Estimating the abundance and effective population size of Maui's dolphins using microsatellite genotypes: Report on the 2020 biopsy sampling survey

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SUMMARY

Here, we report on the first year of a two-year project intended to replicate the 2010-2011 and 2015-2016 genotype mark-recapture surveys of Māui dolphins. From the 11th – 27th February 2020, we conducted a total of 11 small-vessel surveys along the west coast of the North Island from south Kaipara in the north to the Mokau River, Taranaki in the south. During 1,569.5km of survey effort we encountered a total of 26 groups of Māui dolphins, with an average of 2.4 groups per day (ranging from 0-5 groups per day). Group sizes ranged from 1-9 dolphins (average of 3.7-4.2 dolphins using minimum and maximum estimates). Dolphins were encountered between South Kaipara and south of Port Waikato. A total of 50 biopsy samples were collected (ranging from 0-14 samples per day; average of 4.5 per day). Consistent with previous years, the dolphins showed little behavioural response following the biopsy event. There were 47 samples of 30 individual Māui dolphins (haplotype G) and three samples of two Hector's dolphins; including a female (haplotype Jb) first identified in 2010, and a male (haplotype Ca) not previously sampled. Including this newly identified male, we now have four live Hector's dolphins associated with Māui dolphins. Further analysis will be undertaken once the 2021 field season is complete and these data will be used to generate a new abundance estimate.

INTRODUCTION

Māui dolphins, a sub-species of the endemic Hector's dolphin, are listed by the IUCN as Critically Endangered and Nationally Critical in New Zealand (Baker et al. 2019). The recent 2015-2016 abundance estimate (Baker et al. 2016) and subsequent analysis allowing for mortality (Cooke et al. 2018), alongside a larger assessment of the status of Māui and Hector's dolphins (Roberts et al. 2019a, 2019b) provided our most comprehensive understanding of the conservation measures required to protect this sub-species. But this work also highlighted gaps in knowledge. Capture-recapture analyses have proven to be a powerful method for estimating the abundance of cetaceans. However, the usual methods of individual identification using photographic documentation of natural markings are inefficient for Māui dolphins, which show few distinctive, long-term marks on their dorsal fin (Garg 2017). Instead, individual identification using DNA profiling or microsatellite genotyping is the most effective method for capture-recapture estimates of abundance.

This study is the first year of a two-year project intended to replicate the 2010-11 and 2015-16 surveys; representing the "capture" phase of the mark-recapture estimate. The biopsy samples will also allow us to confirm whether Hector's dolphins are present among Māui dolphins as revealed in previous surveys (Hamner et al. 2014; Baker et al. 2016). All surveys were conducted using the same protocols reported in Baker et al. (2016).

EFFORT

Coastal boat surveys on the DOC vessel *Tuatini* were undertaken from the 11th to 27th February 2020 (Figure 1). During this time, 11 surveys were conducted along the west coast of the North Island from south Kaipara in the north to Mokau River in the south (Table 1). As per previous surveys, effort was concentrated alongshore with occasional transects offshore in locations with historically higher numbers of dolphin sightings (Hamilton's Gap, Cochrane's Gap, Karioitahi Beach, Port Waikato) in order to maximise the success of group encounters. The boat was launched from two different locations: Clarks Beach, Manukau Harbour with dedicated survey effort starting at Cornwallis (n = 8) and Raglan wharf (n = 3), surveying to the north and south of these locations.

In total, 88 hours and 47 minutes were spent on the water and a distance of 1,569.5 km was covered on the *Tuatini*. Weather conditions were good overall, with most surveys conducted in a Beaufort 1-2 sea state although the conditions ranged from Beaufort 1-4.

Research team was as follows:
Skippers: Garry Hickman, Pearson Tukua and Cara Hansen (DOC)
Biopsy samplers: Mike Ogle and Callum Lilley (DOC)
Photographers: Lily Kozmian-Ledward (UoA), Rochelle Constantine (UoA) and Cara Hansen (DOC)
Data recorders: Callum Lilley, Kristina Hillock, Garry Hickman, Pearson Tukua, Dannika Tukua (DOC), Rochelle Constantine and Emma Carroll (UoA)

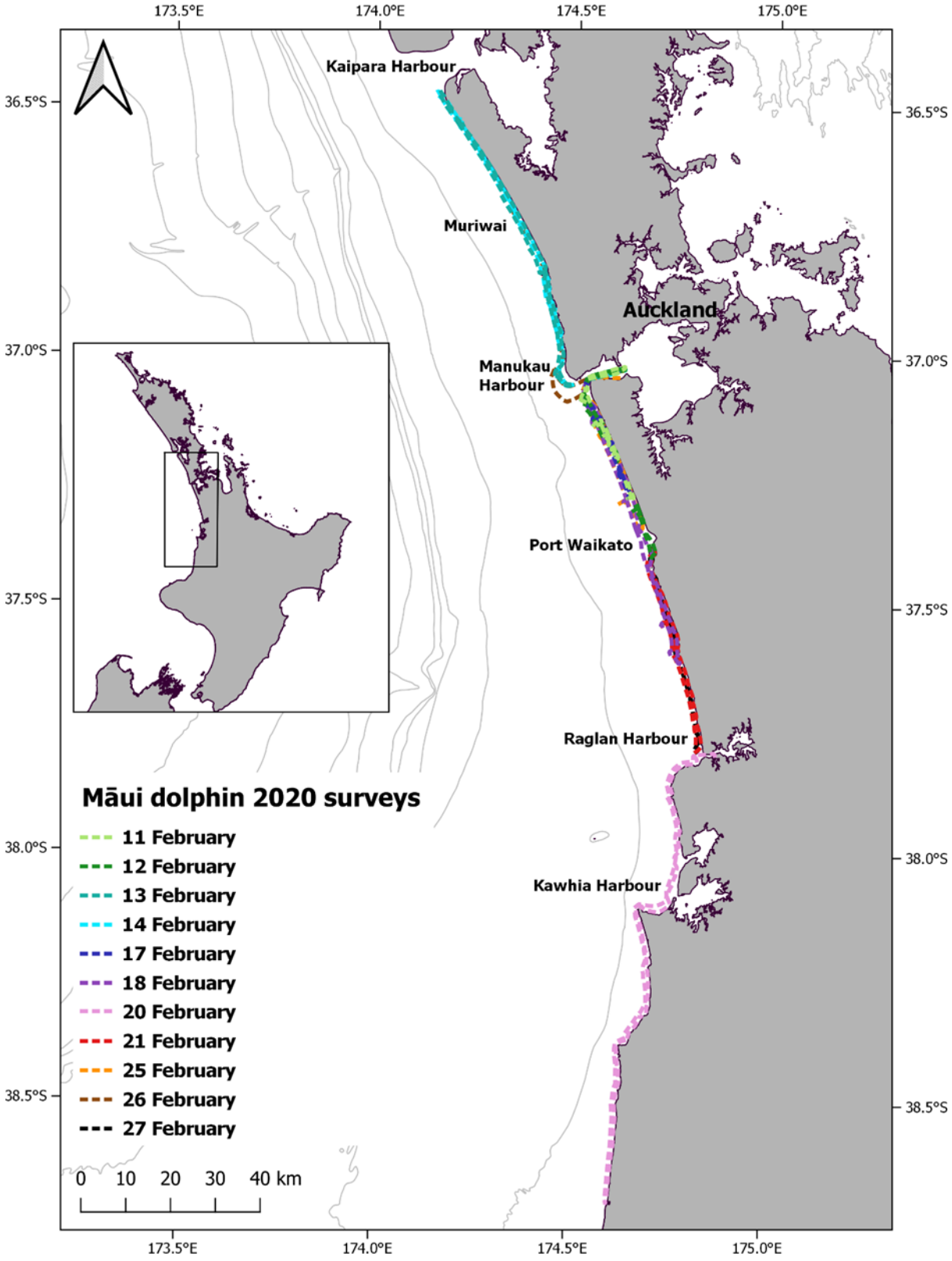

Figure 1. Map of the study area and GPS tracks for the 11 surveys conducted between the 11th and 27th February 2020. See Table 1 for further information.

Table 1. Summary of boat surveys conducted along the west coast, North Island between the 11th and 27th February 2020.

	Date	Location	Launch	Time start	Time end	Time on water hh:mm	Distance km	# groups	# biopsies
1	11-Feb-20	Manukau South	Cornwallis	8:40	15:21	6:41	98.8	1	1
2	12-Feb-20	Manukau South	Cornwallis	8:48	16:36	7:48	123.6	2	7
3	13-Feb-20	Manukau North	Cornwallis	7:38	16:41	9:03	186.5	4	7
4	14-Feb-20	Manukau North	Cornwallis	7:08	17:29	10:21	195.6	3	6
5	17-Feb-20	Manukau South	Cornwallis	8:30	16:46	8:16	93.5	5	14
6	18-Feb-20	Manukau South	Cornwallis	7:45	18:00	10:15	185.5	3	4
7	20-Feb-20	Raglan South	Raglan	7:00	16:30	9:30	244	0	0
8	21-Feb-20	Raglan North	Raglan	8:00	14:50	6:50	106.5	2	3
9	25-Feb-20	Manukau South	Cornwallis	7:30	13:59	6:29	99.6	3	1
10	26-Feb-20	Manukau North	Cornwallis	7:03	13:57	6:54	126.4	0	0
11	27-Feb-20	Raglan North	Raglan	9:30	16:10	6:40	109.5	3	7
				Total		88:47	1,569.5	26	50
				Average		8:07	142.7	2.4	4.5

GROUP ENCOUNTERS

We encountered a total of 26 groups of Māui dolphins during the surveys (Figure 2, Table 2), with an average of 2.4 groups encountered per survey (range = 0-5 groups per survey). We encountered Māui dolphins on nine of the 11 surveys conducted (82%). The dolphins were mainly found in the core area between Cochrane's Gap and Hamilton's Gap just south of the Manukau Harbour entrance and Karioitahi Beach but there were clusters of sightings south of South Kaipara and south of Port Waikato (Figure 2).

Group sizes ranged from 1-9 dolphins with an average of 3.7 – 4.2 dolphins per group (using the minimum and maximum group estimates based on visual counts) (Table 2). The maximum sighted during a survey was 23 dolphins (17 February). Calves (i.e., individuals approximately one-half or less the size of an adult) accounted for 1.03% (n = 1; range 0-1 calves/group) and juveniles (i.e., individuals approximately two-thirds the size of adults) accounted for 11.3% (n = 11; range 0-3) of all dolphins sighted. Calves and juveniles were found in 3.8% (n = 1) and 30.8% (n = 8) of groups respectively. We spent an average of 30 minutes with dolphin groups for a cumulative total of 13 hours 22 minutes with dolphins across all surveys.

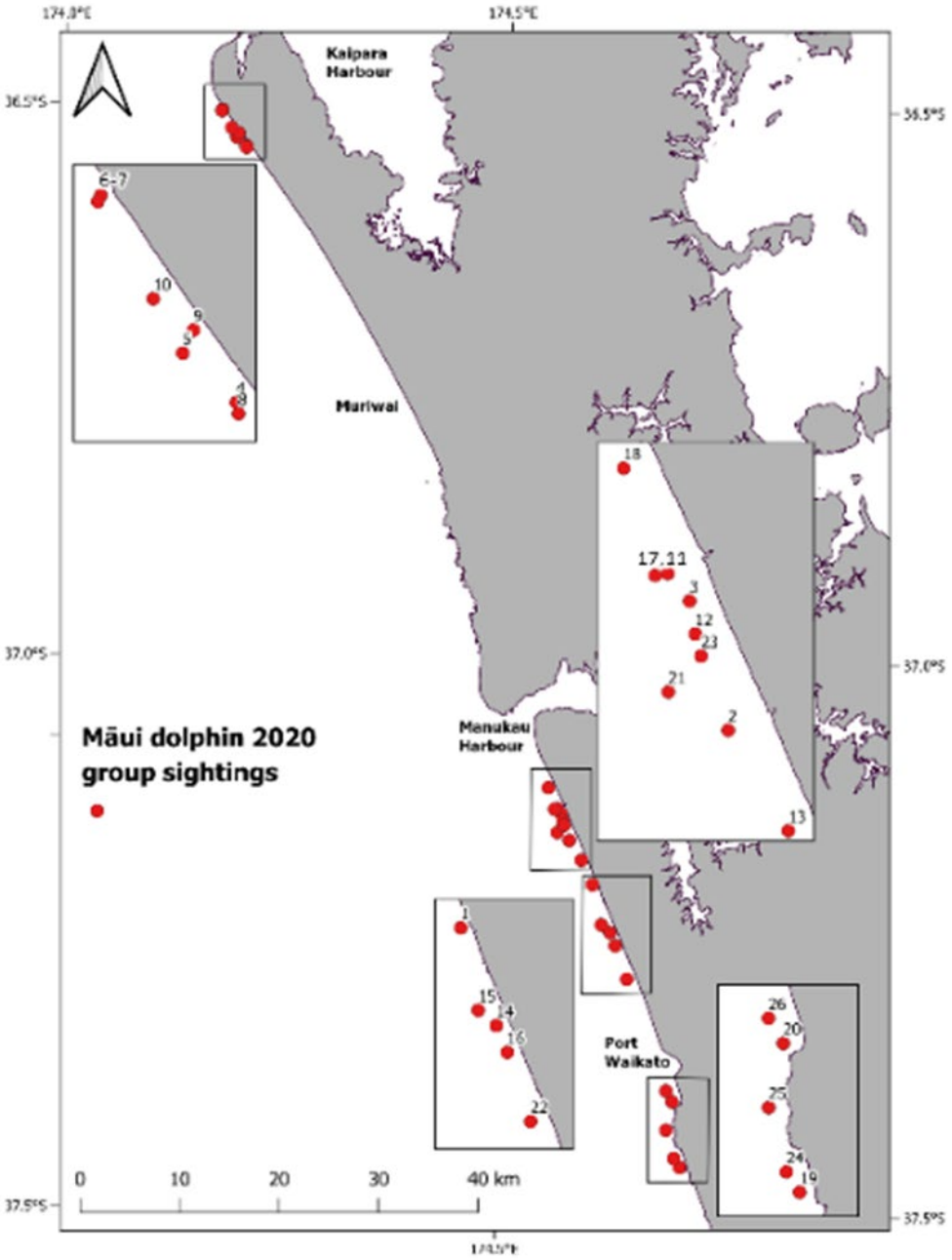

Figure 2. The geographic positions of group encounters (n = 26) between the 11th and 27th February 2020. Inserts show group numbers in areas of higher density sightings (see Table 2 for further information).

Table 2. Summary of dolphin group encounters between the 11th and 27th February 2020.

		Position start		Group size		Number	Time with dolphins
Gp #	Date	Latitude	Longitude	Min	Max	calves/ juvs	hh:mm
1	11-Feb-20	-37.2029	174.6049	2	3	0/0	0:15
2	12-Feb-20	-37.1629	174.5778	6	9	0/0	1:06
3	12-Feb-20	-37.1396	174.5685	5	5	0/0	0:32
4	13-Feb-20	-36.5379	174.2025	3	3	0/0	0:18
5	13-Feb-20	-36.5302	174.1918	3	3	0/0	0:18
6	13-Feb-20	-36.5054	174.1754	4	4	0/0	0:12
7	13-Feb-20	-36.5064	174.1748	6	7	0/0	0:09
8	14-Feb-20	-36.5396	174.2029	3	3	0/1	0:44
9	14-Feb-20	-36.5265	174.1939	6	8	0/0	0:52
10	14-Feb-20	-36.5217	174.1859	4	4	0/0	0:18
11	17-Feb-20	-37.1346	174.5635	3	3	0/1	1:03
12	17-Feb-20	-37.1455	174.57	8	8	1/3	0:49
13	17-Feb-20	-37.181	174.5919	6	6	0/0	0:26
14	17-Feb-20	-37.2458	174.6255	4	4	0/0	0:17
15	17-Feb-20	-37.2391	174.6154	1	2	0/0	0:11
16	18-Feb-20	-37.2576	174.6318	3	3	0/0	1:10
17	18-Feb-20	-37.135	174.5607	6	6	0/2	0:35
18	18-Feb-20	-37.1156	174.5531	3	3	0/1	0:32
19	21-Feb-20	-37.4575	174.7091	4	4	0/0	1:14
20	21-Feb-20	-37.3984	174.6996	1	1	0/0	0:11
21	25-Feb-20	-37.1561	174.5641	2	2	0/1	0:13
22	25-Feb-20	-37.2879	174.6455	2	2	0/0	0:14
23	25-Feb-20	-37.1495	174.5714	2	2	0/0	0:23
24	27-Feb-20	-37.4495	174.7023	4	5	0/1	0:29
25	27-Feb-20	-37.4241	174.6929	5	7	0/1	0:42
26	27-Feb-20	-37.3886	174.692	1	2	0/0	0:09
			Total	97	109	1/11	00:30
			Average	3.7	4.2		13:22

BIOPSY SAMPLING

A total of 50 biopsy tissue samples were collected using the Paxarms™ dart and veterinary capture rifle. Samples were collected on all nine surveys during which dolphins were encountered (Table 1) with sampling reflecting the location of group encounters (Figure 3, Table 3). Skin samples were labelled in the field, transferred to vials filled with 90% ethanol and then stored at -20°C at the New Zealand Cetacean Tissue Archive curated at the University of Auckland.

All (n = 50) biopsy events had a category I (startle response, dolphin moved away (flinch) but stayed in the immediate vicinity of the boat) behavioural reaction to the sample being taken (Table 3) using the categories described in Krützen et al. (2002). Attempts were made to photo-identify dolphins at the same time as they were sampled. The photographs are undergoing final reconciliation with the genetic data to ensure correct assignment of individual sampled and photo-identified. As reported in previous research, dolphins that were biopsied usually re-approached the boat within a short time period (Oremus et al. 2012, Baker et al. 2016). Throughout the encounter, the researchers checked individuals approaching the boat for previous biopsy marks to minimise re-sampling during the encounter.

DNA profiling using mitochondrial DNA sequencing and sex-PCR (as described in Baker et al. 2016) showed that all 50 samples yielded sufficient DNA for analysis (Table 3). Of the 50 samples, there were 47 samples of 30 individual Māui dolphins (haplotype G) and three samples of two individual Hector's dolphins (Table 3). There were 15 Māui dolphins sampled during previous surveys (2001 – 2016) and represent re-captures in 2020, and 15 newly sampled individuals. The three Hector's dolphin samples comprise two samples of one male dolphin (haplotype Ca, sample numbers Chem20NZ42 and Chem20NZ45) collected on different days; this is a newly identified individual. The other Hector's dolphin sample (Chem20NZ23) is of a female with the haplotype Jb, a recapture of an individual sampled in 2010, 2011 and 2015 (Hamner et al. 2014, Baker et al. 2016). This newly identified male increases the total to four live Hector's dolphins (two male and two female) associated with Māui dolphins since 2010. There is no evidence that the sampled dolphins have a Māui dolphin parent and a Hector's dolphin parent (i.e., a hybrid dolphin). Further analysis of microsatellite data will be conducted to identify individuals for the 2021 genotype mark-recapture abundance estimate.

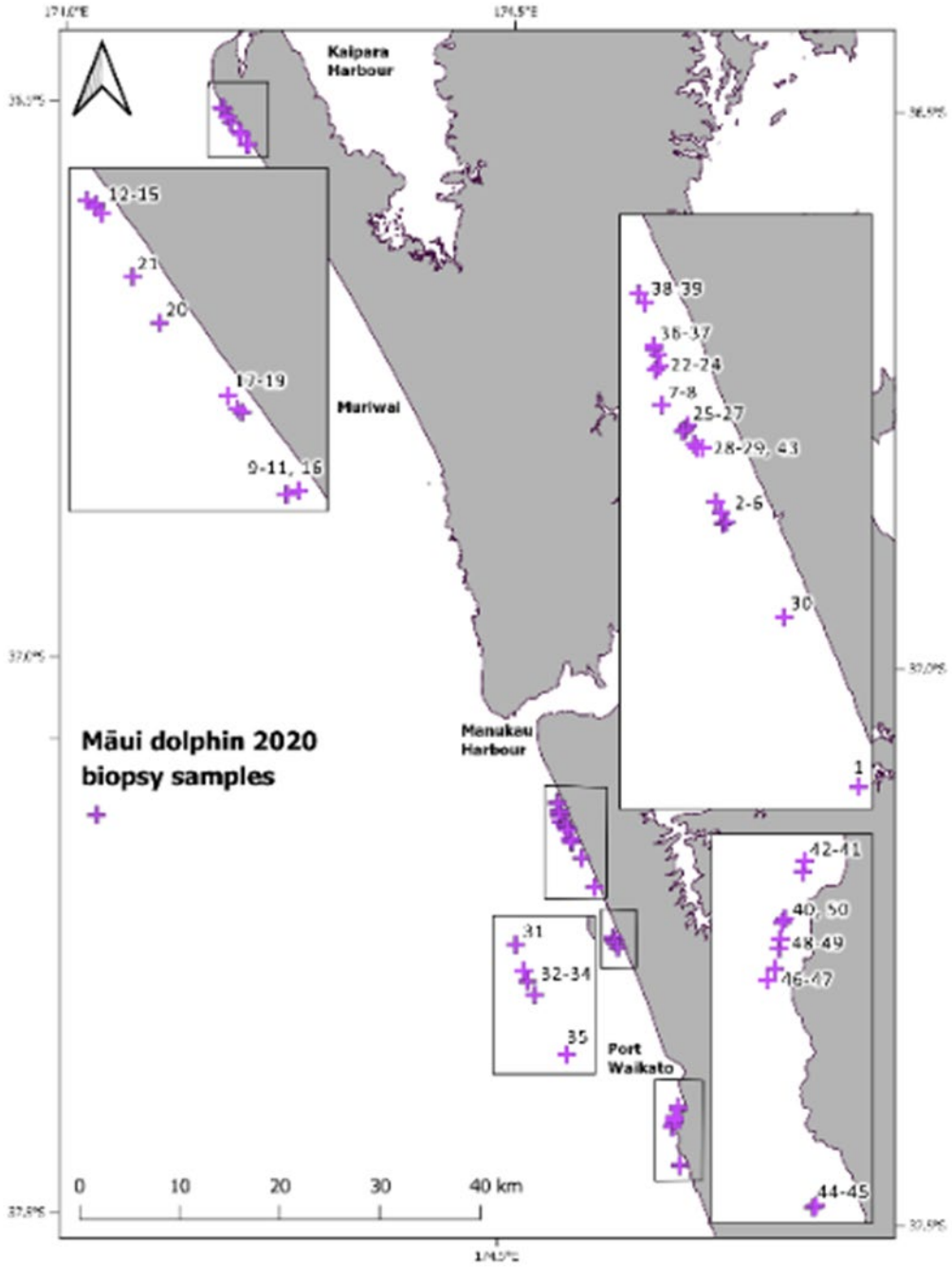

Figure 3. The geographic positions of biopsy samples (n = 50) between the 11th and 27th February 2020. Inserts show biopsy numbers in areas of higher density sampling (see Table 3 for further information).

Table 3. Summary of the Māui dolphin skin sample collection, short-term reactions to biopsy sampling and sex of individuals (M = male; F = female).Three samples with * denote individuals identified as Hector's dolphins. All others are Māui dolphins.

	Sample code	Date	Group #	Latitude	Longitude	Reaction type	Sex
1	Chem20NZ01	11-Feb-20	1	-37.2012	174.6039	1	F
2	Chem20NZ02	12-Feb-20	2	-37.1623	174.5772	1	F
3	Chem20NZ03	12-Feb-20	2	-37.1606	174.5768	1	F
4	Chem20NZ04	12-Feb-20	2	-37.1604	174.5773	1	F
5	Chem20NZ05	12-Feb-20	2	-37.1589	174.5764	1	F
6	Chem20NZ06	12-Feb-20	2	-37.1573	174.5754	1	F
7	Chem20NZ07	12-Feb-20	3	-37.1424	174.5645	1	M
8	Chem20NZ08	12-Feb-20	3	-37.1424	174.5645	1	M
9	Chem20NZ09	13-Feb-20	4	-36.5379	174.2025	1	F
10	Chem20NZ10	13-Feb-20	4	-36.5379	174.2025	1	F
11	Chem20NZ11	13-Feb-20	4	-36.5379	174.2025	1	F
12	Chem20NZ12	13-Feb-20	6	-36.5054	174.1749	1	F
13	Chem20NZ13	13-Feb-20	6	-36.505	174.1749	1	M
14	Chem20NZ14	13-Feb-20	6	-36.5046	174.1737	1	F
15	Chem20NZ15	13-Feb-20	7	-36.5061	174.1758	1	F
16	Chem20NZ16	14-Feb-20	8	-36.5374	174.2041	1	F
17	Chem20NZ17	14-Feb-20	9	-36.5267	174.194	1	M
18	Chem20NZ18	14-Feb-20	9	-36.5285	174.196	1	M
19	Chem20NZ19	14-Feb-20	9	-36.5282	174.1954	1	M
20	Chem20NZ20	14-Feb-20	10	-36.5184	174.1842	1	M
21	Chem20NZ21	14-Feb-20	10	-36.5133	174.1802	1	M
22	Chem20NZ22	17-Feb-20	11	-37.1346	174.5635	1	F
23	Chem20NZ23*	17-Feb-20	11	-37.1364	174.5639	1	F
24	Chem20NZ24	17-Feb-20	11	-37.137	174.5632	1	M
25	Chem20NZ25	17-Feb-20	12	-37.1454	174.5695	1	M
26	Chem20NZ26	17-Feb-20	12	-37.1461	174.5691	1	F
27	Chem20NZ27	17-Feb-20	12	-37.1465	174.5687	1	M
28	Chem20NZ28	17-Feb-20	12	-37.1483	174.5709	1	M
29	Chem20NZ29	17-Feb-20	12	-37.149	174.5714	1	M
30	Chem20NZ30	17-Feb-20	13	-37.175	174.5889	1	F
31	Chem20NZ31	17-Feb-20	14	-37.2458	174.6255	1	F
32	Chem20NZ32	17-Feb-20	14	-37.248	174.6263	1	F
33	Chem20NZ33	17-Feb-20	14	-37.2488	174.6267	1	F
34	Chem20NZ34	17-Feb-20	14	-37.2499	174.6275	1	F
35	Chem20NZ35	17-Feb-20	14	-37.2548	174.6309	1	F
36	Chem20NZ36	18-Feb-20	17	-37.1337	174.5627	1	M
37	Chem20NZ37	18-Feb-20	17	-37.1332	174.5627	1	M
38	Chem20NZ38	18-Feb-20	17	-37.1252	174.5596	1	F
39	Chem20NZ39	18-Feb-20	17	-37.1265	174.5609	1	F
40	Chem20NZ40	21-Feb-20	19	-37.4062	174.6986	1	M

41	Chem20NZ41	21-Feb-20	19	-37.3991	174.7018	1	M
42	Chem20NZ42*	21-Feb-20	20	-37.3974	174.7021	1	M
43	Chem20NZ43	25-Feb-20	23	-37.1489	174.5725	1	F
44	Chem20NZ44	27-Feb-20	24	-37.4496	174.7049	1	F
45	Chem20NZ45*	27-Feb-20	24	-37.4494	174.7054	1	M
46	Chem20NZ46	27-Feb-20	25	-37.4155	174.6955	1	F
47	Chem20NZ47	27-Feb-20	25	-37.4137	174.6968	1	F
48	Chem20NZ48	27-Feb-20	25	-37.4107	174.6976	1	F
49	Chem20NZ49	27-Feb-20	25	-37.4093	174.6977	1	M
50	Chem20NZ50	27-Feb-20	25	-37.4068	174.698	1	F

DISCUSSION

The 2020 field season was able to match the efforts from 2010-11 and 2015-16 seasons allowing some consistency in the third of this series of genetic mark-recapture surveys. The number of surveys, duration of the survey period and coverage of the primary known habitat for Māui dolphins was comparable. We collected more samples than previous surveys spanning broad coverage of the known range of the Māui dolphins and providing a robust platform for the genotype capture-recapture estimate for completion in 2021. The dolphins were mainly found in the core of their range just south of the Manukau Harbour entrance to Karioitahi Beach, but there were clusters of dolphins south of the Kaipara Harbour and south of Port Waikato. Despite mainly excellent sighting conditions on a southern survey to Mokau, no dolphins were encountered.

We encountered fewer groups in total (n = 26, average 2.4/ trip) than previous surveys but similar to 2011 (2.5 groups/ trip). The average group size (3.7- 4.2 individuals) similar to 2011 (4 individuals) but slightly smaller than other years (~4.5 - 6 individuals). As previously reported (Baker et al. 2016), there are slightly higher average group sizes than reported previously (e.g., 1.43 in Slooten et al. (2006), 1.31. in Rayment & Du Fresne (2007) and 1.2 in Childerhouse et al. (2008)) which may be driven by social aggregations (Constantine 2019).

The cumulative total of dolphins sighted on a single survey (23) was similar to 2011 (18 dolphins) but lower than other years (e.g., 2010 = 48 and 2016 = 36), a fluctuation reflected in other measures of the population such as group size and composition. There was only one calf sighted (3.8% of groups) and one or more (maximum = 3) juveniles were encountered in eight groups (30.8%); noting these are cumulative counts. The number of calves and juveniles fluctuates considerably from year to year but with small group sizes and experienced observers, we are confident that we accurately account for these non-adult individuals.

Dolphin reactions to biopsy sampling events continue to be mild and similar to responses reported in previous surveys (Oremus et al. 2012, Baker et al. 2016). Preliminary DNA analysis of the biopsy data showed that of the 50 samples, 47 were Māui dolphins and three were from Hector's dolphins. Two samples were a re-capture of a newly identified male six days apart (haplotype Ca, a common haplotype from the South Island, in particular the east coast). The female Hector's dolphin (haplotype Jb, originating from the west coast, South

Island) has been associated with Māui dolphins since 2010 (Hamner et al., 2014, Baker et al. 2016). Detailed analysis of bi-parentally inherited microsatellite data has reconciled the 2020 samples to previous years. This has revealed 15 dolphins previously identified, including one male first sampled in 2001. All molecular identification data will be reconciled with the photo-identification data to identify individuals using both methods where possible, and this analysis is being finalised over the next few months.

ACKNOWLEDGEMENTS

Many thanks to Garry Hickman for his hard mahi managing the boat surveys, Cara Hansen and Pearson Tukua for skippering the boat during these long surveys; Cara Hansen for arranging the logistics and Kristina Hillock for ensuring we had the support needed to undertake these surveys. Thanks to the dedicated field team collecting samples, data and photographs - Emma Carroll, Cara Hansen, Kristina Hillock, Lily Kozmian-Ledward, Callum Lilley, Mike Ogle, Dannika Tukua and Pearson Tukua. Many thanks to Emma Carroll and Laura Zantis for extracting the DNA and Leena Riekkola for plotting the data. We are grateful for the support of iwi and thank DOC Waikato for their ongoing support with this mahi.

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