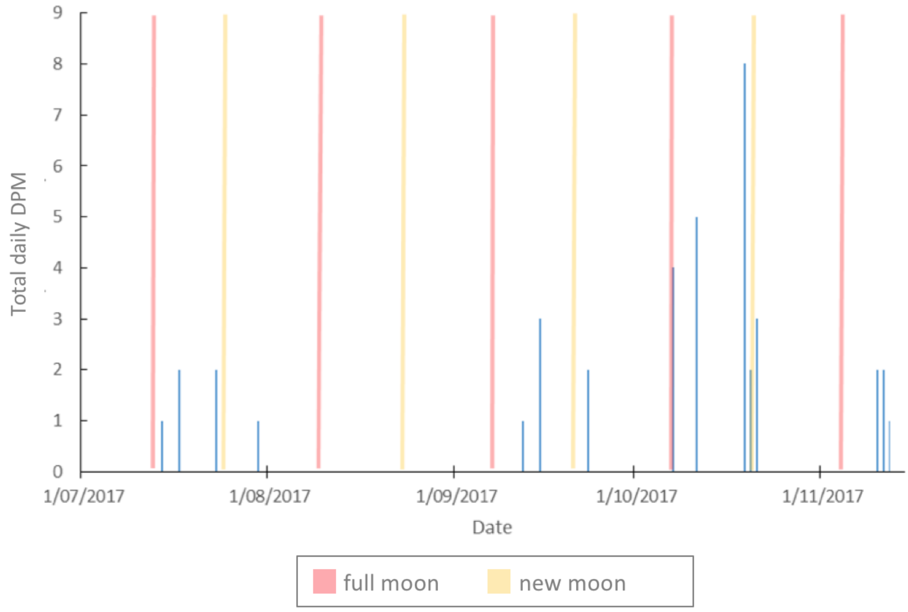

Fig. 9: Total amount of daily high quality NHBF detection positive minutes (DPM) at mooring location number three dating from 01/07/2017 00.00 NZST to 14/11/2017 23:59 NZST.

M4 / Mooring Four:

There were only two detections made at the M4 C-POD, both occurred at night (Fig. 10). There were no detections recorded from the months of June to September (Fig. 10).

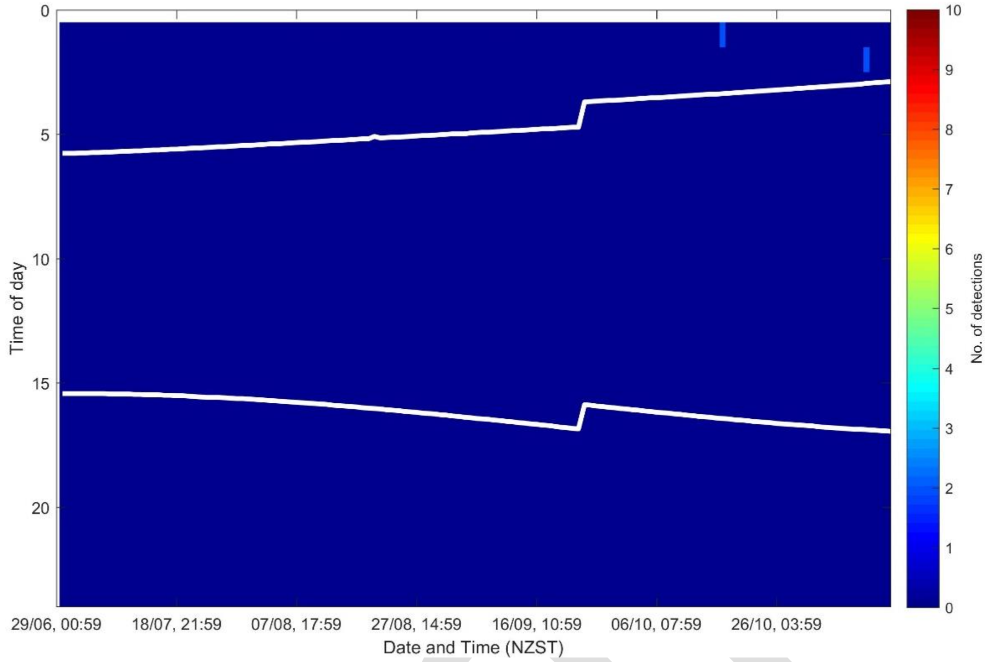

Fig. 10: Detection positive minutes (DPM) for high quality NBHF click trains detected at mooring four of Manukau Harbour C-PODs from the 29/06/2017 00:00 NZST to the 14/11/2017 23:59 NZST. Upper white line represents the sunrise time and lower white line represents sunset time.

M5 – M7 / Mooring Five to Seven:

There were no high quality NHBF detections made by the C-PODs moored at these locations.

Taranaki

There were no high quality NHBF detections made by the C-POD at the Taranaki airport mooring one (see *Appendix B*).

A total of 5 DPM were recorded during the month of January on the C-POD located at the Taranaki mooring two site (Fig. 11, see *Appendix B*).

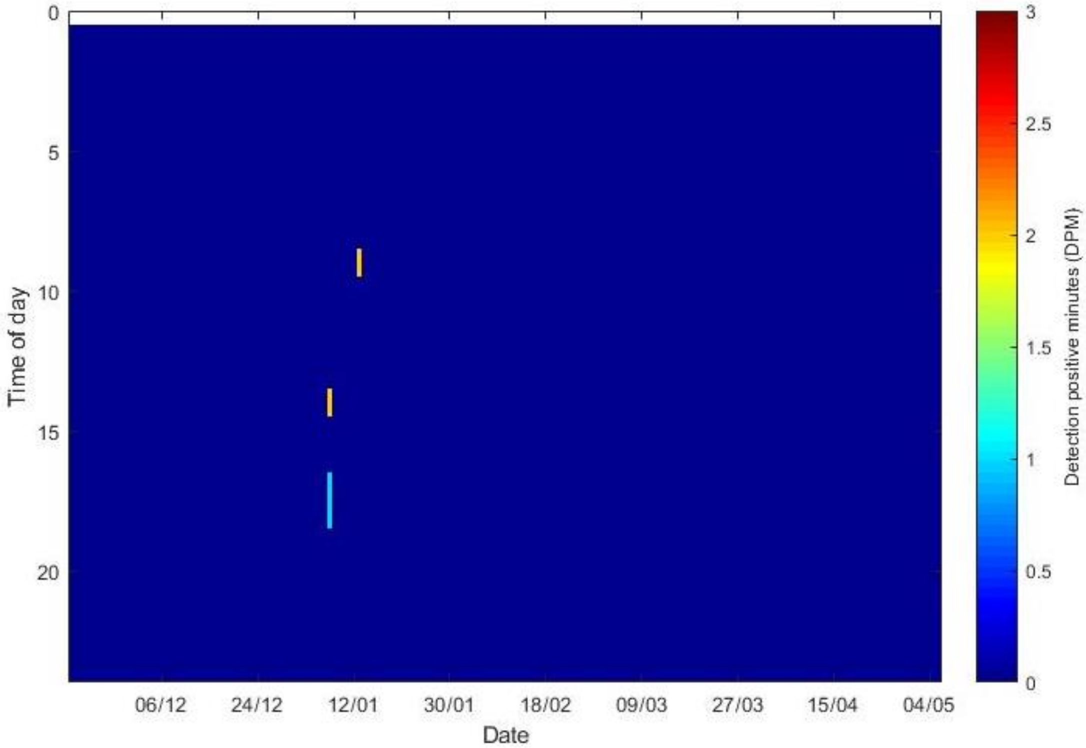

Fig. 11: Detection positive minutes (DPM) for high quality NBHF click trains detected at Taranaki mooring two located offshore from Taranaki from the 29/07/2017 00:00 NZST to the 14/05/2017 23:59 NZST.

Wanganui River

There were no NHBF detections made by the C-POD located at Wanganui river.

High Frequency Sound Trap moored with M2 C-POD

The high frequency sound trap device detected a greater number of clicks than the M2 C-POD for the months of June and July (Fig. 11). There appear to be two peaks of high sound levels from July 14th to 15th and around the 21st July (Fig. 11). During these times the M2 CPOD detected low numbers of clicks, which is similar to the lower numbers of clicks detected by the sound trap (Fig. 11). There seems to be little concern that the sound level affected the C-PODs ability to detect NBHF clicks.

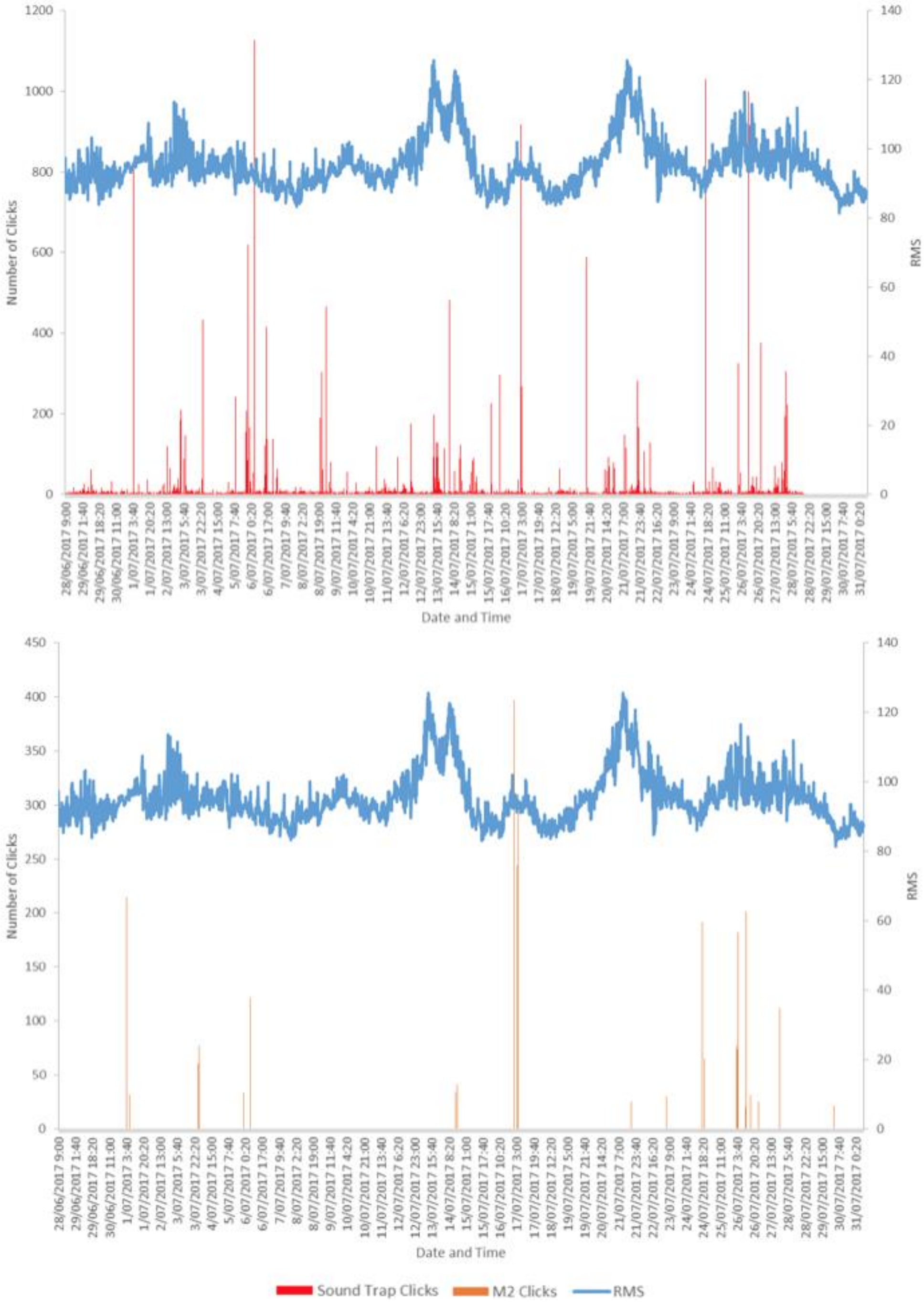

Fig. 12: Number of high quality NBHF clicks detected by C-POD M2 and the high frequency sound trap device, compared to the relative sound level represented as root mean squared (RMS) at mooring two from the 28/06/2017 at 09:00 to the 31/07/2017 at 24:00 NZST.

The high frequency sound trap device at mooring two also appears to have detected a greater number of clicks than the M2 C-POD for the month of August (Fig. 12). Overall there were fewer numbers of clicks detected during this month (Fig. 12). There appears to be little concern that the sound level affected the C-PODs ability to detect NBHF clicks.

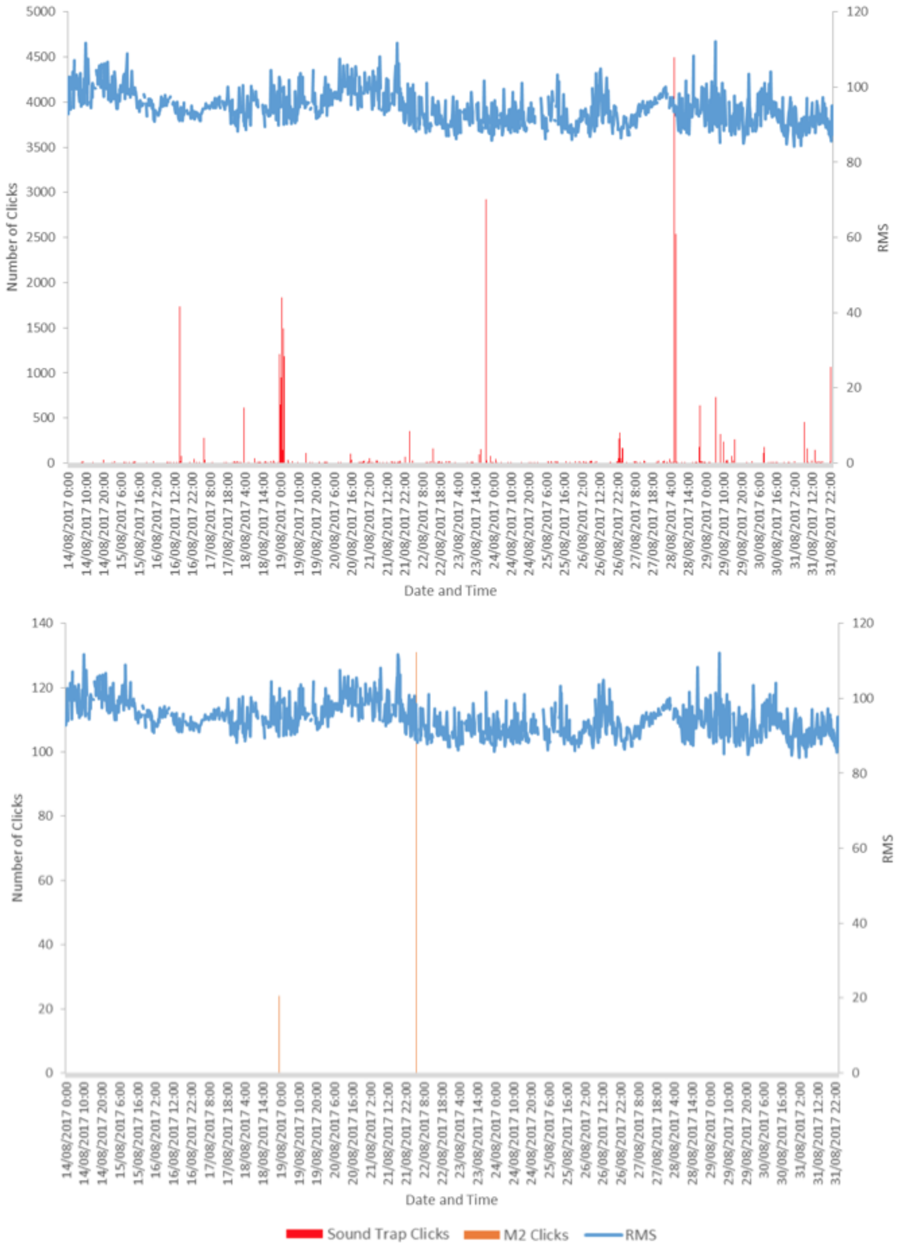

Fig. 13: Number of high quality NBHF clicks detected by C-POD M2 and the high frequency sound trap device, compared to the relative sound level represented as root mean squared (RMS) at mooring two from the 14/08/2017 at 00:00 to the 31/09/2017 at 24:00 NZST.

The high frequency sound trap at mooring two also appears to have detected a greater number of clicks then the M2 C-POD for the month of September (Fig. 13). During times of higher sound levels, from around the 7th to the 11th of September, the sound trap is picking up a significantly greater number of clicks compared to the C-POD (Fig. 13). This indicates that the sound level may have affected the C-POD's ability to detect these high amounts of clicks in the region at this time. Outliers have been removed from the sound trap detections where they exceeded 4000 clicks.

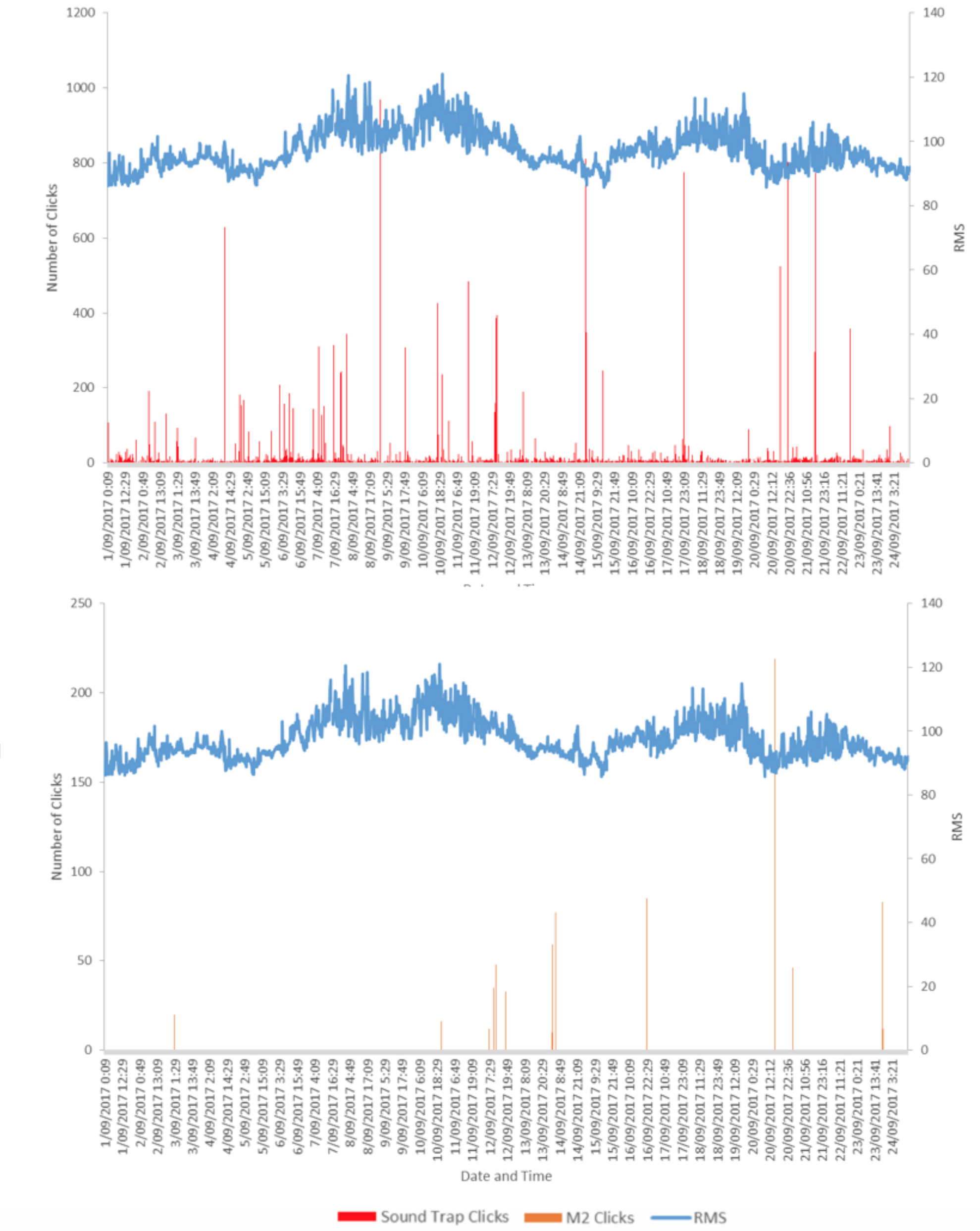

Fig. 14: Number of high quality NBHF clicks detected by C-POD M2 and the high frequency sound trap device, compared to the relative sound level represented as root mean squared (RMS) at mooring two from the 01/09/2017 at 00:09 to the 24/09/2017 at 04:09 NZST.

Discussion

Current research on Māui dolphin distribution is limited. However, previous studies have given some insight into the 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. One of these high density areas is reflected in the research presented in this report, with the Hamilton's Gap C-POD and M2 C-POD showing significantly higher Māui detections compared to all the other sites. If NBHF detections represent numbers of Māui dolphins then the high abundance of detections near Hamilton's Gap indicates that this region is an area of high density. This confirms that Māui dolphin are more commonly found in coastal areas, indicating that they may have high use of the harbours within their range.

Another aim of this research was to determine the extent of their range offshore. This research indicated that the maximum distance offshore that Māui dolphin are found is 14 km. Since there were no detections found at either the Taranaki C-POD or the Wanganui C-POD this indicates that the southern limits if their range of their range is also much less than expected.

At the Hamilton's Gap C-POD there was a large amount of detections made during day time hours. In all of the Manukau Harbour C-PODs there tended to be more detections made during night time hours as compared to the day. This may indicate a diurnal pattern, where Māui dolphin inhabit more coastal waters during day time hours and move out towards more offshore locations during night time hours. However, more research is needed in this area to better understand this pattern to determine whether it is significant and possible reasons for this behavioural movement.

Limitations:

The results of this study is very dependent on NBHF detections being Māui dolphins. Given that there are no other known high frequency animals found in this area 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 B)*. The C-PODs that had NBHF detections all were in various states of being off the vertical axis. When taking into consideration the angle of the C-POD, this decreases the reliability of the data gained in this study. However, the general trends with the Hamilton's Gap C-POD having the highest amount of detections and the decreasing amounts of detections in the Manukau Harbour C-PODs with increasing distance offshore, should remain the same. More research needs to be carried out to determine how much of an effect is created when the C-POD is sitting at 0 degrees.

A further limitation, particularly to Hamilton's Gap C-POD, was that it was difficult to accurately classify species due to the high background sound levels. There were many clicks trains that the KERNO classifier had labelled as NBHF but upon verification it was found that these detections had very high bandwidths and very low number of N cycles. This lead me to think it may have been another dolphin species or that there was inference from another source. In classifying such detections, it came down to personal judgement. Approximately 30% of the NBHF detections had these unusually high bandwidths and low number of N cycles.

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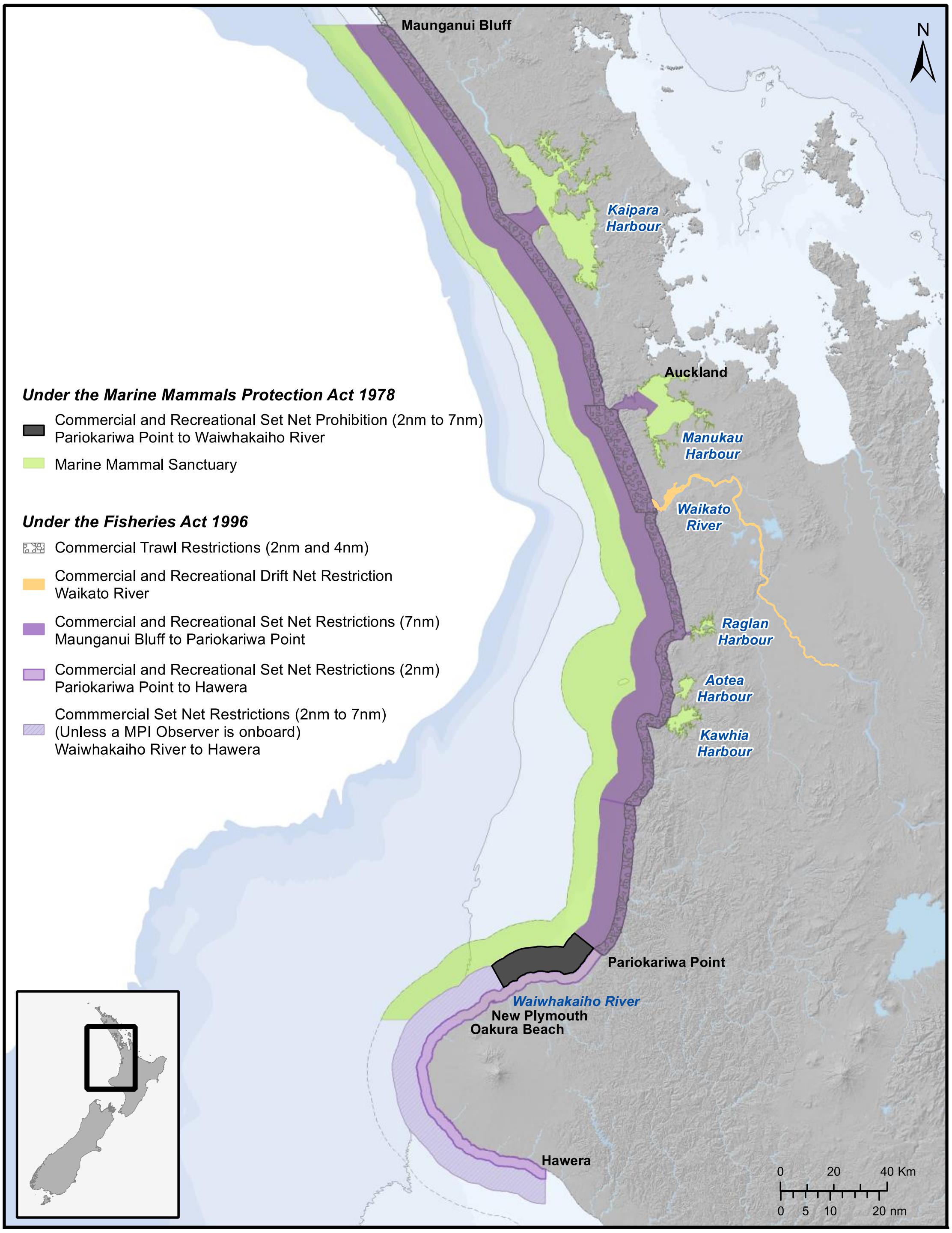
Appendix A: Protection measures under the Marine Mammals Protection Act 1978 and the Fisheries Act 1996 along the West Coast of the North Island, New Zealand (Department of Conservation 2017b).



Appendix B: Summary data for Hamilton's Gap, Manukau Harbour, Taranaki airport and Wanganui river C-PODs.

CPOD 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
Hamilton's Gap(0.91km)	HG1 / POD2721	37.11687	174.5513	61,928	31,667,561	102	2,445	38.57	79d 17h 19m	25d 7h 56m	22C	12	1934
1 (1.9km)	M1	-37.148	174.564	-	-	-	-	-	-	-	-	-	-
2 (8.0km)	M2 / POD2714	-37.161	174.483	10,001	4,584,595	2.16	52	1.01	193d 22m	193d 21m (99%)	16C	31	380
3 (10.1km)	M3 / POD2715	-37.165	174.459	1,816	5,313,358	0.39	9.40	0.20	193d 2h 11m	193d 2h 10m (99%)	16C	33	75
4 (12.1km)	M4 / POD2716	-37.169	174.436	150	32,771,702	0.03	0.78	0.02	193d 2h 24m	193d 2h 23m (99%)	16C	30	3
5 (14.1km)	M5 / POD2722	-37.173	174.413	27	31,888,354	0.01	0.15	0.01	180d 21h 28m	180d 21h 27m (99%)	15C	22	1
6 (16.1km)	M6 / POD1796	-37.177	174.390	0	74,431,350	0.00	0.00	0.00	191d 7h 44m	191d 7h 43m (99%)	14C	25	0
7 (18.2km)	M7 / POD1797	-37.181	174.366	0	21,254,665	0.00	0.00	0.00	105d 5h 31m	105d 5h 30m (99%)	13C	29	0
8 (19.9km)	M8	-37.185	174.343	-	-	-	-	-	-	-	-	-	-
9 (2.8km)	M9	-37.150	174.552	-	-	-	-	-	-	-	-	-	-
Taranaki Airport (M1)	POD2721	Data not available	Data not available	0	63,745,369	0	0	0	123d 8m	101d 3h 11m	17C	1	0
Taranaki (M2)	Unknown	Data not available	-	-	--	-	-	-	-	-	-	-	-
Wanganui River	POD2719	Data not available	Data not available	0	4,347,236	0	0	0	95d 23h 21m	95d 15h 29m (99%)	18C	12	0