Estimating the abundance of Māui dolphins using microsatellite genotypes: Report on the 2015 biopsy sampling survey with initial result of individual identity

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SUMMARY

Here, we update our previous report (28 May 2015) on the first year of a two-year project intended to replicate the 2010-2011 genotype mark-recapture surveys of Māui dolphins. From the 12th February to 1st March 2015, we conducted a total of 12 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 1,655 km of survey effort we encountered a total of 44 groups of Māui dolphins, with an average of 3.8 groups per day (ranging from 0-10 groups per day). Group sizes ranged from 1-12 dolphins (average of 5.0-5.8 dolphins) with calves accounting for 3.2% (n = 7) of all individuals sighted. Dolphins were encountered between Kariotahi Beach and Cochrane's Gap, south of the Manukau Harbour entrance. A total of 48 biopsy samples were collected of which 47 were of sufficient quality for DNA profiling. All the sampled dolphins were assumed to be over the age of one year, based on relative size. Dolphins showed little or no behavioural response to the biopsy sample; this is comparable to previous years. Matching of DNA profiles (mtDNA haplotype, sex and 21 microsatellite loci) showed that the 47 samples represented 40 individual dolphins, 13 males and 27 females ($p = 0.034$). Of these 40 individuals, 38 were identified as Māui dolphins and two as Hector's dolphins, based on diagnostic differences in mtDNA haplotypes and a genotype assignment procedure. One of the Hector's dolphins was a female sampled in 2010 and 2011. The other, a male, has not been sampled previously.

INTRODUCTION

Māui dolphins, a sub-species of the endemic Hector's dolphin, are listed by the IUCN as critically endangered. The recent 2010-2011 abundance estimate and analysis of distribution (Oremus et al. 2012, Hamner et al. 2014a) were valuable tools for the implementation of further conservation measures intended to protect this sub-species. Capture-recapture analyses have proven to be a powerful method for estimating the abundance of cetaceans.

For Māui dolphins, however, the usual method of photo-identification using natural markings is limited by the low percentage of individuals with distinctive scars or notches on their dorsal fins. This reduces the precision of capture-recapture estimates. Instead, individual identification using DNA profiling or microsatellite genotyping is increasingly used to undertake capture-recapture estimates of abundance.

This study is the first year of a two-year project intended to replicate the 2010-11 surveys; representing the "capture" phase of the capture-recapture estimate. The biopsy samples

will also allow us to confirm whether Hector's dolphins are present among Māui dolphins as revealed in the 2010-11 surveys (Hamner et al. 2014b). All surveys were conducted using the same protocols reported in Hamner et al. (2012).

EFFORT

Coastal boat surveys on the DOC vessel *Tuatini* were undertaken from the 12th February to 1st March 2015 (Figure 1). During this time, 12 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 (within 1NM from shore), in order to maximise the success of group encounters. The boat was launched from two different locations: Onehunga wharf (n = 9) and Raglan wharf (n = 3), surveying to the north and south of these locations.

In total, 97 hours and 15 minutes were spent on the water and a distance of 1,655 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 with only short periods of the surveys conducted in Beaufort 4.

The research team included:

- Skipper: Garry Hickman (DOC).
- Biopsy sampler: Scott Baker (OSU-UoA).
- Photographers: Lily Kozmian-Ledward (UoA), Sahar Izadi (UoA), Rochelle Constantine (UoA), Scott Baker (OSU-UoA).
- Data recorders: Will Arlidge (DOC), Rochelle Constantine (UoA), Evan Cameron (DOC), Laura Boren (DOC), Yuin Kai Foong (DOC), Melissa King-Howell (DOC)

Table 1. Boat surveys conducted along the west coast, North Island between the 12th February to 1st March 2015.

	Date	Location	Launch	Time start	Time end	Time on water	Distance km	# groups	# biopsies
1	12-Feb	South Manukau	Onehunga	8:45	16:49	8:04	81	5	7
2	13-Feb	South Manukau	Onehunga	7:45	18:30	10:45	131	7	7
3	14-Feb	South Manukau	Onehunga	7:12	14:55	7:43	70	5	9
4	15-Feb	North Manukau	Onehunga	8:10	16:20	8:10	195	0	0
5	16-Feb	North Manukau	Onehunga	7:45	18:30	10:45	194	0	0
6	17-Feb	South Manukau	Onehunga	7:15	19:15	12:00	168	5	14
7	20-Feb	South Raglan	Raglan	8:40	18:13	9:33	226	0	0
8	21-Feb	North Raglan	Raglan	9:02	15:09	6:07	133	0	0

9	22-Feb	Raglan	Raglan	9:05	15:10	6:05	143	0	0
10	27-Feb	South Manukau	Onehunga	7:54	18:03	10:09	125	7	9
11	28-Feb	South Manukau	Onehunga	7:55	16:05	8:10	124	7	2
12	1-Mar	South Manukau	Onehunga	8:00	13:42	5:42	65	10	0
					Total	97:15	1,655	46	48
					Average	8:36	137.9	3.8	4.0

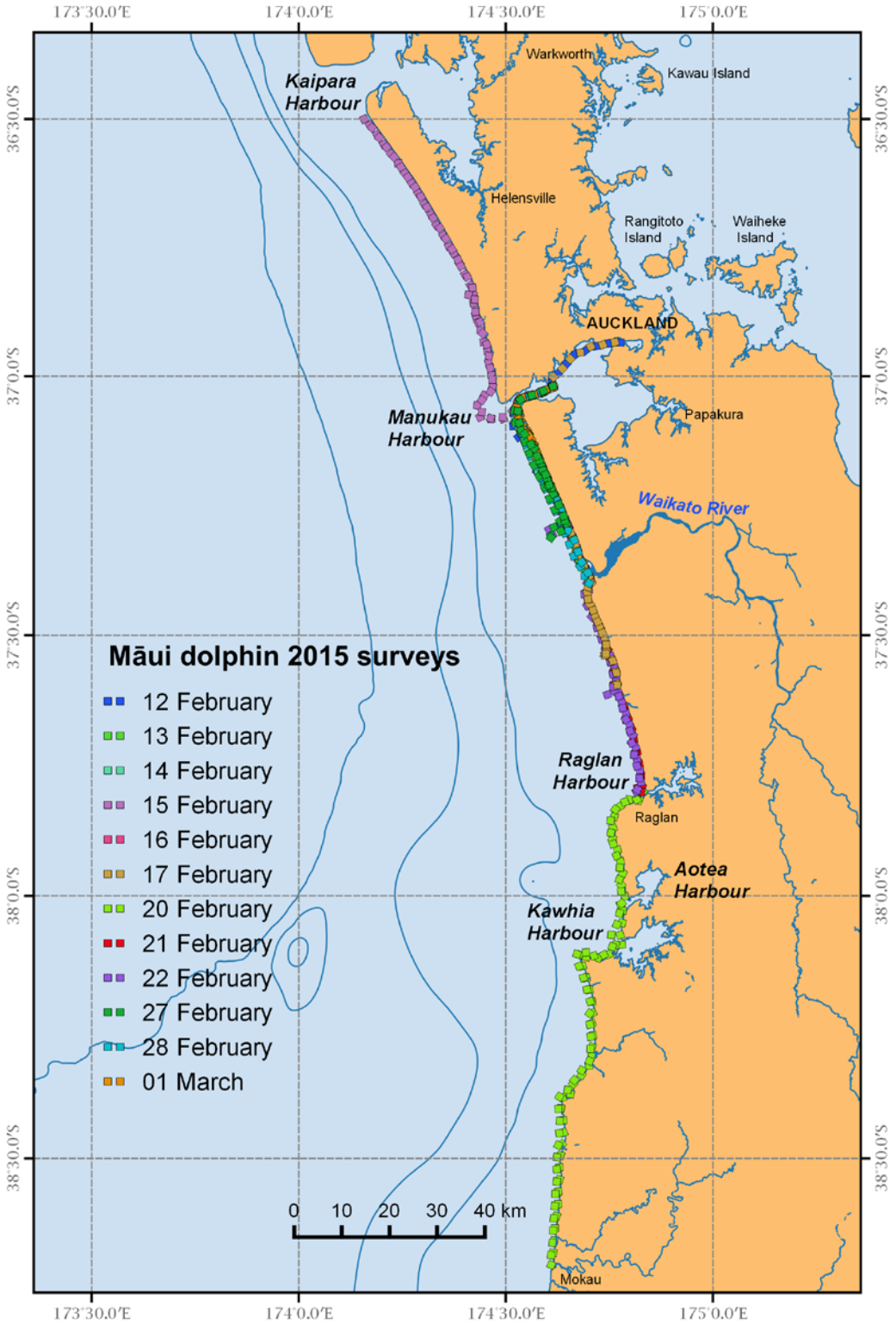

Figure 1. Map of the study area and GPS tracks for the 12 surveys. NB: The tracks for the 15th and 16th February are overlaid on each other.

GROUP ENCOUNTERS

We encountered a total of 44 groups of Māui dolphins during the surveys (Table 2, Figure 2), with an average of 3.8 groups encountered per survey (range = 0-10 groups per survey). We encountered Māui dolphins on seven of the 12 surveys conducted (58%). There was one primary area of dolphin concentration; between Cochrane's Gap and Hamilton's Gap just south of the Manukau Harbour entrance. Despite excellent sighting conditions, there were no sightings north of the Manukau Harbour or south of Kariotahi Beach (Figure 2).

Group sizes ranged from 1-12 dolphins with an average of 5.0-5.8 dolphins per group (using the minimum and maximum group estimates based on visual counts) (Table 2). Using the minimum cumulative count (n = 222) that potentially includes multiple sightings within and between day surveys, calves (i.e., individuals approximately one-half or less the size of an adult) accounted for 3.2% (n = 7; range 0-2 calves/group) and juveniles (i.e., individuals approximately two-thirds the size of adults) accounted for 1.8% (n = 4; range 0-2) of all dolphins sighted. Calves and juveniles were found in 13.6% (n = 6) and 4.5% (n = 2) of groups respectively. We spent an average of 20 minutes 46 seconds with dolphin groups for a cumulative total of 23 hours 45 minutes with dolphins across all surveys.

The behavioural state most frequently observed at the beginning of the encounter was milling (54%) with socialising (10%), foraging (7%), traveling (7%) and mixtures of behavioural states also observed (Table 2). In some cases the dolphins' behavioural state changed throughout the encounter, in particular milling would shift to foraging or socialising. As is frequently reported for Māui dolphins, they approached the research vessel during most encounters.

Table 2. Summary of Māui dolphin group encounters from the 12th February to 1st March 2015.

		Position start		Group size		Number calves/	Time w/ dolphins	
Gp #	Date	Latitude	Longitude	Min	Max	juvs	hh:mm	Behav.
1	12-Feb-15	-37.16653	174.5785	3	5	0/0	1:09	mill/rest
2	12-Feb-15	-37.19487	174.5951	2	3	0/0	0:43	mill
3	12-Feb-15	37.2019	174.5947	4	6	1/0	0:48	mill
4	12-Feb-15	-37.16953	174.5826	1	1	0/0	0:10	mill
5	12-Feb-15	-37.09922	174.5413	5	5	1/0	0:41	social
6	13-Feb-15	-37.15222	174.5718	8	8	1/0	0:53	mill/social
7	13-Feb-15	-37.23622	174.6218	5	6	0/0	1:20	forage
8	13-Feb-15	-37.15891	174.5776	5	5	0/0	0:27	forage
9	13-Feb-15	-37.13478	174.5647	6	7	0/2	0:31	?
10	13-Feb-15	-37.0951	174.5372	2	2	0/0	0:01	mill
11	14-Feb-15	-37.1439	174.5679	8	9	0/2	1:15	social
12	14-Feb-15	-37.15448	174.5749	8	10	2/0	0:38	mill
13	14-Feb-15	-37.17945	174.5763	3	3	0/0	0:42	?
14	14-Feb-15	-37.18124	174.5747	2	2	0/0	0:01	mill
15	14-Feb-15	-37.18403	174.5755	4	4	0/0	0:12	mill
16	17-Feb-15	-37.09978	174.5476	10	12	1/0	1:14	trav/soc

17	17-Feb-15	-37.12672	174.5636	7	7	0/0	0:14	mill
18	17-Feb-15	-37.18737	174.5887	9	9	0/0	0:44	travel
19	17-Feb-15	-37.17501	174.5889	8	9	0/0	0:28	social
20	17-Feb-15	-37.10664	174.5484	9	9	0/0	0:21	mill
21	27-Feb-15	-37.28346	174.6448	2	2	0/0	0:12	travel
22	27-Feb-15	-37.19733	174.5992	2	2	0/0	0:44	mill
23	27-Feb-15	-37.18157	174.5899	6	6	0/0	2:13	travel
24	27-Feb-15	-37.21597	174.6044	9	10	0/0	0:55	mill
25	27-Feb-15	-37.2122	174.6032	6	12	0/0	0:42	mill
26	27-Feb-15	-37.1606	174.5799	8	10	0/0	0:35	mill
27	27-Feb-15	-37.1278	174.5616	9	9	0/0	0:39	mill
28	28-Feb-15	-37.2471	174.6268	2	2	0/0	0:01	mill
29	28-Feb-15	-37.2404	174.6240	6	6	0/0	0:42	social/mill
30	28-Feb-15	-37.2128	174.6091	2	3	0/0	0:20	mill
31	28-Feb-15	-37.2081	174.6046	3	3	0/0	0:05	mill
32	28-Feb-15	-37.1647	174.5738	2	2	0/0	0:10	mill
33	28-Feb-15	-37.1345	174.5674	6	6	0/0	0:40	forage
34	28-Feb-15	-37.1292	174.5597	7	7	1/0	0:30	forag/soc
35	1-Mar-15	-37.0957	174.5359	2	2	0/0	0:03	surfing
36	1-Mar-15	-37.1060	174.5476	4	4	0/0	0:22	social
37	1-Mar-15	-37.1157	174.5551	5	6	0/0	0:34	mill
38	1-Mar-15	-37.1242	174.5616	8	8	0/0	0:43	mill
39	1-Mar-15	-37.1493	174.5752	5	8	0/0	0:35	mill
40	1-Mar-15	-37.1656	174.5825	4	4	0/0	0:09	?
41	1-Mar-15	-37.1518	174.5761	4	6	0/0	0:03	slow trav
42	1-Mar-15	-37.1375	174.5684	6	8	0/0	0:06	surfing
43	1-Mar-15	-37.1116	174.5531	3	3	0/0	0:07	mill
44	1-Mar-15	-37.1056	174.5436	2	2	0/0	0:03	fast trav

Total	222	253	7/4	23hr 45min
Average	5.0	5.8		32 min

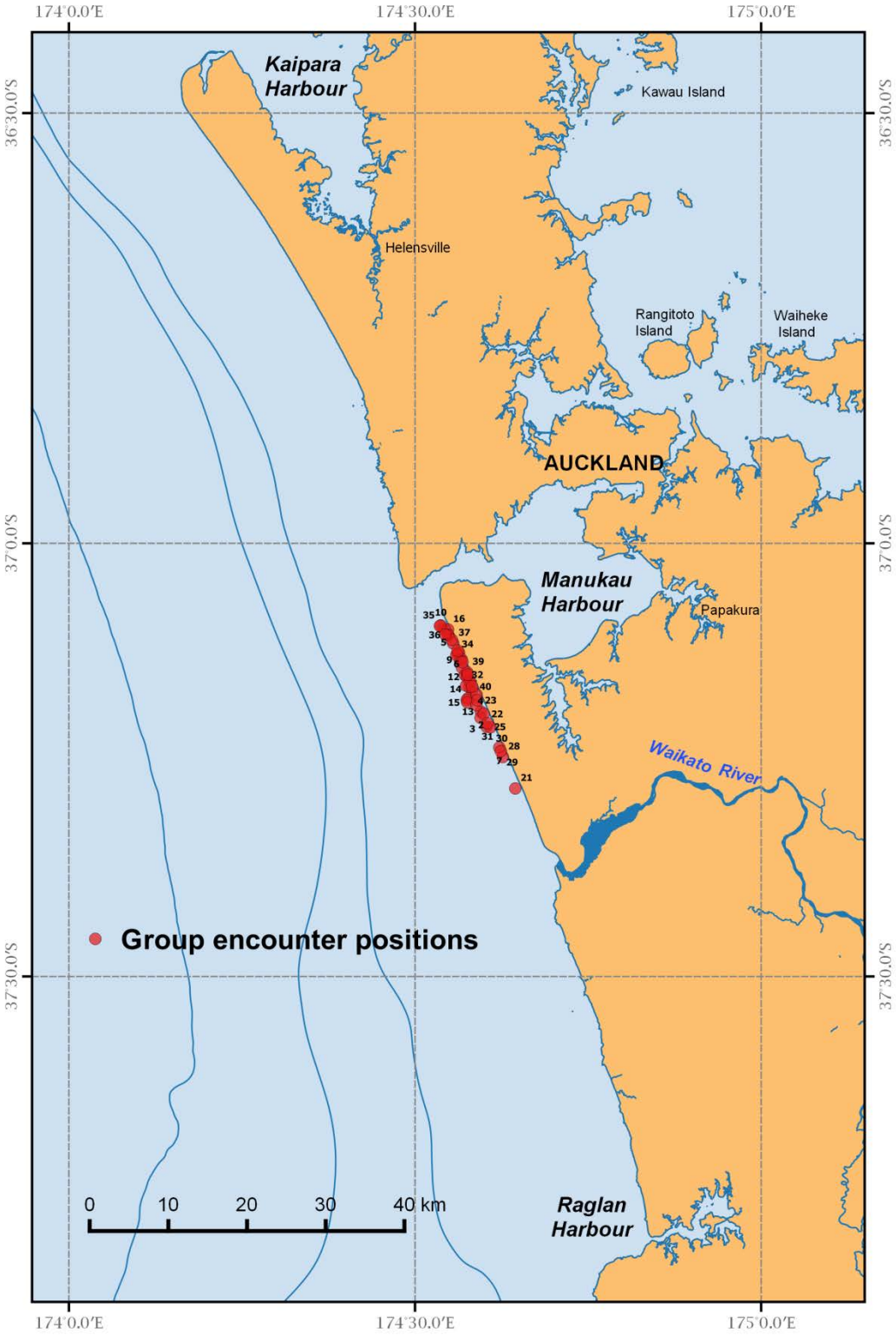

Figure 2. The geographic positions of group encounters (n = 44) from the 12th February to 1st March 2015.

BIOPSY SAMPLING

A total of 48 tissue biopsy samples were collected using the Paxarms™ dart and veterinary capture rifle. Samples were collected on six out of the seven surveys during which dolphins were encountered (Table 1) with sampling reflecting the location of group encounters (Table 3, Figure 3). Skin samples were labelled in the field, transferred to vials filled with 70% ethanol and then stored at -20°C at the University of Auckland's New Zealand Cetacean Tissue Archive. A subsample of each skin biopsy was exported to Oregon State University for DNA extraction and DNA profiling.

The behavioural reactions to biopsy sampling were recorded for the majority of biopsy events (n = 46) and were judged using the categories described in Krützen et al. (2002). Of the 46 reactions 24% (n = 11) were category 0 (no visible reaction) and 76% (n = 35) were category I (startle response, dolphin moved away (flinch) but stayed in the immediate vicinity of the boat) (Table 3). Attempts were made to photo-identify dolphins at the same time as they were sampled. The photographs will be reconciled with the genetic data in further analyses. As reported in previous research, dolphins that were biopsied usually re-approached the boat within a short time period (Oremus et al. 2012). Throughout the encounter, the researchers checked individuals approaching the boat for previous biopsy marks to minimise re-sampling during the encounter.

Table 3. Summary of the Māui and Hector's dolphin skin sample collection, with short-term reactions to biopsy sampling and sex of individuals (M = male; F = female; X = sample failed). Samples CheNI15-04 and CheNI15-08 are Hector's dolphins.

	Sample code	Date	Time	Group #	Latitude	Longitude	Reaction type
1	ChemNI15-01	12-Feb-15	10:32	1	-37.16702	174.57591	1
2	ChemNI15-02	12-Feb-15	10:46	1	-37.16867	174.57298	1
3	ChemNI15-03	12-Feb-15	10:56	1	-37.17007	174.5717	1
4	*CheNI15-04	12-Feb-15	13:19	3	-37.19514	174.5952	1
5	ChemNI15-05	12-Feb-15	15:04	5	-37.09629	174.53978	1
6	ChemNI15-06	12-Feb-15	15:07	5	-37.09658	174.54037	1
7	ChemNI15-07	12-Feb-15	15:12	5	-37.09694	174.54085	1
8	*CheNI15-08	13-Feb-15	9:03	6	-37.15187	174.57288	0
9	ChemNI15-09	13-Feb-15	9:21	6	-37.15285	174.57379	0
10	ChemNI15-10	13-Feb-15	14:29	7	-37.2198	174.60982	0
11	ChemNI15-11	13-Feb-15	14:31	7	-37.21904	174.60991	0
12	ChemNI15-12	13-Feb-15	14:33	7	-37.21557	174.60963	0
13	ChemNI15-13	13-Feb-15	14:44	7	-37.21482	174.60738	0
14	ChemNI15-14	13-Feb-15	16:36	9	-37.14099	174.56859	1
15	ChemNI15-15	14-Feb-15	9:29	11	-37.14323	174.56673	0
16	ChemNI15-16	14-Feb-15	9:34	11	-37.14416	174.56775	1
17	ChemNI15-17	14-Feb-15	9:42	11	-37.14496	174.56761	0
18	ChemNI15-18	14-Feb-15	9:49	11	-37.14646	174.56882	1
19	ChemNI15-10	14-Feb-15	10:05	11	-37.14555	174.56779	0

20	ChemNI15-20	14-Feb-15	10:49	12	-37.15903	174.57652	0
21	ChemNI15-21	14-Feb-15	10:57	12	-37.16249	174.57791	1
22	ChemNI15-22	14-Feb-15	11:19	12	-37.17408	174.57924	1
23	ChemNI15-23	14-Feb-15	11:51	13	-37.18306	174.57988	0
24	ChemNI15-24	17-Feb-15	9:09	16	-37.12299	174.56125	1
25	ChemNI15-25	17-Feb-15	9:09	16	-37.12299	174.56125	1
26	ChemNI15-26	17-Feb-15	9:09	16	-37.12299	174.56125	1
27	ChemNI15-27	17-Feb-15	9:09	16	-37.12299	174.56125	1
28	ChemNI15-28	17-Feb-15	9:09	16	-37.12299	174.56125	1
29	ChemNI15-29	17-Feb-15	9:09	16	-37.12299	174.56125	1
30	ChemNI15-30	17-Feb-15	9:09	16	-37.12299	174.56125	1
31	ChemNI15-31	17-Feb-15	9:09	16	-37.12299	174.56125	1
32	ChemNI15-32	17-Feb-15	9:09	16	-37.12299	174.56125	1
33	ChemNI15-33	17-Feb-15	11:11	16	-37.18737	174.58871	1
34	ChemNI15-34	17-Feb-15	11:11	16	-37.18737	174.58871	1
35	ChemNI15-35	17-Feb-15	11:11	16	-37.18737	174.58871	1
36	ChemNI15-36	17-Feb-15	-	16	-	-	-
37	ChemNI15-37	17-Feb-15	-	16	-	-	-
38	ChemNI15-38	27-Feb-15	11:55	23	-37.18157	174.58987	1
39	ChemNI15-39	27-Feb-15	11:55	23	-37.18157	174.58987	1
40	ChemNI15-40	27-Feb-15	11:55	23	-37.18157	174.58987	1
41	ChemNI15-41	27-Feb-15	11:55	23	-37.18157	174.58987	1
42	ChemNI15-42	27-Feb-15	11:55	23	-37.18157	174.58987	1
43	ChemNI15-43	27-Feb-15	14:08	24	-37.21597	174.60443	1
44	ChemNI15-44	27-Feb-15	14:08	24	-37.18157	174.58987	1
45	ChemNI15-45	27-Feb-15	14:08	24	-37.18157	174.58987	1
46	ChemNI15-46	27-Feb-15	15:44	26	-37.1656	174.58208	1
47	ChemNI15-47	28-Feb-15	13:25	31	-37.20557	174.60368	1
48	ChemNI15-48	28-Feb-15	14:05	33	-37.13339	174.56593	1

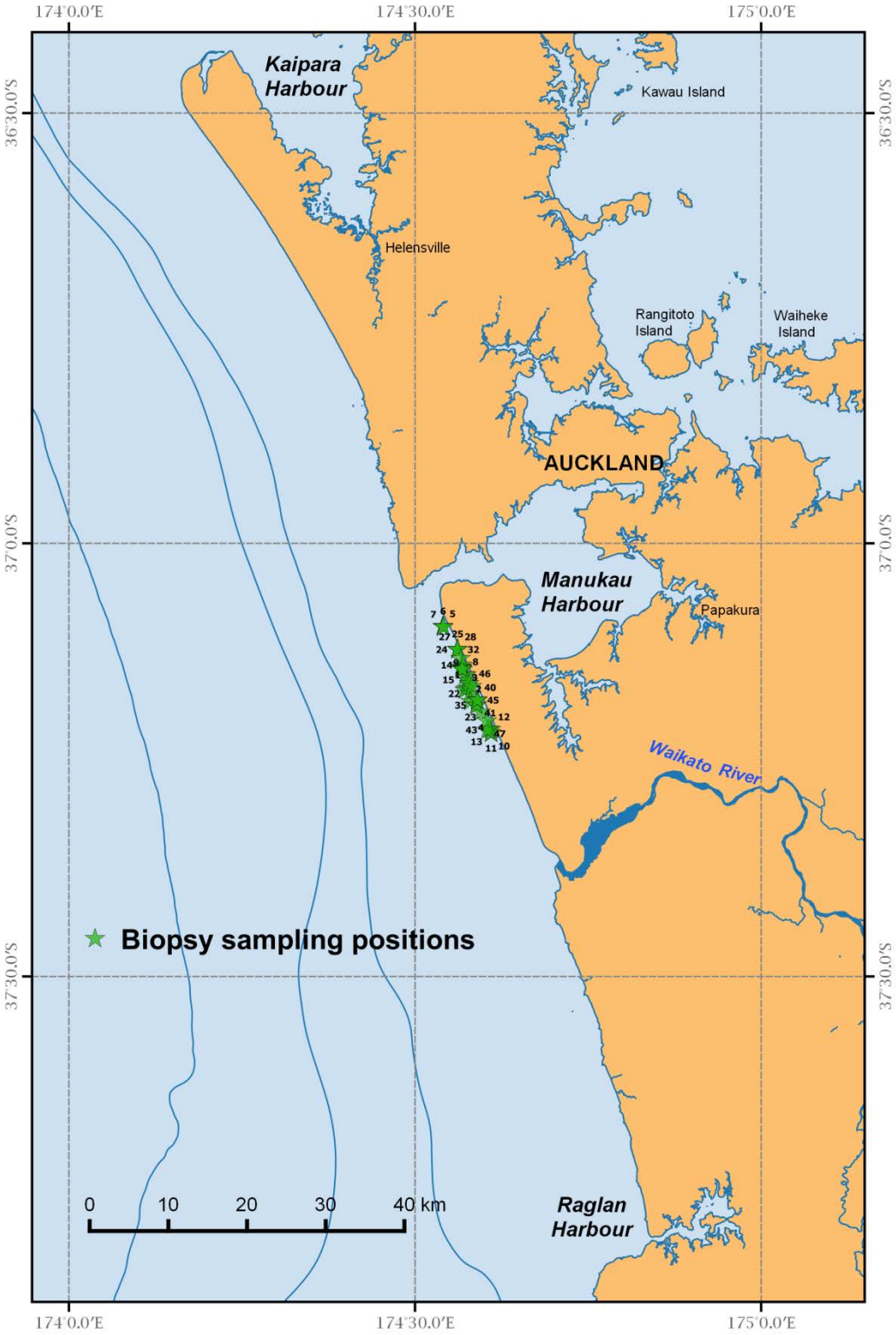

Figure 3. The geographic positions of biopsy samples (n = 48) from the 12th February to 1st March 2015.

DNA PROFILING FOR SUBSPECIES AND INDIVIDUAL IDENTIFICATION

Tissue samples were used for DNA profiling, following the methods described in detail by Hamner et al. (2014b). Of the 48 samples, 47 yielded sufficient DNA for analysis; one sample did not amplify due to the small size of the sample (#3, Table 3). For the 47 samples with adequate DNA, a standard profile included the mtDNA control region haplotype (576 bp in length), sex identification based on a Y-chromosome specific marker and 21 microsatellite loci found to be variable in either Hector's or Māui dolphins (Hamner et al. 2014b). The variability of the microsatellite loci for the 2015 sample was similar to that reported previously (Table 4) and adequate for individual identification with a low probability of identity ($P_{(ID)} = 2.4x10^{-9}$) and reasonably low probability of identity for siblings ($P_{(ID)sib} = 3.1x10^{-4}$).

Within-season matching of the DNA profiles showed the 47 samples represented 40 individuals with a significant female bias (13:27, p = 0.034). Of these, two individuals were sampled three times, three individuals were sampled twice and 35 individuals were sampled only once (Table 4). An initial review of the mtDNA sequences revealed that two of the 40 individuals did not share the 'G' haplotype considered to be diagnostic of the Māui subspecies (Baker et al. 2002) but were, instead, 'Jb' and 'Ca' haplotypes characteristic of Hector's dolphins. Further investigation and matching of microsatellite genotypes, confirmed that these two individuals were Hector's dolphins and that one, a female (see CheNI15-04, Table 4), is a recapture of an individual sampled in 2010 and 2011 (Hamner et al. 2014b). The second Hector's dolphin, a male (see CheNI15-08, Table 4), has not been sampled previously. The female Hector's dolphin (referred to as CheNI10-24 in Hamner et al. 2014b) was previously identified as originating from the west coast of the South Island. Additional analyses are planned to identify the likely regional origin of the male Hector's dolphin.

Table 4: Within-season recapture information for samples collected during the 2015 Maui survey based on DNA profiling. Note, one sample (NI15-03) proved to be of insufficient quality for DNA profiling (denoted by an 'X') and two samples proved to be Hector's dolphins (CheNI15-04 and 08; denoted by an asterix).

Individual	Sex	Hap	12-Feb	13-Feb	14-Feb	17-Feb	27-Feb	28-Feb
ChemNI15-01	F	G	NI15-01					
ChemNI15-02	F	G	NI15-02			NI15-36	NI15-38	
ChemNI15-03	X	X	NI15-03					
*CheNI15-04	F	Jb	NI15-04					
ChemNI15-05	F	G	NI15-05, 06					
ChemNI15-07	F	G	NI15-07					
*CheNI15-08	M	Ca		NI15-08				
ChemNI15-09	F	G		NI15-09				
ChemNI15-10	M	G		NI15-10				
ChemNI15-11	F	G		NI15-11, 13			NI15-42	
ChemNI15-12	F	G		NI15-12				

ChemNI15-14	F	G		NI15-14				
ChemNI15-15	F	G			NI15-15			
ChemNI15-16	F	G			NI15-16			
ChemNI15-17	F	G			NI15-17			
ChemNI15-18	M	G			NI15-18			
ChemNI15-10	F	G			NI15-19			
ChemNI15-20	M	G			NI15-20			
ChemNI15-21	F	G			NI15-21			
ChemNI15-22	F	G			NI15-22			
ChemNI15-23	F	G			NI15-23			
ChemNI15-24	F	G				NI15-24		
ChemNI15-25	F	G				NI15-25, 29		
ChemNI15-26	M	G				NI15-26		
ChemNI15-27	F	G				NI15-27		
ChemNI15-28	F	G				NI15-28		
ChemNI15-30	F	G				NI15-30		
ChemNI15-31	F	G				NI15-31		
ChemNI15-32	F	G				NI15-32		
ChemNI15-33	F	G				NI15-33		
ChemNI15-34	M	G				NI15-34		
ChemNI15-35	M	G				NI15-25		
ChemNI15-37	M	G				NI15-37	NI15-43	
ChemNI15-39	F	G					NI15-39	
ChemNI15-40	F	G					NI15-40	
ChemNI15-41	M	G					NI15-41	
ChemNI15-44	M	G					NI15-44	
ChemNI15-45	M	G					NI15-45	
ChemNI15-46	F	G					NI15-46	
ChemNI15-47	M	G						NI15-47
ChemNI15-48	F	G						NI15-48

DISCUSSION

The 2015 field season was successful in matching the effort of the 2010 and 2011 surveys with a comparable number of surveys, duration of the survey period and coverage of the primary known habitat for Māui dolphins. More importantly for the primary objective of estimating abundance, the 2015 surveys exceeded the previous surveys in the number of individuals identified. In the single season, we identified a total of 40 individuals from 48 samples by comparison to the total of 39 individuals identified from the two combined samples in 2010 (n = 37) and 2011 (n = 36). This minimum census is encouraging and promises to provide a robust basis for the genotype capture-recapture estimate for completion in 2016. Somewhat less encouraging was the notable contraction in the distribution of dolphin encounters in 2015, with the majority found between Cochrane's Gap and Hamilton's Gap just south of the Manukau Harbour entrance.

We encountered a greater average number of groups per survey (3.8) compared with the

previous surveys; 2010 (3.2) and 2011 (2.5). The average group size (5.0-5.8 individuals) was similar to 2010 (5-6 individuals) but higher than the 2011 (4 individuals) group size. These results continue the trend in observing higher average group sizes than previous studies (e.g., Slooten et al. 2006, Rayment & Du Fresne 2007, Childerhouse et al. 2008). Even though the dolphins were encountered in a relatively small area, there were clear differentiations between most groups during the surveys. We saw a maximum number of 36 dolphins during a single survey leg, as judged by visual counts; this is comparable to the previous 2010-2011 surveys.

Calves and juveniles were encountered in 13.6% and 4.5% of groups respectively; this was less that 2010 (46% and 28%) but more calves and fewer juveniles than observed in 2011 (4% and 30%). Typically there was only a single calf present in a group but there may have been older offspring present in the group still associated with their mother. Dolphin reactions to biopsy sampling events were mild (Krützen et al. 2002, Tezanos-Pinto & Baker 2011), and overall slightly lower than those found in the previous 2010-11 surveys (Oremus et al. 2012). Preliminary DNA analysis of the biopsy data showed that of the 47 successful samples, we sampled 40 individual dolphins; 38 Māui dolphins and two Hector's dolphins, one of which (a female) was initially identified in 2010 and 2011 (haplotype Jb, Hamner et al. 2014b). The re-sampling of this female clearly shows that Hector's dolphins can integrate into Māui dolphin social groups over long periods of time, but we have yet to determine whether she has successfully reproduced since 2011 when she was last sighted. The identification of the first living male Hector's dolphin is further evidence of atypical (see Rayment et al. 2011), large-scale movements by Hector's dolphins along the west coast of the North Island. Detailed analysis of bi-parentally inherited microsatellite data is ongoing and this will enable us to fully reconcile the 2015 samples to previous data (see Hamner et al. 2012) and possibly assign the male Hector's dolphin to his regional South Island origin. DNA genotypes will be reconciled with the photo-identification data to identify individuals using both means, where possible.

RECOMMENDATIONS FOR 2016 SURVEYS

Given the success of the 2015 surveys, in terms of effort and collection of biopsy samples, compared to the 2010 and 2011 surveys, we recommend taking steps only to maintain consistency of logistics and personnel in 2016. This includes working with DOC managers in advance on the following:

- allocating adequate time commitment for DOC staff (Hickman) to skipper the boat and coordinate local logistics,
- allocating adequate time commitment for DOC staff (Boren and Arlidge) to assist with logistics and to participate in surveys, and
- assuring the availability of the DOC vessel *Tuatini*, or similar, as the primary survey vessel.

The one exception to an exact repeat of the 2015 operations would be to allocate at least one day of additional survey effort north of the Kaipara Harbour. Although no dolphins were encountered north of the Kaipara entrance in the 2010 or 2011 surveys, there are continued public sightings (unconfirmed) in this area (Ministry for Primary Industries and Department of Conservation 2015). In anticipation of extending the surveys in 2016, consultation with local iwi was undertaken by Constantine and Baker in February 2015, including an invitation for an observer to accompany the surveys. This consultation was

well received and this invitation was accepted.

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