ISSN 1175-1584

MINISTRY OF FISHERIES
Te Tautiaki i nga tini a Tangaroa

Distribution of Maui's dolphin, *Cephalorhyncus hectori maui*

E. Slooten
S. M. Dawson
W. J. Rayment
S. J. Childerhouse

New Zealand Fisheries Assessment Report 2005/28
May 2005

Distribution of Maui's dolphin, *Cephalorhyncus hectori maui*

E. Slooten[1]
S. M. Dawson[2]
W. J. Rayment[1,2]
S. J. Childerhouse[3]

[1]Department of Zoology and [2]Marine Science
University of Otago
P O Box 56
Dunedin

[3]Marine Conservation Unit
Department of Conservation
P O Box 10420
Wellington

New Zealand Fisheries Assessment Report 2005/28
May 2005

Published by Ministry of Fisheries
Wellington
2005

ISSN 1175-1584

Citation:
Slooten, E.; Dawson, S.M.; Rayment, W.J.; Childerhouse, S.J. (2005).
Distribution of Maui's dolphin, *Cephalorhyncus hectori maui*.
New Zealand Fisheries Assessment Report 2005/28. 21 p.

This series continues the informal
New Zealand Fisheries Assessment Research Document series
which ceased at the end of 1999.

EXECUTIVE SUMMARY

Slooten, E.; Dawson, S.M.; Rayment, W.J.; Childerhouse, S.J. (2005). Distribution of Maui's dolphin, *Cephalorhynchus hectori maui*.

***New Zealand Fisheries Assessment Report 2005/28.* 21 p.**

- The geographic range of Maui's dolphin extends at least as far north as Maunganui Bluff and at least as far south as New Plymouth, with highest densities between the Manukau Harbour and Port Waikato.
- Maui's dolphins use at least three of the five west coast harbours.
- The furthest offshore sightings were between 3 and 4 nautical miles from the coastline, inside the 4 n. mile offshore boundary of the protected area.
- In winter, Maui's dolphins were found in deeper waters and were more dispersed with respect to distance offshore.
- Broadly similar seasonal changes in distribution also occur in other areas (Banks Peninsula and west coast South Island).
- There are no major concerns about the northern and offshore boundaries of the protected area.
- However, Maui's dolphins continue to overlap with gillnet fisheries in the harbours and to the south of the protected area.
- Trawling is carried out throughout the range of Maui's dolphins and illegal recreational gillnetting continues inside the protected area.
- The population size estimate of 111 (c.v. 0.44) confirms their critically endangered status.

1. INTRODUCTION

Aerial surveys of the North Island west coast were carried out in summer (14–31 January 2004) and winter (26 June–18 July 2004) to assess the distribution of North Island Hector's dolphins, also known as Maui's dolphin. Offshore distribution has been observed to change seasonally for South Island Hector's dolphin populations, with dolphins strongly concentrated close to shore during summer and more evenly distributed throughout their depth range during winter (Slooten et al. 2005, Rayment et al. 2003). This pattern is more pronounced in the shallow waters around Banks Peninsula than on the more steeply shelving South Island west coast. Aerial surveys in other areas have compared dolphin distribution in midwinter (June-July) and midsummer (December-January). These same months were chosen for the North Island surveys to facilitate comparisons.

The overall objective of these distribution surveys was to assess the risk posed to Maui's dolphin by fishing off the North Island west coast. Specific objectives were to quantify and compare summer and winter distribution. Offshore distribution, including any seasonal differences, can have important implications for the proportion of a population found inside a protected area.

2. METHODS

2.1 Aerial surveys in 2004

In the summer survey (14–31 January 2004) the area from Maunganui Head to just south of New Plymouth was surveyed using transect lines 2 nautical miles (n. mile) apart and extending out to 5 n. mile offshore (Figure 1). For part of this area, between Kaipara and Kawhia Harbours, these lines were extended to 10 n. mile offshore. Within the central area, from Muriwai to just north of Raglan Harbour, the number of survey lines was doubled by inserting 5 n. mile transect lines in between the 10 n. mile lines. This resulted in a transect line run every 1 n. mile of coastline (Figure 1). Alongshore surveys complemented the offshore lines, and informed decisions about stratification of the offshore lines. Past data on dolphin distribution off the North Island west coast were also considered in determining how to stratify survey effort.

Data from the front and rear observers were used in a modified mark-recapture approach (Manly et al. 1996) to estimate *perception* bias, the probability of counting a dolphin group at the surface on the trackline (see Slooten et al. 2004a for details). Observations of dive times recorded between 29-31 January from a Robinson R22 helicopter were used to quantify *availability* bias, the proportion of time that Maui's dolphins are available to be counted from the survey height. The probability of recording a sighting on the trackline, g(0), was calculated as the product of the estimates of perception bias and availability bias.

In the winter survey (26 June–18 July 2004) the area from Maunganui Head to just south of New Plymouth was again surveyed using alongshore survey lines. The central area, from Muriwai to just north of Raglan Harbour, was surveyed using offshore lines out to 10 n. mile from the coast. The results of the summer survey indicated that dolphin densities were highest in this central survey stratum, and these results were consistent with other information about Maui's dolphin distribution gathered in summer and winter (e.g., Dawson & Slooten 1988, Ferreira & Roberts 2003). We therefore concentrated our effort in this central stratum, to maximise sample size.

As proposed at the Aquatic Environment Working Group meeting on 9 June 2004, the offshore survey lines were run at more than double the survey intensity of the summer survey, resulting in transects 0.5 n. mile apart (Figures 1 and 2). All lines were run out to 10 n. mile offshore. First, we flew half of the offshore survey lines (every alternate line, 1 n. mile spacing between lines). We then decided, on the basis of the data from this first set of lines, to run the second set out to 10 n. mile also. If there had been any sightings beyond 7.5 n. mile from shore we would have extended the second set of lines out to 15 n. mile However, none of the sightings on the first (or second) set of lines was beyond 3.3 n. mile offshore.

The design of the survey followed the same principles used on our previous aerial line–transect surveys (e.g., see Slooten et al. 2004a). The coast between Maunganui Bluff and the New Plymouth was first divided into sections of relatively straight coastline and a straight baseline was drawn along the coast. Within these sections, transects were placed at 45° to the baseline. The coastal start point of the first transect within each section was chosen randomly, with the rest of the transect lines spaced evenly. The aircraft was flown at 100 knots and an altitude of 500 feet. The transect lines were navigated using a Garmin GPS12XL or Garmin 196 chartplotting GPS.

The survey team consisted of four observers (two on each side of the aircraft) and the pilot. Flights were typically 2 to 4 hours long. A maximum of three flights was carried out on days with exceptionally good weather. However, a more typical survey day would consist of one early morning flight, surveying six to eight lines. All survey lines were flown in sea states of Beaufort 3 or less[1], starting no earlier than 30 minutes after sunrise and finishing no later than 30 minutes before sunset. Surveys were discontinued if observers were not confident they could see all sightings close to the trackline. Observers swapped positions diagonally between flights (i.e., the observer in the front right position on the first flight would be in the rear left position on the next flight). Surveys were flown in a twin engine, high-wing, six seat aircraft (Partenavia P68). An accident at the Canterbury Aero Club a few days before the start of the winter survey meant that 19 of the 89 survey lines on the winter survey had to be carried out using a two-person helicopter (Robinson R22) (Figure 3). This is unfortunate, but does not cause bias for a study of offshore distribution as the key issue is that survey effort is evenly distributed from the coastline to the maximum offshore survey distance. That was achieved in this survey.

When a group of dolphins was sighted, the observer measured the downward angle to the group perpendicular to the aircraft's track using a hand-held inclinometer (Suunto PC5/36D PCB). Sighting details were dictated into personal dictaphones, with time of sighting noted from digital clocks that were synchronised with GPS time at the start of each flight. Each observer's clock was positioned on the window ledge so that they could see the time without looking away from the sighting. The time and angle of each sighting was used to determine the exact position of dolphin sightings. A GPS-linked Hewlett-Packard 200LX palmtop computer with custom-written software was used to record start and end times of transect lines, the aircraft's track (via recording a GPS fix every 10 s), and sighting conditions (noted at the start of each transect, and whenever they changed).

The survey was conducted in "passing mode" (Buckland et al. 2001), meaning that the course of the aircraft was not diverted when a sighting was made. Maui's dolphins are highly visible from the air, and typically small group sizes make it easy to count individuals. On one occasion, however, we diverted the plane (changed to "closing mode") in order to verify the species identity of a sighting.

The North Island survey was undertaken immediately after a training period at Banks Peninsula, and a survey at Banks Peninsula. Hence observers were very familiar with survey protocols. A detailed account of our protocols for gathering and analysing aerial survey data was given by Slooten et al. (2004a). Offshore distances were measured using ArcView v3.3, a GIS system.

2.2 Previous surveys

We reviewed results from previous surveys by Ferreira & Roberts (2003) and Russell (1999, 2002). Their results are presented and re-analysed where necessary to allow a direct comparison with the 2004 aerial survey data.

[1] Beaufort 3 is defined as a gentle breeze with large wavelets, scattered whitecaps and a windspeed of 7-10 knots.

3. RESULTS

3.1 *Aerial surveys in 2004*

The survey design resulted in exactly equal effort with distance offshore, which makes it easy to interpret plots of sighting locations (Figures 1 and 2). The winter survey resulted in nine sightings of individuals or groups of Maui's dolphins on the offshore survey lines (Figure 2). One additional sighting (just south of Kaipara Harbour) was made on the two sets of alongshore lines and three off-effort sightings were made (one just south of the Kaipara Harbour and two in the Muriwai Beach area). On the summer survey we made eight sightings of Maui's dolphins on the offshore transect lines: six in the central stratum and one each in the northern and southern strata (see Figure 1). A further 12 sightings were made on alongshore surveys and 4 sightings off-effort while travelling between transect lines. In addition, we made 22 sightings from a helicopter while gathering data to estimate the proportion of times the dolphins are visible at the water surface (see Slooten et al. 2005). All these additional sightings were made in the same areas as the sightings on the offshore transect lines, confirming the high-density areas indicated by the on-effort sightings (compare Figures 1, 2, and 13).

The sighting rate on the alongshore lines was lower in winter than summer, consistent with low dolphin densities close to shore in winter. In summer, nearly all sightings were made within 1 n. mile of the coastline, whereas in winter dolphin sightings were much more dispersed. On the winter survey, 33.3% of the sightings (3/9) were within 1 n. mile of the coast (Figure 4). By comparison, 75% of the sightings (6/8) were within 1 n. mile of the coast in summer (Figure 5). The maximum offshore distance was very similar in winter (3.33 n. mile) and summer (3.09 n. mile offshore).

A seasonal difference in offshore distribution is also seen in other Hector's dolphin populations. Off the South Island west coast, Hector's dolphins are strongly concentrated close to shore in summer and more dispersed in winter (Figures 6 and 7). The maximum offshore distance was similar in summer (5.29 n. mile) and winter (5.24 n. mile). However, dolphins were relatively dispersed in winter and more concentrated close to shore in summer (Figures 6 and 7).

Differences between summer and winter distribution appear to be strongest at Banks Peninsula, where few sightings are made beyond 4 n. mile in summer. In winter, most sightings are made beyond this distance offshore (Figures 8 and 9). Hector's dolphins are seen much further offshore at Banks Peninsula than off the west coast of the North Island. They are almost evenly distributed with respect to distance offshore in winter, but are strongly concentrated close to shore during summer. The differences in maximum offshore distances for the three areas appear to relate to water depth.

Seasonal changes in offshore distribution can be important in terms of estimating the proportion of the local population that overlaps with fishing activities. At Banks Peninsula, surveys of offshore distribution have been carried out in two summers and two winters. These surveys showed that in summer an average of 86% of the local population is found within 4 n. mile offshore, i.e., within the offshore boundary of the Banks Peninsula Marine Mammal Sanctuary. In winter, an average of 38% of the local population is found within 4 n. mile offshore.

Water depth may be an important factor in explaining dolphin distribution, and seasonal changes in distribution. In winter, dolphins tended to be found in relatively deeper water. In summer, all sightings were within 20 m water depth, while in winter almost half of the sightings were in water 20–30 m deep (Figure 10).

After correcting for availability and perception bias, the abundance estimate was 111 Maui's dolphins (c.v. 0.44) (Slooten et al. 2004b). Advantages of aerial surveys include the speed with which data can be gathered, and that all individuals can be sampled regardless of age, sex, or reproductive status. A second, and potentially third, summer and winter survey could be carried out to increase sample size, and to allow assessment of year to year variability in offshore distribution. If these surveys were aimed at distribution, rather than abundance, they could be carried out using either a fixed-wing plane or helicopter. Surveys out to 10 n. mile are feasible with a small helicopter carrying one observer (at about the same hourly cost as the fixed-wing plane we used for these surveys).

3.2 Results from previous surveys

Ferreira & Roberts (2003) reported on aerial surveys carried out in 2000-01 and 2001-02. Their survey consisted mainly of alongshore flights, parallel to the shore and out to 9.5 km (5.1 n. mile) offshore (Table 1). About 86% of the survey effort was concentrated within 1 km (0.54 n. mile) of the shore.

Because most of Ferreira & Roberts' (2003) survey lines ran parallel to the shore, it is impossible to construct a plot of offshore distribution that would be directly comparable to Figures 4 and 5. For example, a lack of sightings at a particular distance offshore in the Ferreira & Roberts (2003) survey could indicate: a. there were no dolphins at this distance offshore; b. no survey lines were run at this distance; or c. survey effort was very low and the lack of sightings was due to chance (e.g., no survey lines were run between 2.5 and 4.5 km offshore). Ferreira & Roberts (2003) corrected the number of sightings for survey effort to determine the frequency of sightings by distance offshore (Figure 11). These corrected data should be interpreted with caution, given the uneven allocation of survey effort (Table 1) with only 14% of the total survey effort allocated more than 1 km from shore. About 3% of the survey effort went beyond the most offshore sighting (approx. 3 n. mile) and there was no survey effort beyond 5 n. mile Nevertheless, the results are broadly similar to the summer 2004 survey. Maui's dolphins were sighted to about 3 n. mile offshore and sightings were much more common within 1 n. mile of the coast.

Likewise, Ferreira & Roberts' (2003) results on alongshore distribution (Figure 12) were very similar to those from our 2004 surveys. Again, it is important to consider how sighting effort was allocated. In the Ferreira & Roberts (2003) study, 10 transects were flown in the area north of Kaipara and 19 in the area south of Raglan, out of a total of 121 transects. In the second summer of their survey, a maximum of four transects was flown in areas north and south of the Kaipara-Raglan area, compared to a maximum of 21 transects within the central area (for more detailed information, see Table 1). Nevertheless, Ferreira & Roberts (2003) made regular sightings as far north as the Kaipara Harbour, consistent with results from this and Russell's (1999) studies. Ferreira & Roberts' (2003) southernmost sighting was just south of Raglan, in an area where we also made regular sightings on alongshore and offshore transects (e.g., Figures 4, and 13).

In summary, the Ferreira & Roberts (2003) survey indicates that the offshore distribution of Maui's dolphin extends to at least 3 n. mile offshore and that the alongshore distribution extends at least to Kaipara Harbour in the north and just south of Raglan in the south.

Russell (1999) made sightings only in the Kaipara Harbour to Port Waikato area, but this central area received much more survey effort than the areas further north and south. It would be useful to correct the sightings for survey effort. The lack of research sightings in the northern and southern parts of the range of Maui's dolphin is most likely due to the lower sighting effort there. All other surveys of Maui's dolphin have made sightings further south (Dawson & Slooten 1988, Ferreira & Roberts 2003, the 2004 aerial surveys) and Russell (1999) reported public sightings further south. Dolphins can easily be missed in low-density areas and in areas with low survey effort. Several members of the public, including a fisherman well familiar with the species and a DOC officer, reported a small group of Maui's dolphins in the New Plymouth area while we were carrying out our summer aerial survey. We did not see dolphins in this area on the aerial survey. Kirsty Russell (pers. comm.) searched the area by boat and from the air, and also failed to find the dolphins.

In addition to research sightings, Russell (1999) also reported stranding records and sightings made by members of the public (Figures 14 and 15). She carefully researched these to ensure accurate location and species identification. Strandings and public sightings indicate that the distribution of Maui's dolphin extends at least as far south as New Plymouth.

In the central part of her study area, Russell (1999) made about one sighting on every two surveys, a low sighting rate (also see Table 3). Boat surveys usually have much higher sighting rates, per kilometre of survey effort, than aerial surveys. This low sighting rate is especially surprising, given that boat survey effort was concentrated during the summer and close to shore in areas where dolphins are most common.

Sightings have been made in three of the five harbours included in the protected area (Table 2). Again, it is important to consider the influence of sighting effort. As well as sightings made by members of the public, Russell (2002) reported her own sightings in the Manukau Harbour. These research sightings were made on the way from the ramp where the research boat is launched to the Manukau Harbour entrance. Following the first of these sightings, in December 2000, the researchers formally included the area between the boat ramp and the harbour entrance in their survey effort. Four more research sightings were made in the Manukau Harbour in January 2001 and another two sightings in January 2002.

A study using acoustic data loggers (also known as porpoise detectors or PODs) is underway to provide quantitative data on Maui's dolphin use of these harbours. Preliminary data indicate that Maui's dolphin regularly travel into the Manukau Harbour. Sightings and acoustic detections have been made beyond the eastern boundary of the protected area in the Manukau Harbour (Richlen et al. 2005).

The relative sighting rates for the northern, central, and southern areas differ among the three studies (Table 3). However, all three studies indicated that the highest densities are found in the central area between Manukau Harbour and Port Waikato. The number of sightings per unit of survey effort was 2.5 to 3 times higher in the Manukau Harbour-Port Waikato area than in the Kaipara-Manukau area in each of the studies (Table 3).

4. DISCUSSION

The geographic range of Maui's dolphins extends at least as far north as Maunganui Bluff and at least as far south as New Plymouth. All surveys to date indicate that Maui's dolphin densities are highest in the area from the Manukau Harbour to Port Waikato. Although sightings are less frequent to the north and south, regular sightings are made to at least Maunganui Bluff in the north and New Plymouth in the south. The number of sightings in Taranaki, south of the protected area, appears to be decreasing (Russell 1999, Burkhart & Slooten 2003). Maui's dolphins use at least three of the five west coast harbours (Russell 1999, 2002, Richlen & Slooten 2005). The population size estimate of 111 (c.v. 0.44) confirms the critically endangered status of Maui's dolphin (IUCN 2000).

The furthest offshore sightings of Maui's dolphins were between 3 and 4 n. mile from the coastline. At 4 n. mile, the offshore boundary of the protected area is just outside these sightings. The available data suggest that the offshore boundary of the protected area is sufficient to avoid overlap between dolphins and existing gillnet fisheries. Likewise, the northern boundary at Maunganui Bluff seems appropriate.

Gillnet fisheries continue to overlap with Maui's dolphin in the harbours, which are not included in the protected area, and in the southern part of their distribution (south of Pariokariwa Point). The Maui's dolphin population in the southern area has the highest extinction risk (Burkhart & Slooten 2003). Gillnet fishing effort is relatively high off Taranaki and in the harbours of the North Island west coast (e.g., Burkhart & Slooten 2003).

The level of fishing effort inside west coast harbours, compared to the adjacent open coast, means that even infrequent use of the harbours by Maui's dolphins could be important in terms of entanglement risk. Gillnet fishing by commercial and amateur fishers occurs in each of these harbours (Hokianga, Kaipara, Manukau, Raglan, Aotea, and Kawhia Harbours).

In addition, trawl fisheries overlap with Maui's dolphins throughout their range. Dolphins are regularly caught in trawl fisheries, including the east coast South Island trawl fishery (Baird & Bradford 2000) and the Taranaki jack mackerel fishery (Norden & Fairfax 2004).

The risk of leaving part of the population unprotected is most clearly demonstrated by recent research results from the Banks Peninsula Marine Mammal Sanctuary. The Banks Peninsula population is much larger, and has been studied more intensively and for a longer period (over 20 years). This has made it possible to study the effectiveness of the sanctuary by monitoring survival rates of the local dolphin population. The Banks Peninsula Marine Mammal Sanctuary leaves a significant part of the population unprotected (see above) and allows the continuation of some activities (e.g. trawling) within it that are known to pose a risk to dolphins. Recent research results indicate that the survival rate of this population is still too low to allow population growth (DuFresne 2005).

Given their small population size and critically endangered status, it is vital to ensure that recovery of Maui's dolphin is not hindered by continued catches in fishing operations. Currently, the areas with the highest bycatch risk are the harbours and the area south of the protected area. Inside the protected area, there is a continuing risk of bycatch in trawl fisheries and illegal gillnetting. Some recreational gillnetting continues inside the protected area. We have observed recreational gillnets inside the protected area during the summer survey and during the acoustic monitoring project that began in December 2004. Fisheries officers have confiscated a number of gillnets inside the protected area.

In summary, there are no major concerns about the northern and offshore boundaries of the protected area, given current knowledge about Maui's dolphin distribution and the potential overlap with gillnet fishing. Maui's dolphins continue to overlap with gillnet fisheries in the harbours and to the south of the protected area, and with trawl fisheries throughout their range.

5. ACKNOWLEDGMENTS

We are very grateful to WWF and MFish for providing funding and logistical support for this survey. Part of the research was funded under the Ministry of Fisheries project ENV2004–06, Objective 1. The survey design benefited from discussions with Susan Waugh, Jennifer Brown, Caren Schroder, Paul Starr, and members of the Aquatic Environment Working Group.

6. REFERENCES

Baird, S. J.; Bradford, E. (2000). Estimation of Hector's dolphin bycatch from inshore fisheries, 1997-98 fishing year. Published Client Report on Contract 3024, Funded by Conservation Services Levy. Published in Wellington by Department of Conservation. 20 p. (www.csl.doc.govt.nz/CSL3024.pdf)

Buckland, S.T.; Anderson, D.R.; Burnham, K.P.; Laake J.L., Borchers, D.L.; Thomas, L. (2001). Introduction to distance sampling. Oxford University Press, London. 432 p.

Burkhart, S.M.; Slooten, E. (2003). Population viability analysis for Hector's dolphin *(Cephalorhynchus hectori)*: a stochastic population model for local populations. *New Zealand Journal of Marine and Freshwater Research* 37: 553–566.

Dawson, S.M.; Slooten, E. (1988). Hector's dolphin *Cephalorhynchus hectori:* distribution and abundance. *Reports of the International Whaling Commission,* Special Issue 9: 315–324.

DuFresne, S. (2005). Conservation biology of Hector's dolphin. Unpublished PhD thesis, University of Otago, Dunedin.

Ferreira, S.M.; Roberts, C.C. (2003). Distribution and abundance of Maui's dolphins *(Cephalorhynchus hectori maui)* along the North Island west coast, New Zealand. *DOC Science Internal Series* 93. Department of Conservation, Wellington. 19 p. (www.doc.govt.nz/Publications/004~Science-and-Research/DOC-Science-Internal-Series/PDF/DSIS93.pdf)

Manly, B.F.J.; McDonald, L.L.; Garner. G.W. (1996). Maximum likelihood estimation for the double-count method with independent observers. *Journal of Agricultural and Biological and Experimental Statistics* 1(2): 170–189.

IUCN (2000). Red list of threatened species. IUCN, Gland, Switzerland and Cambridge, United Kingdom. 61 p.

Norden, W.; Fairfax, D. (2004). Common dolphin incidental bycatch. Conservation Services Programme, Occurrence Report 2004/2. (Unpublished report held by Department of Conservation, Wellington.)

Rayment, W.J.; Clement, D.M.; Dawson, S.M.; Neale, D.; Secchi, E.; Slooten, E. (2003). Offshore distribution of Hector's dolphin on the northern west coast of the South Island. Final report to Department of Conservation, on contract Buller 2003 HD002. (Unpublished report held by Department of Conservation, Wellington.)

Richlen, M.; Slooten, E.; Dawson, S.M. (2005). Maui's dolphin use of North Island harbours. Progress Report to Department of Conservation. (Unpublished report held by Department of Conservation, Auckland.)

Russell, K. (1999). The North Island Hector's dolphin: a species in need of conservation. Unpublished MSc thesis, University of Auckland.

Russell, K. (2002). Distribution of public and research sightings of Hector's dolphins within the Manukau Harbour. (Unpublished report held by Ministry of Fisheries, Wellington).

Slooten, E.; Dawson, S.M.; Rayment, W.J. (2004a). Aerial surveys for coastal dolphins: Abundance of Hector's dolphins off the South Island west coast, New Zealand. *Marine Mammal Science 20(3)*: 117–130.

Slooten, E.; Dawson, S.M.; Rayment, W.J.; Childerhouse, S.J. (2004b). Aerial survey of North Island Hector's dolphin. Final report to Department of Conservation and World Wide Fund for Nature, Wellington. (Unpublished report held by Department of Conservation, Wellington and WWF, Wellington.)

Slooten, E.; Rayment, W.J.; Dawson, S.M. (2005). Offshore distribution of Hector's dolphins at Banks Peninsula: Is the Banks Peninsula Marine Mammal Sanctuary large enough? (Unpublished report held by WWF, Wellington.)

Table 1: Survey effort in the Ferreira & Roberts (2003) surveys. *n* represents the total number of transects in a zone; numbers in parentheses represent the number of transects at that particular distance offshore.

	Area	Effort	*n*	Effort (km) at various offshore distances							
Summer of 2000–01	(km^2)	(km)		400–600m	800–1 000m	1 500m	2 500m	4 500m	5 500m	7 500m	9 500m
Cape Reinga – Ahipara	1 012.7	216.0	2	108.0 (1)	108.0 (1)	-	-	-	-	-	-
Ahipara – Kaipara	1 917.5	538.9	4	184.5 (1)	170.0 (2)	-	-	-	-	184.5 (1)	-
Kaipara – Manukau	822.9	931.0	14	166.2 (2)	598.6 (10)	-	166.2 (2)	-	-	-	-
Manukau - Port Waikato	353.7	1 332.5	34	313.5 (8)	627.0 (16)	78.4 (2)	39.2 (1)	78.4 (2)	156.8 (4)	-	39.2 (1)
Port Waikato – Raglan	482.2	624.5	12	140.1 (2)	312.2 (6)	52.0 (1)	52.0 (1)	104.1 (2)	-	-	-
Raglan – Kawhia	382.9	156.4	4	39.1 (1)	117.3 (3)	-	-	-	-	-	-
Kawhia - New Plymouth	1 454.1	620.3	5	156.8 (1)	463.5 (4)	-	-	-	-	-	-
New Plymouth – Paraparaumu	3 047.1	540.0	2	270.0 (1)	270.0 (1)	-	-	-	-	-	-
45° offshore surveys	353.7										
Summer of 2001–02											
Cape Reinga – Ahipara	1 012.7	-	-	-	-	-	-	-	-	-	-
Ahipara – Kaipara	1 917.5	548.9	4	184.5 (1)	274.5 (2)	-	90.0 (1)	-	-	-	-
Kaipara – Manukau	822.9	357.4	5	274.3 (4)	83.1 (1)	-	-	-	-	-	-
Manukau - Port Waikato	353.7	460.1	21	303.4 (17)	156.8 (4)	-	-	-	-	-	-
Port Waikato – Raglan	482.2	312.2	6	208.2 (4)	104.1 (2)	-	-	-	-	-	-
Raglan – Kawhia	382.9	156.4	4	78.2 (2)	78.2 (2)	-	-	-	-	-	-
Kawhia - New Plymouth	1 454.1	627.0	4	313.5 (2)	313.5 (2)	-	-	-	-	-	-
New Plymouth – Paraparaumu	3 047.1	-	-	-	-	-	-	-	-	-	-
45° offshore surveys	353.7	572.4	44								

Table 2: Sightings of North Island Hector's dolphins in west coast harbours (from Russell 2002).

Harbour	Research sightings	Public sightings
Manukau	7	11
Raglan		1
Kaipara		2

Table 3: Relative number of sightings of North Island Hector's dolphins in different areas, including data from Russell (2002), Ferreira & Roberts (2003), and Slooten et al. (2004b)

Area	Kaipara to Manukau	Manukau to Pt Waikato	Pt Waikato to Raglan	Raglan to Kawhia
Russell (2002)				
Sightings	3	14	0	0
Survey effort (km)	664	1286		
Sightings per km	0.005	0.011		
Proportions	0.29	0.71		
Ferreira & Roberts (2003)				
Weighted sightings	3.19	9.06	3.08	1.22
Proportions (4 areas)	0.19	0.55	0.19	0.07
Proportions (2 areas)	0.26	0.74		
Slooten et al. (2004b)				
Sightings	2	4	1	1
Survey effort (km)	475	309	285	251
Sightings per km	0.004	0.013	0.004	0.004
Proportions (4 areas)	0.17	0.53	0.14	0.16
Proportions (2 areas)	0.25	0.75		

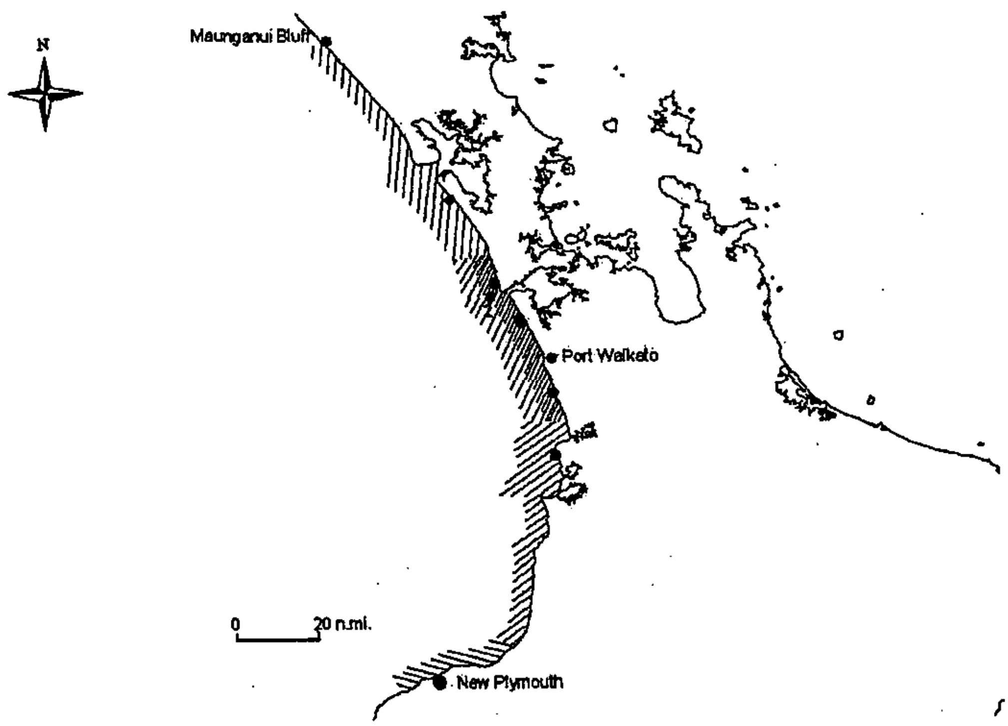

Figure 1: Sightings made on offshore survey lines in summer 2004.

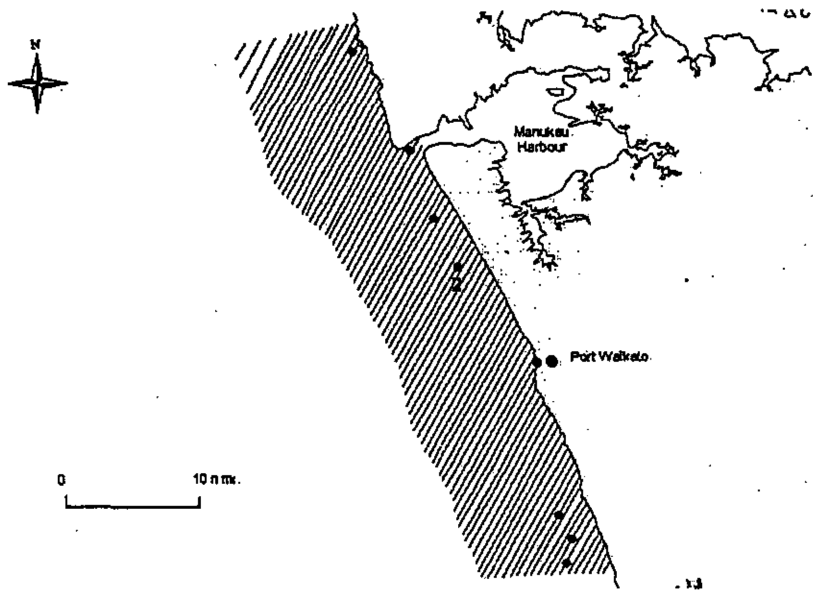

Figure 2: Sightings made on offshore survey lines in winter 2004.

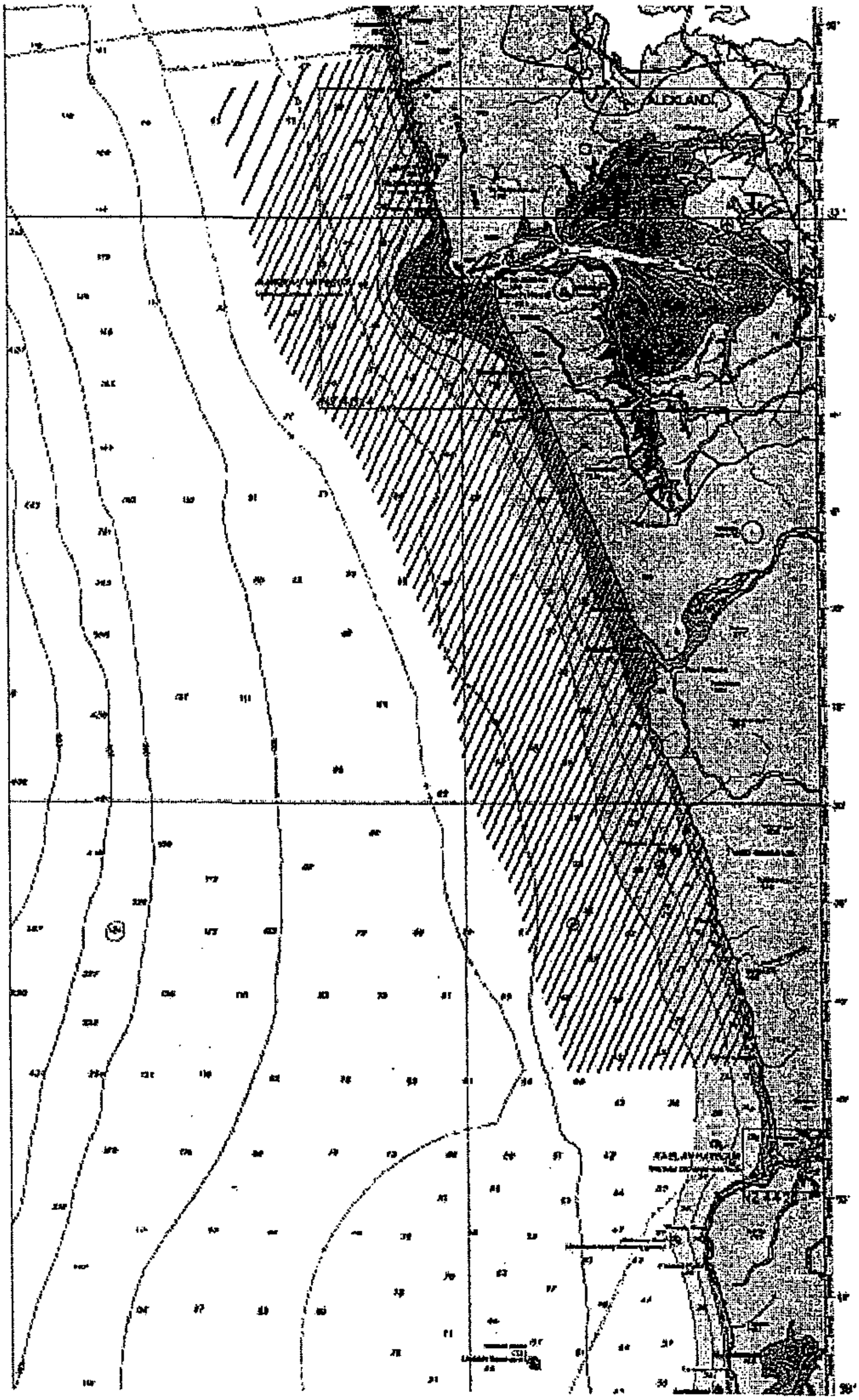

Figure 3: Survey lines completed using the fixed-wing plane (black, 70 lines) and helicopter (grey, 19 lines). Basemap modified from LINZ chart (2003), used with permission.

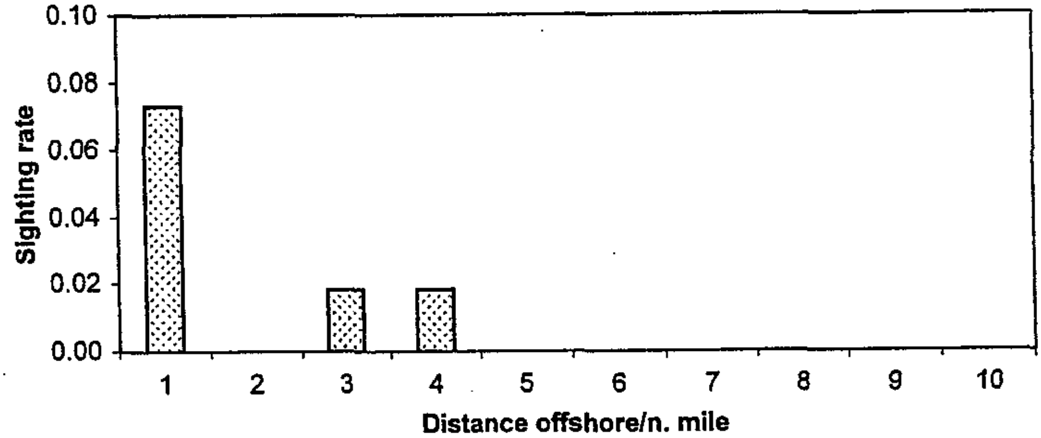

Figure 4: Offshore distribution of sightings made in winter 2004 off North Island west coast. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort (n = 9 *sightings*).

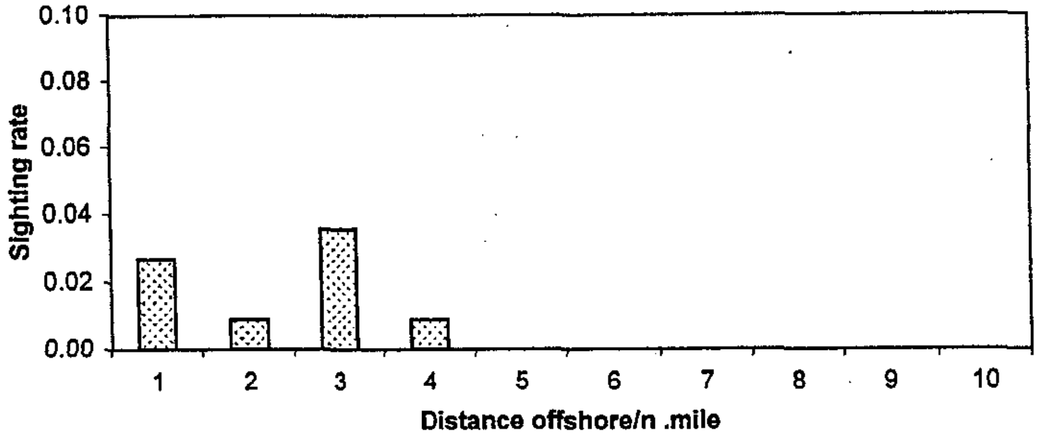

Figure 5: Offshore distribution of sightings made in summer 2004 off North Island west coast. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort (n = 6 sightings, central stratum only).

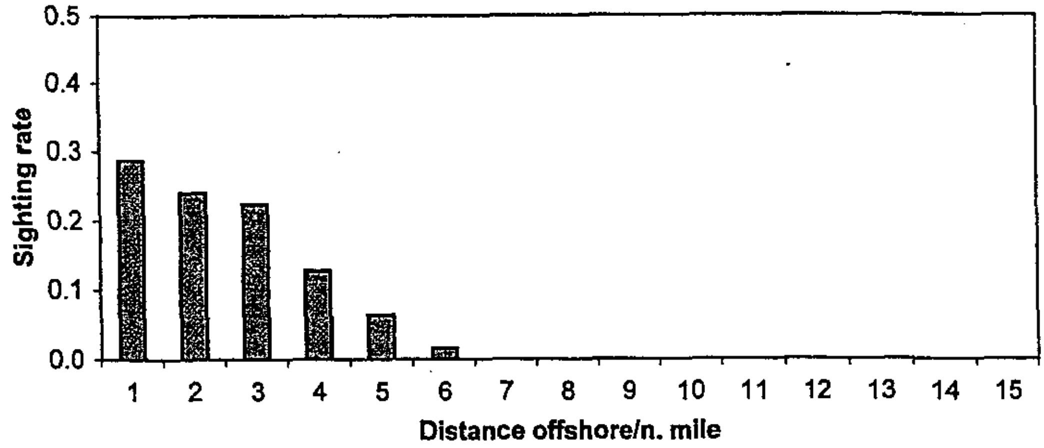

Figure 6: Offshore distribution of sightings made in winter 2003 off South Island west coast. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort (n = 60 sightings).

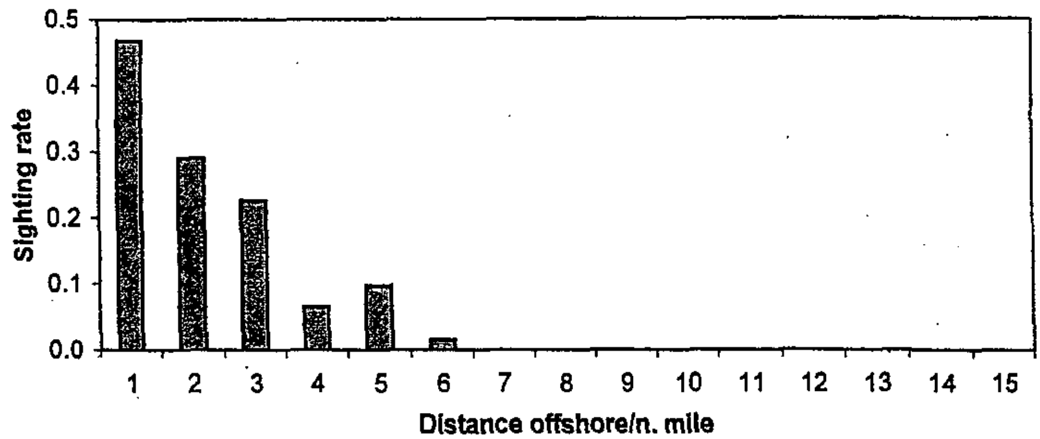

Figure 7: Offshore distribution of sightings made in summer 2003 off South Island west coast. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort (n = 72 sightings).

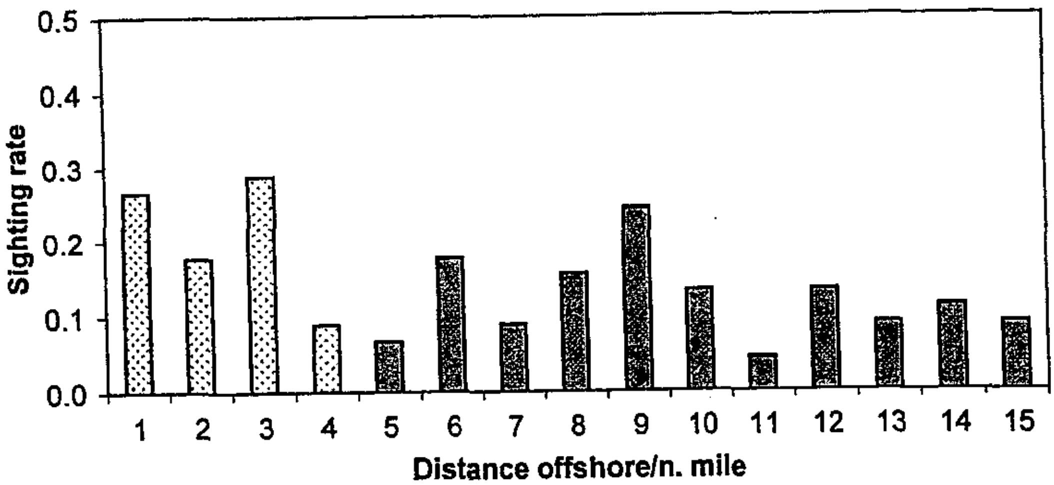

Figure 8: Offshore distribution of sightings made in winter 2002 and 2004 off Banks Peninsula. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort. Dotted bars are inside protected area, solid bars are outside protected area (n = 97 sightings).

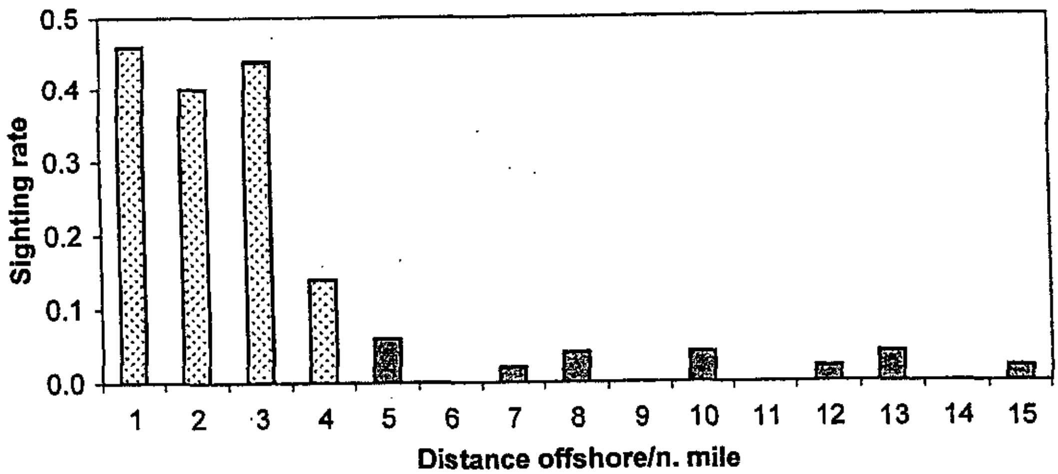

Figure 9: Offshore distribution of sightings made in summer 2002 and 2004 off Banks Peninsula. Sighting rate = number of dolphin groups per nautical mile (n. mile) of survey effort. Dotted bars are inside protected area, solid bars are outside protected area (n = 84 sightings).

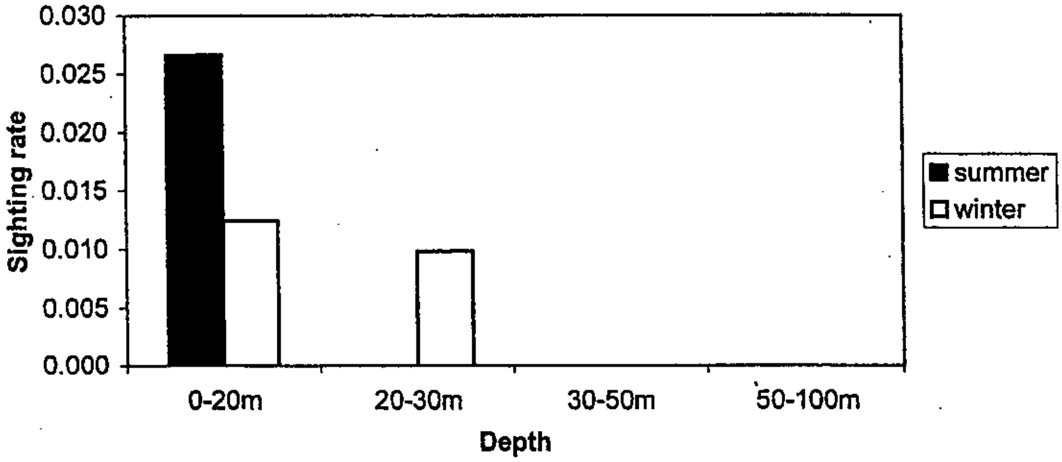

Figure 10: Relationship between sighting rate and water depth for the central stratum of the North Island west coast. The sighting rate is expressed in sightings per km of survey effort.

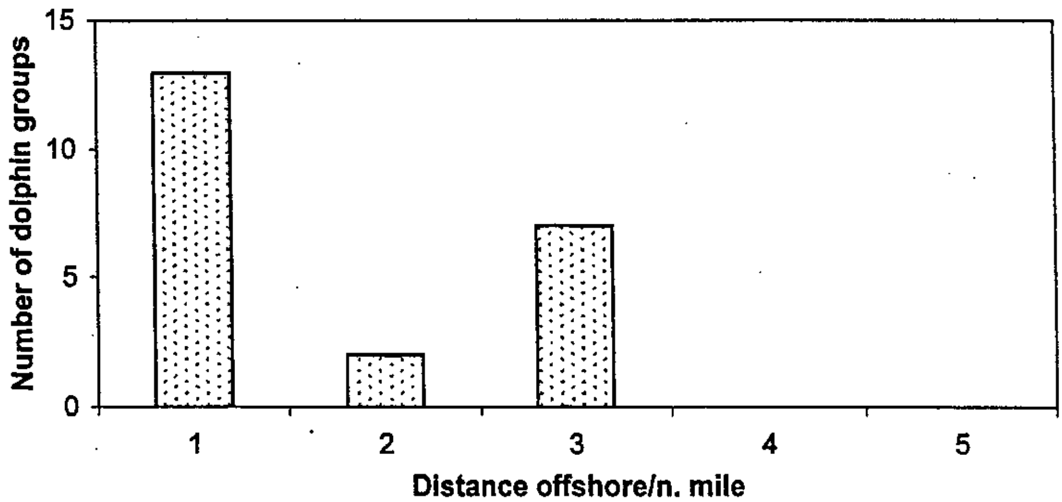

Figure 11: Frequency of sightings at different distances from shore, corrected for survey effort, modified from Ferreira and Roberts (2003). The furthest offshore sightings were recorded during October 2001.

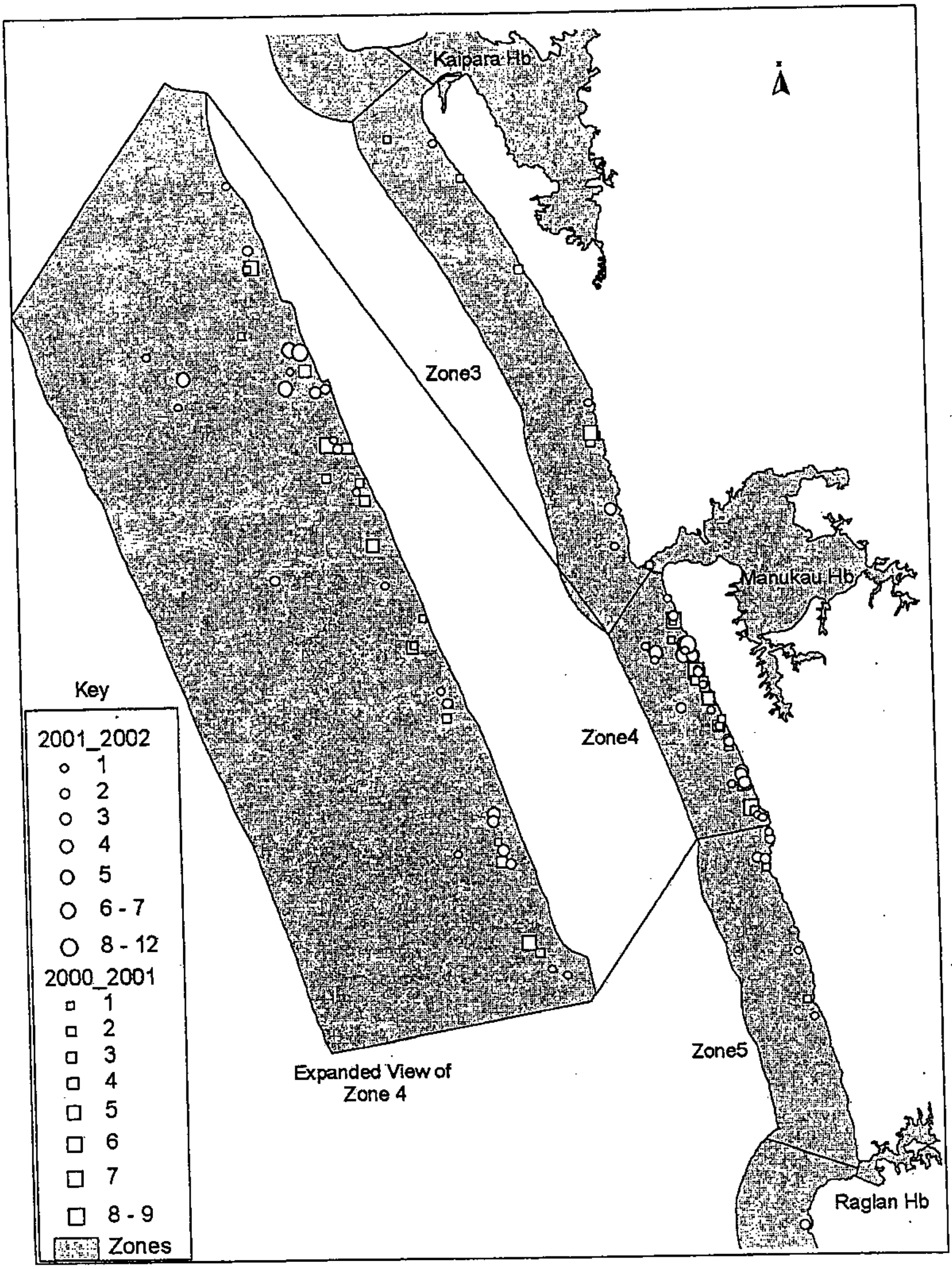

Figure 12: Distribution of North Island Hector's dolphin sightings during surveys conducted in the summers of 2000–01 and 2001–02, reported by Ferreira & Roberts (2003). The four furthest offshore sightings in zone 4 were recorded during October 2001.

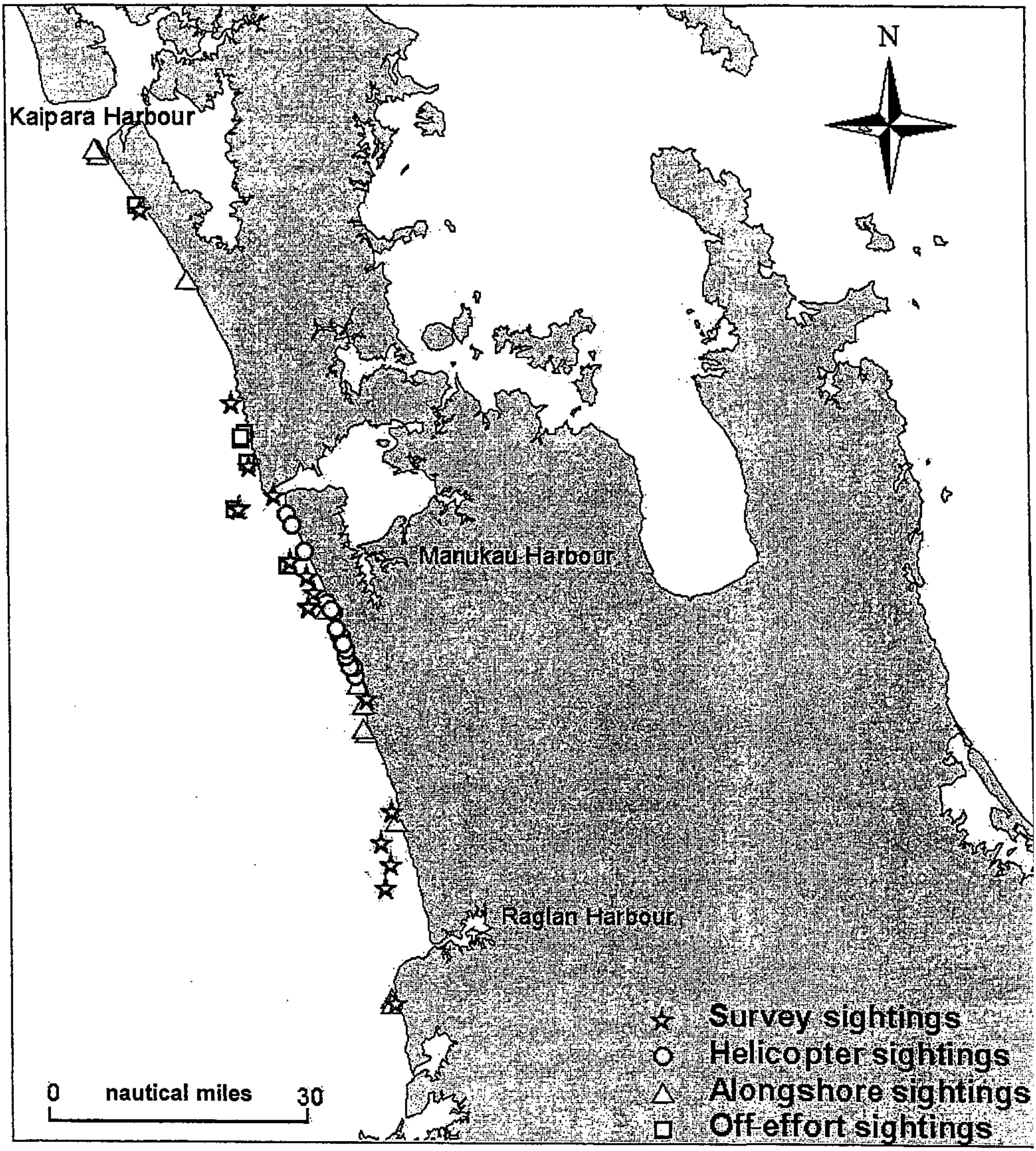

Figure 13: All sightings made in our summer and winter aerial survey, to provide a comparison with Figure 12. Includes sightings on offshore survey lines (from Figures 1 and 2), alongshore lines, off effort and during helicopter surveys to estimate the proportion of time dolphins spend at the surface.

Figure 14: Public sightings of North Island Hector's dolphins in the 1970s (left), 1980s (middle), and 1990s (right), from Russell (1999).

Figure 15: Stranding locations of North Island Hector's dolphins, 1970–2000 (from Russell 1999).