Return to previous file: MCU13c

Figure 35. Wandering means: mean center for each animal for each month of transmissions.

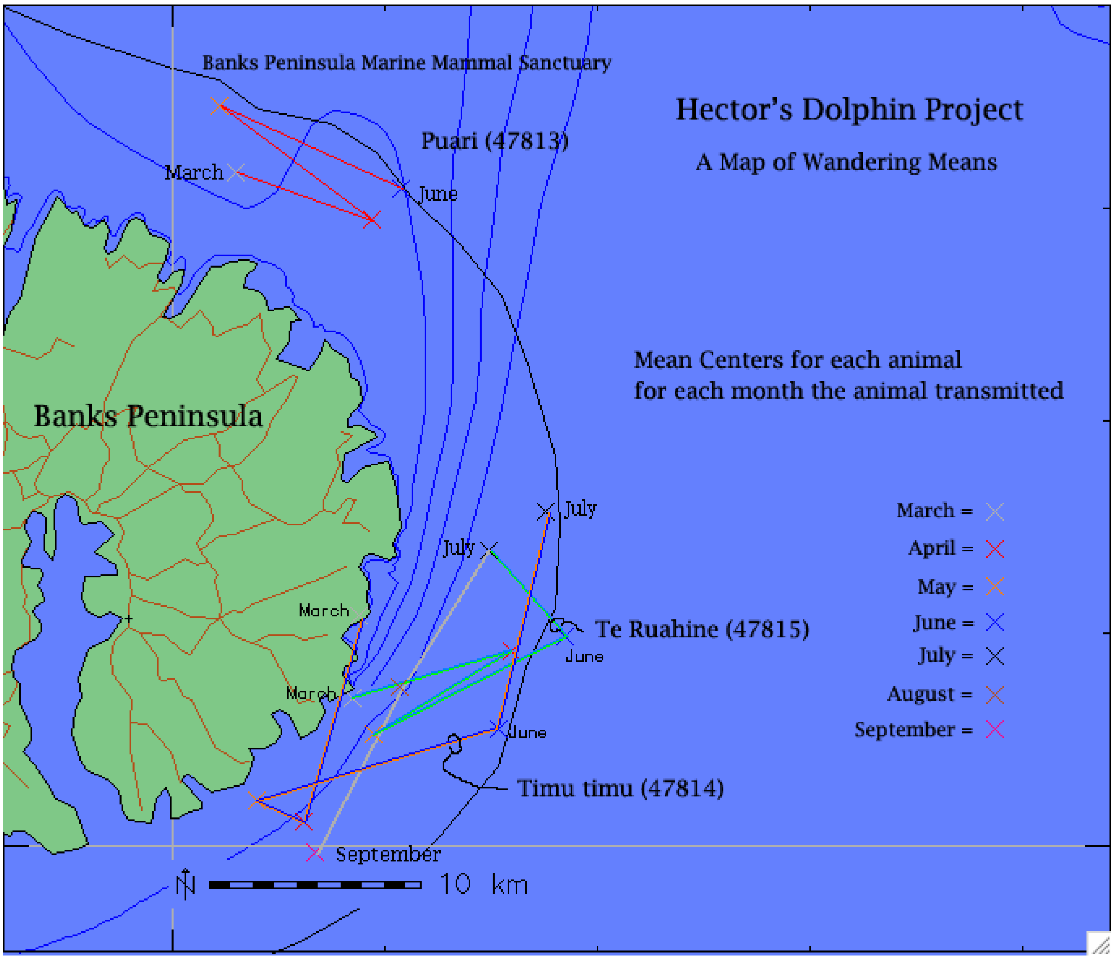
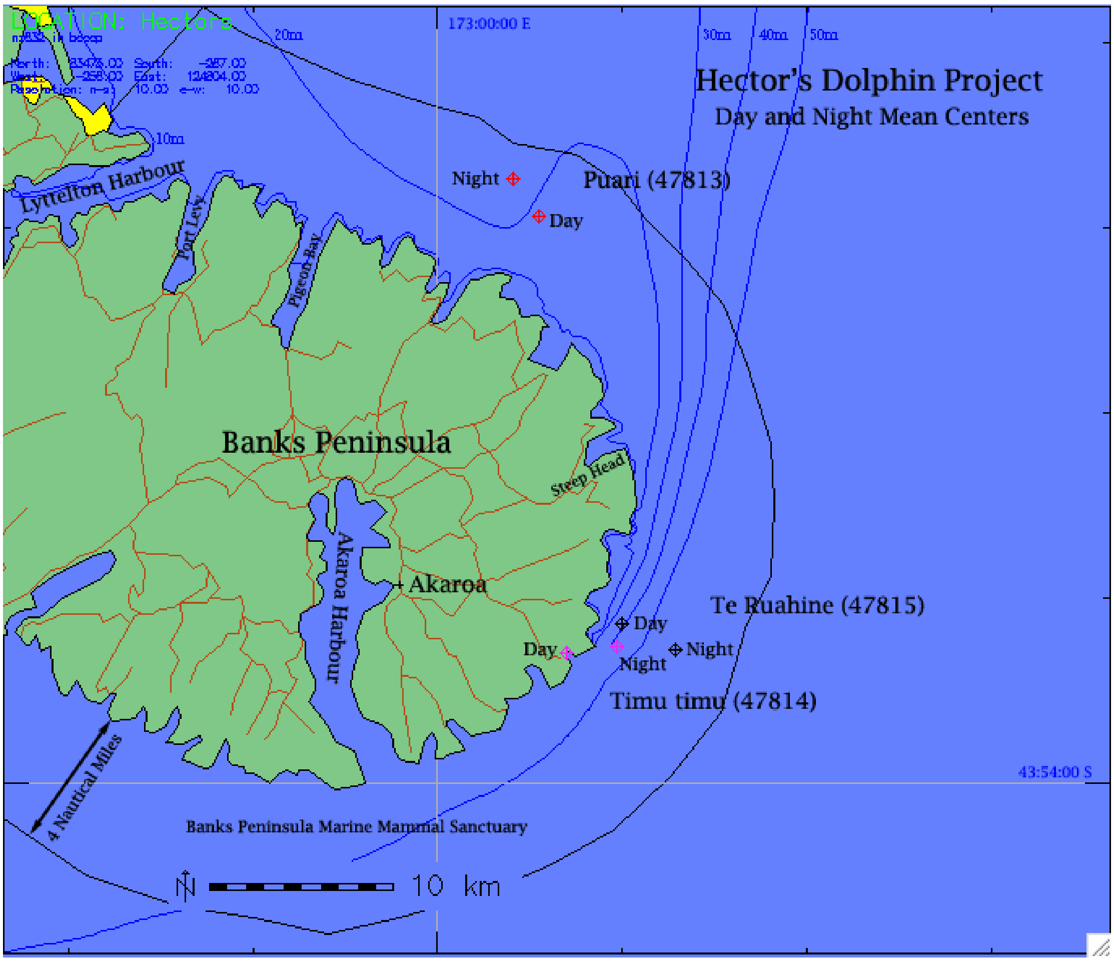


Figure 36. Day and night mean centers for study dolphins for location classes 1,2, and 3. All night positions were recorded after sunset until sunrise, local time; all day positions were recorded after sunrise until sunset, local time.



Monitoring

During the summer of 2004, the Department of Conservation vessel Ranger II and the vessel Seafox conducted surveys to monitor the tagged dolphins on 8, 9, 12, 15, 16, 21, 22 and 25 March 2004. No tagged dolphins were seen on these trips.

On 16 March 2004, a pod of between 75-100 dolphins was sighted at Akaroa Heads, with telemetry data indicating that dolphin 47815 was in the group. Though not photographed, a dolphin tour boat operator and DOC staff saw the animal briefly. The dolphin was swimming normally within the pod.

On 21 March 2004, dolphin 47815 was sighted in Akaroa Harbour by three commercial vessel operators including Mr. Geoff Hamilton of the Onuku Farm Hostel, Mr. Chris Jenkins, an employee of Dolphin Experience, and Mr. Craig Rhoades, head skipper for Akaroa Harbour Cruises. All three boat operators saw the animal and identified it by the large “2” written on the backplate of the tag attachment. The animal, seen as close as two meters, was reported as being very interested in the boats (boat positive) and swimming normally within the pod. Observation lasted for approximately one hour. Stone and Hutt, once notified, proceeded to the area but did not sight the animal. Mr. Chris Jenkins of Dolphin Experience provided photographs (Figures 37 and 38).

On 22 March 2004, Akaroa Harbour was surveyed but no tagged dolphins were sighted. Dolphins were not scheduled to transmit on this day.

On 23 March 2004, researchers drove by vehicle to five headlands around Banks Peninsula with a radio receiver to attempt land-based monitoring of tagged dolphins. No signals were received. Weather conditions prevented boat surveys off the headlands where tagged animals were transmitting.

On 25 March 2004, boat surveys were undertaken in the southern bays of Banks Peninsula utilizing a radio receiver. No tagged dolphins were seen or detected.

On 26 March 2004, Mr. Chris Jenkins of Dolphin Experience reported seeing a dolphin with a tag, but was unable to determine the tag number. The dolphin was reported to be swimming and behaving normally.

The Akaroa Field Centre staff continued regular monitoring cruises out from Akaroa once or twice a week, through the time of this report, but did not encounter any of the tagged dolphins nor were any reported by other vessel operators in the region.

During the summer of 2005, there were several reports from the Akaroa commercial dolphin vessels of dolphins sighted with two holes in their dorsal fins, swimming within dolphin pods. These dolphins were not observed by researchers nor were any photographs taken of which we are aware.

Figure 37. Dolphin 47815 (Te Ruahine) sighted in Akaroa Harbour 21 March 2004.

Photo by Chris Jenkins

Figure 38. Dolphin 47815 (Te Ruahine) sighted in Akaroa Harbour 21 March 2004.

Photo by Chris Jenkins

DISCUSSION

This successful field trial has provided new understanding of the biology and behaviour of this species from the unprecedented combination of satellite tracking, health assessments and molecular analyses. The critical early stages of the project involving the capture, health assessments, tagging and release of the study dolphins went very well. The telemetry data received were of consistently high quality, and the battery-powered tags exceeded the three-month requirement as specified by the Department of Conservation.

A point of particular concern in the trial was the effect of the capture and handling on the animals. Dr. Alan Baker caught and tagged 27 Hector's dolphins in the 1970s without mishap, and we chose to use that same technique in this study. With Dr. Baker's assistance, we obtained the same tail grab device and designed all associated lines and equipment to duplicate Baker's proven method. The method was successful, and the animals responded well to the procedures without apparent adverse effect on health status. The out-of-water time for each study dolphin successively decreased due to the field team's acquired experience. The third dolphin was out of the water nearly 30% less time than was the first.

Based on plasma cortisol levels, a standard indicator of stress in vertebrates, these dolphins showed either no response or only minimal response to capture and handling. The levels detected were similar to those reported for captive bottlenose dolphins and killer whales habituated to handling and blood sampling (Suzuki *et al.* 2003). The cortisol levels were also much lower than in free-living beluga whales that had been chased and captured for blood sampling (St. Aubin and Geraci 1989; Ortiz and Worthy 2000). It is possible that insufficient time had elapsed between capture and blood sampling to detect a response from the adrenal gland; it is reported that it might take one hour for cortisol levels to rise in bottlenose dolphins (Thompson and Geraci 1986). Alternatively, because Hector's dolphins are naturally boat positive and were not chased prior to capture, it is possible the procedure was not excessively stressful. Elevation of heart rate and respiratory rate are more immediate indicators of stress than is the release of adrenal corticosteroids. Heart rate and respiratory rate were monitored by the supervising veterinarian for all dolphins from capture to release. With the exception of a transitory elevation in heart rate following biopsy of the dorsal fin in the older female dolphin, there was no discernable change in rate throughout the handling period for all three dolphins. Furthermore, the heart rates were similar to those reported for harbour porpoises on which satellite transmitters were deployed in Danish waters (Eskesen *et al.* submitted manuscript). As in the previous study on harbour porpoises, heart rate appears positively correlated with cortisol levels as in the case of Puari (47813). However, by contrast with porpoises where there was no relationship found between cortisol level and respiration rate, there appears to be an elevation of respiratory rate in Puari over that seen in the two younger dolphins.

At the end of the handling procedure, the dolphins were suspended in the water in the stretcher while their behaviour and respiration were observed for several minutes prior to release. All were judged to be behaving and breathing normally and swam away from the boat with normal vigorous locomotion.

After their release, the animals were monitored through the positions provided by their tags for 24 hours a day for five days, and then every other day for 10 days. According to Geertsen *et al*. (in press) the behavioural effects on a captive satellite-tagged harbour porpoise (*Phocoena phocoena*) lasted less than 24 hours. We therefore judged that if the capture and handling were to have a negative health effect on the animals, it would be most evident in the first 24 hours, with a decreasing risk as time progressed.

The satellite tag attachment required that two 7mm holes be biopsied through the dorsal fin. The positions of these holes were carefully planned to avoid any large blood vessels in the dorsal fin, and thus penetrated epidermis (skin) and the dense collagenous connective tissue of the fin. This was achieved successfully causing only minimal bleeding in all of the dolphins, and without requiring additional cauterization of vessels. The biologically inert material in contact with the dolphin tissue was chosen to avoid an inflammatory response; inflammation was further suppressed by administration of flunixin. Since dolphin integument heals remarkably rapidly compared to that of terrestrial mammals, it could be expected that the exposed dermis would be healed within a matter of days (Orams and Deakin 1997).

During the early hours, days and weeks after tagging, the telemetry data indicated that the animals were actively moving about the waters of the study area in ways that we would expect, based on the many years of visual observations of this species in this area (for example, see Bräger *et al.* 2002). We would have been concerned had a tagged dolphin stopped in one place, swum far up inside a harbour or bay for a prolonged period, or displayed other behaviours that have rarely, if ever, been observed in the Peninsula region. The Hector’s dolphin population of the Banks Peninsula region is the most-studied population in New Zealand, which is why this area was selected for the trial: the telemetry could be interpreted against a large background of other data collected over many years.

Analysis of the telemetry data offered new information about the home ranges for this species. In natural history terms, an animal’s home range is defined as “that area traversed by the individual in its normal activities of food gathering, mating, and caring for young” (Burt 1943). Translating that into statistical measure requires that it is some fixed percentage of a region defined from the animal’s area utilization distribution. The satellite telemetry data have provided this measure for individual dolphins during the period of this study, but in more detail than provided by photo-identification study in the past, and in vastly shorter time than was spent on previous efforts.

From the spatial distribution, it was evident that the animals each had preferred areas; Puari (47813) remained to the north of Banks Peninsula, while Timu Timu (47814) and Te Ruahine (47815) lived more to the southeast of Banks Peninsula. All three dolphins, over time, displayed a mean center of activity in the general region from which they were caught, which indicates a relatively high degree of site tenacity during the tagging period. In fact, Puari, who was caught on the north side of the

Peninsula, stayed almost entirely out of the ranges of Timu Timu and Te Ruahine, both of which were captured in the same area to the southeast of the Peninsula.

This satellite telemetry study used two methods to estimate home range: the mean activity radius, which provides a measure of dispersion, and the Anderson Fourier Home Range, which illustrates all the data and the spatial statistical weight of the data. Both methods provide information on animal utilization of the oceans extending offshore throughout their range. It needs to be emphasized that the dolphins' ranges can change over seasons and time, and that this study represents only the months of tag transmissions. Further to this point is the wandering means analysis, which shows monthly shifts in the mean center for each animal.

Using the statistical mean of all positions as the center of the home range for each dolphin for the period of the study, the home range, measured as a radius from the mean center for each study dolphin, was: a) Puari #47813: 10.35 km (SE=0.443, n=359); b) Timu Timu #47814: 10.68 km (SE=0.43, n=361); and c) Te Ruahine #47815: 13.77 km (SE=0.44, n=429).

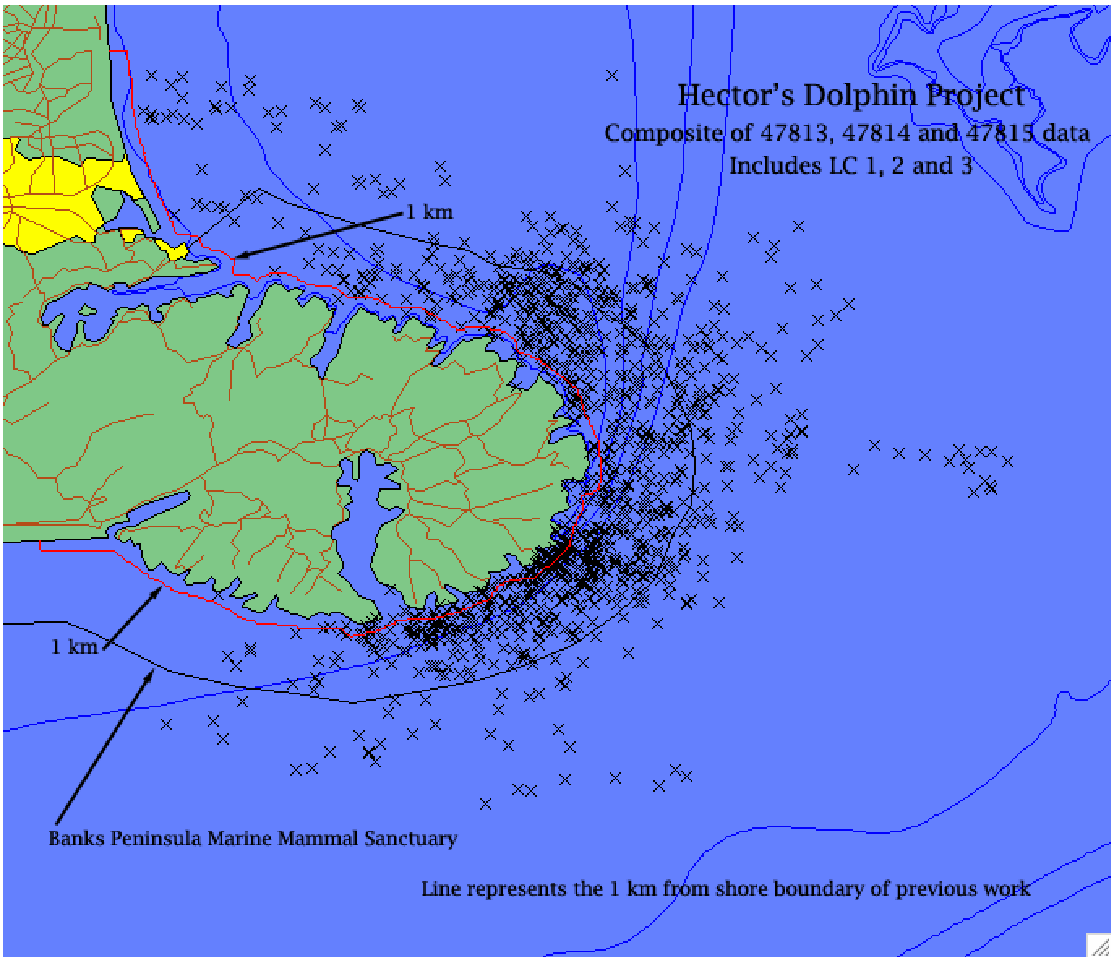
The mean home ranges as calculated in this report were of similar size for each dolphin. There are no similar studies for this species with which to compare, although Bräger *et al.* (2002) found a mean along-shore range of 31.0 km (SE = 2.43, n=32) using photo-identification and comparing resightings along a 1km-deep band of the Canterbury coast over a 12-year period. The Bräger photo-identification study sampled animals just within 1km of the shore and thus provided a measure only of along-shore distribution, whereas satellite telemetry provided data on each animal both near and offshore, greatly increasing its observed ranges and adding a new, more realistic offshore dimension to our understanding of the animals' distributions (Figure 39).

This satellite tagging trial required two days of fieldwork and six months of remote monitoring via satellite telemetry. In contrast, the Bräger *et al.* data were collected over 12 years and required 577 days (only 61 days in winter) of fieldwork. Each approach provides important information that, when taken together, complements our understanding of dolphin distribution and behaviour in the region.

While Bräger *et al.* described along-shore range, satellite telemetry provided more extensive and detailed individual animal movements, yielding unprecedented insights into the offshore ranges of these animals. Photo-identification is limited – data are usually collected only close to shore, only on good weather days, and only on the few identifiable individuals.

Photo-identification provides very few data points per animal when compared to satellite telemetry. For example, an individual dolphin was sighted on average 16 times in the Bräger *et al.* study over 12 years, while the satellite telemetry trial recorded an average 383 positions per animal over six months.

Figure 39. Extent of the data collection area for previous study (Bräger *et al.* 2002) on Hector's dolphin home ranges in the area, plotted against all positions for all dolphins in this telemetry study. The Bräger *et al.* study sampled only within the narrow 1km strip near shore as shown inside the red line. The satellite data from this study cover a vastly larger area, and required only 2 days of field time, compared to the 577 days spent on the along-shore survey.



The rich telemetry data sets for each of the three study dolphins provide many future opportunities for analysis beyond the goals of this study. For example, preliminary analyses of day and night mean centers appear to show a diurnal trend. This observation supports a previous study (Stone *et al*. 1995), but further exploration of these telemetry results is warranted.

Concurrent with telemetry data tracking, efforts were made to visually resight the animals for assessment of tagging impact. Akaroa field staff conducted surveys to locate the animals, but was only successful once. On several other days, commercial tour operators in Akaroa reported and, in one case photographed, a tagged animal. Tagged dolphins were seen on 16 and 21 March and 26 April swimming in Akaroa Harbour and interacting with other dolphins and tour boat operators, all of which indicated normal behaviour, as reported to us.

The dolphins were difficult to relocate visually given the two-to-four-hour lag required for the ARGOS system to process the information and make it available. Visually resighting animals is not a predictable way to monitor tagged dolphins that exhibit swimming ranges similar to those observed in this study.

Hormone analysis was conducted for all three dolphins. Cortisol levels were similar to those reported for captive cetaceans and were much lower than levels reported in free-living animals captured for sampling (Thompson and Geraci 1986; St. Aubin and Geraci 1989; Ortiz and Worthy 2000; Suzuki *et al*. 2003), indicating either that the study animals were sampled before their adrenals could respond, or that the capture and handling were not particularly stressful. St. Aubin and Geraci (1989) found that beluga whales (*Delphinapterus leucas*) were measured at 90$\pm$43 nmol/l, range 18-196 nmol/l. Buholzer *et al.* (2004) found that captive harbour porpoises (*Phocoena phocoena*) had mean cortisol levels of 20 µg/l or 2.0 µg/dl when they were in the water and 72 µg/l or 7.2 µg/dl when taken out of the water. Wild harbour porpoises had significantly higher mean levels of 170 µg/l or 17 µg/dl when taken on board for tagging. The Hector's dolphins in this study had markedly lower levels of this hormone.

It appears that dolphin 47813 may have been pregnant or cycling due to elevated progesterone levels. There are no previous data on this hormone level for this species, but Sawyersteffan *et al.* (1983) provides levels of progesterone in the pregnant and non-pregnant bottlenose dolphins, *Tursiops truncatus*. Bottlenose dolphin progesterone levels during gestation were 5.8-43.2 ng/ml. Comparing these data to our results indicate that pregnancy is a possibility for 47813, although it is impossible to say with certainty from only one blood test from a species on which no previous data exist. If the animal were pregnant, it was in the early stages because the pregnancy was not detectable during examination at the time of the health assessment. Ultrasonic imaging of the uterus was not possible because of logistical constraints.

Tag detachment remains an area of this work that could benefit from additional research and development, although this study used the most current tag detachment methodologies. The tags were designed to detach from the dorsal fin over time through the natural corrosive action of the metals holding the tag in place. However, the exact rates of corrosion are dependent on salinity, temperature and water movement and are thus extremely hard to estimate. Ideally, a tag should be designed to detach mechanically when the battery reaches a certain level, just prior to the end of its transmission life. This study specifically designed a tag with only two attachment holes; to our knowledge, this is the first satellite tag to be attached to a dolphin's dorsal fin with only two attachment pins. This important improvement reduces the number of attachment pins that need to corrode. By weakening the rear pin as we did, detachment of the tag could occur more quickly when the front nut corroded. If the rear nut corroded first, the tag would still be held in place until the front nut corroded. Two of the tags stopped transmitting somewhat earlier than the expected battery life and it is likely that these tags detached from the dolphins. However, there might be great variability in the expected battery life when using small batteries with long duty cycles (Teilmann *et al*. 2004). It is also possible that the batteries were simply depleted, or that other unknown malfunctions occurred in the tags.

It has been difficult to relocate the animals after tagging to assess their long-term status. A major impediment to this was the DOC contract specification that the dolphins chosen for tagging should have no obvious marks that would allow for individual identifications. Perhaps 5-10% of this species can be identified through marks on their bodies and dorsal fins; these marks have been used to follow the movements and natural history of individuals over many years by the authors of this study and by other researchers. However, since the contract for this work specified that we not tag individually identifiable animals, visually re-identifying animals from such marks is not possible.

A second impediment to re-identifying the study subjects was that cold branding (a technique that would have left a permanent mark on the animals' sides, thereby enabling re-identification over the years of monitoring) was also not allowed by the contract. The only remaining techniques for re-identifying the animals are to visually identify the individuals in the field by the two small biopsy plugs taken from the dorsal fin, or to genetically 'recapture' the individuals by comparing DNA profiling with other biopsy samples. Visual re-sighting is unlikely given the remarkable healing ability of dolphin integument. It is most likely that the biopsy holes would heal over once the pins were gone and would not be visible without very close inspection (Orams and Deakin 1997). Re-identification by DNA profiling is also unlikely given the relative abundance of the local population. Even so, it is important that observation effort continue in the region. Ideally, the study animals could be re-captured to conduct a follow-up health assessment in order to compare the results to the initial data, but finding the individuals will be difficult.

This study has shown that Hector's dolphin is a suitable species for telemetry studies.

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APPENDIX Wildlife Computers Program Sheets

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Report for Spot tag 03S3690 on 04-Mar-2004 at 06:12:53

PUARI-47813

Spot Time: 04-Mar-2004 at 07:10:42
Spot3Host version: 3.10.0004
Spot3ware version: 3.10m
Spot belongs to:
Department of Conservation
Transmission Frequency 401 652545.8 Hz

Extended Argos PTT number: 47813 or 04A4095F Hex.  Uplink/LUT number:
4752/95
  transmitting with fast repetition rate of 44.00 seconds
  and slow repetition rate of 89.00 seconds.
  It checks for dry (to start transmitting) every 0.25 seconds
  and switches to its slow repetition rate after 10 successive dry
transmissions
  Transmissions will suspended after being dry for never hours,
  and resume after being wet for 08 seconds.

Total Transmits to date = 867
Maximum transmissions per day = 700

Transmit on these hours:
1 - 22,
Transmit on these days:
Jan: 7, 8, 15, 22, 29,
Feb: 5, 12, 19, 26,
Mar: 4 - 9, 11, 13, 15, 17, 19, 22, 25, 28, 31
Apr: , 3, 7, 11, 15, 19, 23, 28,
May: 3, 8, 13, 18, 24, 30,
Jun: 5, 11, 17, 24,
Jul: 1, 8, 15, 22, 29,
Aug: 5, 12, 19, 26,
Sep: 2, 9, 16, 23, 30,
Oct: 7, 8, 15, 22, 29,
Nov: 5, 12, 19, 26,
Dec: 3, 10, 17, 24, 31

Time at temperature Histograms are not collected.
```

Report for Spot tag 03S3691 on 05-Mar-2004 at 06:33:01

TIMU TIMU 47814

Spot Time: 05-Mar-2004 at 07:28:58
Spot3Host version: 3.10.0004
Spot3ware version: 3.10m

Spot belongs to:
Department of Conservation
Transmission Frequency: 401 652535.9 Hz

Extended Argos PTT number: 47814 or 04A4096A Hex. Uplink/LUT number: 4752/106
  transmitting with fast repetition rate of 45.00 seconds
  and slow repetition rate of 90.00 seconds.
  It checks for dry (to start transmitting) every 0.25 seconds
  and switches to its slow repetition rate after 10 successive dry transmissions
  Transmissions will suspended after being dry for never hours,
  and resume after being wet for 08 seconds.

Total Transmits to date = 1551
Maximum transmissions per day = 700

Transmit on these hours:
1 - 22,
Transmit on these days:
Jan: 1, 8, 9, 16, 23, 30,
Feb: 6, 13, 20, 27,
Mar: 5 - 10, 12, 14, 16, 18, 20, 23, 26, 29,
Apr: 1, 4, 8, 12, 16, 20, 24, 29,
May: 4, 9, 14, 19, 25, 31
Jun: , 6, 12, 18, 25,
Jul: 2, 9, 16, 23, 30,
Aug: 6, 13, 20, 27,
Sep: 3, 10, 17, 24,
Oct: 1, 8, 9, 16, 23, 30,
Nov: 6, 13, 20, 27,
Dec: 4, 11, 18, 25,

Time at temperature Histograms are not collected.

Report for Spot tag 03S3692 on 05-Mar-2004 at 06:31:28

```
TE RUAHINE 47815

Spot Time: 05-Mar-2004 at 07:28:19
Spot3Host version: 3.10.0004
Spot3ware version: 3.10m
Spot belongs to:
Department of Conservation

Transmission Frequency: 401 652422.5 Hz


Extended Argos PTT number: 47815 or 04A40979 Hex.  Uplink/LUT number:
4752/121
  transmitting with fast repetition rate of 46.00 seconds
  and slow repetition rate of 91.00 seconds.
  It checks for dry (to start transmitting) every 0.25 seconds
  and switches to its slow repetition rate after 10 successive dry
transmissions
  Transmissions will suspended after being dry for never hours,
  and resume after being wet for 08 seconds.

Total Transmits to date = 1329
Maximum transmissions per day = 700

Transmit on these hours:
1 - 22,
Transmit on these days:
Jan: 1, 8, 9, 16, 23, 30,
Feb: 6, 13, 20, 27,
Mar: 5 - 10, 12, 14, 16, 18, 20, 23, 26, 29,
Apr: 1, 4, 8, 12, 16, 20, 24, 29,
May: 4, 9, 14, 19, 25, 31
Jun: , 6, 12, 18, 25,
Jul: 2, 9, 16, 23, 30,
Aug: 6, 13, 20, 27,
Sep: 3, 10, 17, 24,
Oct: 1, 8, 9, 16, 23, 30,
Nov: 6, 13, 20, 27,
Dec: 4, 11, 18, 25,

Time at temperature Histograms are not collected.
```