Autopsy of cetaceans including those incidentally caught in commercial fisheries, 2002/03

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ABSTRACT

Morphological characteristics, estimated age, gender, reproductive status, stomach contents and cause of death have been determined for 11 Hector's dolphins (*Cephalorhynchus hectori hectori*), one Maui's dolphin (*Cephalorhynchus hectori maui*), four common dolphins (*Delphinus delphis*), and one bottlenose dolphin (*Tursiops truncatus*). The common dolphins and one Hector's dolphin were killed incidentally in commercial fishing operations. The remaining Hector's dolphins and the Maui's dolphin were retrieved either from set-nets (n = 1), or found beachcast along the west coast of the North Island (n = 1), west coast of the South Island (n = 7), or east coast of the South Island (n = 2). The beachcast carcasses ranged from freshly dead to skeletal remains. The stomachs of five Hector's dolphins had detectable remains consisting of fish, otoliths, and fish bones. Fish and squid were equally represented in the stomachs of the common dolphins. Age was estimated by counting dentinal growth layer groups in stained sections of teeth. Two female Hector's dolphins were too decomposed to determine reproductive status but the remaining two were immature. Of five male Hector's dolphins, one was pubertal, three immature, and one was too decomposed for examination of gonads. The male Maui's dolphin and the bottlenose dolphin were also immature. Of the four common dolphins, two Hector's dolphins, and the bottlenose dolphin known to have been net-entangled, all had lesions consistent with death from asphyxiation. Two of the nine beachcast Hector's dolphins had lesions indicative of entanglement, two did not appear to have been entangled and parasitic pneumonia may have had a role in their death, one died from acute blunt trauma of unknown origin, and four were too decomposed to determine cause of death. The Maui's dolphin died from complications associated with *Aspergillus fumigatus* infection of the lungs.

Keywords: autopsy, morphology, Hector's dolphin, *Cephalorhynchus hectori hectori*, Maui's dolphin, *Cephalorhynchus hectori maui*, common dolphins, *Delphinus delphis*, bottlenose dolphin, *Tursiops truncatus*, New Zealand

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1. Introduction

The objective of this study was to fulfil the requirements of DOC contract CSL00/3025 by recording and interpreting data on cetaceans submitted for autopsy. 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 11 Hector's dolphins *(Cephalorhynchus hectori hectori),* one Maui's dolphin *(Cephalorhynchus hectori maui),* four common dolphins *(Delphinus delphi*s), and one bottlenose dolphin (*Tursiops truncatus*) killed incidentally in fishing operations or found beachcast.

The Hector's dolphin (*Cephalorhynchus hectori*) is a small coastal species and New Zealand's only endemic cetacean (Baker 1978). The species is divided between at least four genetically distinct sub-populations, with a South Island population of approximately 7300 individuals, and a North Island population with fewer than 100 individuals (Ferreira & Roberts 2003). The North Island population is genetically and morphologically distinct and is now called Maui's dolphin (Pichler et al. 1998; Baker et al. 2002). The South Island population has a NZ threat classification of nationally vulnerable, while the North Island population is listed as nationally critical. The life history characteristics of the species are similar to other members of the genus *Cephalorhynchu*s, such as Commerson's dolphin *(C. commersoni*) and are characterised by a low potential for population growth (Lockyer et al. 1988; Slooten & Lad 1990). This, combined with a low rate of female dispersal between populations, increases 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 Banks Peninsula in November 1988 (Dawson & Slooten 1992) and in the Manukau Harbour and adjacent coast of the north-western North Island in October 2003. Each year, particularly during the summer months November to March, Hector's and Maui's dolphins are found beachcast or incidentally caught in the inshore set-net gill fishery. Life history parameters and cause of death have been reported for animals submitted for autopsy between 1997 and 2001 (Duignan et al. 2003) and for the 2001/02 season (Duignan et al. 2004). This report includes similar data collected on animals submitted during 2002/03.

The common dolphin *(Delphinus delphi*s) 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 1999). Group sizes vary seasonally and diurnally, but *D. delphis* are regularly found in groups of several hundred, 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).

The bottlenose dolphin (*Tursiops truncatus*) is known from warm and temperate waters worldwide, is most common inshore, even entering rivers and estuaries, and is rarely seen in the open ocean. However, they have been reported up to 800 km from the nearest land (Watson 1981). In New Zealand they are most common in the Marlborough Sounds, Bay of Plenty, Hauraki Gulf and Northland (Baker 1999). There is an isolated population resident in Doubtful Sound in Fiordland and this appears to be the southern limit for this species in New Zealand. The bottlenose dolphin included in this report is the first submitted to Massey University for autopsy with a history of net entanglement.

2. Materials and methods

2.1 MATERIALS

A total of 17 dolphins were submitted for autopsy. Most of the dolphins were shipped frozen and wrapped in plastic and woven nylon body bags. Two animals (H61/02 and H70/03) were submitted chilled, but unfrozen. In most cases the carcass was tagged with a CSL or DOC tag and accompanied by a data sheet. Animals untagged are indicated in Tables 1 and 2. The four common dolphins included three males and one female. The catch co-ordinates were reported for the male dolphins, but not for the female although the capture date and name of the vessel (not shown) were included on the CSL data sheet provided (Table 1). The bottlenose dolphin was found beachcast on the Coromandel Peninsula, but came ashore entangled in fishing gear. The latter was sent directly to CSL for analysis by the DOC personnel who found the carcass.

The four female Hector's dolphins were all from the west coast South Island population. All were found beachcast between August and November 2002 (Table 2). Of the five male Hector's, four were from the east coast and one from Westport. Two of the east coast animals were retrieved from nets. H62/02 was caught in a gill net set for rig north of Potato Point, Blueskin Bay, Otago (Table 2). The second (WB03-07Chh) was entangled in a set net off South Bay, Kaikoura, in February 2003 (Table 2). The remaining animals were beachcast.

TABLE 1. CAPTURE DATA FOR CETACEANS, 2002/03.

CODE	PATHOLOGY NO.	CSL NO.	DATE (d/m/y)	LATITUDE	LONGITUDE	SEX
Common dolphin *Delphinus delphis*						
WB03-02Dd	33982	NT	1 Oct 02	ND	ND	F
WB03-04Dd	34086	84	17 Oct 02	39° 53′S	173° 41′E	M
WB03-17Dd	34705	1026	30 Apr 03	40° 21′S	170° 00′E	M
WB03-18Dd	34712	1028	30 Apr 03	40° 21′S	170° 00′E	M
Bottlenose dolphin *Tursiops truncatus*						
WB03-40Tt	35153	NT	5 Sep 03	Beachcast (ND)		M

NT = not tagged. ND = no data provided.

Two Hector's dolphins were too decomposed to determine their gender. Both were found beachcast on the west coast in May 2003 (Table 2).

Only one Maui's dolphin was autopsied. It was a male animal and it was found beachcast in June 2003 at O'Neils Beach on the Auckland west coast (Table 2).

TABLE 2. CAPTURE/REPORTING DATA FOR BEACHCAST AND BYCAUGHT *Cephalorhynchus* sp., 2002/03.

CODE	PATHOLOGY NO.	DOC TAG NO.	DATE (d/m/y)	CIRCUMSTANCES	LOCATION
Hector's dolphin—Female					
WB03-01Chh	33976	H58/02	07 Oct 02	Beachcast	Barrytown Beach, Punakaiki
WB03-05Chh	34363	H60	25 Nov 02	Beachcast	Westport
WB03-06Chh	34371	H56/02	14 Aug 02	Beachcast	Pororari Beach Spit, Punakaiki
WB03-10Chh	34462	H59/02	10 Nov 02	Beachcast	Farewell Spit, Golden Bay
Hector's dolphin—Male					
WB03-03Chh	34209	H61	17 Dec 02	Beachcast	Timaru
WB03-07Chh	34399		07 Feb 03	Entangled in net	South Bay Kaikoura, reef 40m offshore
WB03-08Chh	34400		11 Dec 02	Beachcast	Kaikoura, 200m S of Otumatu Rock
WB03-11Chh	34463	H62/02	20 Dec 02	Bycatch	Blueskin Bay, Otago, 45 42S, 170 38E
WB03-27Chh	34851	H63/02	22 Dec 02	Beachcast	North Beach, Westport (near set-net)
Hector's dolphin—Gender unknown					
WB03-16Chh	34679	H69/03	04 May 03	Beachcast	Blaketown Beach, Greymouth
WB03-28Chh	34854	H68/03	02 May 03	Beachcast	North Beach, 2km south of Orowaiti River
Maui's dolphin—Male					
WB03-19Chm	34780	H70/03	04 Jun 03	Beachcast	O'Neils Beach, West Coast, Auckland

2.2 METHODS AND NECROPSY PROTOCOL

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 (mm) 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, where appropriate due to state of decomposition, and stored at –20°C for future fatty acid analysis. The internal organs were examined systematically for lesions and tissues sampled for histopathology, virology (only if fresh), parasitology, bacteriology (faeces routinely sampled but tissues only where appropriate), toxicology (blubber), genetics (skin), and anatomical studies (skeleton or skull if requested by Te Papa). The stomach was removed, tied off, and stored chilled until the contents could be examined the same or 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. Any pathology found was 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 was 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 10–20 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 as per Lockyer & Smellie (1985) and Bacha & Wood (1990). 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).

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.

3. Results

3.1 MORPHOMETRICS

An extensive set of standard measurements was taken where possible given the state of decomposition of each carcass (Table 3).

3.2 STOMACH CONTENTS

The stomach weight and the weight of the contents were recorded for each animal where possible (Table 4). The contents were not identifiable to species for any animal but further work on materials collected will be conducted by Kirsty Russell, Auckland University. Only four 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. Incidentally the two known bycatch Hector's dolphins had the most undigested remains. The dolphin caught in Blueskin Bay had an undigested fish in its stomach while the dolphin caught in Kaikoura had fish bones as well as otoliths. Two dolphins had no stomachs due to scavenging and decomposition. The Maui's dolphin had also eaten relatively recently and intact fish, invertebrates, bones and otoliths were found in both the first and second chambers of the stomach.

The male common dolphins had evidence of recent feeding with a range of food items in the stomachs including intact fish, otoliths, bones and squid, squid mantles, and squid beaks. The female dolphin had an empty stomach (Table 4). The bottlenose dolphin had been entangled for some time and was severely emaciated. The only material found in its stomach was plant debris.

3.3 AGE DETERMINATION

Data on tooth size and the number of dentinal growth layer groups (GLGs) counted are given in Table 5. Because of technical problems with the sectioning equipment the sections obtained from some teeth (asterisks on Table 5) were not of high enough quality to determine the age with certainty. A second tooth sample from each of these animals is being processed at the time of writing, and the results will be included in an amended report. For the Hector's dolphins with teeth (n = 11) the mean tooth weight and size was similar to that reported previously (Slooten 1991; Duignan et al. 2003). The teeth did not have obvious incremental layers in the cementum, but there were clearly defined bands in the

TABLE 3. MORPHOMETRIC DATA FOR CETACEANS, 2002/03.

CODE	PATHOLOGY NO.	WT (kg)	STD LT (m)	SN-AN (m)	SN-GEN (m)	SN-ODF (m)	SN-OF (m)	F LT (m)	F WD (m)	DF HT (m)	DFB LT (m)	FLK WD (m)	FLK LT (m)	GT PEC (m)	BLUB.D (mm)	BLUB.L (mm)	BLUB.V (mm)
Hector's dolphin—Female																	
WB03-01Chh*	33976	31.0	1.45	1.06	1.02	0.65	0.35	0.18	0.08	0.08	0.23	0.28	0.12	0.75	16	15	8
WB03-05Chh	34363	20.6	1.36	1.06	0.95	0.66	0.36	0.21	0.08	0.08	0.18	0.27	0.12	0.69	10	5	6
WB03-06Chh*	34371	30.7	1.22	0.88	0.79	0.53	0.27	0.23	0.09	0.12	0.27	0.38	0.13	0.77	11	10	8
WB03-10Chh	34462	31.0	1.27	0.92	0.88	0.62	0.32	0.21	0.08	0.09	0.24	0.27	0.12	0.79	12	11	12
Hector's dolphin—Male																	
WB03-03Chh	34209	8.0	0.77	0.55	0.49	0.39	0.20	0.18	0.06	0.08	0.17			0.56	17	11	12
WB03-07Chh	34399	36.0	1.24	0.92	0.77	0.59	0.30	0.19	0.08	0.10	0.24	0.45	0.14	0.84	15	11	12
WB03-08Chh	34400	30.0	1.17	0.86	0.75	0.54	0.27	0.18	0.08	0.09	0.21	0.38	0.12	0.76	20	15	19
WB03-11Chh	34463	34.0	1.20	0.85	0.74	0.57	0.30	0.19	0.08	0.08	0.21	0.36		0.08	13	15	17
WB03-27Chh	34851	28	1.19	0.87	0.75	0.6	0.29	0.19	0.07	0.1	0.23	0.33	0.11	0.75	18	12	16
Hector's dolphin—Gender unknown																	
WB03-16Chh*	34679	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
WB03-28Chh*	34851	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Maui's dolphin—Male																	
WB03-19Chm	34780	38.5	1.32	0.94	0.81	0.61	0.32	0.23	0.09	0.11	0.24	0.42		0.83	11	11	14
Common dolphin—Female																	
WB03-02Dd	33982	100.0	2.15	1.55	1.47	0.97	0.48	0.33	0.12	0.21	0.38	0.16	0.44	1.09	14	11	10
Common dolphin—Male																	
WB03-04Dd	34086	102.0	2.06	1.54	1.37	0.93	0.49	0.31	0.12	0.2	0.33	0.46	0.17	1.08	12	13	12
WB03-17Dd	34705	76.0	1.79	1.31	1.19	0.93	0.47	0.31	0.11	0.18	0.26	0.4	0.15	0.95	15	11	15
WB03-18Dd	34712	88.0	2	1.45	1.28	0.25	0.9	0.28	0.1	0.19	0.29	0.34	0.15	0.95	15	9	11
Bottlenose dolphin—Male																	
WB03-40Tt	35153	61.0	1.93			0.77	0.5	0.32	0.11	0.18	0.24	0.41		1.01	16	10	14

* Advanced decomposition.

TABLE 4. STOMACH CONTENTS.

CODE	PATH-OLOGY 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	PARA-SITES (Y/N)	ULCERS
Hector's dolphin											
WB03-01Chh	33976	0.41	0.39	0.02	1 squid beak, too decomposed to assess anything else						
WB03-03Chh	34209										
WB03-05Chh	34363	0.3	0.29	0.01						N	C1
WB03-06Chh	34371	0.81	0.77	0.04						N	C2
WB03-07Chh	34399	0.52	0.51	0.01			fish bones, squid beaks			Y	C2
WB03-08Chh	34400	0.3	0.28	0.02						Y	C2
WB03-10Chh	34462	0.59	0.57	0.02						Y	-
WB03-11Chh	34463	0.66	0.51	0.05			1 whole fish			Y	C1
WB03-16Chh*	34679										
WB03-27Chh	34851	0.47	0.45	0.02	otoliths					Y	C2
WB03-28Chh*	34854										
Maui's dolphin											
WB03-19Chm	34780	1.68	0.63	0.96	3 fish, 1 invertebrate, fish bones, eyeballs, otoliths	0.05	fluid, otoliths, fish bones	0.002	fluid	N	No
Common dolphin											
WB03-02Dd	33982			0.24						Y	C1
WB03-04Dd	34086	2.91	1.75	1.15	6 × fish, squid, fish bones	added C1	overflow from C1	None	None	Y	C1
WB03-17Dd	34705	1.69	0.84	0.86	7 squid + beaks, 2 fish + otoliths				N	-	
WB03-18Dd	34712	2.83	1.51	1.29	2 fish, 7 squid mantle, squid beaks, otoliths					N	C2
Bottlenose dolphin											
WB03-40Tt	35153	0.43	0.42	0.01	Plant debris					N	C1

* Advanced decomposition.

TABLE 5. AGE ESTIMATION BASED ON DENTINAL GROWTH LAYER GROUPS (GLG) FOR CETACEANS, 2002/03.

CODE	PATH-OLOGY NO.	CSL CODE	TOOTH				
			WEIGHT (g)	LENGTH (mm)	WIDTH (mm)	DEPTH (mm)	GLGs
Hector's dolphin							
WB03-01Chh	33976	H58/02	0.13	14	2.8	2.6	10
WB03-03Chh	34209	H61/02	0.06	7.8	1.8	1.7	1.5
WB03-05Chh	34363	H60/02	0.11	12.3	2.5	2.6	13
WB03-06Chh	34371	H56/02	0.11	9.3	3.1	2.7	15
WB03-07Chh	34399		0.12	12.7	2.5	2.6	9
WB03-08Chh	34400		0.12	12.6	2.7	2.7	5
WB03-10Chh	34462	H59/02	0.1	11.9	2.5	2.3	5
WB03-11Chh	34463	H62/02	0.09	12.4	2.6	2.5	1.5
WB03-16Chh	34679	H69/02	0.06	7.8	1.8	1.7	12
WB03-27Chh	34851	H63/02	0.1	12.2	2.8	2.9	3
WB03-28Chh	34854	H68/03	0.12	12	3.2	2.8	6*
Maui's dolphin							
WB03-19Chm	34780	H70/03	0.12	12.3	3	2.9	*
Common dolphin							
WB03-02Dd	33982		0.15	13.7	3.6	3.2	4
WB03-04Dd	34086	84	0.16	14.4	3	3.6	*
WB03-17Dd	34705	1026	0.15	16.2	3.5	3.1	3 to 4*
WB03-18Dd	34712	1028	0.16	14.5	3.7	3	8
Bottlenose dolphin							
WB03-40Tt	35153		0.6	21.7	7.3	7	*

* To be re-cut and read due to poor quality of tooth sections.

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 one and a half years to 15 years old.

The common dolphins ranged from animals three or four years old to one male that was eight years old. The bottlenose dolphin is one of the animals for which a second tooth is being sectioned.

3.4 REPRODUCTIVE STATUS

Females

Morphometric data on reproductive tracts are given in Table 6. Hector's dolphin WB03-06Chh (H56/02) was badly decomposed with loss of much of the genital area and mammary glands. The ovaries were present, however they were inactive, without evidence of ovulation or corpora (Table 6). The reproductive tract and mammary glands of WB03-10Chh (H59/02) were immature. These findings are similar to those for female Hector's dolphins, 6 years and younger, reported by Slooten (1991) and also consistent with those of immature female dolphins, 5 years or younger, from previous bycatch reports (Duignan et al. 2003, 2004). The gonads of three dolphins (H58/02 and H60/02) had been scavenged or decomposed and were not available for examination.

The common dolphin had a 13 mm corpus albicans in the left ovary but the uterus was not well developed and milk was not present in the mammary glands. This dolphin was estimated to be four years old and may be at the end of puberty and showing the first evidence of ovarian activity.

TABLE 6. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS, 2002/03.

CODE	PATHOLOGY NO.	RIGHT OVARY				LEFT OVARY				GRAVID (Y/N)	MILK (Y/N)
		WT (g)	L×W×D (mm)	CA	CL	WT (g)	L×W×D (mm)	CA	CL		
Hector's dolphin											
WB03-01Chh	33976	–	scavenged	–	–	–	–	–	–	–	–
WB03-05Chh	34363	–	scavenged	–	–	–	–	–	–	–	–
WB03-06Chh	34371	1	27×12×7			1	27×12×10			N	N
WB03-10Chh	34462	0.5	22×10×2	–	–	0.7	25×10×4	–	–	N	N
Common dolphin											
WB03-02Dd	33982	2	30×14×14	–	–	4.9	39×21×18	13 mm diameter	–	N	N

CA = Corpus albicans. CL = Corpus luteum.

Males

The gonads were examined for four male Hector's dolphins and one Maui's dolphin. Of these, one animal (WB03-07Chh) had testes with histological features consistent with transition from puberty to maturity. The summed testicular weight of 198 g is below the range previously found for fully mature combined testicular mass (266 g–1210 g) as reported by Slooten (1991) and Duignan et al. (2003), but similar to that of a mature-inactive male that had a combined testicular mass of 185 g (Duignan et al. 2003). Although the gradation between immature, pubertal and mature is probably indistinct, pubescent males would be expected to have an intermediate combined testicular mass. The remaining dolphins were definitely immature with summed testicular mass ranging from 21 g to 30 g. In previous studies the combined testicular mass for the gonads of immature dolphins ranged from 10.9 g to 29.6 g (Duignan et al. 2003, 2004).

Of the three male common dolphins, one (WB03-04Dd) was sexually mature with active spermatogenesis and summed testicular mass of 1078 g. This dolphin was also of mature body size at 2.06 m standard length. Active gonads are consistent with its capture date in mid October as most reproductive activity for this species occurs in spring and summer (Watson 1981; Leatherwood et al. 1983). The two remaining dolphins were shorter in body length and had markedly smaller testes at 56 g and 66 g summed mass respectively. The gonads were mature but inactive and consistent with their time of death in the autumn as both were caught on 30 April. The bottlenose dolphin had an immature reproductive tract (Table 7).

TABLE 7. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS, 2002/03.

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×DIAMETER (mm)	SUMMED TESTICULAR WT (g)
Hector's dolphin								
WB03-03Chh*	34209	–	–	–	–	–	–	–
WB03-07Chh	34399	94	74	129×28	104	89	106×30	198
WB03-08Chh	34400	13	9	70×19	17	12	81×19	30
WB03-11Chh	34463	8	6	49×12	9	7	56×13	17
WB03-27Chh	34851	11	7	53×15	10	7	54×14	21
Maui's dolphin								
WB03-19Chm	34780	52	39	105×30×21	52	38	99×32×27	104
Common dolphin								
WB03-04Dd	34086	568.0	517.0	263×60	510.0	478.0	270×59	1078.0
WB03-17Dd	34705	29.0	22.0	85×19	27.0	20.0	85×22	56.0
WB03-18Dd	34712	34.1	19.1	103×22	32.2	28.7	105×21	66.3
Bottlenose dolphin								
WB03-40Tt	35153	5	4	48×9	6	3	55×11	11

* Gonads decomposed.

3.5 PATHOLOGY

Entanglement-related pathology is included in Table 8. It should be noted that freezing can compromise the interpretation of subtle pathological changes and make the determination of cause of death difficult.

Of the four female Hector's dolphins, only one (H59/02) showed clear evidence of having died as a result of fishing operations. This animal had net marks on its skin, subcutaneous trauma, and respiratory congestion and oedema characteristic of asphyxiation. This animal had been found beachcast on Farewell Spit. An incidental finding in this animal was lungworm infection. The remaining females were either too autolysed to permit detection of possible entanglement related pathology or had been badly scavenged. Thus, the probability of their having been bycaught is unknown.

Five male Hector's dolphins were examined. Two (H62/02 and WB03-07Chh) were known to have died after entanglement in fishing gear and they had epidermal and pulmonary pathology consistent with this. Both also had evidence of blunt trauma. H63/02 had similar pathology although it was found beachcast in Westport. Thus the probability of entanglement for this dolphin is also high. WB03-08Chh and H61/02 are less likely to have died as a result of fishing operations. Both had evidence of blunt trauma with the juvenile H61/02 having trauma to the head and neck that may have been the result of boat strike or aggression from other dolphins, predator attack (killer whales), or trauma in rough seas. WB03-08Chh had severe parasitic pneumonia that may have had a role in its demise.

TABLE 8. PATHOLOGY OF CETACEANS, 2002/03.

CODE	PATH-OLOGY NO.	DOC CODE	ENTANGLEMENT-RELATED PATHOLOGY	
			GROSS	ENTANGLEMENT PROBABILITY
Hector's dolphin—Female				
WB03-01Chh*	33976	H58/02	Too autolysed	Unknown
WB03-05Chh*	34363	H60/02		Unknown
WB03-06Chh*	34371	H56/02	7	Unknown
WB03-10Chh	34462	H59/02	1,3,5	High
Hector's dolphin—Male				
WB03-03Chh*	34209	H61/02	3	Low
WB03-07Chh	34399		1,3,5	High
WB03-08Chh	34400		1,3	Low
WB03-11Chh	34463	H62/02	1,3,5	High
WB03-27Chh	34851	H63/02	1,3,5	High
Hector's dolphin—Gender unknown				
WB03-16Chh*	34679		Too autolysed	Unknown
WB03-28Chh*	34854		Too autolysed	Unknown
Maui's dolphin—Male				
WB03-19Chm	34780	H70/03	1,2,3	Low
Common dolphin—Female				
WB03-02Dd	33982		5	High
Common dolphin—Male				
WB03-04Dd	34086	84	1,3,5	High
WB03-17Dd	34705	1026	1,3,5	High
WB03-18Dd	34712	1028	1,3,5,7	High
Bottlenose dolphin				
WB03-40Tt	35153		1,5	High

LEGEND

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

7 = Bone fractures

* = Marked decomposition

The juvenile male Maui's dolphin died from natural causes with severe fungal pneumonia caused by *Aspergillus fumigatus* infection.

All of the common dolphins were known bycatch. Their pathology is consistent with this in that all have epidermal net marks, evidence of acute blunt trauma, and acute pulmonary and tracheal congestion, oedema, and haemorrhage. WB03-18Dd also had a fractured flipper.

The bottlenose dolphin was found beachcast with fishing gear entangled around its rostrum and embedded in the gingival at the commisures of the mouth. The latter, along with drag caused by the mass of gear, prevented feeding and this animal was severely emaciated. Its ultimate cause of death was respiratory failure as indicated by markedly congested and oedematous lungs.

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 Ltd data sheets, or by orange tags attached around the tail-stock. The orange tags around the tail-stock of Hector's dolphins were very effective for animal identification. It was beneficial having 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 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 are maintained frozen. Two carcasses were submitted chilled but not frozen. This is ideal for pathology and is recommended for animals originating on the North Island where shipping chilled carcasses should be possible logistically. A second originated in Timaru, but was transported personally by Al Hutt to avoid having it frozen and to facilitate a speedy diagnosis.

The life history characteristics of the common dolphin are similar to those examined in previous CSL contracts (Duignan et al. 2003, 2004), and in previous studies (Leatherwood et al. 1983). The three male dolphins had not attained full adult length and only the largest appears to have attained gonadal maturity. The female common dolphin was the largest of the four common dolphins submitted and she had attained gonadal maturity at four years. The common dolphins were all caught as a result of commercial fishing activities and had cutaneous, soft tissue, and pulmonary lesions suggestive of blunt trauma, entanglement and asphyxiation.

The Hector's dolphins caught by commercial or recreational nets and those found beachcast were from areas of the west and east coasts of the South Island, areas which have a high Hector's dolphin population (Slooten & Dawson 1994; Slooten et al. 2002). A single Maui's dolphin from the west coast of the North Island where a relict population occurs (Ferreira & Roberts 2003), was also submitted for necropsy. Morphological features of these animals were consistent with those reported previously for *Cephalorhynchus hectori* (Mörzer-Bruyns & Baker 1973; Slooten 1991; Slooten & Dawson 1994). The life history data collected from these dolphins complements data from 12 animals examined in 1999, 16 examined in 2000, and 18 in 2001, and 10 from 2002 (Duignan et al. 2003, 2004). The sex ratio of dolphins submitted was equal, as compared to a bias in previous years with males comprising 62% of the animals submitted in 2001, 56% in 2000, and 83% in 1999. This male bias over the previous three years differs from a female bias reported by Slooten (1991). Whether the bias represents a population bias or a sampling artefact is unknown. There was also a bias towards younger and immature animals as in previous studies based on bycatch and beachcast animals (Slooten 1991; Dawson 1991; Duignan et al. 2003, 2004).

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 have been archived for future studies. As in previous years, the stomach contents of Hector's and Maui's dolphins have been archived for Kirsty Russell, Auckland University, for studies on foraging. Stomach contents of Hector's dolphins were similar to those examined by Duignan et al. (2003). The remains predominately consisted of indigestible teleost fish bones and otoliths and invertebrate carapaces. Fish predominated in the stomachs of Hector's and Maui's dolphins, but fish and squid were equally represented in the stomach of common dolphins. The bottlenose dolphin was so emaciated that there were no recognizable food remains in its stomach.

The principle of 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 consistency with earlier studies this investigation employed a method previously used to age Hector's dolphins (Slooten 1991) that is based on paraffin embedding of decalcified teeth followed by thin sectioning. It is a particularly difficult method and inferior to methods used on other small cetaceans such as the related Commerson's dolphin (Lockyer et al. 1988). Consultation with Dr Lockyer (Age Dynamics, Denmark) in August 2003, and future collaboration with her in 2004, will probably see a revision of the methodology employed at Massey especially in light of difficulties experienced with some teeth for this study.

Entanglement in fishing gear may result in traumatic lesions immediately apparent in the exterior of the carcass such as abrasions, amputations, penetrating wounds and fracture of limb bones, mandibles or teeth (Kuiken 1994; Kuiken et al. 1994; Garcia Hartman 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, haemorrhage, and skeletal fractures that are apparent at necropsy. More specific 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 on the endocardium or epicardium; and on histology, hyper-contraction of myofibres is seen along with fibre fragmentation and vacuolation (Lunt & Rose 1987). Cutaneous lesions, characteristic of net marks, were observed on four Hector's dolphins, all of the common dolphins and the bottlenose dolphin. Three Hector's dolphins were too decomposed to definitely determine any skin pathology and two appeared not to have net impressions on the skin. However, net marks are not always evident on dolphins known to have been entangled and there should be some caution in the interpretation of this finding (Duignan et al. 2003).

Acute pulmonary lesions indicative of asphyxiation were present in both Hector's dolphins and in the bottlenose and common dolphins known to have died as a result of capture in fishing gear. These lesions 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. These animals also appeared to have acute subendocardial cardiomyopathy (hyper-contraction 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. Generally cardiac lesions take hours to develop to a stage where necrosis is unequivocal. In humans with myocardial infarction, necrosis is not seen for up to twelve hours post infarction (Kumar et al. 1992). However ultrastructural changes as determined by electron microscopy can be seen after two hours. Electron microscopy cannot be carried out on pre-frozen tissue. Thus too little time may elapse between the onset of a lesion in the dolphin myocardium and the death of the animal. Freezing may also induce changes that can be confused with true lesions. This problem can only be addressed by conducting necropsies on fresh unfrozen dolphins as soon as possible after death by entanglement.

Of the nine Hector's dolphins that were beachcast, two (22%) have a high probability, based on observed lesions, of having died as a result of entanglement in fishing gear. One juvenile animal appears to have died suddenly from blunt trauma, but the origin of that trauma could not be determined. Two others had severe parasitic pneumonia and that may have played a role in their death. The remaining four animals were too decomposed to determine cause of death. The Maui's dolphin died as a result of severe pulmonary infection by the opportunistic terrestrial fungus, *Aspergillus fumigatus*. In this case the fungus invaded the pulmonary artery from the lung and caused intra thoracic haemorrhage that caused death. Aspergillosis is extremely rare in dolphins worldwide, but has been reported in striped dolphins, *Stenella coeruleoalba*, and bottlenose dolphins debilitated by morbillivirus infection (Domingo et al. 1992; Lipscomb et al. 1994). A previous case was reported for a juvenile male Hector's dolphin with fulminating pulmonary and cerebral aspergillosis (Duignan et al. 2003). In neither case was morbillivirus implicated based on virus isolation and immunohistochemical staining of tissues for morbillivirus antigen (Duignan et al. manuscript in preparation). However, the underlying cause for immunosuppression in Hector's and Maui's dolphins remains unresolved.

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