Autopsy of cetaceans incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01

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Part 1 Autopsy report for 1997/98

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ABSTRACT

Morphological characteristics, estimated age, gender, reproductive status and stomach contents were determined for 12 Hector's dolphins (*Cephalorhynchus hectori*) and 2 dusky dolphins (*Lagenorhynchus obscurus*). The dusky dolphins and 3 of the Hector's dolphins were killed incidentally in commercial fishing operations. The dusky dolphins were caught in the Cook Strait and north of the Auckland Islands, while two Hector's dolphins were captured at the mouth of the Rangitata River in the Canterbury Bight, and one off the north Canterbury coast. The remaining 9 Hector's dolphins were either retrieved from set nets (n = 3) or found beachcast along the Canterbury Coast. One carcass was not labelled. Morphological characteristics of the animals were similar to those in the literature. The stomachs of all dolphins contained bones and otoliths of teleost fish. The Hector's dolphins had also eaten invertebrates such as crab and squid. Dolphins were aged using thin, stained sections of teeth. The age frequency distribution for Hector's dolphins was similar to that previously reported for this species with an over-representation of immature animals. Reproductive characteristics were also as previously reported with the single female Hector's dolphin sexually immature at 5 years old. All the males were immature apart from the oldest, which was estimated to be 7 years old. The dusky dolphins were sexually mature females as indicated by the presence of a corpus albicans on one ovary. They were estimated to be 7 and 8 years old. Histological characteristics of the older animal suggest that it had experienced at least one pregnancy. Of the eight dolphins known to have been entangled in nets, all had lesions consistent with death from entanglement and asphyxiation. Of the remaining six Hector's dolphins that were beachcast, three had lesions indicative of entanglement, two had lesions suggestive of this fate and one had some of the suite of lesions associated with death by asphyxiation.

Keywords: dolphins, Hector's, *Cephalorhynchus hectori*, dusky, *Lagenorhynchus obscurus*, autopsy, stomach contents, estimated age, North Island, South Island, New Zealand

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1. Introduction

The primary objective of this study was to fulfil the requirements of DOC contract CSL 96/3040 by recording and interpreting data on each animal (see Appendix 2 for Data sheet form). These data included species, sex, size, body condition, age, reproductive status, and stomach contents. This report details the findings pertinent to this objective and includes data on 12 Hector's dolphins (*Cephalorhynchus hectori*) and 2 dusky dolphins (*Lagenorhynchus obscurus*) killed incidentally in fishing operations.

A second objective was to examine the carcasses for evidence of disease and to collect material for ongoing and future research projects. To this end, entire skeletons were collected for the Museum of New Zealand Te Papa, Wellington (Anton van Helden), genetic samples were collected for the University of Auckland (Dr Scott Baker) and the Massey University Institute of Molecular Biosciences, Palmerston North (Prof. David Penny). Anatomical specimens were provided for post-graduate studies, blubber for eco-toxicology (Dr Paul Jones and Dr Hamish Reid, Institute of Environmental Science and Research, ESR) and foraging studies. Studies on pathology and disease are ongoing and include the epidemiology of viral infections (dolphin distemper or morbillivirus infection), parasite and bacterial infections. These studies on pathogens and disease are of particular importance in regard to the status of the endemic Hector's dolphins as relatively little is known of their health status and susceptibility to disease.

Hector's dolphin is a small coastal species and New Zealand's only endemic cetacean (Baker 1978). The total population is estimated to be 7270 animals (Slooten et al. 2002). Four genetically distinct and largely geographically isolated populations of *Cephalorhynchus hectori* are found off the northwest coast of the North Island, and the west, east, and southern coasts of the South Island (Pichler et al. 1998). The life history characteristics of the species are similar to other members of the genus *Cephalorhynchus*, such as Commerson's dolphin (*C. commersoni*) and are characterised by a low potential for growth (Lockyer et al. 1988; Slooten & Lad 1990). This, combined with a low rate of female dispersal between populations, increase the vulnerability of the species to local extinction if mortality rates exceed recruitment. Entanglement appears to be one of the most significant factors negatively impacting the species and was the impetus for establishment of a Marine Mammal Sanctuary around the Bank's Peninsula in November 1988 (Dawson & Slooten 1992). Causes of natural mortality are not well understood, but predation by sharks may be of significance (Slooten & Dawson 1994). Although most research to date has focused on establishing life history parameters to construct predictive models of fisheries impacts (Slooten & Lad 1990; Martien et al. 1999), there is clearly a need for more research into the natural causes of morbidity and mortality.

The dusky dolphin is also an inshore species, but it has a more circumpolar distribution in warm-temperate and cold-temperate waters of the Southern Hemisphere (Leatherwood et al. 1983). In New Zealand, it is found commonly from East Cape to as far south as Campbell Island (Baker 1999a). Group sizes vary seasonally, at least in Cook Strait, where hundreds may be seen in summer, but pods of 6–15 are more common in winter (Leatherwood et al. 1983). Causes of mortality for dusky dolphins include stranding (Duignan unpubl. data), predation (Constantine et al. 1998) and entanglement (Leatherwood et al. 1983; Van Bressem et al. 1993). Little is known about causes of disease among New Zealand dusky dolphins, but dolphin pox and herpes-like viral infections are common in this species off Peru (Van Bressem et al. 1993). Parasitic mastitis caused by *Crassicauda* sp. is thought to be a cause of reproductive failure for a related species, the Atlantic white-sided dolphin (*Lagenorhynchus acutus*) (Geraci & St. Aubin 1987). A similar parasitic infection was found in the mammary gland of one of the dusky dolphins in this study and has been observed in stranded individuals of this species in New Zealand (Duignan et al., this paper). Further investigation of the causes of morbidity and mortality for dusky dolphins is required.

2. Materials and methods

2.1 MATERIALS

A total of 12 Hector's dolphin carcasses were received, consisting of 1 female and 11 male dolphins. In addition, there were 2 female dusky dolphins. For the 3 Hector's dolphins and 2 dusky dolphins retrieved from trawl nets the observer's data are recorded with the catch date, time, and coordinates (Appendix 1, Table 1.1). The 3 Hector's dolphins that were caught in trawl nets were captured off the Canterbury coast south of Kaikoura (n = 1) and at the mouth of the Rangitata River in the Canterbury Bight (n = 2). The coordinates reported for one of these dolphins placed its capture location within the river itself (Fig. 1.1). Of the two dusky dolphins caught in trawl nets, one was captured in the Cook Strait and the other to the north of the Auckland Islands. The remaining Hector's dolphins were either removed from set nets (n = 3), found beachcast (n = 5), or are of unknown origin (n = 1). The Hector's dolphins retrieved from set nets included two from the same net at Gore Bay, Canterbury, and one from a net approximately 2 nautical miles from Sumner Head (Appendix 1, Table 1.2). The remaining dolphins of known origin came from Leithfield Beach, Canterbury, in the vicinity of Saltwater Creek (Table 1.2). The unlabelled dolphin was also thought to have come from the Canterbury coast.

The dolphin carcasses were delivered to Massey University frozen and wrapped in clear plastic bags and woven nylon sacks. Five were identified by Conservation Services Levy (CSL) observer data sheets inserted into their mouths, 10 dolphins had orange tags tied to their tailstocks and one had no identification. On receipt, the dolphins were stored at –20°C until necropsy.

All the Hector's dolphins were removed from the freezer together and retagged as they were unwrapped. The dusky dolphins were examined singly on receipt. Species and sex were recorded based on external morphology and photographs

Figure 1.1. Capture locations for Hector's and dusky dolphins incidentally caught in fishing operations, 19997/98 season.

of the external characteristics of each carcass. A unique code and pathology number was assigned to each animal as follows:

For example:

WB98-10Ch

WB—whale bycatch, 98—year, 10—animal number, and Ch—abbreviation of species scientific name; in this case *Cephalorhynchus hectori*.

2.2 METHODS

2.2.1 Necropsy protocol

Pathological examination and sampling was conducted according to a standard protocol adapted from published small cetacean necropsy protocols (Geraci & Lounsbury 1993; Jefferson et al. 1994). The procedure included recording the body weight (kg), external measurements (m), and examination of the carcass for external lesions such as trauma, net marks, tissue loss, scars, etc. Carcasses were placed with the left side down and an incision made through the blubber from the cranial insertion of the dorsal fin to the ventral midline. Blubber depth (m) was measured dorsally, laterally and ventrally along this incision. Then the carcass was carefully flensed and the subcutis examined for evidence of trauma. Lesions in the blubber and subcutis were sampled for histopathology by fixing tissue in 10% buffered formalin. A blubber sample was taken and stored at –20°C for future fatty acid analysis. A sample of blood (10 ml) was collected from one of the large vessels of the heart. The internal organs were examined systematically for lesions and tissues sampled for histopathology, virology, parasitology, bacteriology (faeces routinely and tissues where appropriate), toxicology (liver, kidney, bile), genetics (skin, heart muscle), and anatomical studies. The stomach was removed, tied off, and stored chilled until the contents could be examined the following day. At least three of the largest teeth from the middle of the dental arcade of the mandible were extracted, washed and stored in 70% ethanol until they were prepared for age determination. The reproductive organs were carefully dissected, measured (mm), weighed (g), and stored in 10% buffered formalin. The females' reproductive tracts were photographed.

2.2.2 Stomach contents

The full stomachs were weighed (kg), then opened with scissors and all material washed into a 1 mm sieve. The stomach was then re-weighed to allow the weight of the stomach contents to be determined. Large, relatively undigested material was removed at this stage, and if possible an axial length (mm) was measured for fish and squid. Smaller, more digested material was gradually sorted using a black-bottomed tray. Otoliths were clearly visible against this background, and as they are denser than most of the other material, they sank to the bottom of the tray. Otoliths, squid beaks and other relevant food material were also removed and stored in 70% ethanol. Parasites were collected and preserved in 5% buffered formalin. Lesions in the gastric mucosa were described, counted, and examples photographed.

2.2.3 Age determination

Age determination was based on a modification of a published protocol for Hector's dolphins (Slooten 1991). Briefly, the teeth were weighed (g) using a Mettler PM 4800 Delta Range balance, and the length and greatest diameter (mm) measured using Vernier callipers. The teeth were then washed in tap water and decalcified for 24 hours in 5% nitric acid using at least 100 mL per gram of tooth. After an overnight soak in water, the teeth were immersed in formol formic acid for 24 hours and then washed overnight in running tap water. The teeth were then soft enough to cut approximately one-third away using a microtome blade. The cut surface was placed face down in a plastic cassette and embedded in paraffin wax. The cassettes were processed by a Citadel Tissue Processor (Shandon, UK) as for soft tissues. Sections were cut at 2–4 µm intervals using a microtome (Microtek Cut 4055F) and stainless steel disposable microtome blades (S35 Feather Safe Razor Co. Medical Division, Japan). Multiple sections were cut through each tooth and at least two teeth were processed per animal. The sections were stained with toluene blue, washed in water, dehydrated in absolute alcohol, cleaned in xylene, and mounted on glass slides using rapid mounting medium.

The tooth sections were read independently by two observers at 16–80× magnification and the number of dentinal growth layer groups (GLGs) assigned by consensus between the readers.

2.2.4 Reproductive status

Females

Reproductive tracts were dissected out and examined grossly. The uterine horns were opened and examined for signs of pregnancy. A sample of each horn was removed, fixed in 10% buffered formalin, embedded in paraffin, sectioned at 4 µm intervals, and stained with hematoxylin for microscopic examination. The length and diameter of the ovaries were measured (mm) using Vernier callipers, and the ovaries weighed (g) using a Mettler PM 4800 Delta Range balance. The ovaries were sliced at 2 mm intervals along their long axis with a scalpel. The slices were examined for the presence of corpora lutea (CL) and corpora albicantia (CA), both macroscopically and using a dissecting microscope at 10× magnification. Sections were processed for microscopic examination as described above. Sexual maturity was defined as the age at which a female had ovulated at least once, and established by the presence of at least one corpus in the ovaries (Harrison et al. 1972). The CAs were classified as per Marsh & Kasuya (1984) and Slooten (1991) as follows:

Large CAs (mean diameter 7–10 mm) were clearly visible as a mass on the surface of the ovary and had a clearly defined stigma. Based on microscopic examination, there were few if any luteal cells, abundant fibrous connective tissue and numerous blood vessels. As the CA ages, the volume of connective tissue decreases relative to the number of vessels.

Medium CAs (mean diameter 3.5–7 mm) protruded less from the surface of the ovary. Histologically, most of the connective tissue had been removed and the blood vessels were more prominent.

Small CAs (mean diameter 1.5–3.5 mm) were visible on the surface of the ovary as small wrinkled scars. Histologically there was very little fibrous tissue and blood vessels formed the bulk of the tissue.

Histological sections of the uterine horns were classified as follows (Lockyer & Smellie 1985; Bacha & Wood 1990):

Immature The endometrium was thin and lined by a simple cuboidal epithelium. The glands were sparse and small with no clear lumen. The stratum vasculare was poorly developed and the arteries had a thin intima and smooth muscle tunic.

Mature-anoestrus The endometrium was thicker than in the immature uterus but the glands were equally sparse and relatively small. However, the tunica vasculare was prominent and the arteries had a tunica intima thickened by elastic fibres and smooth muscle.

Mature-lactating Similar to the previous class, except that the endometrium appeared more vascular post-parturition.

Mature-prooestrus and *Mature-oestrus* These stages were characterised by increasing depth of the endometrium and progressively greater development and complexity of the endometrial glands.

The mammary glands of all females were dissected to determine the degree of development and to look for evidence of milk secretion. Where milk was present, a sample was frozen at –80°C and stored for future research.

Males

The length and midline diameter of the testes (excluding epididymis) were measured (mm) using Vernier callipers and weighed (g) using a Mettler PM 4800 Delta Range balance. The epididymis was weighed (g) separately. Testes were sectioned at 3 mm intervals using a scalpel and examined for evidence of pathological changes. Histological samples taken from the centre of the testis and epididymis, were embedded in paraffin wax, sectioned at 4 mm intervals, mounted on glass slides and stained with haematoxylin and eosin. The sections were then examined microscopically at 16–80× magnification to assess the maturity of the seminiferous tubule epithelium and for the presence of spermatozoa. Because the cell associations forming the epithelium vary segmentally in mammalian testes, the predominant association in the section was used to classify the stage of maturity. The gonads were classified as immature, pubertal, mature-inactive, or mature-active (Collet & Saint Girons 1984; Slooten 1991).

Immature The seminiferous tubules/cords were narrow and often had no apparent lumen. Sertoli cells and spermatogonia lined the tubules but no further differentiation of germinal cells was apparent. There were abundant interstitial cells. The duct of the epididymis was lined by simple cuboidal epithelium and had a completely empty lumen.

Pubertal The seminiferous tubules were larger than for immature animals and there was consequently less interstitial tissue. The epithelium of the tubules contained spermatogonia, spermatocytes and occasional spermatids but no spermatozoa.

Mature-inactive The seminiferous tubules occupied most of the cross-sectional area and had a defined lumen. The epithelium had sertoli cells, spermatogonia, spermatocytes and early spermatids. Occasional tubule sections may have contained late spermatids. The interstitial cells occupied very little space between the seminiferous tubules. The ducts of the epididymis did not contain spermatozoa.

Mature-active The majority of tubule sections in the testis were lined by an epithelium that has a sequence of differentiation from spermatogonia through to spermatozoa. There was relatively little interstitial tissue present. The lumen of the epididymis might be full of spermatozoa.

2.3 STATISTICAL ANALYSES

Analyses of correlation between age and length in male Hector's dolphins was carried out using InStat software (Graph Pad Software Inc., San Diego, California, U.S.A.).

3. Results for 1997/98

3.1 MORPHOMETRICS

An extensive set of standard measurements were taken from each carcass (Appendix 1, Table 1.3). Certain measurements were not available for one animal (WB98-29Ch) because the abdominal region had been scavenged by a shark.

3.2 STOMACH CONTENTS

The weight of the contents of each compartment were recorded for each animal; when data was available, the total weight of the complete full and empty stomach was recorded (Appendix 1, Table 1.4). The contents were not identifiable to species for any animal. The dusky dolphins had fish bones and otoliths in the first chamber but no identifiable items in the remaining two chambers. All the Hector's dolphins had fish otoliths, and in most cases fish bones, in at least one stomach compartment. In addition, two Hector's dolphins had pieces of a crab in the stomach and one animal had a single squid beak. Otoliths and invertebrate parts have been stored in 70% ethanol to allow more detailed analysis of diet. Blubber samples were stored for future analysis of fatty acid signatures.

3.3 AGE DETERMINATION

Data on tooth size and the number of dentinal GLGs counted are given in Appendix 1, Table 1.5. For Hector's dolphins (n = 12) the mean tooth weight was 0.1 g, mean length 12.1 mm and mean diameter 2.5 mm. These sizes are similar to previous reports (Slooten 1991). The teeth did not have obvious incremental layers in the cementum but there were clearly defined bands in the dentine. Accepted protocol for small cetaceans is that one dark band (stained) and one light band (unstained) constitute one year's growth (Perrin & Myrick 1980; Slooten 1991). Based on this assumption, the Hector's dolphins ranged in age from 1 to 7 years (mean 3.9 years) and the dusky dolphins were 7 and 8 years old. The Hector's dolphins all died in January or February at the completion of an unstained band or start of a stained band. This is similar to a previous study on a larger sample of dolphins (Slooten 1991). The Hector's dolphin sample was biased, with young animals 5 years or less over-represented and no animals older than 7 years (Fig. 1.2). This is similar but even more marked than the age bias reported by Slooten (1991) in which 41 of 60 specimens (68%) were 5 years or under.

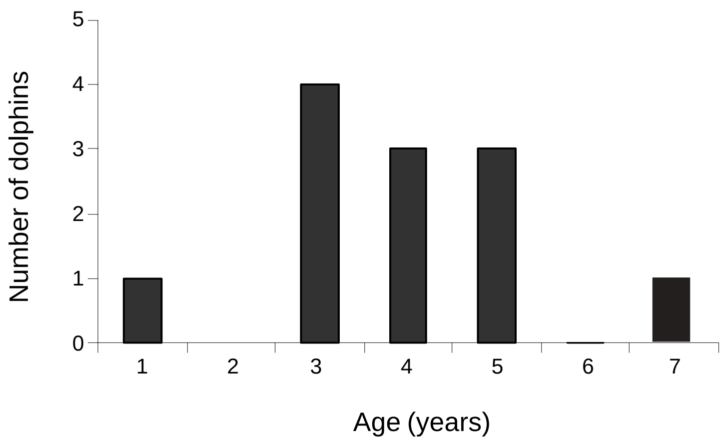


Figure 1.2. Age-frequency plot for Hector's dolphins.

For male Hector's dolphins (n = 11) there was no significant association between standard body length (Std L) and age (Fig. 1.3). This is similar to findings of Slooten (1991) where growth slowed after 2 years. However, when one particularly small dolphin (WB98-28Ch) was removed from the data set the association between length and age became significant for the remaining 10 males ($r = 0.7$, $P = 0.028$).

The female Hector's dolphin was 5 years old and at 1.3 m was larger than the two males of similar age, which measured 1.17 m and 1.19 m. This apparent sexual dimorphism agrees with the findings of Slooten (1991) in which a larger sample of animals was available.

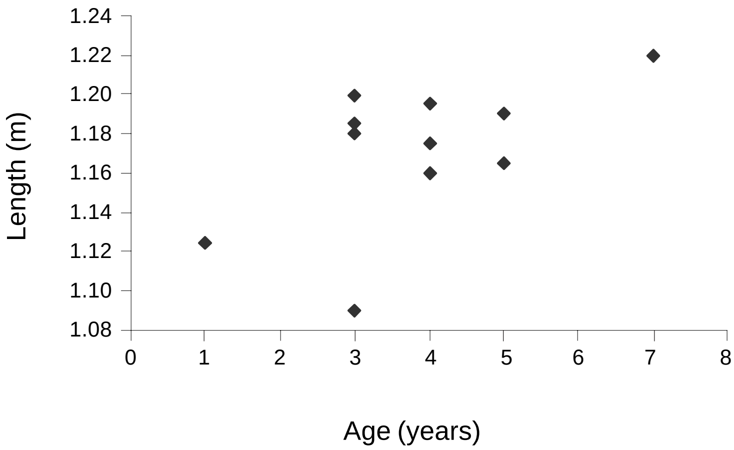


Figure 1.3. Age–length distribution of male Hector's dolphins (the very small 3-year-old male was removed for the statistical analysis).

3.4 REPRODUCTIVE STATUS

Females

Morphometric data on reproductive tracts are given in Appendix 1, Table 1.6. One dusky dolphin (WB98-04Lo) was aged 8 years. She had a large CA on her right ovary that histological examination found to be composed of a mature collagen-rich fibrous stroma with well-developed blood vessels. There were no apparent luteal cells. The histology of the uterine horns was consistent with her being mature-anoestrus based on the criteria given in Section 2.2.4. It is possible that this female had already given birth because the histology of the uterus was consistent with that of animal that had experienced parturition (Bacha & Wood 1990). The second dusky dolphin (WB98-31Lo), although larger than the first, was estimated to be only 7 years old. She also had a large CA, but it was more regressed than that of the first, with less fibrous tissue and blood vessels more closely apposed. On histological examination, the uterus was found to be in a similar mature-anoestrus stage but the tunica vasculare was not as well developed as in the first dolphin, suggesting that WB98-31Lo had not experienced pregnancy and parturition. Neither dolphin had milk in the mammary glands but one animal (WB98-31Lo) had a nematode parasite (*Crassicauda* sp.) in the ducts of the left mammary gland.

The five-year-old female Hector's dolphin had small smooth ovaries with no evidence of either a CL or CA. The uterine wall was also histologically immature and there was no evidence of lactation. These findings are similar to those for three other four-year-old Hector's dolphins reported in Slooten (1991).

Males

The oldest male (WB98-18Ch) was 7 years old and had a combined testicular mass (includes epididymis) of 267 g (Appendix 1, Table 1.7). This is slightly below the range of testicular maturity weight reported by Slooten (1991) in which mature males had combined testicular weights ranging from 304 g to

1210 g. However, the male in this study has to be regarded as mature based on histology as it had active spermiogenesis and large volumes of spermatozoa in the epididymis. The remaining dolphins (n = 9) in this study were immature with a mean combined testicular and epididymal mass of 31 g.

Unsexed animals

One dolphin (WB98-29Ch) could not be sexed because most of its abdominal region had been scavenged by a shark.

3.5 PATHOLOGY

Pathological findings were not covered by the terms of the contract. However, in view of the fact that some of the dolphins were beachcast rather than retrieved directly from nets, data are included on pathological findings related to death by entanglement (Appendix 1, Table 1.8). It should be stated that freezing will compromise the interpretation of subtle pathological changes.

Among the pathological changes associated with death from entanglement are traumatic lesions directly attributable to fishing gear (Garcia Hartmann et al. 1994; Kuiken 1994; Kuiken et al. 1994). This includes superficial skin lesions encircling the rostrum, head or any extremity; cleanly-cut pieces from extremities; or deep puncture wounds. Pathological changes in deeper tissues include evidence of blunt trauma such as fractures or contusions. Changes consistent with death from asphyxiation include pulmonary oedema, congestion, alveolar or bullous emphysema, stable froth in airways, and pleural congestion. There may also be congestion of pericardial vessels and ecchymotic haemorrhages (haemorrhagic spots) on the endocardium or epicardium. Less highly associated with entanglement is body condition and evidence of recent feeding (Kuiken 1994). In general, poor body condition and/or lack of food in the stomach might indicate some other cause of death. All organ systems should be examined by a pathologist competent in the diagnosis of disease in cetaceans to rule out all possibilities.

Both dusky dolphins were removed from nets and although they had lesions indicative or suggestive of entanglement, only one had skin lesions associated with net entanglement (Appendix 1, Table 1.8).

Among the Hector's dolphins, three were entangled in commercial nets and had distinct skin lesions (see Fig. 1.4, next page). Three were retrieved from recreational nets (WB98-23Ch, WB98-28Ch and WB98-29Ch), but only two had distinct skin lesions while the third (WB98-23Ch) had severe blunt trauma to subcutaneous tissues. Of the remaining six dolphins the probability of entanglement, based on skin lesions (see Fig. 1.5), was high for three, moderate for two animals, and low for the last animal. However, even for the three with no skin lesions, or equivocal lesions, there were pulmonary lesions that would suggest asphyxiation.

In all of the dolphins examined there were no other apparent pathological changes that could have caused death.

Figure 1.4. WB98-22Ch showing encircling skin lesions indicative of probable entanglement.

Figure 1.5. WB98-25Ch showing braided skin lesion indicative of probable entanglement.

4. Discussion

The dolphins examined for this contract were received frozen and double-bagged. In general the packaging was of a high standard and the animals were usually identified by the observer's report placed in the oral cavity. However, the data sheet or tag was missing for one of the Hector's dolphins. A system of double-labelling using sheep ear tags inserted into a flipper might prevent recurrence of this problem. In terms of record keeping, it would also be of benefit to the contractor if a list of animals being shipped could be forwarded by mail or e-mail to allow a cross-check between animals shipped and those received. In that way, any animal that arrived without the observer's report could be traced. From a health and safety aspect, the packaging was sufficient to prevent contamination of the environment by the carcasses, provided they remained frozen.

The number of dusky dolphins examined in this study is too small to make any inferences about the species, except that it confirms that the species occurs in Cook Strait and as far south as the subantarctic islands. Both animals were female and both apparently sexually mature. The younger of the two dolphins at approximately 7 years may have been closer to puberty than full maturity, but the 8-year-old may have had at least one calf. Dusky dolphins are thought to reach sexual maturity at approximately 1.65 m (Leatherwood et al. 1983) and both females in this study were near or above this length. Although one of the females had a nematode parasite within one of her mammary glands there was no indication of mastitis as reported in Atlantic white-sided dolphins with similar infection (Geraci & St. Aubin 1987). Both of the dusky dolphins were caught as a result of commercial fishing activities, but only one had unequivocal skin lesions attributable to entanglement. This emphasises that pathological lesions other than skin lesions alone need to be considered in determinations of cause of death.

The Hector's dolphins incidentally caught by commercial fishers were captured off the north Canterbury coast and at the mouth of the Rangitata River, sites within the range of the species (Cawthorn 1988; Slooten & Dawson 1994). The dolphins caught by recreational nets and those found beachcast were also from an area of the Canterbury coast with a high Hector's dolphin population (Slooten & Dawson 1994). Morphological features of these animals were consistent with those reported previously (Mörzer Bryuns & Baker 1973; Slooten 1991; Slooten & Dawson 1994). It was also found that most of the animals were immature, which is consistent with previous reports of incidentally caught Hector's dolphins (Slooten 1991; Dawson 1991). Unlike previous studies, the animals submitted for this investigation were predominantly male. In a study that included 60 Hector's dolphins (Slooten 1991), the ratio of male to female was approximately equal. The bias in this study is more likely to reflect a sampling bias than the structure of the population.

Determination of the species of fish and invertebrates ingested by the dolphins was beyond the scope of this investigation, but all hard parts removed from the stomachs were archived for future studies. All animals had some remains of fish, squid, or other invertebrates, suggesting that they had eaten shortly before death.

Age determination in cetaceans, based on counting growth layers or annuli in teeth, is commonly used on a variety of species (Perrin & Myrick 1980). Although widely used, the technique is subject to difficulties in methodology, interpretation, reader variability, variability among teeth, and the lack of known-age animals (Dapson 1980). The method used to section teeth can also introduce marked biases into the interpretation of age. For this reason, and because teeth from known-age Hector's dolphins were not available, it was decided to employ a method similar to that used previously on this species (Slooten 1991) and on the related Commerson's dolphin (Lockyer et al. 1988). The results obtained are comparable to those reported by Slooten (1991) and are in agreement with other findings on the animals such as reproductive status and morphology. Even though most of the males were immature, there was no good correlation between age and Std L indicating that they achieved adult size early. This agrees with the findings of Slooten (1991). Only one male had active spermatogenesis—and at seven years old was slightly younger than the youngest male with active testes reported by Slooten (1991). In the latter study, there was one six-year-old male that was classed as pubertal and the next youngest males were nine years old. From this, it may be concluded that sexual maturity in males may be achieved as early as seven years. Only one five-year-old female was examined and she had an immature reproductive tract. This agrees with the findings of Slooten (1991) for a female of this age.

The pathological findings indicate that there is a high probability that entanglement caused the deaths of both the dusky dolphins, and 9 of the Hector's dolphins examined. This is based on a consideration of external lesions, internal lesions, body condition, presence of food material in the stomach and the absence of any other pathology that could have caused death (Garcia Hartmann et al. 1994; Kuiken 1994; Kuiken et al. 1994). Two of the beachcast Hector's dolphins were regarded as having a moderate probability of having died as a result of entanglement. One had parallel linear cuts in the skin encircling the rostrum that were probably caused by a net; but the other dolphin only had a few nicks in the dorsal fin and leading edges of the flukes that may or may not have been caused by a net. Both had similar lung pathology to the other dolphins and there was no other cause of death determined. The dolphin that was ranked with a low probability of entanglement had no skin lesions or evidence of trauma. However, it did have oedematous lungs with stable froth in the airways which is consistent with asphyxiation. As with one of the dusky dolphins, and described in other studies (Kuiken 1994), traumatic lesions are not always apparent in animals known to have been entangled. Detailed pathological examination of incidentally caught and stranded Hector's dolphins by an experienced veterinary pathologist is required to determine more precise criteria for cause of death in this species.

5. References

For details of references quoted in Part 1, see the combined reference list at the end of Part 3 (pp. 58–60).

Appendix 1

TABLES OF RESULTS

TABLE 1.1. CAPTURE DATA FOR HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATHOLOGY NO.	DATE	TIME	LATITUDE	LONGITUDE	SEX
Dusky dolphin						
WB98-04Lo	28950	16 Feb 98	2000	50ºS	166ºE	F
WB98-31Lo	29634	17 Aug 98	2030	41ºS	174ºE	F
Hector's dolphin						
WB98-18Ch	29383	17 Feb 98	1700	44ºS	171ºE	M
WB98-19Ch	29384	1 Mar 98	1859	42ºS	173ºE	M
WB98-22Ch	29387	19 Jan 98	0900	44ºS	171ºE	M

TABLE 1.2. STRANDING DATA FOR HECTOR'S DOLPHINS, 1997/98.

CODE	PATHOLOGY NO.	DOC TAG NO.	DATE	CIRCUMSTANCES	LOCATION	COMMENTS
Hector's dolphin—Female						
WB98-25Ch	29390	H18/98	12 Feb 98	Beachcast	Woodend Beach	
Hector's dolphin—Male						
WB98-20Ch	29385	No tag	–	–	–	
WB98-21Ch	29386	H15/98	4 Feb 98	Beachcast	Leithfield beach, 200 m north of Saltwater Creek	
WB98-23Ch	29388	H17/98	8 Feb 98	Entangled in set net	Gore Bay	
WB98-24Ch	29389	H13/98	2 Jan 98	Beachcast adjacent to set net	Leithfield Beach	
WB98-26Ch	29391	H12/98	2 Jan 98	Beachcast adjacent to set net	Leithfield Beach	
WB98-27Ch	29392	H14/98	4 Jan 98	Beachcast	Saltwater Creek, 320 m north of mouth	
WB98-28Ch	29393	H16/98	8 Feb 98	Entangled in set net	Gore Bay	
Hector's dolphin—Unknown sex						
WB98-29Ch	29394	H19/98	16 Jan 98	Entangled in set net	2 nautical miles off Sumner Head	Scavenged

– Indicates data is not available.

TABLE 1.3. MORPHOMETRIC DATA FOR HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATHOL-OGY No.	Wt (kg)	Std L (m)	Sn-An (m)	Sn-Gen (m)	Sn-ODF (m)	Sn-OF (m)	FL (m)	FW (m)	DF Ht (m)	DF BL (m)	Flk W (m)	Gt Pec (m)	Blub.D (m)	Blub.L (m)	Blub.V (m)
Hector's dolphin—Female																
WB98-25Ch	29390	34.8	1.30	0.92	0.82	0.63	0.28	0.18	0.08	0.09	0.21	0.37	0.72	0.018	0.013	0.016
Hector's dolphin—Male																
WB98-18Ch	29383	34.6	1.22	–	0.71	0.60	0.30	0.20	0.08	0.09	0.21	0.40	0.74	0.018	0.016	0.018
WB98-19Ch	29384	27.7	1.18	0.85	0.75	0.58	0.30	0.19	0.07	0.07	0.19	0.36	0.75	0.013	0.011	0.014
WB98-20Ch	29385	26.6	1.16	0.83	0.70	0.56	0.30	0.18	0.08	0.08	0.18	0.32	0.64	0.018	0.016	0.017
WB98-21Ch	29386	28.2	1.19	0.81	0.67	0.58	0.29	0.17	0.75	0.75	0.18	0.32	0.70	0.018	0.017	0.021
WB98-22Ch	29387	30.4	1.18	0.83	0.69	0.59	0.30	0.19	0.08	0.08	0.18	0.35	0.70	0.014	0.014	0.016
WB98-23Ch	29388	27.8	1.13	0.82	0.71	0.54	0.30	0.02	0.07	0.07	0.18	0.33	0.73	0.02	0.017	0.019
WB98-24Ch	29389	28.9	1.17	0.85	0.73	0.58	0.30	0.17	0.08	0.06	0.20	0.33	0.71	0.018	0.013	0.017
WB98-26Ch	29391	29.1	1.19	0.86	0.75	0.57	0.39	0.20	0.07	0.08	0.20	0.36	0.72	0.017	0.014	0.016
WB98-27Ch	29392	33.3	1.20	0.85	0.75	0.59	0.30	0.18	0.08	0.07	0.19	0.38	0.77	0.019	0.014	0.013
WB98-28Ch	29393	27.2	1.09	0.72	0.63	0.56	0.24	0.18	0.07	0.08	0.18	0.34	0.64	0.015	0.013	0.015
Hector's dolphin—Unknown sex (scavenged)																
WB98-29Ch	29394	13.0	1.20	0.94	–	0.60	0.35	0.18	0.07	0.06	0.18	0.32	–	0.017	0.013	–
Dusky dolphin—Female																
WB98-04Lo	28950	64.6	1.62	1.13	1.07	0.75	0.35	0.31	0.10	0.20	0.23	0.40	0.92	0.017	0.013	0.015
WB98-31Lo	29634	70.6	1.77	1.30	1.19	0.79	0.43	0.36	0.11	0.22	0.27	0.47	1.03	0.014	0.013	0.014

Wt = weight; Std L = standard body length; Sn-An = snout to anus length; Sn-Gen = snout to genital slit length; Sn-ODF = snout to origin of dorsal fin length; Sn-OF = snout to origin of flipper ; FL = flipper length; FW = flipper width; DF Ht = dorsal fin height; DF BL = dorsal fin length at base; Flk W = fluke width; Gt Pec = girth at pectoral flippers; Blub. D = dorsal blubber depth; Blub. L = lateral blubber depth; Blub. V = ventral blubber depth.

– Indicates data is not available.

TABLE 1.4. STOMACH MORPHOMETRICS AND CONTENTS FOR HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATHOLOGY NO.	STOMACH		COMPARTMENT 1		COMPARTMENT 2		COMPARTMENT 3		PARASITES	ULCERS
		FULL WT (kg)	EMPTY WT (kg)	CONTENTS WT (kg)	COMPOSITION	CONTENTS WT (kg)	COMPOSITION	CONTENTS WT (kg)	COMPOSITION		
Hector's dolphin—Female											
WB98-25Ch	29390	–	–	0.0613	Fish parts, otoliths	TLTM	Fish otoliths	TLTM	Fluid only	Y	–
Hector's dolphin—Male											
WB98-18Ch	29383	–	–	0.428	Fish otoliths, invertebrate	0.0075	Fish otoliths	TLTM	Fluid only	Y	–
WB98-19Ch	29384	–	–	TLTM	Fish otolith	TLTM	Fish otolith	TLTM	–	Y	–
WB98-20Ch	29835	–	–	0.014	Fish otolith	0.015	Fish otoliths	0.014	Fluid only	Y	–
WB98-21Ch	29386	–	–	0.034	Fish bones, otoliths	TLTM	Fish bones	TLTM	Fish otoliths	Y	–
WB98-22Ch	29387	–	–	TLTM	Fish otoliths	TLTM	Fish otoliths	TLTM	Fish otoliths	Y	–
WB98-23Ch	29388	–	–	0.454	Fish bones, otoliths, crab pieces	0.0004	Fish bones, otoliths	TLTM	Fluid only	Y	–
WB98-24Ch	29389	–	–	TLTM	–	TLTM	–	TLTM	Fish otolith	Y	–
WB98-26Ch	29391	–	–	0.0011	Fish otoliths	0.0112	Crab carpace	0.0003	Fluid only	Y	–
WB98-27Ch	29392	–	–	0.526	Fish (342 mm), otoliths, squid beak	0.0022	Fluid only	TLTM	Fluid only	Y	–
WB98-28Ch	29393	–	–	0.279	Fish parts, otoliths	TLTM	Fish otoliths	TLTM	Fluid, fish otoliths	Y	–
Dusky dolphin—Female											
WB98-04Lo	28950	–	–	0.113	Fish bones, otoliths	TLTM	Fluid only	TLTM	Fluid only	N	–
WB98-31Lo	29634	2.25	1.95	0.297	Fish bones, otoliths	TLTM	Fluid only	TLTM	Fluid only	Y	2 in C2

TLTM = Too little to measure; C1, C2, etc. = compartment 1, 2, etc.

– Indicates data is not available.

TABLE 1.5. AGE ESTIMATION BASED ON DENTINAL GROWTH LAYER GROUPS FOR HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATH-OLOGY NO.	TOOTH WT (g)	L (mm)	D (mm)	AGE (y)
Hector's dolphin—Female					
WB98-25Ch	29390	0.09	12.2	2.3	5
Hector's dolphin—Male					
WB98-18Ch	29383	0.13	13.1		7
WB98-19Ch	29384	0.09	12.2	2.5	4
WB98-20Ch	29385	0.10	11.7	2.5	4
WB98-21Ch	29386	0.09	11.6	2.3	5
WB98-22Ch	29387	0.12	12.5	2.7	3
WB98-23Ch	29388	0.07	10.5	2.2	1
WB98-24Ch	29389	0.08	12.3	2.6	5
WB98-26Ch	29391	0.10	12.6	2.4	3
WB98-27Ch	29392	0.10	11.8	2.3	4
WB98-28Ch	29393	0.11	12.4	2.6	3
Hector's dolphin—Unknown sex (scavenged)					
WB98-29Ch	29394	0.08	12.3	2.4	3
Dusky dolphin—Female					
WB98-04Lo	28950	0.25	11.8	3.2	8
WB98-31Lo	29634	0.30	12.0	3.0	7

TABLE 1.6. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATH-OLOGY NO.	RIGHT OVARY				LEFT OVARY				UTERINE MATUR-ITY	GRAVID*	MILK PRES-ENT
		WT (g)	L×W×D (mm)	CA (mm)	CL	WT (g)	L×W×D (mm)	CA (mm)	CL			
Hector's dolphin												
WB98-25Ch	29390	0.8	23 × 10 × 6	–	–	0.6	21 × 11 × 4	–	–	IM	N	N
Dusky dolphin												
WB98-04Lo	28950	6.9	42 × 20 × 8	12 × 10 × 10	–	3.3	40 × 19.5 × 8	–	–	MA	N	N
WB98-31Lo	29634	3.0	37 × 14 × 8	–	–	6.0	40 × 18 × 16	9 × 9 × 9	–	MA	N	N

* Determined by the presence of a grossly detectable embryo or foetus.

– Indicates data not available.

CA = Corpus albicens; CL = Corpus luteum; IM = Immature; MA = Mature-anoestrus; N = No

TABLE 1.7. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S DOLPHINS, 1997/98.

CODE	PATH-OLOGY NO.	RIGHT TESTIS Wt+epid (g)	RIGHT TESTIS Wt–epid (g)	RIGHT TESTIS L×W×D (mm)	LEFT TESTIS Wt+epid (g)	LEFT TESTIS Wt–epid (g)	LEFT TESTIS L×W×D (mm)	TESTIS MATURITY	COMBINED TESTICULAR MASS* (g)
WB98-18Ch	29383	137.1	113.2	130 × 34 × 56	129.3	106.2	138 × 32 × 51	MA	266.5
WB98-19Ch	29384	16.7	8.1	57 × 21 × 12	16.8	8.9	59 × 18 × 9	IM	33.5
WB98-20Ch	29385	17.5	11.1	70 × 20 × 12	16.5	10.3	65 × 19 × 13	IM	34.0
WB98-21Ch	29386	4.4	4.4	48 × 18 × 7.5	7.5	4.6	50 × 18 × 8	IM	11.9
WB98-22Ch	29387	18.2	10.2	72 × 18 × 19	16.6	9.7	61 × 20 × 9	IM	34.8
WB98-23Ch	29388	9.0	4.8	51 × 12 × 15	8.3	4.0	50 × 16 × 10	IM	17.3
WB98-24Ch	29389	22.7	13.5	74 × 22 × 16	25.1	15.7	77 × 22 × 16	IM	47.8
WB98-26Ch	29391	12.3	5.8	54 × 10 × 16	13.1	8.3	53 × 10 × 14	IM	25.4
WB98-27Ch	29392	21.4	12.5	71 × 24 × 10	22.1	13.4	73 × 27 × 11	IM	43.6
WB98-28Ch	29393	15.2	7.2	60 × 13 × 16	13.1	7.5	60 × 16 × 11	IM	28.3

IM = Immature; MA = Mature-active.

* Includes epididymis weight.

TABLE 1.8. PATHOLOGY OF HECTOR'S AND DUSKY DOLPHINS, 1997/98.

CODE	PATH-OLOGY NO.	BODY CONDI-TION	SKIN LESIONS	SUBCUT-ANEOUS LESIONS	LUNG PATHOLOGY	RECENT FEEDING	ENTANGLE-MENT PROBABILITY
Hector's dolphin—Female							
WB98-25Ch	29390	Good	Yes	NVL	–	Yes	High
Hector's dolphin—Male							
WB98-18Ch	29383	Excellent	Yes		Oedema	Yes	High
WB98-19Ch	29384	Good	Yes	NVL	Oedema, stable froth	Yes	High
WB98-20Ch	29385	Excellent	Yes	NVL	Oedema	Yes	High
WB98-21Ch	29386	Excellent	Possible	NVL	Congested	Yes	Moderate
WB98-22Ch	29387	Good	Yes	NVL	Oedema, stable froth	Yes	High
WB98-23Ch	29388	Excellent	Possible	Severe trauma	Oedema	Yes	High
WB98-24Ch	29389	Good	No	NVL	Oedema, stable froth	No	Low
WB98-26Ch	29391	Good	Yes	NVL	Oedema	Yes	High
WB98-27Ch	29392	Good	Yes	NVL	Oedema, stable froth	Yes	Moderate
WB98-28Ch	29393	Good	Yes	NVL	Oedema	Yes	High
Hector's dolphin—Unknown sex (scavenged)							
WB98-29Ch	29394	Good	Yes	NVL	Scavenged	Scavenged	High
Dusky dolphin							
WB98-04Lo	28950	Good	No	NVL	Oedema	Yes	High
WB98-31Lo	29634	Good	Yes	NVL	Oedema	Yes	High

NVL = No visible lesions.

– Indicates data not available.

Appendix 2

HECTOR'S DOLPHIN DATA SHEET

Specimen # WB00- __________
Pathology # ________________
Date of Capture: ______________ Necropsy Date: _____________
Sex: ________ Age: Juv., SubAd., Ad.

Measurements:

1. Weight:	2. Total length:
3. Snout-anus:	4. Snout-genital slit:
5. Snout-origin dorsal fin:	6. Snout-origin flipper:
7. Flipper length:	8. Flipper width:
9. Dorsal fin height:	10. Dorsal fin lt. Base:
11. Fluke width:	12. Pectoral girth:
13. Blubber: Dorsal Lateral Ventral	

GROSS PATHOLOGY
External Examination (see diagram and eyes, ears, flippers)

Internal Examination (Blubber, subcutis, mammary gland, fascia, muscle, skeleton)

Alimentary system (mouth, teeth, oesophagus, stomach, small intestine, large intest., liver, pancreas, peritoneum, lymph nodes).

Respiratory system (sinuses, larynx, trachea, bronchi, lungs, pleura, lymph nodes)

1

Cardiovascular (Heart, pericardium, great vessels)

Urogenital system (kidneys, bladder, ureters, urethra, gonads, vagina/penis/prepuce)

Lymphatic (thymus, spleen, lymph nodes)

Endocrine (thyroid, adrenals)

Nervous system (only if head trauma).

REPRODUCTIVE SYSTEM

Female:

Ovaries:	Weight	Dimensions (L × W × D)	CA(#, Size)	CL (size)
Right:				
Left:				

Pregnant: Yes / No Milk: Yes / No

Foetus: Length (crown–rump, mm):______ Weight: _______kg. Sex: M / F

Male:

Testes:	Weight + epidid (kg)	Weight – epidid (kg)	Length x diameter (mm).
Left:			
Right:			

2

STOMACH

	Chamber 1	**Chamber 2**	**Chamber 3**
Contents Wt.			
Type			
Lesions			

Parasites collected: Yes / No

SAMPLE CHECKLIST

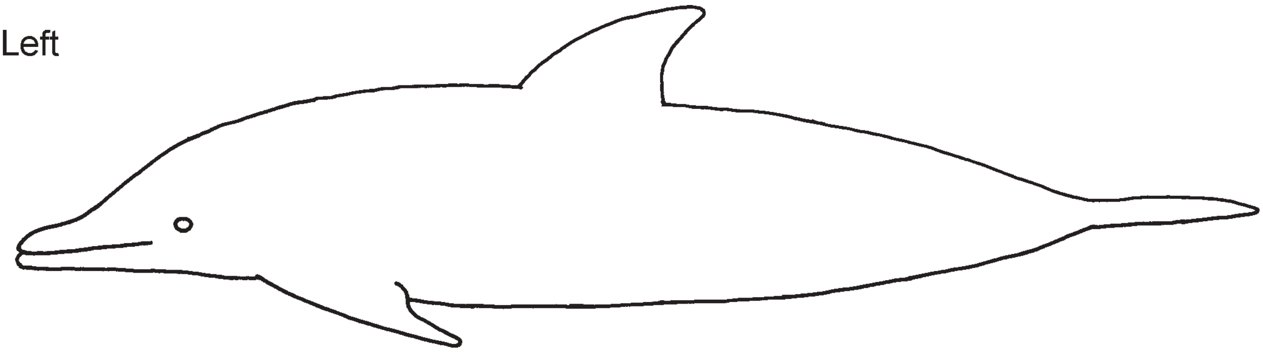
Discipline	**Tissue**	**Storage**	**Check**
Histopathology	Lung, Heart, Liver, Spleen, Thyroid, Trachea, Kidney, Diaphragm, Adrenals, CNS, Any lesion, Gonads, Mammary gland, foetus.	Formalin	
Toxicology/Diet	Blubber	Freezer (300g, whirlpack)	
Age determination	Teeth (approx. 4)	To Gareth	
Museum	Skull	Big freezer	
Bacteriology	Lesion	pottle	
Parasitology	Lung GIT	Alcohol To Barb	
Genetics	Skin	Alcohol vial	
Serology	Blood	- 80 freezer	

DIAGNOSIS

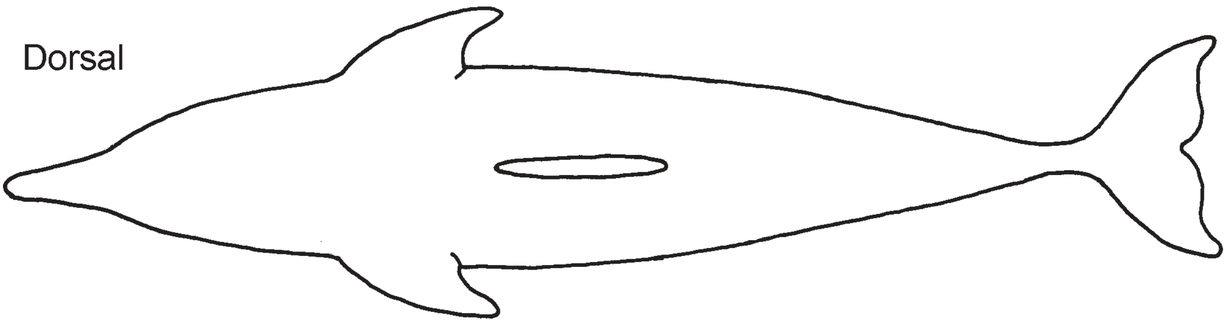
Examiner(s): (Please sign)

3

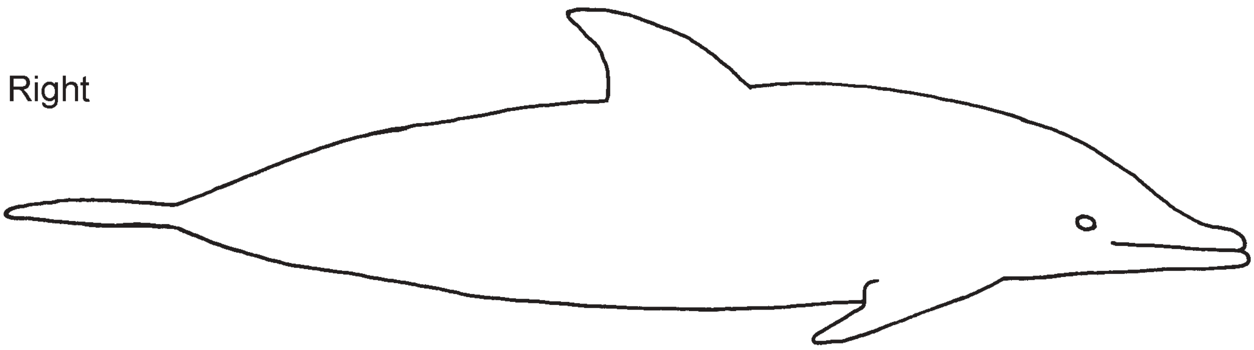
Left



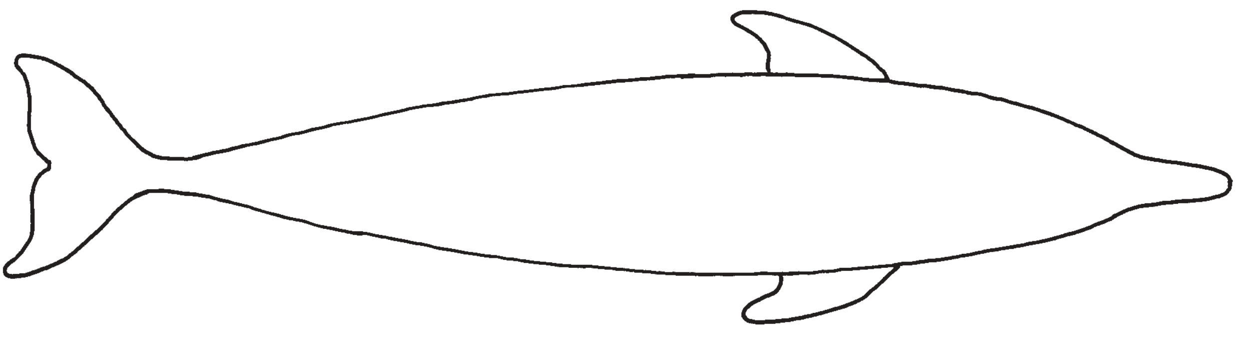
Dorsal



Right



Ventral



Note: No CSL autopsy contract was let during 1998/1999 because of the New Zealand sea lion mortality event in January–February of 1998 (see Baker 1999b). Therefore, there is no autopsy report for that period.

Part 2 Autopsy report for 1999/2000

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ABSTRACT

Morphological characteristics, estimated age, gender, reproductive status, stomach contents, and cause of death were determined for 16 Hector's dolphins (*Cephalorhynchus hectori*) and 1 common dolphin (*Delphinus delphis*). The common dolphin and one Hector's dolphin were incidentally killed in commercial fishing operations: the common dolphin off the Wanganui coast in October 1999, and the Hector's dolphin off the Canterbury coast in November 1997. The remaining 15 Hector's dolphins were either retrieved from recreational set nets (n = 1) or found beachcast along the west coast of the South Island (n = 3) or east coast of the South Island (n = 7). One North Island Hector's dolphin was found beachcast at Kawhia. Stranding data was not available for another 3 Hector's dolphins. Tissues from major organs were received for one animal that had been autopsied on the beach. The stomachs of all dolphins contained the remains of teleost fish such as otoliths and bones. The Hector's dolphins had also eaten invertebrates (e.g. crab, krill, and squid). Dolphins were aged using thin, stained sections of teeth and counting dentinal growth layer groups. The age frequency distribution for the Hector's dolphins examined was similar to that previously reported for this species, with an over-representation of immature animals. The sex ratio was equal. Six female Hector's dolphins were classified as sexually immature, and estimated to be between 1 and 2.5 years old. Two males were sexually mature and at least 5 years old, while two 5 and 5.5-year-old males were still pubescent. Three males were immature and estimated to be 1.5–3 years old. The gonads of 2 other females and 1 male Hector's dolphin had been scavenged or were too decomposed to determine sexual maturity. The female common dolphin was 5–6 years old, and was sexually immature, as indicated by the absence of *corpora* on the ovaries. Dolphins known to have been entangled in nets all had lesions consistent with death from entanglement and asphyxiation. Of the 15 beachcast Hector's dolphins, 7 had lesions indicative of entanglement, 2 had lesions consistent with trauma and sudden death, 2 were too decomposed to determine the cause of death, 1 was a neonate that probably died following separation, and 1 had severe trauma unrelated to bycatch.

Keywords: dolphins, Hector's, *Cephalorhynchus hectori*, common, *Delphinus delphis,* autopsy, stomach contents, estimated age, North Island, South Island, New Zealand

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1. Introduction

The primary objective of this study was to fulfil the requirements of DOC contract CSL 99/3025 by recording and interpreting data on each animal. These data included species, sex, size, body condition, age, reproductive status, stomach contents, and cause of death. This report details the findings pertinent to this objective and includes data on 16 Hector's dolphins (*Cephalorhynchus hectori)* and one common dolphin (*Delphinus delphis*) killed incidentally in fishing operations or found beachcast.

A second objective was to examine the carcasses for evidence of disease and to collect material for ongoing and future research projects as outlined in Part 1 of this report. Part 1, Section 1 contains general information on Hector's dolphins.

The common dolphin is a pelagic, offshore species and has a very wide distribution, occurring in all warm-temperate, subtropical, and tropical waters worldwide (Leatherwood et al. 1983). In New Zealand, it is frequently found in the coastal waters of both the North and South Islands (Baker 1999a). Group sizes vary seasonally and diurnally, but *D. delphis* are regularly found in herds of hundreds, and sometimes of more than a thousand, individuals (Leatherwood et al. 1983). The causes of mortality for common dolphins include stranding (usually of single animals), entanglement, and capture in direct-drive fisheries (Leatherwood et al. 1983).

2. Material and methods

2.1 MATERIALS

Sixteen Hector's dolphin carcasses were received, consisting of eight females and eight males. One female common dolphin was also received. The Hector's dolphin and common dolphin retrieved from trawl nets were recorded with the catch date, time, and coordinates (Appendix 1, Table 2.1) by CSL observers. The Hector's dolphin was captured off the Canterbury coast, and the common dolphin off the southwest coast of Wanganui (Fig. 2.1). The remaining Hector's dolphins were either removed from set nets (n = 1), found beachcast (n = 11), or are of unknown origin (n = 3).

The Hector's dolphin retrieved from a set net was found off Sumner Bay, Christchurch (Appendix 1, Table 2.2). The remaining dolphins of known origin were found along the west and east coasts of the South Island (n = 10). A single specimen of a North Island Hector's dolphin was found at Kawhia (Table 2.2).

Nine dolphin carcasses (Tables 2.1 and 2.2) were delivered to Massey University frozen and wrapped in clear plastic bags and woven nylon sacks. Four dolphins were identified by Conservation Services Levy (CSL) observer data sheets or by stranding forms inserted into their mouths, seven had orange tags tied to their

Figure 2.1. Capture locations for Hector's and common dolphins incidentally caught in fishing operations, 1999/2000.

tailstocks and five had no identification. Samples from one dolphin (WB00-13Ch) were sent in an insulated bin with a stranding form inside. On receipt, the dolphins were stored at –20°C until necropsy.

2.2 METHODS AND NECROPSY PROTOCOL

See Part 1, Section 2.2 for details.

3. Results for 1999/2000

3.1 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table 2.3).

3.2 STOMACH CONTENTS

The stomach weight and the weight of its contents were recorded for each animal (Appendix 1, Table 2.4). The contents were not identifiable to species for any animal. The common dolphin had fish otoliths, fish bones, and squid beaks in the first chamber, but no identifiable items in the remaining two chambers. Thirteen of the Hector's dolphins had fish otoliths, and in most cases fish bones, in at least one stomach compartment. Of these, five animals also had squid beaks in the stomach, two animals had pieces of crab and two had shrimp or krill. The dolphin sampled in the field (WB00-13Ch) had a piece of bubble-wrap plastic in the first stomach compartment along with otoliths and fish bones while the remaining two chambers were empty. Three dolphins had empty stomachs. Otoliths and invertebrate parts have been stored in 70% ethanol for more detailed analysis of diet at or immediately before the time of death. Blubber samples were also stored frozen at –80°C for analysis of fatty acid signatures.

3.3 AGE DETERMINATION

Data on tooth size and the number of dentinal growth layer groups (GLGs) counted are given in Appendix 1, Table 2.5. For those North and South Island Hector's dolphins with teeth (n = 15), the mean tooth weight was 0.09 g, mean length 10.6 mm and mean diameter 2.3 mm. These sizes are similar to those reported previously (Slooten 1991; Part 1 of this report). The teeth did not have obvious incremental layers in the cementum, but there were clearly defined bands in the dentine of most animals. The accepted protocol for small cetaceans is that one dark band (stained) and one light band (unstained) constitute one year's growth (Perrin & Myrick 1980; Slooten 1991). Based on this assumption, the Hector's dolphins ranged in age from 0.5 years to at least 5.5 years old (mean = 2.7 years) and the North Island Hector's dolphin was 2–4 years old. The common dolphin was 5–6 years old. The ages given are minimum estimates based on clearly defined bands. The Hector's dolphin sample was biased, with young animals less than 5 years old over-represented. The age bias is similar to that in a previous investigation of incidentally caught animals (Part 1) and is similar, but even more marked than the age bias reported by Slooten (1991), in which 41 of 60 specimens (68%) were 5 years old or younger.

3.4 REPRODUCTIVE STATUS

Females

Morphometric data on reproductive tracts are given in Appendix 1, Table 2.6. Six of the female Hector's dolphins (0.5–4 years old) had small smooth ovaries with no evidence of corpora. The uterine wall was also histologically immature and there was no evidence of lactation. These findings are similar to those for female Hector's dolphins, 4 years and younger, reported by Slooten (1991). The results are also consistent with those for an immature female dolphin from a previous bycatch report (Part 1). The gonads of two female Hector's dolphins (WB00-16Ch) and (WB00-09Ch) had been scavenged and were not available for examination.

The common dolphin was 5–6 years old. There were no visible corpora in serial sections of the ovaries. The histology of the uterine horns was consistent with this animal being immature, based on criteria given in Part 1, Section 2.2.4. Milk was not present in the mammary glands.

Males

Of the eight male Hector's dolphins, two were classed as mature, two were pubescent, three were immature and one (WB00-13Ch) was too decomposed to determine sexual maturity by microscopic examination of the gonads. The two mature males (WB00-22Ch and WB00-24Ch) were at least 5 years and 5.5 years old and had combined testicular masses (including the epididymis) of 871 g and 374 g, respectively (Appendix 1, Table 2.7). This is within the range of testicular maturity weight reported by Slooten (1991) in which mature males had combined testicular masses ranging from 304 g to 1210 g. The testes of one of these males also had active spermatogenesis and small volumes of spermatozoa in the epididymis, indicating maturity. The two pubescent males were also 5 years and 5.5 years old, but had combined testicular masses of 57 g and 32 g respectively, which is considerably less than the range considered for maturity. A single pubescent male, reported by Slooten (1991), had a combined testicular mass of 65 g. The remaining dolphins (n = 3) in this study were immature with a mean combined testicular mass of 8 g.

3.5 PATHOLOGY

Pathological findings were covered by the terms of the contract for the first time this year. Data on entanglement-related pathology and incidental findings are, therefore, included in this report (Appendix 1, Table 2.8). It should be noted that freezing will compromise the interpretation of subtle pathological changes.

Among the pathological changes associated with death from entanglement are traumatic lesions directly attributable to fishing gear (Garcia Hartman et al. 1994; Kuiken 1994; Kuiken et al. 1994). This includes superficial skin lesions encircling the rostrum, head or any extremity; cleanly-cut pieces from extremities; or deep puncture wounds. Pathological changes in deeper tissues include evidence of blunt trauma such as fractures or contusions. Changes consistent with death from asphyxiation include pulmonary oedema, congestion, alveolar or bullous emphysema, stable froth in airways, and pleural congestion. There may also be congestion of pericardial vessels and ecchymotic haemorrhages (haemorrhagic spots) on the endocardium or epicardium; and on histology, hypercontraction, fibre fragmentation and fibre vacuolation of the myocardium. Less highly associated with entanglement is body condition and evidence for recent feeding (Kuiken 1994). In general, poor body condition and/or lack of food in the stomach might indicate some other cause of death. In all cases, all organ systems should be examined by a pathologist competent in the diagnosis of disease in cetaceans to rule out all possibilities.

The common dolphin entangled in commercial nets had pulmonary pathology and trauma indicative or suggestive of entanglement (Appendix 1, Table 2.8).

Among the Hector's dolphins, one was entangled in commercial nets (WB00-23Ch) and another in recreational nets (WB00-17Ch) and both had distinct skin lesions and pulmonary pathology (Table 2.8). Of the remaining 14 dolphins, the probability of entanglement was high for seven (50%) based on skin lesions and pulmonary lesions that would suggest asphyxiation; it was moderate for two animals, with signs of sudden death/recent trauma; and low for two animals. Two dolphins were too decomposed for conclusive assessment of the cause of death. However, one of them (WB00-16Ch) was a neonate and may have died following separation from its mother. The single North Island Hector's dolphin (WB00-09Ch) was also too decomposed to determine its cause of death, but signs of recent feeding suggested a sudden death, possibly related to entanglement.

One of the Hector's dolphins (WB00-25Ch), for which the probability of entanglement was high, also had a large bite wound on the back of the head and neck region. The presence of a beachcast blue shark (*Prionace glauca*) and gill netting nearby suggests that the shark may have been the cause of this wound while entangled in the net, but pulmonary lesions in the dolphin indicates that asphyxiation was the primary cause of death.

Of the two dolphins for which the probability of entanglement was low, one (WB00-13Ch) had been necropsied at the stranding site (Fig. 2.2). It was emaciated, had a fractured spine, and also had plastic debris in its stomach (Jim Lilley, Marine Watch, Christchurch, pers. comm.). Because the authors of this report did not see the fracture, we cannot comment on when it occurred or how it affected the animal's body condition. The spine will be examined after all the soft tissues have been removed. The second dolphin was less than one year old and may have died after parental separation.

Many of the Hector's dolphins had incidental pathologies including gastrointestinal ulcers (n = 6), tattoo skin lesions (n = 4), lungworms (n = 9), cystic changes in the thyroid gland (n = 1), *Crassicauda* sp. in the pterygoid sinus (n = 1), flukes in the mesenteric lymph nodes (n = 3) and bone fractures

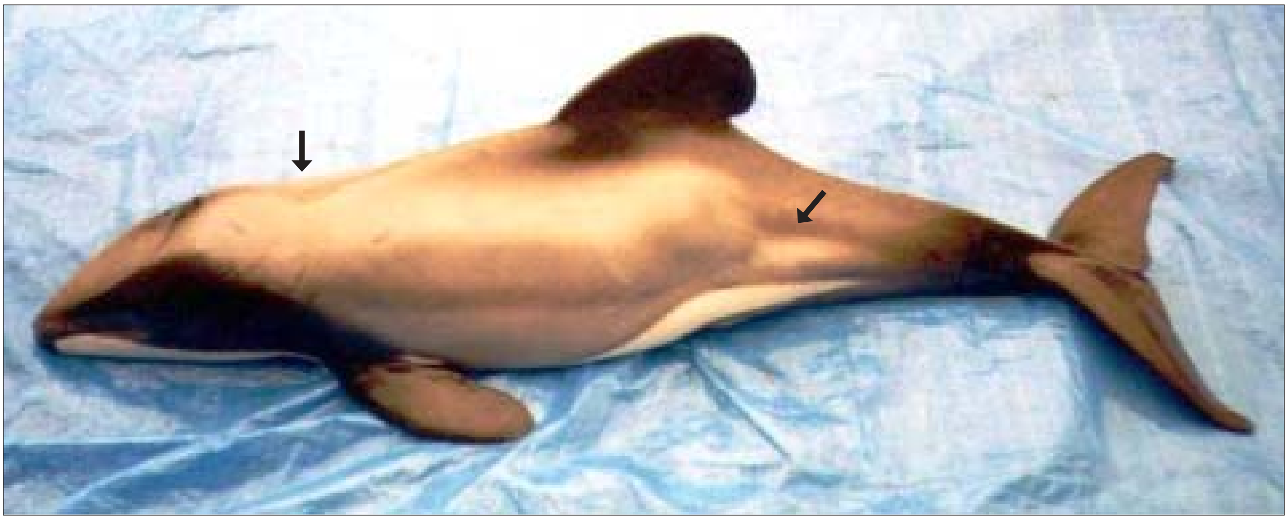

Figure 2.2. *(Top)* Left lateral view of an emaciated Hector's dolphin (WB00-13Ch). Emaciation is apparent from the pronounced 'neck' and also the hollowed out appearance of the dorsal musculature along the spine (both arrowed).
(Bottom) Dorsal view of WB00-13Ch with spinal fracture apparent as an angular deformity to the right (arrowed).

from previous traumas (n = 2) (Table 2.8). There was no evidence that these incidental changes could have caused death. An exception to this may have been the spinal fracture sustained by WB00-13Ch, which could have resulted in its emaciated body condition and subsequent death.

3.5.1 Gastrointestinal ulcers

Ulceration and inflammation of the stomach can be attributed to parasitic and non-parasitic causes. Most reports of ulceration in marine mammals directly associate the ulcers with parasitism by nematodes, e.g. *Anisakis* sp., *Contracaecum osculatum*, *Pholeter gastrophilus*, and *Phocanema decipiens.* Parasite-induced ulcers are typically shallow and have the anterior end of the worm embedded in the ulcer bed. The ulcers can be acute and haemorrhagic, or chronic with healing by fibrosis and granulation. In severe infections, perforation of the stomach wall can occur, causing peritonitis and death (Geraci & St Aubin 1987). Transmission of the nematodes occurs through the consumption of infected fish, crustaceans or squid, and are normally found free in the stomach or attached to the gastric mucosa (Geraci & St Aubin 1987). Non-parasitic ulceration in captive cetaceans can be attributed to histamine toxicosis (Geraci & St Aubin 1987) where high concentrations of histamine as part of a herring diet may cause excessive gastric acid secretion. Alternatively, starvation, stress or trauma have been proposed as causes of gastric ulcers.

In this study, six dolphins had mild to moderate ulceration of the first and second chambers. Even though parasites were not always present when the stomachs were examined, it is likely that the ulcers were induced by nematode attachment. The absence of perforation of the stomach wall suggests the ulceration was not a contributing cause of death.

3.5.2 Tattoo skin lesions

Tattoo skin lesions were observed in four Hector's dolphins and are characteristic of poxvirus infection documented in several species of other dolphins including dusky and bottlenose dolphins (*Tursiops truncatus*) (Van Bressem et al. 1993). The tattoo skin lesions appear as irregular, slightly depressed, grey to black pits in the skin that often form circles on the head, dorsum or extremities. The means of transmission of the poxvirus is unknown, but presumed to be skin contact, or via the respiratory or oral tracts (Buller & Palumbo 1991). The prevalence of tattoo skin lesions in other species has been correlated with body length, where neonates and juveniles do not show the marks until they reach a certain body length, suggesting that they are protected by antibodies from the mother's milk (passive immunity). Once the animal is weaned, passive immunity wanes and prevalence rates increase. Immunity against the poxvirus gradually develops with body length (and age, by inference) and the prevalence of lesions decreases. The tattoo skin lesions are not thought to compromise the health of the dolphin, although some severe cases have been reported in other species (Van Bressem et al. 1993).

3.5.3 Lungworms

Lungworms have been reported in many species of cetaceans, including the Hector's dolphin (McKenzie & Blair 1983; Balbuena et al. 1994). The nematodes readily colonise the lung with transmission of parasites possibly occurring through the placenta and mammary glands (Balbuena et al. 1994). In this study, the lungs of nine Hector's dolphins were infected with nematodes, and included animals of all age classes. The greater part of each worm was free in the lumen of the bronchi, but the caudal end of the worm was tightly coiled and buried in the lung parenchyma at the end of the terminal bronchioles. Small calcified nodules (a result of the infection) were especially apparent in the sub-pleural lung parenchyma and on histological examination there was either a focal inflammatory response in the affected bronchiole or no significant response. It is unlikely that these nematode infections compromised the health of the dolphins or caused death.

3.5.4 Other parasitic infection

Parasitic infection by *Crassicauda* sp. was observed in the left and right pterygoid sinus of one Hector's dolphin (WB00-05Ch). There was a multi-nodular mass (15 × 4 mm) beneath the sinus epithelium on the right side associated with attachment of the worms. Three Hector's dolphins had parasitic trematodes in the mesenetric lymph nodes that resulted in focal necrosis of the medulla.

3.5.5 Thyroid cysts

One Hector's dolphin (WB00-22Ch) had cystic changes in the left lobe of the thyroid gland. Endocrine pathology is associated with physiological stress in other species. The significance of these changes for Hector's dolphins is unknown, but they indicate that studies on endocrine function are required.

3.5.6 Trauma

One Hector's dolphin (WB00-17Ch) had a fracture of the spine that appeared externally as a marked ventro-lateral deviation of the spine at the level of the dorsal fin caudal insertion and a bony ridge that extended caudo-ventrally towards the anus and the right side. From a dorsal aspect, there was a marked lateral deviation of the spine at this location consistent with spinal fracture and realignment. Dissection revealed the fracture was at the level of the 19^{th} vertebra, or 4^{th} vertebra caudal to the most distal rib. The spine had realigned at approximately 140° and there was contraction amounting to three vertebral body lengths. A well-developed callus surrounded the fractured vertebral body and extended between the two ends of the fracture. The callus is indicative that the trauma occurred several weeks before death. The etiology of the fracture is unknown, but would have required severe trauma that may have been the result of a boat strike, or an attempt at predation by killer whales (*Orcinus orca*), or aggression from bottlenose dolphins. A second dolphin (WB00-13Ch) also had a fractured spine as described above. The etiology is also unknown, but may be similar to the previous case.

4. Discussion

The dolphins examined for this contract were received frozen and double bagged. In general the packaging was of a high standard and the animals were usually identified by the observer's report or stranding form stuck into their oral cavities, or by an orange tag around their tailstocks. However, the data sheet or tag was missing for five Hector's dolphins. The missing details of one dolphin were obtained from D. Neale (DOC Hokitika). In terms of animal identification, the orange tags around the tailstocks were very effective. Samples from a beach autopsy of WB00-13Ch were sent in an insulated bin with a stranding form inside. It was beneficial to have a list of animals being shipped forwarded by e-mail to allow a cross-check between animals shipped and those received. In that way, any animal that arrived without the observer's report or tag could be traced. From a health and safety perspective, the packaging was sufficient to prevent contamination of the environment by the carcasses provided they remained frozen.

The number of common dolphins examined here is too small to make any conclusion about the biology of the species. The only animal submitted was a sexually immature female. Common dolphins are thought to reach sexual maturity at approximately 1.7 m (Leatherwood et al. 1983), but the female in this study exceeded this length. The common dolphin was caught as a result of commercial fishing activities and had pulmonary lesions suggestive of asphyxiation, but did not have unequivocal skin lesions attributable to entanglement. This emphasises that pathological lesions other than skin lesions alone need to be considered in the determination of cause of death.

The Hector's dolphin incidentally caught by commercial fishers was captured off the Canterbury coast, a site within the range of the species (Cawthorn 1988; Slooten & Dawson 1994). The dolphins caught by recreational nets and those found beachcast were in areas off the west and east coasts of the South Island where there are greater numbers of Hector's dolphins (Slooten & Dawson 1994). Three carcasses were not labelled and their origin remains unknown.

Morphological features of the Hector's dolphins were consistent with those reported previously (Mörzer Bryuns & Baker 1973; Slooten 1991; Slooten & Dawson 1994). It was also found that most of the animals were sexually immature, which is consistent with previous reports of incidentally caught Hector's dolphins (Slooten 1991; Dawson 1991; Part 1 of this report). As in a previous study that included 60 Hector's dolphins (Slooten 1991), the sex ratio of animals submitted for this investigation was equal. This differs from the study described in Part 1 of this report where the animals were predominantly males, which was probably a reflection of sampling bias rather than the structure of the population.

Determination of the species of fish and invertebrates ingested by the dolphins was beyond the scope of this investigation, but all hard parts removed from the stomachs were archived for future studies. Most animals had some remains of fish, squid or other invertebrates suggesting that they had eaten shortly before death.

Age determination in cetaceans, based on counting growth layers or annuli in teeth, is commonly used on a variety of species (Perrin & Myrick 1980). Although widely used, the technique is subject to difficulties in methodology, interpretation, reader variability, variability among teeth, and the lack of known-age animals (Dapson 1980). The method used to section teeth can also introduce marked biases into the interpretation of age. For this reason, and because teeth from known-age Hector's dolphins were not available, it was decided to employ a method similar to that used previously on this species (Slooten 1991) and on the related Commerson's dolphin (Lockyer et al. 1988). The results obtained are comparable to those reported by Slooten (1991) and are in agreement with other findings on the animals such as reproductive status and morphology. The pubescent and immature males in this study were of similar ages to the pubescent and immature males reported by Slooten (1991). Two males with large and histologically mature testes in this study had a minimum age of 5 years, but it should be emphasised that their true ages may be greater that this. However, the quality of the tooth sections precluded a more confident estimate of age.

The pathological findings indicate that there is a high probability that entanglement caused the deaths of the common dolphin, and nine of the Hector's dolphins examined. Two other Hector's dolphins appear to have died suddenly and possibly as a result of entanglement. This is based on a consideration of pathological changes, body condition, presence of food material in the stomach and the absence of any other pathology that could have caused death (Garcia Hartmann et al. 1994; Kuiken 1994; Kuiken et al. 1994). The specific details are presented above (Section 3.5) and in Table 2.8. Briefly, some animals had gross evidence of physical trauma immediately prior to death. This took the form of sub-cutaneous and muscular contusion with oedema and haemorrhage. Pathology associated with asphyxiation included acute diffuse congestion and oedema of the lungs, congestion and haemorrhage in the airways, and blood-stained froth in the airways. Obstruction of airflow often resulted in bullous emphysema. Some animals also had congestion of pericardial and cardiac blood vessels. The histological changes in the lungs consisted of congestion and flooding of the alveoli with fluid (oedema). Acute destruction of alveolar walls (alveolar emphysema) was also a common finding. Myocardial haemorrhages were not detected but may have been obscured by freezing artefacts. However, hypercontraction and fragmentation, particularly in the deeper parts of the ventricular walls were common observations suggesting acute hypoxia.

5. References

For details of references quoted in Part 2, see the combined reference list at the end of Part 3 (pp. 58–60).

Appendix 1

TABLES OF RESULTS

TABLE 2.1. CAPTURE DATA FOR HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY NO.	CSL NO.	DATE	TIME (24 h)	LATI-TUDE	LONGI-TUDE	SEX
Common dolphin							
WB00-06Dd	31067	622	13 Oct 99	2300	39ºS	174ºE	F
Hector's dolphin							
WB00-23Ch	31309	–	27 Nov 97	0745	43ºS	172ºE	F

– Indicates data is not available.

TABLE 2.2. STRANDING DATA FOR HECTOR'S DOLPHINS, 1999/2000.

CODE	PATH-OLOGY NO.	DOC TAG NO.	DATE	TIME (24 h)	CIRCUM-STANCES	LOCATION	COMMENTS
North Island Hector's dolphin—Female							
WB00-09Ch	31122	–	10 Mar 00	–	Beachcast	Albatross Bay, Kawhia	Scavenged
South Island Hector's dolphin—Female							
WB00-16Ch	31296	H29/00	22 Jan 00	0945	Beachcast	1.3 km N of Waimairi Surf Club	Scavenged
WB00-17Ch	31298	H24/98	Summer 98	–	Incidental bycatch	Sumner Bay, Christchurch	
WB00-20Ch	31304	H31/00	11 Mar 00	1100	Beachcast	PC Bay, Akaroa	
WB00-21Ch	31305	–	18 Aug 99	0947	Beachcast	Gillespie Beach	
WB00-25Ch	31312	–	6 Feb 99	–	Beachcast	Takutai Beach, Hokitika	No data
WB97-61Ch	38737	–	–	–	–	–	
South Island Hector's dolphins—Male							
WB00-05Ch	31046	–	7 Jan 00	1630	Beachcast	Irongate, Sth of Rakatura, Kaikoura	
WB00-10Ch	31126	H28/00	22 Dec 99	–	Beachcast	Caroline Bay Beach, Timaru	
WB00-11Ch	31157	H33/00	27 Mar 00	0725	Beachcast	100 m S of South Brighton Surf Club	
WB00-13Ch	31130	97/97	4 Dec 97	0655	Beachcast	Mouth of Avon/Heathcote Estuary	Scavenged
WB00-18Ch	31299	H25/98	–	–	–	Banks Penisula	No data
WB00-19Ch	31300	H32/00	19 Mar 00	1000	Beachcast	Opihi River Mouth	
WB00-22Ch	31308	–	16 Jul 98	–	Beachcast	Westport	
WB00-24Ch	31311	–	–	–	–	–	No data

– Indicates data is not available.

TABLE 2.3. MORPHOMETRIC DATA FOR HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY No.	Wt (kg)	Std L (m)	Sn–An (m)	Sn–Gen (m)	Sn–ODF (m)	Sn–OF (m)	F L (m)	F W (m)	DF Ht (m)	DF BL (m)	Flk W (m)	Gt Pec (m)	Blub.D (m)	Blub.L (m)	Blub.V (m)
North Island Hector's dolphin—Female																
WB00-09Ch	31122	–	1.45	1.05	0.97	0.67	–	0.21	0.070	0.090	0.270	0.32	–	–	–	–
South Island Hector's dolphins—Female																
WB00-16Ch	31296	28.6	0.79	0.58	0.54	0.39	0.22	0.16	0.054	0.056	0.180	0.20	–	0.015	0.008	0.008
WB00-17Ch	31298	35.2	1.21	0.85	0.82	0.61	0.31	0.23	0.078	0.084	0.220	0.35	0.79	0.017	0.009	0.017
WB00-20Ch	31304	18.9	1.19	0.84	0.77	0.56	0.28	0.20	0.065	0.081	0.175	0.30	0.66	0.011	0.010	0.011
WB00-21Ch	31305	18.1	1.21	0.85	0.81	0.59	0.30	0.21	0.065	0.055	0.170	0.20	0.60	0.001	0.001	0.002
WB00-23Ch	31309	37.4	1.20	0.92	0.89	0.60	0.30	0.22	0.080	0.080	0.190	0.38	0.80	0.012	0.010	0.012
WB00-25Ch	31312	36.0	1.29	0.94	0.91	0.64	0.34	0.23	0.085	0.105	0.230	–	0.86	0.015	0.014	0.015
WB97-61Ch	28737	–	0.77	0.55	0.52	0.39	0.23	0.19	0.090	0.090	0.140	0.29	0.51	0.009	0.008	0.009
South Island Hector's dolphin—Male																
WB00-05Ch	31046	31.1	1.15	0.85	0.73	0.56	0.28	0.20	0.075	0.075	0.175	0.38	0.79	0.018	0.011	0.013
WB00-10Ch	31126	30.9	1.18	0.85	0.73	0.57	0.30	0.21	0.080	0.070	0.210	0.39	0.77	0.017	0.015	0.016
WB00-11Ch	31157	12.6	0.86	0.61	0.53	0.43	0.23	0.17	0.060	0.070	0.160	0.27	0.54	0.014	0.016	0.016
WB00-13Ch	31130	–	1.16	0.84	0.70	–	0.31	0.22	0.075	0.088	–	0.38	0.61	–	–	–
WB00-18Ch	31299	26.4	1.14	0.82	0.71	0.53	0.24	0.19	0.064	0.070	0.170	0.36	0.74	0.018	0.012	0.018
WB00-19Ch	31300	15.5	0.91	0.67	0.60	0.44	0.21	0.16	0.060	0.065	0.145	0.21	0.66	0.016	0.015	0.014
WB00-22Ch	31308	34.8	1.18	0.86	0.72	0.56	0.28	0.22	0.080	0.095	0.205	0.40	0.82	0.016	0.014	0.015
WB00-24Ch	31311	39.0	1.23	0.88	0.76	0.60	0.30	0.22	0.080	0.100	0.200	0.46	0.81	0.010	0.009	0.010
Common dolphin—Female																
WB00-06Dd	31067	86.2	1.93	1.40	1.34	0.80	0.45	0.28	0.095	0.160	0.360	0.32	1.10	0.011	0.007	0.009

Wt = weight; Std L = standard body length; Sn-An = snout to anus length; Sn-Gen = snout to genital slit length; Sn-ODF = snout to origin of dorsal fin length; Sn-OF = snout to origin of flipper; FL = flipper length; FW = flipper width; DF Ht = dorsal fin height; DF BL = dorsal fin length at base; Flk W = fluke width; Gt Pec = girth at pectoral flippers; Blub. D = dorsal blubber depth; Blub .L = lateral blubber depth; Blub.V = ventral blubber depth.

– Indicates data is not available.

TABLE 2.4. STOMACH MORPHOMETRICS AND CONTENTS FOR HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY NO.	STOMACH FULL WT (kg)	STOMACH EMPTY WT kg	COMPARTMENT 1 CONTENTS WT (kg)	COMPARTMENT 1 COMPOSITION	COMPARTMENT 2 CONTENTS WT (kg)	COMPARTMENT 2 COMPOSITION	COMPARTMENT 3 CONTENTS WT (kg)	COMPARTMENT 3 COMPOSITION	PARASITES	ULCERS
North Island Hector's dolphin—Female											
WB00-09Ch	31122	0.643	–	0.176	Fish bones, otoliths	–	–	–	–	N	–
South Island Hector's dolphin—Female											
WB00-16Ch	31296	–	–	–	–	–	–	–	–	N	–
WB00-17Ch	31298	1.097	0.486	–	Fish bones, otoliths, lenses, 1 shrimp	TLTM	Fish lenses	TLTM	Fish otoliths,lenses, squid beak	Y	C3
WB00-20Ch	31304	0.394	0.391	TLTM	Fish otoliths,lenses	TLTM	Squid beak	–	–	Y	C3
WB00-21Ch	31305	0.291	–	–	Fish otoliths,lenses, arthropods	TLTM	Fish otoliths,lenses	–	–	Y	–
WB00-23Ch	31309	1.547	0.503	0.481	Fish bones, otoliths, lenses, squid beak, crab, krill	–	Fish otoliths,lenses, squid beak, krill	–	–	Y	C2, 3
WB00-25Ch	31312	0.628	0.566	–	Fish bones,otoliths, pieces	TLTM	Fish otoliths, bivalves	–	–	Y	C2
WB97-61Ch	28737	–	–	–	–	–	–	–	–	N	–
South Island Hector's dolphin—Male											
WB00-05Ch	31046	–	–	0.539	Fish bones,otoliths, squid beaks	TLTM	Fluid only	TLTM	Fluid only	Y	C2, 3
WB00-10Ch	31126	0.870	–	0.390	Fish bones,otoliths, pieces	TLTM	Fish otoliths	TLTM	Fluid only	N	C2
WB00-11Ch	31157	0.830	0.830	–	–	–	–	–	–	N	–
WB00-13Ch	31130	–	–	–	Fish bones,otoliths,plastic	–	–	–	–	Y	–
WB00-18Ch	31299	0.486	0.307	0.060	Fish bones, otoliths, lenses, Squid beaks	–	–	–	–	N	–
WB00-19Ch	31300	0.106	0.099	0.001	Fish otoliths, lenses, gravel,	0.002	Fish otoliths, gravel	–	–	N	–
WB00-22Ch	31308	0.391	0.381	–	fish otoliths,lenses	–	–	–	–	Y	C1, 3
WB00-24Ch	31311	0.685	0.554	0.008	Fish otoliths, lenses, crab	TLTM	Fish otoliths, lenses	–	–	N	C2
Common Dolphin—Female											
WB00-06Dd	31067	2.053	1.225	0.296	Otoliths, fish bones, squid beaks	–	–	TLTM	Fluid only	N	–

TLTM = too little to measure; C1, C2, etc. = compartment 1, 2, etc.

– Indicates data is not available.

TABLE 2.5. AGE ESTIMATION BASED ON DENTINAL GROWTH LAYER GROUPS FOR HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY NO.	WT (g)	L (mm)	W (mm)	AGE (years)	COMMENTS
North Island Hector's dolphin—Female						
WB00-09Ch	31122	0.11	12.3	3.2	2–4	
South Island Hector's dolphin—Female						
WB00-16Ch	31296	0.02	6.2	2.1	0.5	Neonate
WB00-17Ch	31298	0.10	9.0	5.0	2.5	
WB00-20Ch	31304	0.08	11.0	2.5	1.5	
WB00-21Ch	31305	0.07	10.2	2.4	2.0	
WB00-23Ch	31309	0.10	18.0	2.2	1.5	
WB00-25Ch	31312	0.11	12.6	3	1.5	
WB97-61Ch	28737	–	–	–	< 1	Neonate
South Island Hector's dolphin—Male						
WB00-05Ch	31046	0.10	11.5	2.5	5.0	
WB00-10Ch	31126	0.12	12.4	2.5	5.5	
WB00-11Ch	31157	0.07	8.2	2.1	3+	
WB00-13Ch	31130	0.11	12.2	2.5	3–4	
WB00-18Ch	31299	0.10	11.0	1.0	1.5–3	
WB00-19Ch	31300	0.02	5.0	1.0	2.0	
WB00-22Ch	31308	0.09	9.0	1.0	5.5	
WB00-24Ch	31311	0.13	11.0	1.0	5+	Difficult to read
Common dolphin—Female						
WB00-06Dd	31067	0.18	14.7	3.1	5–6	

– Indicates data is not available.

TABLE 2.6. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY NO.	RIGHT OVARY				LEFT OVARY				UTERINE		MILK
		Wt (g)	L×W×D (mm)	CA	CL	Wt (g)	L×W×D (mm)	CA	CL	MATURITY	GRAVID*	PRESENT
North Island Hector's dolphin												
WB00-09Ch	31122†	–	–	–	–	–	–	–	–	–	N	N
South Island Hector's dolphins												
WB00-16Ch	31296†	–	–	–	–	–	–	–	–	–	–	–
WB00-17Ch	31298	1	27 × 13 × 3	–	–	1	26 × 14 × 3	–	–	IM	N	N
WB00-20Ch	31304	< 1	20 × 12 × 2	–	–	< 1	21 × 11 × 2	–	–	IM	N	N
WB00-21Ch	31305	< 1	24 × 7 × 1	–	–	< 1	20 × 9 × 1	–	–	IM	N	N
WB00-23Ch	31309	< 1	30 × 12 × 2	–	–	< 1	30 × 14 × 3	–	–	IM	N	N
WB00-25Ch	31312	< 1	26 × 12 × 3	–	–	< 1	27 × 14 × 4	–	–	IM	N	N
WB97-61Ch	28737	< 1	13 × 6 × 1	–	–	< 1	14 × 8 × 2	–	–	IM	N	N
Common dolphin												
WB00-06Dd	31067	5	26 × 20 × 13	–	–	2	26 × 13 × 9	–	–	IM	N	N

CA = Corpus albicens; CL = Corpus luteum; IM = Immature.

* Determined by the presence of a grossly detectable embryo or foetus.

† Scavenged.

– Indicates data is not available.

TABLE 2.7. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S DOLPHINS, 1999/2000.

CODE	PATH-OLOGY NO.	RIGHT TESTIS			LEFT TESTIS			TESTIS MATUR-ITY	COMBINED TESTICULAR MASS* (g)
		Wt+epid (g)	Wt–epid (g)	L×D (mm)	Wt+epid (g)	Wt–epid (g)	L×D (mm)		
South Island Hector's dolphin									
WB00-05Ch	31046	29	20	73 × 24	28	20	72 × 23	P	57
WB00-10Ch	31126	16	9	60 × 18	16	9	66 × 19	P	32
WB00-11Ch	31157	2	1	41 × 6	3	1	51 × 5	IM	5
WB00-13Ch	31130	–	–	–	–	–	–	–	–
WB00-18Ch	31299	6	4	53 × 14	6	4	46 × 13	IM	12
WB00-19Ch	31300	4	3	66 × 10	3	–	51 × 18	IM	7
WB00-22Ch	31308	432	397	191 × 77	439	403	193 × 74	MI	871
WB00-24Ch	31311	188	153	151 × 55	186	145	151 × 50	MA	374

IM = Immature; MA = Mature-active; MI = Mature-inactive; P = Pubertal;.

* Includes epididymis weight.

– Indicates data is not available.

LEGEND TO SYMBOLS ON TABLE 2.8

1 = Respiratory congestion and oedema
2 = Pulmonary emphysema
3 = Trauma (contusion, free blood in abdomen)
4 = Foreign matter in lungs
5 = External net entanglement marks

I = Tracheal and bronchial congestion/haemorrhage
II = Bronchiole excessive mucus
III = Pulmonary interlobular/lobular oedema/congestion
IV = Pulmonary aveolar emphysema
V = Cardiac fibre hypercontraction
VI = Cardiac fibre fragmentation

A = Gastrointestinal ulcers
B = Tattoo skin lesions
C = External wound—shark bite
D = Thyroid cysts
E = Lungworm
F = Crassicouda in Pterygoid sinuses
G = Fluke in mesenteric lymph node
H = Previous trauma (bone fractures)
I = Foreign matter in stomach (plastic)

AI = Pulmonary multi-focal inflammation
AII = Bronchiole focal supprative inflammation
AIII = Bronchiole nematode with pyogranulomatous inflammation
AIV = Pulmonary sub-pleural granulomatous inflammation
AV = Bronchiole lymphoid nodules
AVI = Bronchial and bronchiole nematodes
BI = Pox inclusion bodies
CI = Cardiac nuclear rowing
CII = Cardiac non-suppurative inflammation

TABLE 2.8. PATHOLOGY OF HECTOR'S AND COMMON DOLPHINS, 1999/2000.

CODE	PATHOLOGY NO.	ENTANGLEMENT-RELATED PATHOLOGY			INCIDENTAL FINDINGS	
		GROSS	HISTOLOGICAL	PROBABILITY	GROSS	HISTOLOGICAL
North Island Hector's dolphin—Female						
WB00-09Ch	31122	*	–	*	–	–
South Island Hector's dolphin—Female						
WB00-16Ch	31296	–	*	*	–	–
WB00-17Ch	31298	1, 5	III, IV, V	High	E, G, H	AIII
WB00-20Ch	31304	1, 2, 5	III, IV, V	High	E	–
WB00-21Ch	31305	–	*	*	–	–
WB00-23Ch	31309	1, 2, 3, 5	III, IV, V	High	A,G	AI, AIV
WB00-25Ch	31312	1, 2, 5	III, IV, V	High	A, C, E	AIII, AIV, AV
WB97-61Ch	28737	–	*	Low	E	AVI‡
South Island Hector's dolphin—Male						
WB00-05Ch	31046	3, 4, 5	III, V, VI	High	A, B, E, F	AI, BI, CI
WB00-10Ch	31126	1, 3, 5	III, IV, V	High	A, B, E	AII, AIII, BI
WB00-11Ch	31157	1, 5	III	High	B, E	AIII
WB00-13Ch	31130	–	–	Low	H, I	–
WB00-18Ch	31299	1, 3, 5	II, III, IV, V, VI	High	E, G	–
WB00-19Ch	31300	3	–	Mod	B, E	BI
WB00-22Ch	31308	–	I, III†	Mod	A, D	–
WB00-24Ch	31311	1, 4, 5	III†	High	A	AIV
Common dolphin—Female						
WB00-06Dd	31067	1, 2, 3	III, IV, V	High	–	CII

* Too decomposed to determine pathology/probability.
† Heart too decomposed.
‡ Too decomposed to tell if accompanied by inflammation.
– Indicates data is not available.

Part 3 Autopsy report for 2000/01

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ABSTRACT

Morphological characteristics, estimated age, gender, reproductive status, stomach contents and cause of death were determined for 18 Hector's dolphins (*Cephalorhynchus hectori*), 3 dusky dolphins (*Lagenorhynchus obscurus*) and one common dolphin (*Delphinus delphis*). The dusky and common dolphins were incidentally killed in commercial fishing operations. The Hector's dolphins were retrieved either from amateur set nets (n = 3), found beachcast on the west coast of the South Island (n = 6), the east coast of the South Island (n = 6) or south of Auckland (n = 3). The stomachs of 7 Hector's dolphins were empty. The stomachs of all remaining dolphins contained the remains of teleost fish such as otoliths and bones, and squid. Fish predominated in the stomachs of Hector's dolphins, but fish and squid were equally represented in the stomachs of the dusky and common dolphins. Salps were found in the stomach of one dusky dolphin. Age was estimated for all dolphins by counting dentinal growth layer groups in stained sections of teeth. The age frequency distribution for the Hector's dolphins examined was similar to that previously reported for this species with an over-representation of immature animals. The female Hector's dolphins were sexually immature and ranged from < 1 year (neonatal) to c.6 years old. Based on estimated age and morphometrics, two other females from which the gonads had been scavenged were either immature or pubertal. Four male Hector's dolphins had mature gonads and were between 4 and 7.5 years old while 4 others, estimated to be between 3 and 5 years, had histologically immature gonads. One of the 2 males with scavenged gonads was a neonate with non-erupted teeth. The female dusky and common dolphins were sexually immature as indicated by the absence of corpora on the ovaries. Both were estimated to be 4.5 years old. The male dusky dolphin was sexually mature at 8 years old. Of the 3 Hector's dolphins and all the dusky and common dolphins known to have been entangled in nets, all had lesions consistent with death from entanglement and asphyxiation. Nine of the 15 remaining beachcast Hector's dolphins had lesions indicative of entanglement, 3 had lesions consistent with trauma and sudden death, 2 were too decomposed to determine cause of death, and 1 had died from natural disease.

Keywords: dolphins, Hector's, *Cephalorhynchus hectori*, dusky, *Lagenorhynchus obscurus*, common, *Delphinus delphis,* autopsy, stomach contents, estimated age, North Island, South Island, New Zealand

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1. Introduction

The primary objective of this study was to fulfil the requirements of DOC contract CSL00/3025 by recording and interpreting data on each animal. These data included species, sex, size, body condition, age, reproductive status, stomach contents, and cause of death. This report details the findings pertinent to this objective and includes data on 18 Hector's dolphins (*Cephalorhynchus hectori),* three dusky dolphins (*Lagenorhynchus obscurus*) and one common dolphin (*Delphinus delphis*) killed incidentally in fishing operations or found beachcast.

A second objective was to examine the carcasses for evidence of disease and to collect material for ongoing and future research projects as outlined in Part 1 of this report.

Part 1, Section 1 contains general information on dusky and Hector's dolphins. Part 2, Section 1 contains general information on common dolphins.

2. Materials and methods

2.1 MATERIALS

Two females and one male dusky dolphin and one female common dolphin were received for autopsy this year. The catch date, time, and location coordinates were recorded by CSL observers for the dusky and common dolphins retrieved from trawl nets (Appendix 1, Table 3.1).

Fifteen South Island Hector's dolphin carcasses were received consisting of 5 females, 9 males and one animal which could not be sexed. One Hector's dolphin (WB01-20Ch), consisted only of skeletal remains, while a second animal (WB01-35Ch) was partially autopsied on the beach by biologists and the carcass submitted did not include the gonads and stomach. Two animals could not be sexed grossly because of decomposition and scavenging, however, one was identified as male by DNA analysis. Three North Island Hector's dolphins were amongst those received, including a decomposed specimen which was sexed by DNA analysis as female, and two others physically identified as male.

While 11 of the 18 Hector's dolphin carcasses had not been labelled, details of their death were available. The 15 South Island Hectors dolphins were either removed from set nets (n =3), found beachcast (n = 11), or floating at sea (n = 1). The three South Island Hector's dolphins retrieved from recreational set nets, were found off Amberley Beach, Christchurch; Granity Beach, Buller; and south of the Waimangaroa River mouth, Hokitika (Appendix 1, Table 3.2). The remaining 12 South Island Hector's dolphins were found along the west and east coasts of the South Island. The three North Island Hector's dolphins were from the Waikato-Manukau area of the North Island, and all were beachcast, one

Figure 3.1. Capture locations for dusky and common dolphins incidentally caught in fishing operations, 2000/01.

with evidence of net entanglement (Appendix 1, Table 3.2). The capture locations for the dusky and common dolphins (all retrieved from nets) are depicted graphically in Fig. 3.1.

The carcasses were delivered to Massey University frozen and wrapped in clear plastic bags and woven nylon sacks. Four were identified by Conservation Services Levy (CSL) observer or Independent Fisheries data sheets, 7 dolphins had orange tags attached around the tailstock, and 11 had no identification, but stranding forms were obtained at a later date. On receipt, the dolphins were stored at –20°C until necropsy. The species and sex was recorded based on external morphology and photographs taken of the external characteristics of each carcass.

2.2. METHODS AND NECROPSY PROTOCOL

See Part 1, Section 2.2 for details.

3. Results for 2000/01

3.1 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table 3.3).

3.2 STOMACH CONTENTS

The stomach weight and the weight of the contents were recorded for each animal (Appendix 1, Table 3.4). The contents were not identifiable to species for any animal. Nine Hector's dolphins had contents in at least one stomach compartment. Most of these contents were indigestible remains of teleost fish such as bones, eye lenses and otoliths, and an occasional squid beak. Four Hector's dolphins had empty stomachs. The stomach of one dolphin (WB01-35Ch) had been removed prior to arriving at Massey University, one animal had been scavenged and three dolphins were too decomposed, preventing the retrieval of stomach contents. The dusky and common dolphins had fish otoliths, bones and squid beaks in at least two compartments. Most of the contents were indigestible, except for one dusky dolphin (WB01-12Lo) in which the first chamber of the stomach was full with predominantly whole, fresh squid, as well as indigestible teleost fish remains. Otoliths and invertebrate parts have been stored in alcohol for more detailed analysis of diet at or immediately before the time of death. Blubber samples have also been stored frozen at –80°C for analysis of fatty acid signatures.

3.3 AGE DETERMINATION

Data on tooth size and the number of dentinal growth layer groups (GLGs) counted are given in Appendix 1, Table 3.5. For the South Island Hector's dolphins with teeth (n = 12) the mean tooth weight and size was similar to that reported previously (Slooten 1991; Part 1 and Part 2 of this report). The teeth did not have obvious incremental layers in the cementum, but there were clearly defined bands in the dentine of most animals. The accepted protocol for small cetaceans is that one dark band (stained) and one light band (unstained) constitute one year's growth (Perrin & Myrick 1980; Slooten 1991). Based on this assumption, the South island Hector's dolphins ranged in age from neonates (teeth not erupted and not sectioned) to at least 7.5 years old. The three North Island Hector's dolphins ranged between 4 and 7 years old. The dusky dolphins included two young females both estimated as 4.5 years old, and an 8-year-old mature male, while the female common dolphin was approximately 4 years old. The ages given are minimum estimates based on clearly defined bands. The Hector's dolphin sample was biased with young animals over-represented. The age bias is similar to that in the previous bycatch investigations (Part 1 and Part 2 of this report.) and is similar but even more marked than the age bias reported by Slooten (1991) in which 41 of 60 specimens (68%) were five years or younger.

3.4 REPRODUCTIVE STATUS

Females

Morphometric data on reproductive tracts are given in Appendix 1, Table 3.6. Three female Hector's dolphins (3, 4.5, and 6 years) had small smooth ovaries with no evidence of corpora. The uterine wall was also histologically immature and there was no evidence of lactation. These findings are similar to those for female Hector's dolphins, 6 years and younger, reported by Slooten (1991). The results are also consistent with those of immature female dolphins, 5 years or younger, from previous bycatch reports (Part 1 and Part 2 of this report). The gonads of three dolphins had been scavenged and were not available for examination. However, one of these (WB01-33Ch) was a neonate and would have been immature, while the other two were 6 and 7 years old and would have been either pubertal or in early maturity. The only female North Island Hector's dolphin in the sample had no gonads suitable for examination, due to decomposition.

The dusky dolphins were approximately 4.5 years old and the common dolphin was 4 years old. There were no visible corpora in serial sections of the ovaries. The histology of the uterine horns was consistent with sexual immaturity based on the criteria given in Part 1, Section 2.2.4. Milk was not present in the mammary glands.

Males

The gonads were examined for seven male Hector's dolphins. Of these, two were classed as mature-active, one as mature-inactive, and three as immature, based on histological characteristics (Appendix 1, Table 3.7). The two mature-active males were at least 5 and 6 years old and had combined testicular masses (including the epididymis) of 1053 g and 937 g respectively (Appendix 1, Table

3.7). This is within the range of mature combined testicular masses (266 g to 1210 g) reported by Slooten (1991) and in Parts 1 and 2 of this report. The testes of these males had active spermatogenesis and spermatozoa in the testes, epididymis and penis indicating maturity. The mature-inactive male had a combined testicular mass of 185 g, which is considerably greater than that for the immature dolphins that had combined masses of between 10.9 g and 29.6 g. Although the gradation between immature, pubertal and mature is probably indistinct, pubescent males would be expected to have an intermediate combined testicular mass. This is indicated in previous reports with pubescent males having a combined testicular mass of 65 g (Slooten 1991), 57 g and 32 g (see Part 2 this report). The gonads of two dolphins had been scavenged and could not be examined, but based on morphometrics one was a neonate and therefore sexually immature. The other was at least 2 years old, but could not be accurately aged because of damage to the teeth. The gonads of one dolphin (WB01-35Ch) had been removed and could not be examined, but based on an estimated age of 4 years old and morphometrics it was likely to be sexually pubescent or mature. The only male North Island Hector’s dolphin with gonads present was an immature animal.

The male dusky dolphin had mature active testes and was approximately 8 years old.

3.5 PATHOLOGY

Data on entanglement-related pathology is included in this report (Appendix 1, Table 3.8). This Table does not include details of incidental pathology as reported in Part 2 of this report. It should be noted that freezing can compromise the interpretation of subtle pathological changes.

Among the three dusky dolphins and one common dolphin incidentally caught in commercial fishing operations, three had distinct net marks in the skin encircling the rostrum and along the leading areas of the dorsal fin, pectoral flippers and tail flukes. One dusky dolphin (WB01-11Lo) had been decapitated and had deep lacerations along the tailstock probably caused by a sharp implement such as a propeller. Evidence of blunt trauma with erythema of blubber, haemorrhage and oedema of muscle along the mandible, cranium, thorax and abdomen, and free blood-stained fluid in the abdomen was also observed in three dolphins. Trauma was particularly severe in the common dolphin, which had a comminuted fracture of the occipital bone at the posterior of the cranium resulting in laceration of the cerebellum by bone fragments. The tongue was also congested and haemorrhagic and enlarged to fill the oral cavity. All of the dusky dolphins and the common dolphin had moderate to severe pulmonary oedema and congestion, and myocardial hyper-contraction, hyper-eosinophilia and fibre fragmentation (Appendix 1, Table 3.8). Regurgitated stomach contents were observed in the airways of one dusky dolphin. In all animals examined there were no other apparent pathological changes that could have caused death.

Among the three Hector’s dolphins known to have been entangled in recreational set nets, all had distinct net marks in the skin encircling the rostrum and along the leading areas of the dorsal fin, pectoral flipper and tail flukes. Evidence of blunt trauma with erythema of blubber, haemorrhage and oedema of muscle along the thorax and cranium; and free blood-stained fluid in the abdomen was also observed. Two of these dolphins had moderate to severe pulmonary oedema and congestion, and all three dolphins had myocardial hyper-contraction, hyper-eosinophilia, and fibre fragmentation (Appendix 1, Table 3.8). Regurgitated stomach contents were observed in the mouth and oesophagus of two dolphins.

Of the remaining 15 dolphins, including the 3 North Island Hector's dolphins, the probability of entanglement was high for 9 (60%) based on skin lesions and in some cases lesions that would suggest pulmonary asphyxiation and recent trauma; it was moderate for 3 dolphins with signs of sudden death and recent trauma. One beachcast Hector's dolphin died from fulminating mycotic pneumonia and encephalitis caused by *Aspergillus* sp. Two dolphins were too decomposed and scavenged for conclusive assessment of the cause of death. However, one (WB01-34Ch) was a neonate and may have died following separation from its mother.

4. Discussion

The dolphins examined for this contract were received frozen and double bagged. In general the packaging was of a high standard and the animals were identified by CSL observer or Independent Fisheries data sheets, or by orange tags attached around the tailstock. Although tags were missing for 11 Hector's dolphins, stranding forms were sent at a later date. The orange tags around the tailstock were very effective for animal identification. It was beneficial to have a list of animals being shipped forwarded by email to allow a cross-check between animals shipped and those received. In that way, any animal that arrived without a CSL tag or stranding form could be traced. From a health and safety perspective, the packaging was sufficient to prevent contamination of the environment by the carcasses provided they remained frozen.

The number of dusky dolphins was too small to allow any conclusions about the ecology of the species but the life history characteristics of the individuals examined conform to published data for this species (Leatherwood et al. 1983). Dusky dolphins are thought to reach sexual maturity at a standard length of approximately 1.65 m. Both females were close to this length and were classified as sexually immature, while the male was larger and classified as sexually mature. All of the dusky dolphins were caught as a result of commercial fishing activities, and all had pulmonary and cardiac lesions suggestive of asphyxiation, two had trauma, and only two had unequivocal skin lesions attributable to entanglement. This demonstrates that pathological lesions, other than skin lesions alone, need to be considered in determination of cause of death.

The life history characteristics of the common dolphin are similar to those examined in a previous CSL contract (see Part 2), and in previous studies (Leatherwood et al. 1983). The only animal submitted was a sexually immature female that, at 1.8 m Standard Length should have attained breeding size based on published data (Leatherwood et al. 1983). The dolphin was caught as a result of commercial fishing activities and had pulmonary and cardiac lesions suggestive of asphyxiation, and skin lesions attributable to entanglement.

The morphological features of the South Island Hector's dolphins were consistent with those reported previously (Mörzer Bruyns & Baker 1973; Slooten 1991; Slooten & Dawson 1994). The life history data collected from these dolphins complement data from previous bycatch reports of 15 animals examined in 1999 and 2000 (Parts 1 and 2 of this report.). The sex ratio of the dolphins investigated was slightly biased, comprising 60% males as compared to only 56% in 2000 and up to 83% in 1999. This male bias differs from a female bias reported by Slooten (1991). Whether the bias represents a population bias or a sampling artefact is unknown. Most of the animals examined were sexually immature which is consistent with previous reports on incidentally caught Hector's dolphins (Slooten 1991; Dawson 1991; Part 1 and Part 2 of this report).

Determination of the species of fish and invertebrates ingested by the dolphins was beyond the scope of this investigation, but all hard parts removed from the stomachs were archived for future studies. The stomach contents of the Hector's dolphins were similar to those listed in Part 1 and Part 2 of this report. As in previous studies, the stomach contents consisted predominately of indigestible teleost fish and invertebrate remains, with fish predominating in the stomach of Hector's dolphins, but fish and squid equally represented in the stomach of dusky and common dolphins. One North Island Hector's dolphin had fish bones, otoliths, eye lenses, and a copepod crustacean in its stomach. The presence of mostly indigestible remains suggests that the dolphins had not eaten shortly before death, except for one dusky dolphin, which had a full stomach consisting mostly of whole, fresh squid. The occurrence of regurgitation in two Hector's dolphins is but one of the biases inherent in the use of stomach contents or faeces as an indicator of diet in marine mammals (Jobling & Brieby 1986; Bowen & Harrison 1996). This is because both techniques rely on identifying the remains of prey species and if regurgitation has occurred there are no hard parts available for analysis. Recently, blubber fatty acid signature analysis has been advocated as a more sensitive method of investigating diet. This technique is currently under development at Massey University for future studies on the foraging ecology of marine mammals (Iverson et al. 1997).

Age determination in cetaceans, based on counting growth layers or annuli in teeth, is commonly used on a variety of species (Perrin & Myrick 1980). Although widely used, the technique is subject to difficulties in methodology, interpretation, reader variability, variability among teeth, and the lack of known-age animals (Dapson 1980). The method used to section teeth can also introduce marked biases into the interpretation of age. For this reason, and because teeth from known-age Hector's dolphins were not available, a method similar to that used previously on this species (Slooten 1991; Part 1 of this report) and on the related Commerson's dolphin (Lockyer et al. 1988) was chosen. The age of animals in this study, as determined by counting dentinal GLGs, corresponded to the morphometric data and reproductive status for the animals examined.

Entanglement in fishing gear may result in traumatic lesions immediately apparent in the exterior of the carcass such as abrasions, amputations, penetrating wounds and fractures of limb bones, mandibles or teeth (Garcia Hartmann et al. 1994; Kuiken 1994; Kuiken et al. 1994). For cetaceans, diagnosis of the aetiology is relatively simple because the sensitive hairless skin is easily damaged and characteristic net marks are often left as impression marks around the rostrum, melon and flippers or dorsal fin. Acute blunt trauma to the body may result in contusions, haemorrhages, and skeletal fractures that are apparent at necropsy. More specific indicators are the cardio-pulmonary changes associated with asphyxiation. These changes include diffuse pulmonary oedema, congestion, emphysema, blood-stained froth in airways and pleural congestion. There may also be congestion of pericardial vessels, ecchymotic haemorrhages (haemorrhagic spots) on the endocardium or epicardium. On histological examination, hypercontraction of myofibres is seen along with fibre fragmentation and vacuolation (Lunt & Rose 1987). Contraction banding is also seen in the media of coronary arteries of people who have died from drowning (Factor & Cho 1985; Lunt & Rose 1987). These acute changes are associated with hypoxia of the myocardium and end in coagulative myocardial necrosis if the individual survives long enough. Similar changes, called coagulative myocytolysis, are associated with excessive endogenous catecholamine (adrenaline) release typical of trapped and stressed animals (Szakacs et al. 1959; Pack et al. 1994). This lesion also occurs in people who have experienced head trauma (Bakay & Glasaur 1980), victim assault (Cebelin & Hirsch 1980), cocaine abuse (Lipscomb 1992), and drowning (Lunt & Rose 1987). Hypoxia, as occurs during drowning or asphyxiation, may exacerbate the effects of catecholamines on the myocardium (Leitch et al. 1976; Pack et al. 1994). Similar pathogenesis is likely in traumatised and asphyxiated dolphins.

External skin lesions, characteristic of net marks, were observed on 12 Hector's dolphins, two dusky dolphins, and the common dolphin. Two Hector's dolphins were too decomposed to definitely determine any skin or subcutaneous lesions, these animals have, therefore, not been included in the following discussion. Eight (53%) of the remaining Hector's dolphins, two dusky dolphins and the common dolphin had evidence of blunt trauma before death as indicated by erythema of the blubber, oedema and haemorrhage of the muscle, or fractures of the skeleton. Of the Hector's dolphins with trauma, one animal had mild trauma limited to the abdomen, 3 animals had cranial trauma, and 4 had severe and extensive trauma involving the head and neck, thorax and abdomen. One North Island Hector's dolphin also had internal trauma. The severe trauma would probably have compromised survival of these dolphins had they not asphyxiated (Szakacs et al. 1959; Bakay & Glasaur 1980; Cebelin & Hirsch 1980). Of the dusky dolphins, one had moderate trauma to the mandible that would be unlikely to cause death, and while the other dolphin had blunt trauma limited to the abdomen it had severe and extensive propeller wounds. Whether the propeller cuts happened after death or close to the time of death could not be determined due to carcass decomposition. In the case of the common dolphin, there was severe and extensive trauma of the cranium that would probably have proved fatal.

Six Hector's dolphins were too decomposed, or scavenged, to allow the determination of pulmonary and cardiac pathology. These animals have, therefore, not been included in the following discussion. Acute pulmonary changes indicative of asphyxiation were present in 10 Hector's dolphins, all the dusky dolphins, and in the common dolphin. This took the form of acute diffuse congestion and oedema of the lungs, congestion and haemorrhage in the airways, and blood-stained froth in the airways. Nine (68%) Hector's dolphins and all the common and dusky dolphins also appeared to have acute subendocardial cardiomyopathy (hyper-contraction, hyper-eosinophilia and fibre fragmentation) of the thickest part of the left ventricular wall consistent with coagulative myocytolysis or coagulative necrosis. Both lesions are morphologically similar, particularly in the peracute to acute stage of lesion development. Cardiac lesions generally take hours to develop to a stage where necrosis is unequivocal. In humans with myocardial infarction, necrosis is not seen for up to 12 hours post-infarction (Kumar et al. 1992). However, ultrastructural changes as determined by electron microscopy can be seen after 2 hours. In this study, light microscopy was used to examine pre-frozen cardiac tissue (instead of electron microscopy which cannot be applied to pre-frozen tissue). While cardiac damage was sustained by many of the animals examined, due to the limitations of the techniques used, and the length of time before necrosis becomes apparent, cardiac lesions would not have been detected. Freezing may also induce tissue changes that can be confused with true lesions. This problem needs to be addressed by conducting necropsies on fresh, unfrozen Hector's dolphins as soon as possible after death.

Two Hector's dolphins also appeared to have myopathy of the diaphragm that was probably caused by agonal spasm of the muscle associated with asphyxia. As with the possible myopathy in cardiac muscle, the diaphragmatic lesions should be further investigated by sampling fresh carcasses.

Because the morphology of the dolphin larynx keeps the alimentary tract and respiratory tracts separate, it is less likely that reflux would pose a risk of aspiration than in pinnipeds or terrestrial mammals. However, captive dolphins are known to eject food material through their blowholes on occasion, suggesting that the larynx is not necessarily fixed in place (J.R. Geraci pers. comm.) Gastric contents and fish scales were found in the lungs of one of the dusky dolphins suggesting that aspiration can occur. It is not possible to determine when regurgitation occurred relative to the exact time of death but there was no evidence of inflammation suggesting that it happened close to the time of death. Two Hector's dolphins had regurgitated stomach contents in the oesophagus and pharynx. Both of these had evidence of blunt trauma; one animal had severe extensive trauma while the other had moderate trauma limited to the cranium. Trauma may have been implicated in the regurgitation.

In conclusion, the results indicate that entanglement resulted in the death of three dusky dolphins, one common dolphin, and three South Island Hector's dolphins. There is also a high probability that entanglement caused the deaths of seven of the remaining twelve South Island Hector's dolphins, and two North Island Hector's dolphins, examined. The probability of entanglement was moderate for one other North Island Hector's dolphin and two other South Island Hector's dolphins that appear to have died suddenly. Only one South Island Hector's dolphin appears to have died from natural causes and two were too decomposed to establish the cause of death. Most of the animals that were entangled died of acute asphyxiation and cardiomyopathy probably induced by hypoxia and catecholamine release. Many animals had also been subjected to mild to severe trauma that would probably have compromised survival in some dolphins had they not asphyxiated. Such trauma can result in severe muscular and abdominal haemorrhages and may also result in intestinal accidents such as intussusception, as seen in two dolphins. Trauma to the head may result in concussion that cannot be diagnosed in frozen carcasses and may also cause endogenous catecholamine release from the adrenal glands that is known, at least in humans, to cause lesions in the cardiac muscle that result in heart failure. Animals so affected would be unlikely to survive. Impacts that do not necessarily result in visible trauma may cause reflux that, if aspirated, can cause foreign-body pneumonia in animals that survive the initial impact.

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Appendix 1

TABLES OF RESULTS

TABLE 3.1. CAPTURE DATA FOR DUSKY AND COMMON DOLPHINS, 2000/01.

CODE	PATHOLOGY NO.	CSL NO.	DATE	TIME	LATI-TUDE	LONGI-TUDE	SEX
Dusky dolphin							
WB01-01Lo	31440	–	–		41ºS	174ºE	M
WB01-11Lo	32197	1521	7 Feb 01	1452	46ºS	170ºE	F
WB01-12Lo	32198	1160	17 Jan 01	1011	46ºS	170ºE	F
Common dolphin							
WB01-13Dd	32199	1045	15 Dec 00	0200	40ºS	173ºE	F

– Indicates data is not available.

TABLE 3.2. STRANDING DATA FOR BEACHCAST HECTOR'S DOLPHINS, 2000/01.

CODE	PATH-OLOGY NO.	DOC TAG NO.	DATE	TIME	CIRCUM-STANCES	LOCATION	COMMENTS
North Island Hector's dolphin—Female							
WB01-06Ch	32074	–	5 Mar 01	–	Beachcast	Karioitahi Beach, Waiuku	Scavenged, DNA*
North Island Hector's dolphin—Male							
WB01-27Ch	32339	–	29 May 01	–	Beachcast	Karioitahi Beach, Waiuku	Decomposed
WB01-41Ch	32441	–	22 Jul 01	–	Beachcast	Port Waikato	
South Island Hector's dolphin—Female							
WB01-02Ch	31818	H34/00	29 Oct 00	1230	At sea	Port Levy, Christchurch	
WB01-16Ch	32209	H37/01	18 Jan 01	1800	Incidental†	Amberley Beach, Christchurch	
WB01-18Ch	32213	–	27 Nov 00	–	Beachcast	Mahinapua Beach, Hokitika	Scavenged, DNA*
WB01-29Ch	32374	WC130	6 Jun 01	1515	Incidental†	Granity Beach, Buller	
WB01-33Ch	32388	–	12 Jan 01	–	Beachcast	Cats Eye Pt, Kakanui	Scavenged
South Island Hector's dolphin—Male							
WB01-03Ch	31853	–	15 Nov 00	0815	Beachcast	N of Hokitika	
WB01-14Ch	32211	–	25 Feb 01	–	Beachcast	North Beach, Westport	
WB01-15Ch	32208	H36/00	19 Dec 00	0945	Beachcast	Leithfield Beach, Christchurch	
WB01-17Ch	32210	H39/01	2 Feb 01	1805	Beachcast	Waimakariri R. mouth, Chch	
WB01-19Ch	32216	–	23 Nov 00	2030	Beachcast	S Arahura R. mouth, Hokitika	Scavenged
WB01-21Ch	32218	–	25 Feb 01	–	Incidental†	S Waimangaroa R. mouth, Hokitika	
WB01-34Ch	32389	–	2 Jan 01	–	Beachcast	Papanui Inlet	Scavenged
WB01-35Ch	32390	WC131	25 Nov 99	–	Beachcast	Nth Hector	Autopsied on beach
WB01-40Ch	32436	H40/01	21 Jul 01	–	Beachcast	Port Levy Harbour	
South Island Hector's dolphin—Unknown sex							
WB01-20Ch	32566	–	5 Mar 01	–	Beachcast	N of Mokihinni R. mouth, Westport	Skeleton only

* Sex determined by DNA analysis. † Incidental to fishing. – Indicates data is not available.

TABLE 3.3. MORPHOMETRIC DATA FOR HECTOR'S, DUSKY AND COMMON DOLPHINS, 2000/01.

CODE	PATHOLOGY No.	Wt (kg)	Std L (m)	Sn–An (m)	Sn–Gen (m)	Sn–ODF (m)	Sn–OF (m)	F L (m)	F W (m)	DF Ht (m)	DFB L (m)	Flk W (m)	Gt Pec (m)	Blub.D (m)	Blub.L (m)	Blub.V (m)
North Island Hector's dolphin—Female																
WB01-06Ch	32074	–	1.58	1.15	1.07	0.74	0.35	0.27	0.09	0.11	0.23	0.51	–	–	–	–
North Island Hector's dolphin—Male																
WB01-27Ch	32339	–	–	–	–	–	–	0.22	0.08	0.09	0.19	0.36	–	–	–	–
WB01-41Ch	32441	36.0	1.34	0.91	0.77	0.65	0.32	0.23	0.09	0.11	0.22	0.43	–	0.010	0.006	0.007
South Island Hector's dolphin—Female																
WB01-02Ch	31818	26.5	1.08	0.78	0.75	0.52	0.27	0.19	0.07	0.08	0.18	0.30	0.72	0.018	0.018	0.017
WB01-16Ch	32209	31.0	1.21	0.89	0.84	0.58	0.30	0.21	0.07	0.08	0.20	0.36	0.75	0.010	0.013	0.014
WB01-18Ch	32213	–	1.38	1.01	0.94	0.69	0.31	0.21	0.07	0.08	0.21	0.34	–	–	–	–
WB01-29Ch	32374	43.0	1.33	0.95	0.91	0.63	0.31	0.23	0.08	0.10	0.24	0.40	0.83	0.017	0.015	0.018
WB01-33Ch*	32388	6.8	0.76	0.58	0.52	0.39	0.20	0.16	0.06	0.07	0.14	0.25	0.44	0.012	0.011	0.014
South Island Hector's dolphin—Male																
WB01-03Ch	31853	36.0	1.27	0.93	0.81	0.64	0.33	0.24	0.09	0.10	0.21	0.43	0.76	0.015	0.012	0.015
WB01-14Ch	32211	–	1.21	0.84	0.76	0.54	0.26	0.21	0.08	0.10	0.19	0.38	–	0.013	0.012	0.011
WB01-15Ch	32208	34.5	1.22	0.86	0.75	0.60	0.29	0.22	0.08	0.08	0.19	0.41	0.79	0.014	0.013	0.014
WB01-17Ch	32210	24.0	1.09	0.76	0.65	0.50	0.27	0.18	0.07	0.07	0.17	0.33	0.70	0.016	0.013	0.017
WB01-19Ch	32216	27.5	1.23	0.89	0.77	0.60	0.29	0.21	0.08	0.06	0.18	0.36	–	–	–	–
WB01-21Ch	32218	29.0	1.13	0.83	0.72	0.56	0.29	0.20	0.07	0.09	0.19	0.35	0.73	0.014	0.011	0.014
WB01-34Ch*	32389	6.6	0.72	0.53	0.48	0.37	0.22	0.14	0.05	0.06	0.13	0.17	–	0.010	0.009	0.010
WB01-35Ch	32390	–	1.21	0.9	0.76	–	0.31	0.33	0.09	0.11	–	0.46	0.77	–	–	–
WB01-40Ch	32436	19.6	1.10	0.75	0.67	0.54	0.27	0.18	0.07	0.09	0.19	0.35	0.63	0.014	0.013	0.014
South Island Hector's dolphin—Unknown sex																
WB01-20Ch	32566	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dusky dolphin—Female																
WB01-11Lo	32197	70.0	1.63	1.20	1.12	0.71	0.37	0.36	0.10	0.21	0.27	0.47	1.11	0.015	0.014	0.014
WB01-12Lo	32198	74.0	1.70	1.19	1.12	0.80	0.39	0.33	0.10	0.19	0.25	0.46	1.07	0.014	0.010	0.014
Dusky dolphin—Male																
WB01-01Lo	31440	86.0	1.76	1.24	1.07	0.81	0.39	0.36	0.11	0.23	0.31	0.53	1.02	0.015	0.012	0.011
Common dolphin—Female																
WB01-13Dd	32199	74.5	1.82	1.31	1.25	0.82	0.40	0.30	0.10	0.18	0.29	0.42	1.00	0.014	0.014	0.013

Wt = weight; Std L = standard body length; Sn-An = snout to anus length; Sn-Gen = snout to genital slit length; Sn-ODF = snout to origin of dorsal fin length; Sn-OF = snout to origin of flipper; FL = flipper length; FW = flipper width; DF Ht = dorsal fin height; DFB L = dorsal fin length at base; Flk W = fluke width; Gt Pec = girth at pectoral flippers; Blub. D = dorsal blubber depth; Blub. L = lateral blubber depth; Blub .V = ventral blubber depth. * Neonate. – Indicates data is not available.

TABLE 3.4. STOMACH MORPHOMETRICS AND CONTENTS FOR HECTOR'S, DUSKY, AND COMMON DOLPHINS, 2000/01.

CODE	PATH-OLOGY NO.	STOMACH		COMPARTMENT 1		COMPARTMENT 2		COMPARTMENT 3		PARA-SITES	ULCERS
		FULL WT (kg)	EMPTY WT kg	CONTENTS WT (kg)	COMPOSITION	CONTENTS WT (kg)	COMPOSITION	CONTENTS WT (kg)	COMPOSITION		
North Island Hector's dolphin—Female											
WB01-06Ch	32074	–	–	–	–	–	–	–	–	–	–
North Island Hector's dolphin—Male											
WB01-27Ch	32339	–	–	–	–	–	–	–	–	–	–
WB01-41Ch	32441	0.735	0.714	0.005	Fish bones, otoliths, lenses, 1 copepod	0.015	Fish bones, otoliths, lenses	0.001	Fish otolith, fluid	N	–
South Island Hector's dolphin—Female											
WB01-02Ch	31818	0.282	0.282	–	–	–	–	–	–	Y	–
WB01-16Ch	32209	0.458	0.401	0.032	Fish otoliths	0.008	Fish otoliths, grit	0.017	Fish otoliths, grit	Y	1 in C2
WB01-18Ch	32213	–	–	TLTM	Fish otoliths, lenses	–	–	–	–	N	–
WB01-29Ch	32374	1.000	0.400	0.400	Fish bones, otoliths, fluid	0.100	Fish bones, fluid	0.100	Fluid	Y	1 in C2
WB01-33Ch	32388	–	–	–	–	–	–	–	–	–	–
South Island Hector's dolphin—Male											
WB01-03Ch	31853	0.454	0.454	TLTM	Fish otoliths	TLTM	Fish otoliths	–	–	Y	1 in C2
WB01-14Ch	32211	0.502	0.45	0.024	Fish bones, otoliths	0.013	Fish bones, lenses, 1 squid beak	0.015	Fluid	Y	1 in C2
WB01-15Ch	32208	0.530	0.509	0.007	Fluid	0.004	Fish otoliths	0.01	Fluid	Y	1 in C2
WB01-17Ch	32210	0.228	0.199	0.021	Fish bones, otoliths	0.004	Fish bones, otoliths	0.004	–	Y	–
WB01-19Ch	32216	–	–	–	–	–	–	–	–	–	–
WB01-21Ch	32218	0.529	0.479	0.009	Fish otoliths, 1 squid beak	0.013	Fish bones, otoliths, lenses	0.028	Fluid	Y	1 in C2
WB01-34Ch	32389	–	–	–	–	–	–	–	–	–	–
WB01-35Ch	32390	–	–	–	–	–	–	–	–	–	–
WB01-40Ch	32436	0.325	–	–	–	–	–	–	–	Y	1 in C1
South Island Hector's dolphin—Unknown sex											
WB01-20Ch	32566	–	–	–	–	–	–	–	–	–	–
Dusky dolphin—Female											
WB01-11Lo	32197	1.054	0.786	0.092	Fish otoliths, lenses, 3 squid beaks, salps	0.099	Fish otoliths, lenses, 6 squid beaks, salps	0.077	Fish otoliths, 1 squid beak, salps	Y	5 in C2
WB01-12Lo	32198	2.882	0.775	2.003	Fish bones, otoliths, lenses, 14 squid, beaks, lenses, parts	0.055 –	Fish otoliths, 1 squid beak	0.049 –	Fish otoliths, fluid, 2 squid beaks, lenses	– Y	– 4 in C2
Dusky dolphin—Male											
WB01-01Lo	31440	1.559	1.314	0.245	Fish bones, otoliths, lenses	TLTM	Fish bones, otoliths	–	–	Y	2 in C2
Common dolphin											
WB01-13Dd	32199	1.115	0.9	0.16	Fish bones, otoliths, 3 squid beaks	0.012	Fish otoliths, squid beaks, fluid	0.043	Fluid	Y	–

TLTM = Too little to measure; C1, C2, etc. = compartment 1, 2, etc. – Indicates data is not available.

TABLE 3.5. AGE ESTIMATION BASED ON DENTINAL GROWTH LAYER GROUPS FOR HECTOR'S, DUSKY, AND COMMON DOLPHINS, 2000/01.

CODE	PATHOLOGY NO.	WT (g)	L (mm)	W (mm)	AGE (years)	COMMENTS
North Island Hector's dolphin—Female						
WB01-06Ch	32074	0.10	8.0	1.0	5.5	
North Island Hector's dolphin—Male						
WB01-27Ch	32339	0.29	12.6	3.0	7	
WB01-41Ch	32441	0.10	12.7	3.2	4	
South Island Hector's dolphin—Female						
WB01-02Ch	31818	0.10	10.0	1.0	4.5	
WB01-16Ch	32209	0.10	10.0	1.0	3	
WB01-18Ch	32213	0.10	9.0	1.0	7	
WB01-29Ch	32374	0.30	12.0	2.6	6	
WB01-33Ch	32388	–	–	–	<1	No teeth—neonate
South Island Hector's dolphin—Male						
WB01-03Ch	31853	0.10	11.0	1.0	5	
WB01-14Ch	32211	0.10	10.0	2.0	7.5	
WB01-15Ch	32208	0.10	9.0	1.0	6	
WB01-17Ch	32210	0.10	15.0	1.0	5	
WB01-19Ch	32216	0.10	9.0	1.0	>2	Damaged tooth
WB01-21Ch	32218	0.29	10.0	1.0	4	
WB01-34Ch	32389	–	–	–	<1	No teeth—neonate
WB01-35Ch	32390	0.29	11.1	2.8	4	
WB01-40Ch	32436	0.10	11.7	2.5	3	
South Island Hector's dolphin—Unknown sex						
WB01-20Ch	32566	–	–	–	–	No teeth
Dusky dolphin—Female						
WB01-11Lo	32197	0.20	17.0	2.0	4.5	
WB01-12Lo	32198	0.20	14.0	2.0	4.5	
Dusky dolphin—Male						
WB01-01Lo	31440	0.30	17.0	2.0	8	
Common dolphin—Female						
WB01-13Dd	32199	0.10	12.0	1.0	4	

– Indicates data is not available.

TABLE 3.6. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S, DUSKY, AND COMMON DOLPHINS, 2000/01.

CODE	PATH-OLOGY NO.	RIGHT OVARY Wt (g)	RIGHT OVARY L×W×D (mm)	RIGHT OVARY CA	RIGHT OVARY CL	LEFT OVARY Wt (g)	LEFT OVARY L×W×D (mm)	LEFT OVARY CA	LEFT OVARY CL	UTERINE MATUR-ITY	GRAVID*	MILK PRES-ENT
North Island Hector's dolphin												
WB01-06Ch	32074†	–	–	–	–	–	–	–	–	–	–	–
South Island Hector's dolphin												
WB01-02Ch	31818	1.0	25 × 7 × 2	–	–	1.0	23 × 7 × 2	–	–	IM	N	N
WB01-16Ch	32209	1.0	34 × 11 × 2	–	–	1.0	31 × 9 × 2	–	–	IM	N	N
WB01-18Ch	32213†	–	–	–	–	–	–	–	–	–	–	–
WB01-29Ch	32374	1.0	29 × 8 × 4	–	–	1.0	28 × 9 × 4	–	–	IM	N	N
WB01-33Ch	32388†	–	–	–	–	–	–	–	–	IM	–	–
Dusky dolphin												
WB01-11Lo	32197	4.0	36 × 13 × 5	–	–	3.0	33 × 14 × 6	–	–	IM	N	N
WB01-12Lo	32198	3.0	41 × 15 × 7	–	–	6.0	19 × 46 × 10	–	–	IM	N	N
Common dolphin												
WB01-13Dd	32199	5.0	35 × 20 × 12	–	–	3.0	32 × 15 × 10	–	–	IM	N	N

CA = Corpus albicens; CL = Corpus luteum; IM = Immature; N = No.

* Determined by presence of embryo or foetus.

† Scavenged.

– Indicates data is not available.

TABLE 3.7. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS FOR HECTOR'S AND DUSKY DOLPHINS, 2000/01.

CODE	PATH-OLOGY NO.	RIGHT TESTIS Wt+epid (g)	RIGHT TESTIS Wt–epid (g)	RIGHT TESTIS L×W×D (mm)	LEFT TESTIS Wt+epid (g)	LEFT TESTIS Wt–epid (g)	LEFT TESTIS L×W×D (mm)	TESTIS MATUR-ITY	COMBINED TESTICULAR MASS* (g)
North Island Hector's dolphin									
WB01-27Ch	32339	–		–	–	–	–	–	–
WB01-41Ch	32441	12.2	9.0	68 × 17	17.4	12.5	77 × 16	IM	29.6
South Island Hector's dolphin									
WB01-03Ch	31853	513.0	454.0	195 × 85	540.0	476.0	210 × 80	MA	1053.0
WB01-14Ch	32211	95.0	75.0	130 × 48 × 40	90.0	65.0	130 × 50 × 45	MIA	185.0
WB01-15Ch	32208	487.0	419.0	221 × 77 × 65	450.0	386.0	210 × 70 × 60	MA	937.0
WB01-17Ch	32210	10.0	6.0	54 × 15 × 12	6.0	4.0	46 × 14 × 13	IM	16.0
WB01-19Ch	32216	–	–	–	–	–	–	–	–
WB01-21Ch	32218	11.0	8.0	64 × 21 × 13	11.0	8.0	69 × 19 × 12	IM	22.0
WB01-34Ch	32389	–	–	–	–	–	–	–	–
WB01-35Ch	32390	–	–	–	–	–	–	–	–
WB01-40Ch	32436	5.2	3.7	46 × 12	5.7	4.1	50 × 11	IM	10.9
Dusky dolphin									
WB01-01Lo	31440	242.0	160.0	230 × 45 × 27	237.0	159.0	240 × 45 × 28	MIA	479.0

IM = Immature, MA = Mature-active, MIA = Mature-inactive.

* Includes epididymis weight.

– Indicates data is not available.

LEGEND TO SYMBOLS ON TABLE 3.8

1 = Respiratory congestion and oedema
2 = Pulmonary emphysema
3 = Trauma (contusion, free blood in abdomen)
4 = Foreign matter in lungs
5 = External net entanglement marks
6 = Regurgitated food in oesophagus

I = Tracheal & bronchial congestion/haemorrhage
II = Bronchiole excessive mucus
III = Pulmonary interlobular/ lobular oedema/ congestion
IV = Pulmonary aveolar emphysema
V = Cardiac myofibre hypercontraction
VI = Cardiac myofibre fragmentation
VIII = Tricuspid valve oedematous and hemorrhagic
IX = Diaphragmatic myofibre hypercontraction
X = Diaphragmatic myofibre fragmentation
XI = Haemorrhage on aorta

TABLE 3.8. PATHOLOGY OF HECTOR'S, DUSKY, AND COMMON DOLPHINS, 2000/01.

CODE	PATHOLOGY NO.	ENTANGLEMENT-RELATED PATHOLOGY		ENTANGLEMENT PROBABILITY
		GROSS	HISTOLOGICAL	
North Island Hector's dolphin				
WB01-06Ch	32074	5	*	High
WB01-27Ch	32339	5	*	High
WB01-41Ch	32441	1, 3	II, III, V, VI	Moderate
South Island Hector's dolphin				
WB01-02Ch	31818	1, 5	III	High
WB01-03Ch	31853	1, 5	III	High
WB01-14Ch	32211	1, 3, 5	I, III, V, VI, IX, X	High
WB01-15Ch	32208	5	V, VI	High
WB01-16Ch	32209	3, 5	V, VI	High
WB01-17Ch	32210	1, 3	I, V, VI	Moderate
WB01-18Ch	32213	5	*	High
WB01-19Ch	32216	5	*	High
WB01-20Ch	32566	Skeleton only		Unknown
WB01-21Ch	32218	1, 3, 5, 6	I, III, V, VI	High
WB01-29Ch	32374	1, 3, 5, 6	I, III, V, VI	High
WB01-33Ch	32388	1, 3	I, III, scavenged	Moderate
WB01-34Ch	32389	*	–	Unknown
WB01-35Ch	32390	1, 3, 5	I, III, V, VI	High
WB01-40Ch	32436	1, 4	II, III, IX, X	Low
Dusky dolphin				
WB01-01Lo	31440	1, 4, 5	III, V, VI	High
WB01-11Lo	32197	1, 3, 6	I, III, V, VI	High
WB01-12Lo	32198	1, 3, 5	1, III, V, VI,	High
Common dolphin				
WB01-13Dd	32199	1, 3, 5	I, III, V, VI	High

* Too decomposed to determine pathology/probability.
– Indicates data is not available.