Preliminary aerial survey for Hector's dolphin *(Cephalorhynchus hectori)*, north-west North Island

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Published by
Department of Conservation
Head Office, PO Box 10-420
Wellington, New Zealand

This report was commissioned by Wanganui Conservancy.

ISSN 1171-9834

Reference to material in this report should be cited thus:

Duffy, C.; Williams, B., 2001.
Preliminary aerial survey for Hector's dolphin *(Cephalorhynchus hectori),* north-west North Island. *Conservation Advisory Science Notes No. 332,* Department of Conservation, Wellington.

Keywords: Hector's dolphin, *Cephalorhynchus hectori,* survey methodology, aerial survey, Taranaki Bight.

Abstract

In April 1999 New Plymouth Area conducted an aerial survey for Hector's dolphin *(Cephalorhynchus hectori)* between Urenui and Tirua Point. All coastal waters within 2 km (1.1 nautical miles) of shore were searched using an overhead fixed-wing aircraft flown at an altitude of 120 m. Counts were made of common dolphin, bottlenosed dolphin and 14 other species of marine mammal, sea bird and pelagic fish. No Hector's dolphin were observed. Reasons for the apparent absence of Hector's dolphin are discussed. The report concludes with recommendations on the design of future aerial surveys for Hector's dolphin off north-west North Island.

1. Introduction

Hector's dolphin *(Cephalorhynchus hectori)* is threatened by incidental fisheries mortality throughout its range (Dawson & Slooten 1988; Slooten & Dawson 1988; Slooten & Lad 1991; Pichler et al. 1998; Martien et al. 1999). Its vulnerability is heightened by a low potential for population growth, high site fidelity and genetic isolation of the regional populations (Slooten & Lad 1991; Pichler et al. 1998). Of these the North Island population is most at risk from extinction due to its small size (c. 146 individuals) and the high level of fishing effort within its range (Dawson & Slooten 1988; Martien et al. 1999).

Attempts by the Department of Conservation to survey Hector's dolphin off North Taranaki have been hampered by the amount of time required to conduct boat surveys, and unpredictable weather and sea conditions. Poor access to the coast and poor launching facilities also limit the size of boat that can be used off the beach. In April 1999 New Plymouth Area conducted a trial aerial survey as an alternative to boat-based methodologies. This report presents the results of that survey and makes recommendations on the design of future aerial surveys for North Island Hector's dolphin.

2. Survey area

The width of the continental shelf off North Taranaki ranges from about 85 to 124 km (Fig. 1). The sea floor shelves gently away from the coast, with 80 m depth reached about 40 km offshore. Shelf habitats include large areas of gravels, sands and muds (King et al. 1985). The inshore environment is influenced by relatively warm water flowing south-east as the West Auckland Current, and cooler water flowing north-east as the Westland Current (Heath 1985). Monthly mean sea surface temperature (SST) varies from about 14 °C in winter to over 22 °C in summer (Chiswell 1994).

3. Methods

Three line transects were flown between Urenui and Tirua Point on 13 April 1999 (Fig. 1). These were orientated parallel to the shore at distances of 500 m, 1000 m and 1500 m from mean high water. The positions of the transects were plotted on a chart of the area (N.Z.43 Manukau Harbour to Cape Egmont, Hydrographic Office RNZN 1980) using the Nobletec Visual Navigator program installed on a lap-top computer. This computer was connected to a Trimble Scoutmaster GPS and installed in the survey aircraft. This was used to navigate the aircraft along the transects, and to record its track and the positions of groups of dolphins. The aircraft used for the survey was a Cessna 172. The crew consisted of three observers and the pilot. One observer operated the navigation program, and a second recorded flight information and sightings manually. The survey was conducted between 1430 and 1730, with a 30 minute break to refuel the aircraft between the 1000 m and 1500 m transects.

Transects were flown at an altitude of 120 m (400 ft) and a speed of 80 knots. All marine life observed within 500 m each side of the aircraft was identified and recorded. Distance from the aircraft was estimated by noting the position of the shore along the wing strut at the start of the 500 m transect. The 1000 m and 1500 m transects were flown once. The 500 m transect was flown twice. When an individual or group of dolphins was sighted, the animals' position was recorded and they were circled to enable species identification and estimation of group size. The transect was then restarted from the end of the track recorded on the lap-top. Information recorded on each dolphin sighting was: pod size, general direction of movement relative to the shore, number of calves present, and behaviour.

4. Results

Total flying time was 3 hours. Conditions were sunny with light cloud cover. Visibility was excellent. Wind direction was 310° magnetic at 5 knots. Sea conditions were calm. Surface water throughout the survey area was turbid, with large plumes of heavily discolored water off Tongaporotu and Mokau Rivers (Fig. 1). At Tirua Point there was a conspicuous front where clean oceanic water occurred within 1000 m of the coast.

No Hector's dolphin were observed. Other species observed were New Zealand fur seal *(Arctocephalus forsteri),* bottlenose dolphin *(Tursiops truncatus),* common dolphin *(Delphinus delphis),* blue penguin *(Eudyptula minor),* red-billed gull *(Larus scopulinus),* southern black-backed gull *(Larus dominicanus),* Australasian gannet *(Sula serrator),* white-fronted tern *(Sterna striata),* kahawai *(Arripus trutta),* albacore *(Thunnus alalunga),* marlin *(Tetrapturus* sp.*),* mako shark *(Isurus oxyrinchus),* blue shark *(Prionace glauca)* and smooth hammerhead shark *(Sphyrna zygaena).* Species counts for each transect are given in Table 1.

The New Zealand fur seal was observed in the water close to rocks at Ngarapupu Point. The bottlenose dolphins were located in the plume from Mokau River, 1.5 km south-west of the river mouth. The pod contained six adults and four juveniles. When sighted they were moving in a northerly direction. At one point an adult swam rapidly ahead of the pod and appeared to take a fish swimming close to the surface. Both sightings of common dolphins were made in the plume from Awakino River (about 3.5 km north of Mokau River, Fig. 1). The common dolphins sighted on T2 were in groups of eight and five animals, and one isolated individual. Each of the groups included a calf. Two unidentified sharks were also observed in the plume. The common dolphins sighted on T3 were in two groups of three and two individuals. No calves were seen with these animals. The charted depth in the area of the sightings of both dolphin species is 7-10 m.

One school of kahawai was sighted south of Tongaporutu River, and one school of unidentified fish and another kahawai school were sighted between Urenui and Pariokariwa Point. All other pelagic fish sightings were made north of Awakino River. The mako shark was estimated to be greater than 3 m total length (TL), the hammerhead sharks between 1.5 and 2 m TL and the blue sharks about 2 m TL.

Gannets and white-fronted terns were observed throughout the survey area. Only two little blue penguins were observed south of Awakino River. Sightings of all other seabird species were restricted to the area between Awakino River and Tirua Point. At least 30 red-billed gulls were observed feeding above two kahawai schools located about 500 m south of the reef at Tirua Point. A similar number of red-billed gulls were observed roosting on the reef.

5. Discussion

Although no Hector's dolphin were observed, it would have been possible to correctly identify them from the air. Birds as small as little blue penguins and objects such as plastic shopping bags were clearly visible up to 500 m from the path of the aircraft. Potential reasons for the nil result include incorrect choice of survey area, incorrect timing of the survey, or failure to detect animals that were present in the survey area.

North Island Hector's dolphin occur from Hawke Bay to Palliser Bay, and from Wanganui River north to the southern end of Ninety Mile Beach, but are most abundant between New Plymouth and Kaipara Harbour (Morzer Bruyns & Baker 1973; Baker 1983; Cawthorn 1988; Slooten & Dawson 1988; B. Dix pers. comm.; C. Duffy pers. obs.). Urenui was chosen as the southern limit of the survey area because Hector's dolphin are most frequently recorded north of Urenui Bay, particularly near the mouth of Mokau River (Appendix 1). Tirua Point was chosen as the northern limit of the survey area because it is a prominent landmark, and its distance from New Plymouth airport allowed two transects to be flown before refuelling was required. The outer limit of the survey area was based on Dawson & Slooten's (1988) finding that 45.5% of

east coast South Island Hector's dolphin occur within 800 m of shore during summer. Hector's dolphin are rarely seen more than five nautical miles offshore, or in water deeper than 80 m (Morzer Bruyns & Baker 1973; Baker 1983; Slooten & Dawson 1988).

East coast South Island Hector's dolphin disperse offshore during winter (Dawson & Slooten 1988) and the low number of records from North Taranaki in autumn and winter suggest North Island Hector's dolphin may also do this (Appendix 2). However, the existing data also indicate that if any offshore movement occurs in North Taranaki it probably does not begin until late April - early May (Appendix 2). The offshore movement of east coast South Island Hector's dolphin is thought to be related to prey distribution (Slooten pers. comm.). Hector's dolphin predominantly feed on small schooling fish and in Canterbury they may move offshore to feed on winter spawning aggregations of sprat (Sprattus antipodum) (Ayling & Cox 1982; Baker 1983; Slooten & Dawson 1988). Eight species of small fish recorded in the diet of South Island Hector's dolphin commonly occur off North Taranaki (Anderson et al. 1998). Unfortunately no information is available on the diet of North Island Hector's dolphin, or the seasonal distribution of their prey. Temperature can have a strong influence on fish distributions, and sea surface temperature (SST) in the survey area had fallen from 21 to 21.5°C in February to about 19.5 °C at the time the survey was conducted (Appendix 3). SST maps show a tongue of relatively cool water was present along much of the coastline, while warmer water covered the outer shelf and shelf break (Appendix 3). This warm water pushed on to the coast at the northern boundary of the survey area near Tirua Point. The boundary between these water masses was visible from the air as a conspicuous front marked by an abrupt change in water colour and foam lines. However, the presence of other dolphin species and large numbers of predatory pelagic fish close to shore indicates small schooling fish were probably still abundant in at least the northern part of the survey area.

Hector's dolphin may have been present in the survey area but were not detected. This possibility is illustrated by the fact that the bottlenose dolphins encountered on T1 were only recorded once. The probability of detecting a group of dolphins is dependent upon the amount of time the animals are potentially visible at the surface (i.e. their availability to the observer) and factors affecting the observer's ability to recognise animals in their field of view (Laake et al. 1997). The latter include sea state, glare, cloud cover, visibility from the survey platform, distance from the observer, and observer experience (Hammond 1986; Hiby & Hammond 1989; Laake et al. 1997). Observation conditions for T1-T3 were excellent, but the final half of T4 was badly affected by glare caused by the low angle of the sun. Future surveys should be timed to avoid this. Although sea surface conditions were excellent, high turbidity meant that only animals at or immediately below the surface were visible. High turbidity is a general feature of Hector's dolphin habitat, and they frequently congregate off river mouths and large estuaries where turbidity is greatest (Morzer Bruyns & Baker 1973; Baker 1983; Cawthorn 1988; Slooten & Dawson 1988). Consequently the survey design can not be modified to avoid these areas. The small size and pale colour of Hector's dolphin may have made them hard to detect, but under the prevailing conditions animals of similar size (i.e. New Zealand fur seal, hammerhead sharks) were de-

tectable up to 500 m from the aircraft. Visibility from the aircraft was good laterally but limited directly below and in front of it. It is therefore possible that dolphins surfacing along the aircraft's track were missed.

Observer experience is an important source of error in visual surveys (Hammond 1986; Laake et al. 1997). Laake et al. (1997) conducted an experiment to estimate the probability of detecting harbour porpoise from aerial surveys that included observer experience as a factor. They estimated that experienced observers detected 86% of available porpoises (i.e. those at the surface in the observer's field of view), whereas inexperienced observers only detected 23%. Using this information and the estimated availability of porpoises in the survey area, Laake et al. (1997) estimated that the detection probability by inexperienced observers was only 0.076 (SE = 0.046). None of the observers that participated in this survey was experienced in aerial surveys for Hector's dolphin.As harbour porpoise are similar in size and behaviour to Hector's dolphin it is possible that Hector's dolphin were missed by the observers.

Finally it is possible that Hector's dolphin only occur sporadically off North Taranaki. This seems highly likely, particularly if declining abundance (Slooten & Lad 1991; Martien et al. 1999) has resulted in contraction of their range. Martien et al. (1999) estimated the 1985 abundance of Hector's dolphin off the west coast of North Island at 140 individuals, compared to an estimated population size in 1970 of 437-524. Although there is little evidence that Hector's dolphin make extensive along-shore movements (Dawson & Slooten 1988; Pichler et al. 1998) recent sightings off North Taranaki (Appendix 1) may be of animals normally resident off Kawhia Harbour or further north (Morzer Bruyns & Baker 1973; Baker 1983; Cawthorn 1988).

6. Future aerial surveys

Aerial surveys are regularly used to estimate the abundance of cetaceans (e.g. Leatherwood et al. 1978; Kraus et al. 1983; Hammond 1986; Barlow et al. 1988; Hiby & Hammond 1989; Forney et al. 1995; Young 1995, 1998; Laake et al. 1997), and are likely to be the most cost-effective means of surveying North Island Hector's dolphin. However, the sampling design employed in this survey is not suitable for statistical analysis because T2 overlaps with T1 and T4. The transects also run the entire length of the survey area, resulting in minimal replication.

Any future aerial survey of North Island Hector's dolphin should aim to provide a statistically robust estimate of total abundance. It should be timed for midsummer (i.e. late January to early March), and cover the area from Kaipara to Urenui out to a distance of five nautical miles from shore, or a depth of 80 m. Sampling effort should be randomised within at least two, possibly three strata (Hammond 1986; Hiby & Hammond 1989). The first stratum should be from the shore out to 1000 m (i.e. the expected area of maximum Hector's dolphin abundance). Transects in this stratum should be placed randomly

along a track located 500 m from shore. The results of research currently being undertaken by Kirsty Russell (School of Environmental & Marine Sciences, University of Auckland) may enable this stratum to be further divided into areas containing predictable concentrations of Hector's dolphin, and those where Hector's dolphin only occur sporadically. The remaining stratum would be from 1000 m from shore to the outer boundary of the survey area. The most efficient way of sampling this stratum is likely to be randomly locating transects along a zig-zag track between the inner and outer boundary. Survey effort could be apportioned between strata using the methodology of Eberhardt et al. (1979). Transect length should be a constant proportion of the area of each stratum (Hammond 1986).

Although Hector's dolphin abundance is likely to decline with distance offshore, randomisation of sampling removes the need to orient transects perpendicular to the shore in order to ensure an unbiased estimate of total abundance (Hammond 1986; Hiby & Hammond 1989). This is important given the low population estimates for Hector's dolphin in the survey area (Dawson & Slooten 1988; Martien et al. 1999). Low abundance decreases the probability of detecting dolphins (Laake et al. 1997). By orienting transects parallel to the shore within the 0-1000 m stratum the probability that no dolphins will be recorded on any of the transacts will be minimised. By also recording dolphins seen between transects (i.e. off survey) it should be possible to simultaneously census this stratum.

7. Acknowledgements

We thank Martin Rutledge (Department of Conservation), Kirsty Russell (School of Environmental & Marine Sciences, University of Auckland) and Jim Young (Centre for Computing and Biometrics, Lincoln University) for their advice on methodologies and the design of aerial surveys for cetaceans. Anton Van Helden (Museum of New Zealand), Barry Hartley, Chris Powell and Jason Sait provided records of Hector's dolphin from North Taranaki. Bruce Dix (Department of Conservation) provided details of Hector's dolphin sightings from Palliser Bay. Elizabeth Slooten (Environmental Science, University of Otago) and Franz Pichler (School of Biological Sciences, University of Auckland) provided advice on the biology of Hector's dolphin. Sam Ferreira (Department of Conservation) provided advice on the manuscript.

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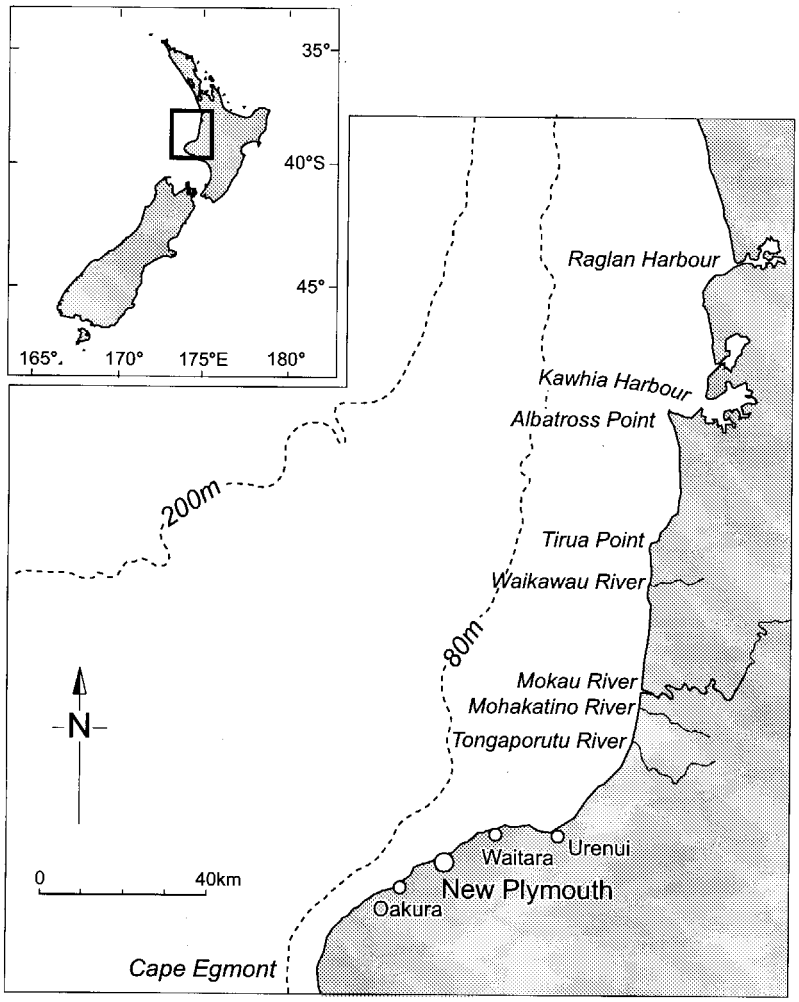
Figure 1. North Taranaki coastal locations: the aerial survey was conducted between Urenui and Tirua Point.

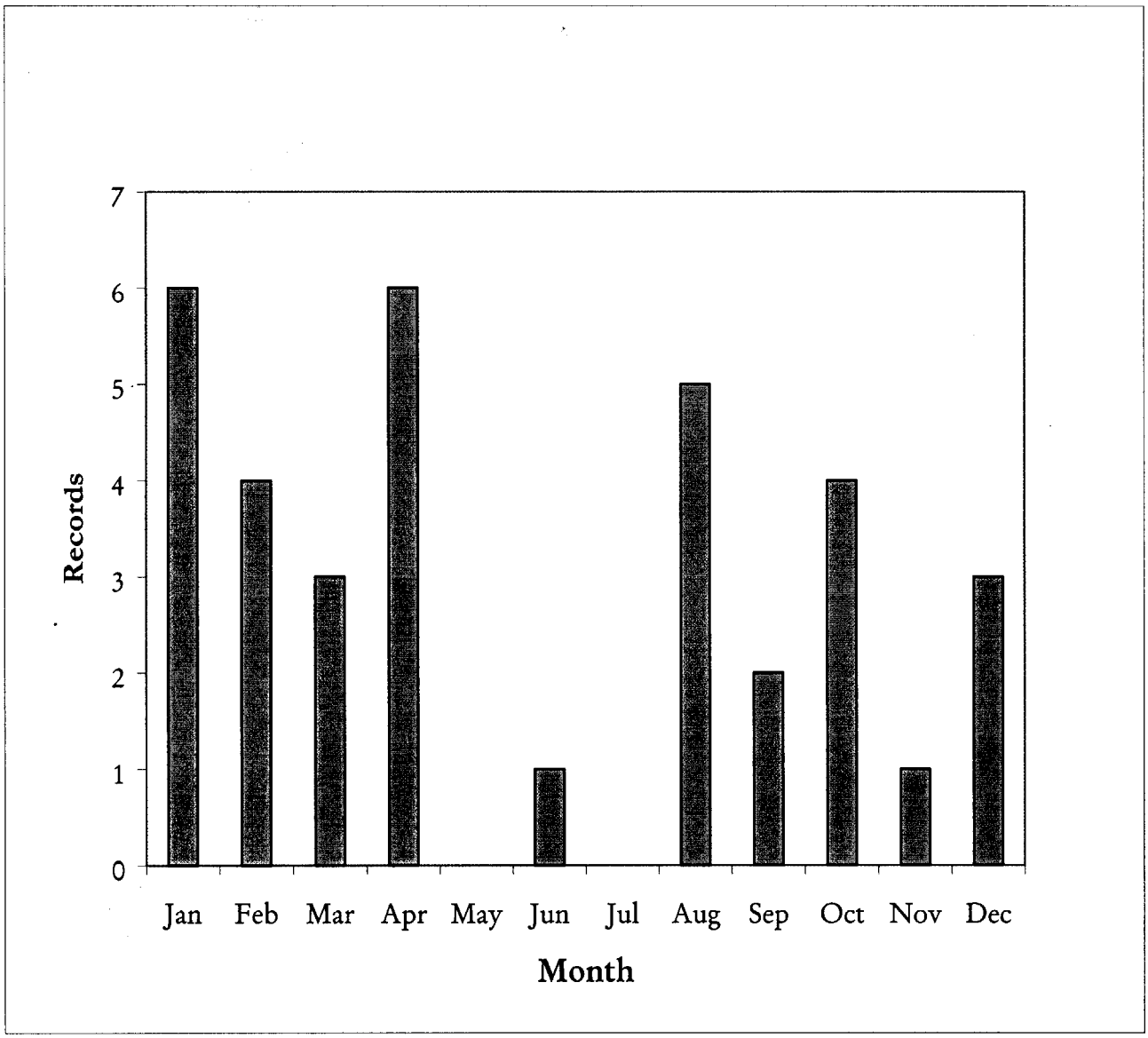


Appendix 1.
Sightings and strandings of Hector's dolphin *(Cephalorhynchus hectori)* from North Taranaki.

Day	Month	Year	Location	Comments	No.
20	December	1950	Nukuhakari	Stranding, skull in Taranaki Museum	1
29	March	1970	Pukearuhe	sighting, Cawthorn 1988	2
17	April	1970	New Plymouth	sighting, Cawthorn 1988	3
18	April	1970	Pukearuhe	sighting, Cawthorn 1988	1
1	January	1973	Pukearuhe	Stranding, 1.18 m female, umbilical cord still attached	1
30	April	1974	Waiiti	sighting, B. Hartley	2
28	August	1974	Oakura	stranding, female	1
24	August	1975	Oakura	stranding, 1.53 m	1
29	March	1976	Pukearuhe	sighting, B. Hartley	2
17	April	1976	Piritoki Reef	sighting, B. Hartley	3
18	April	1976	Pukearuhe	sighting, B. Hartley	1
	September	1976	Waitara	sighting, B. Hartley	1
	January	1977	Mokau	drowned in set net, B. Hartley	1
	January	1977	Bell Block	drowned in set net, B. Hartley	1
2	August	1977	Seal Rock, Sugar Loaf Islands	drowned in set net, B. Hartley	1
26	January	1979	Waiiti	stranding, B. Hartley	1
5	February	1979	Tongaporutu	stranding, 1.5 m	1
11	March	1979	Mokau	stranding, 1.4 m male	1
17	April	1979	Onaero	stranding, 1.62 m female	1
20	October	1981	Mokau	sighting, Cawthorn 1988	1
14	December	1985	Onaero	stranding	1
27	September	1988	Tongaporutu	stranding, 1.39 m male	1
6	December	1988	Oakura	stranding	1
25	February	1989	Marakopa	sighting, B. Hartley	4
26	February	1989	Marakopa	sighting, B. Hartley	1
8	April	1989	Opunaki Beach, New Plymouth	stranding, 1.56 m, evidence of predation by white shark	1
12	November	1989	Urenui	stranding, 0.9 m male	1
	January	1990	Mokau	sighting, B. Hartley	2
2	February	1990	Mokau	sighting, B. Hartley	2
8	October	1995	Waiwakaiho River	neonate found in stomach of white shark netted in 60 m depth	1
	January	1996	Mokau	sighting, DOC files	30
9	June	1997	Whitecliffs	sighting, Chris Powell	6
10	August	1999	Awakino	sighting, Jason Sait	6
14	August	1999	Mokau River	sighting, D. Taucher, milling around 300 m offshore just north of the river mouth	4
18	October	1999	Mokau River	sighting, Ray Christiensen (commercial fisher), reported to Bryan Williams	5
24	October	1999	Mokau River	sighting by commercial fishers reported to Bryan Williams	2

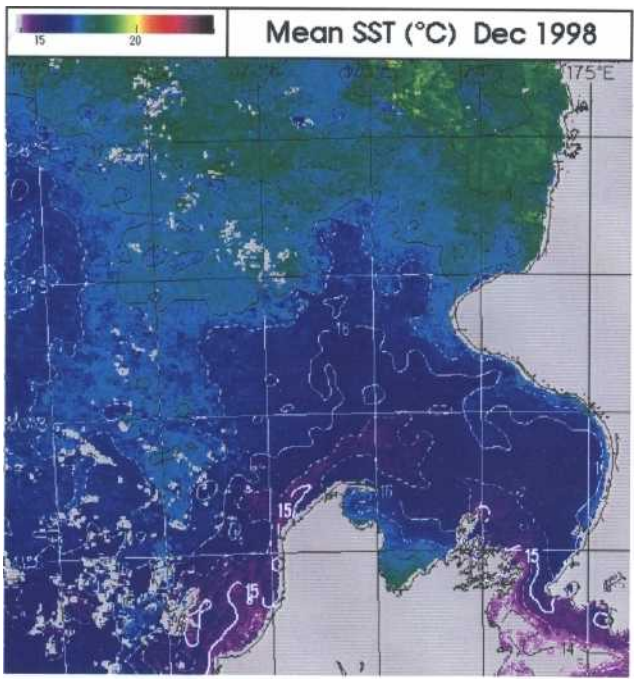
Appendix 2.

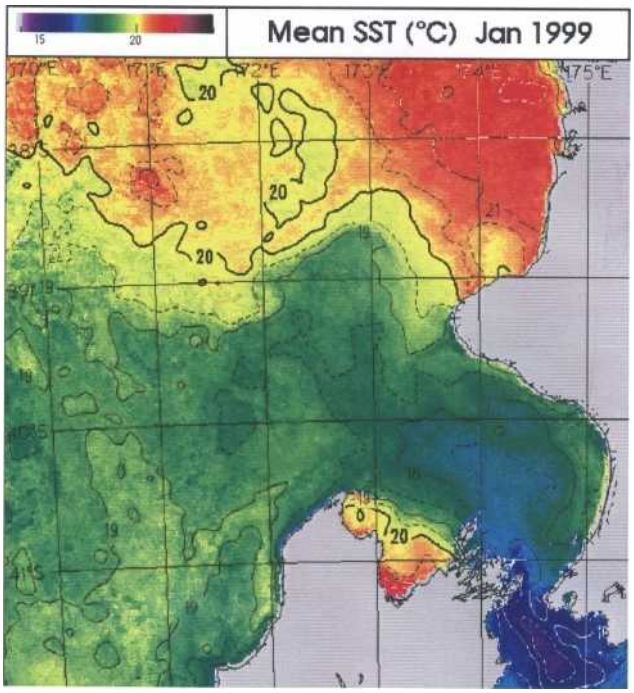
Seasonality of sightings and strandings of Hector's dolphin *(Cephalorhynchus hectori)* from North Taranaki (n = 37)-

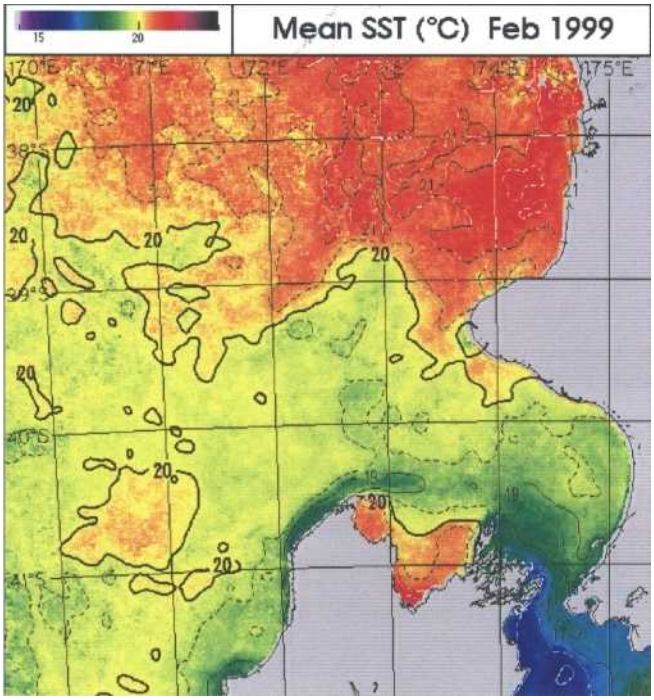


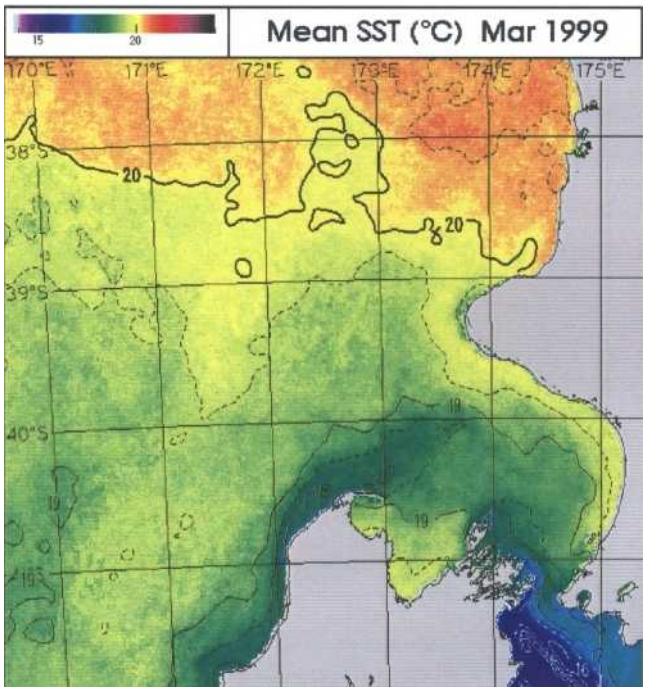
Appendix 3 .

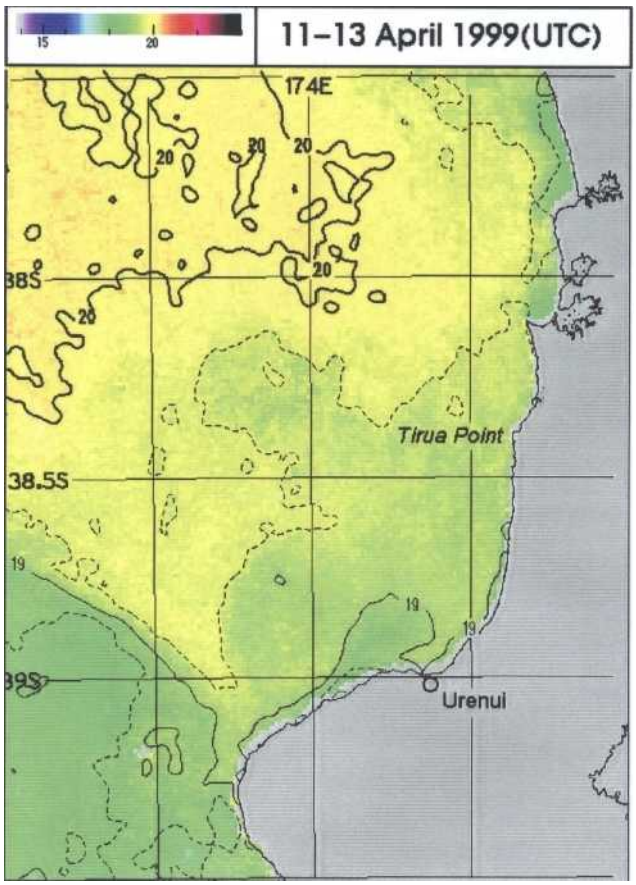
Sea surface temperature (SST) off North Taranaki from December 1998 to 13 April 1999. (Data copyright: NIWA, Wellington)






Mean SST (°C) Feb 1999
15
20
170°E
171°E
172°E
174°E
175°E
38°S
39°S
40°S
41°S
20
21
19


Mean SST (°C) Mar 1999
15
20
170°E
171°E
172°E
173°E
174°E
175°E
38°S
39°S
40°S
20
19


11–13 April 1999(UTC)
15
20
174E
38S
38.5S
39S
20
19
Tirua Point
Urenui