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

DOC SCIENCE INTERNAL SERIES 118

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Published by
Department of Conservation
P.O. Box 10-420
Wellington, New Zealand

DOC Science Internal Series is a published record of scientific research carried out, or advice given, by Department of Conservation staff, or external contractors funded by DOC. It comprises progress reports and short communications that are generally peer-reviewed within DOC, but not always externally refereed. Fully refereed contract reports funded from the Conservation Services Levy (CSL) are also included.

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ISSN 1175-6519

ISBN 0-478-22415-X

In the interest of forest conservation, DOC Science Publishing supports paperless electronic publishing. When printing, recycled paper is used wherever possible.

This report was prepared for publication by DOC Science Publishing, Science & Research Unit; editing and layout by Ian Mackenzie. Publication was approved by the Manager, Science & Research Unit, Science Technology and Information Services, Department of Conservation, Wellington.

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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 111 New Zealand fur seals (*Arctocephalus forsteri*), 27 New Zealand sea lions (*Phocarctos hookeri*) and one leopard seal (*Hydrurga leptonyx*) killed incidentally in fishing operations. The sea lions were caught in the vicinity of the Auckland Islands, the fur seals at five primary locations around the South Island, and the leopard seal off the Bounty Islands. For sea lions and fur seals, associations were established between morphological characteristics such as standard body length, axillary girth, and blubber depth as an indication of body condition. The stomach contents of both sea lions and fur seals contained mixed vertebrate and invertebrate prey items, however arrow squid predominated in the stomachs of sea lions and teleost fish in those of fur seals. The stomach of the leopard seal was empty. An estimate of age for the sea lions and fur seals was determined based on two morphological characteristics of the lower canine tooth, the dentinal annuli or growth layer groups (GLG) and external root ridges (RR). Where the actual ages of four sea lions were known, the estimated age was similar to the actual age but too few data points were available for statistical analyses. Where sample sizes were adequate, age estimates based on GLG counts and RR were significantly correlated as in the case of the male fur seals ($P<0.0001$). It is not assumed that either method accurately estimate age but they probably give a reasonable approximation. There was a significant association between age estimates and standard body length for male sea lions and fur seals and female fur seals suggesting continued growth into maturity. Female sea lions older than 3 years appear to undergo oestrus. The lack of detectable embryos or foetuses in older females caught in February and March suggest that embryonic diapause may occur. Most (61%) of the female fur seals were pregnant as expected since they were caught between June and September. The teeth of females were particularly difficult to read and probably underestimate the actual age of these animals. Male sea lions were sexually mature from 5 years, whereas male fur seals classed as mature active ranged from 5 to 14 years old. The temporal distribution of mature male fur seals with active or inactive testes suggests that there is a seasonal peak in spermatogenesis in spring. The leopard seal was a sexually immature male.

Keywords: seals, sea lions, autopsy, stomach contents, estimated age, reproduction, Auckland Islands, Bounty Islands, Snares Islands, New Zealand

Duignan, P.J. 2003. Part 1: Autopsy report for 1997/98. Pp. 5–40 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. Autopsy of pinnipeds incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 118*. Department of Conservation, Wellington. 106 p.

1. Introduction

The primary objective of this study was to fulfil the requirements of contract 96/3040 by recording and interpreting data on each animal as per the form reproduced in Appendix 2. These data included species, sex, size, body condition, stomach contents, age and reproductive status. This report details the findings pertinent to this objective and includes data on 111 New Zealand fur seals (*Arctocephalus forsteri)*, 27 New Zealand sea lions (*Phocarctos hookeri)*, and one leopard seal (*Hydrurga leptonyx*).

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, skulls were collected for the Museum of New Zealand Te Papa (Anton van Helden), genetic samples for the University of Auckland (Dr Gina Lento), University of Canterbury (Dr Neil Gemmel), and the Massey University Institute of Molecular Biosciences (Prof. David Penny). Anatomic specimens were collected for comparative studies (samples were collected for both Assoc. Prof. Ted Kirk, Massey University, and Assoc. Prof. Ted Miller, Memorial Uni Canada), faecal samples for bacteriology, and blubber for eco-toxicology for the Institute of Environmental Science and Research (Dr Paul Jones and Dr Hamish Reid) and foraging studies at Massey University (Dr P.J. Duignan). Studies on pathology and disease are ongoing and include the epidemiology of viral infections (seal distemper or morbillivirus infection), parasite and bacterial infections. From these studies it is now apparent that pinnipeds in New Zealand harbour several known bacterial pathogens including several serotypes of *Salmonella* that are rare among terrestrial mammals and humans in this country (manuscript in preparation). In addition, fur seals and sea lions were found to be infected by a potentially zoonotic form of tuberculosis (Hunter et al. 1998; Duignan et al. 2001).

The New Zealand or Hooker's sea lion is New Zealand's only endemic pinniped (Wilson 1979). However, it is listed as threatened because of its limited modern distribution, restriction to three principal breeding sites in the subantarctic (Auckland and Campbell Islands), and limited population growth despite protection (Childerhouse & Gales 1998). The historic range of the sea lion included the main islands in the New Zealand archipelago and also the Chatham Islands (cf. Childerhouse & Gales 1998). At present the species inhabits a roughly triangular range between Cook Strait, Campbell Island, Macquarie Island and the southwest of the South Island and is centred on the Auckland Islands where major rookeries are located (Cawthorn et al. 1985; Crawley 1990). The sea lion was exploited commercially in the early 1800s and had almost vanished by 1830 (Baker 1990). Commercial sealing ended in 1894, but the impact of the kills on the sea lion population is unknown. The total population of the New Zealand sea lion was estimated at between 11 600 and 15 200 during the 1995/96 breeding season (Gales & Fletcher 1999). The current data show that pup production at Sandy Bay, Enderby Island, has been stable for the past 30 years and that no major changes in pup production are apparent at Dundas Island and Figure of Eight (the three rookeries in the Auckland Islands). There are no recent census data for Campbell Island. Over the past decade some pups have been born on Stewart Island and on the Otago coast suggesting limited recolonisation of the historic range.

Among the threats to the species listed in the threatened species recovery plan are causes of natural mortality (predation, disease, and environmental factors) and human impact (competition for resources, entanglement, introduced animals, introduced diseases or toxins, Gales 1995). Relatively little is known about the impact of predators but shark bite wounds are frequently observed and cannibalism of pups by adult males has been reported (Wilkinson et al. 2000). Disease may also have a significant impact as demonstrated by a mass mortality event in 1998 apparently caused by a previously unknown *Campylobacter* sp. bacterium and perhaps triggered by unusual environmental conditions (Baker 1999; Stratton et al. 2001). The mass mortality investigation also identified parasitic enteritis as an as yet unquantified cause of neonatal mortality (Duignan; in Baker 1999).

Fishing is the most significant human threat to the population (Gales 1995). The southern trawl fishery for squid (SQU6T) operates on the southern and eastern edges of the Snares shelf and on the Auckland Islands shelf in depths of about 150–250 m. The proximity of the fishing grounds (around the edge of the Auckland Islands shelf) to New Zealand sea lion foraging areas has resulted in incidental catches (Baird 1994, 1995). To alleviate the impact on sea lions, the Minister of Fisheries established a 12 nautical-mile fishing exclusion zone around the Auckland Islands in 1982. In 1993 this zone was officially confirmed as a marine mammal sanctuary under the Marine Mammal Protection Act (1978). Government observers have been placed on some vessels to record incidental catch of marine mammals since 1988 (Baird 1994, 1995).

The New Zealand fur seal is found around the rocky coast of New Zealand, the subantarctic islands, and along the southern and eastern coasts of Australia (Crawley 1990). Major breeding colonies occur in southern New Zealand and on the subantarctic islands (Crawley & Warneke 1979; Bonner 1981; Wilson 1981). Fur seals were hunted extensively by both Polynesians and Europeans resulting in dramatic population decline and even local extinction in some areas (Falla 1962; Taylor et al. 1995). Fur seals became fully protected by New Zealand in 1894 (Sorensen 1969), and since then protection has rarely been lifted allowing numbers to increase (Falla 1962). Current and historical data are too fragmentary to estimate current population size. However, by contrast with sea lions, it is thought that the fur seal population is increasing and is currently estimated to be between 50 000 and 100 000 animals (Taylor 1990; Baird 1994, 1995). In contrast to New Zealand sea lions, the fur seal population appears more susceptible to fluctuations in prey availability caused by El Nino–Southern Oscillation cycles (Hugh Best, DOC pers. comm.).

Although the New Zealand fur seal is not listed as threatened, there is relatively little data available on vital life history parameters including current population size, age at first reproduction, pupping interval, maximum age, annual survival rate, mortality rates and causes of natural mortality. Fur seals are sympatric with sea lions on the Auckland Islands, but were not impacted by the 1998 mortality event. However, the disease syndrome described for sea lions and the causative agent are present in fur seals (Duignan et al. 1999; Stratton et al. 2001). Thus, further research into causes of natural mortality is required before the impact of disease on the population can be determined.

The impact of human interactions may be more easily quantified. In the last 20 years there has been a dramatic expansion of middle-depth and deep-water trawl fisheries in New Zealand. Incidental catches of fur seals occur throughout much of New Zealand's 200 nautical-mile Economic Exclusion Zone. However, catches are most frequent in the middle-depth trawl fisheries off the west coast of the South Island, particularly in fisheries for hoki (*Macruronus novaezelandiae*), southern blue whiting (*Micromesistius australis*, on the Bounty Platform) and arrow squid (*Nototodarus sloanii*, Auckland Islands shelf, Snares Islands shelf). The number of seals caught annually is estimated from observer's reports, but the impact of catches cannot currently be estimated because of lack of population data. The present report contains life history data on one fur seal incidentally caught by the fishing industry.

Leopard seals are generally solitary animals that are uncommon throughout their range, but frequently seen around New Zealand's subantarctic islands (Reeves et al. 1992). In winter and spring they may also occur around the main islands (Reeves et al. 1992). Leopard seals recently stranded on the North Island and examined at Massey University have been found as far north as New Plymouth and Hawke's Bay (Duignan unpubl. data).

2. Materials and methods

2.1 MATERIALS

The carcasses of New Zealand sea lions, fur seals and the leopard seal that had been caught in fishing operations were delivered to Massey University in batches of between 3 and 47 animals. The carcasses were frozen and wrapped in thick plastic bags and woven nylon sacks. Most were identified by Conservation Services Levy (CSL) observer data sheets inserted into the mouth. Observer data sheets were not available for two male and two female fur seals. On receipt, the seals were unwrapped, tagged with a flipper tag, and stored frozen at –20°C until necropsy.

2.2 METHODS

2.2.1 Necropsy protocol

The species and sex was recorded based on external morphology (Crawley 1990). A unique code and pathology number was assigned to each animal as follows:

SB97-01Ph

SB—seal bycatch, 97—year, 01—animal number, and Ph—abbreviation of species scientific name; in this case *Phocarctos hookeri*.

Pathological examination and sampling was conducted according to a standard protocol. The procedure included recording the body weight (kg), external measurements (m), and examination of the carcass for external lesions such as trauma, hair loss, scars, etc. Both external and internal gross lesions of interest were photographed. On opening the carcass along the ventral midline, the blubber depth (m) was recorded over the mid-sternum. Blubber samples were taken from the dorsal aspect of the left pelvis for fatty acid analysis of diet, and stored frozen at –80°C for further research. The internal organs were examined systematically for lesions and tissues sampled for histopathology, virology, parasitology, bacteriology (faeces routinely and tissues where appropriate), toxicology (blubber), genetics (skin), and anatomical studies (baculum or os-penis). The stomach was removed, tied off, and frozen at –20°C until the contents could be examined at a later date. The mandible was dissected out, labelled and prepared for age determination. The reproductive organs were carefully dissected and stored in 10% buffered formalin.

2.2.2 Stomach contents

The stomachs were weighed (kg), opened using scissors and all material washed into a 1 mm sieve. The stomach lining was then re-weighed to allow the weight of the stomach contents to be determined. Large, relatively undigested material was removed at this stage. The axial length (mm) and weight (g) of any whole fish was measured. Smaller, more digested material was gradually sorted using a black-bottomed tray. Otoliths are clearly visible against this background, and as they are denser than most of the other material, they sink to the bottom of the tray. Otoliths, squid beaks and other relevant food material were 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

The mandibles were macerated by suspending them in warm (20°C) water heated by an aquarium heater and agitated by air bubbling from an aquarium pump and airstone. After several days submersion the canine teeth were removed manually and cleaned. The teeth were placed in sockets drilled into wooden blocks and mounted in place using Selley's Multipurpose Polymer Repair System (Selley's Chemical Company Ltd, Auckland, see Fig. 1.1). The teeth were then sectioned longitudinally by placing the blocks in a clamp unit on a movable saw bench. Using a Strues Disoplan T.S. diamond saw (Strues, Copenhagen, Denmark) the teeth were sectioned longitudinally through the pulp cavity from root to crown. The cut surface of each tooth was polished using graded silicone carbide grit (size 200–600, Alanda Engineering, Palmerston North). This was used to erase all saw lines. Polished half teeth were etched for 22 hours in a solution of 5% formic acid and 95% formalin (10%) (Stirling 1969). The teeth were neutralised by soaking for 4 hours in an ammonia solution (200 : 1 0.88% NH_4 in 75 mL dH_2O). This was followed by rinsing in running tap water for 4 hours and air drying. The cut surfaces were then hand rubbed with graphite paper and graphite powder. To read the etched surface, reflected light was projected across the surface highlighting light and dark bands. A pair of dark and light bands was interpreted as one year's growth

Figure 1.1. Materials used in the preparation of lower canine teeth for age determination. Blocks of wood with sockets drilled to suit various tooth sizes, and a multipurpose polymer used to secure the teeth.

(Stirling 1969). Reading was facilitated by wetting the surface of the cut section and by using a 10× magnifying loop. The teeth were read independently by two observers and the number of growth layer groups (GLGs) assigned by consensus between the readers (Fig. 1.2). The observers did not know the actual ages of any tagged animals.

For each tooth the number of external root ridges (RR) on the canine teeth was recorded (Fig. 1.3). In Antarctic fur seals (*Arctocephalus gazella*) the root of

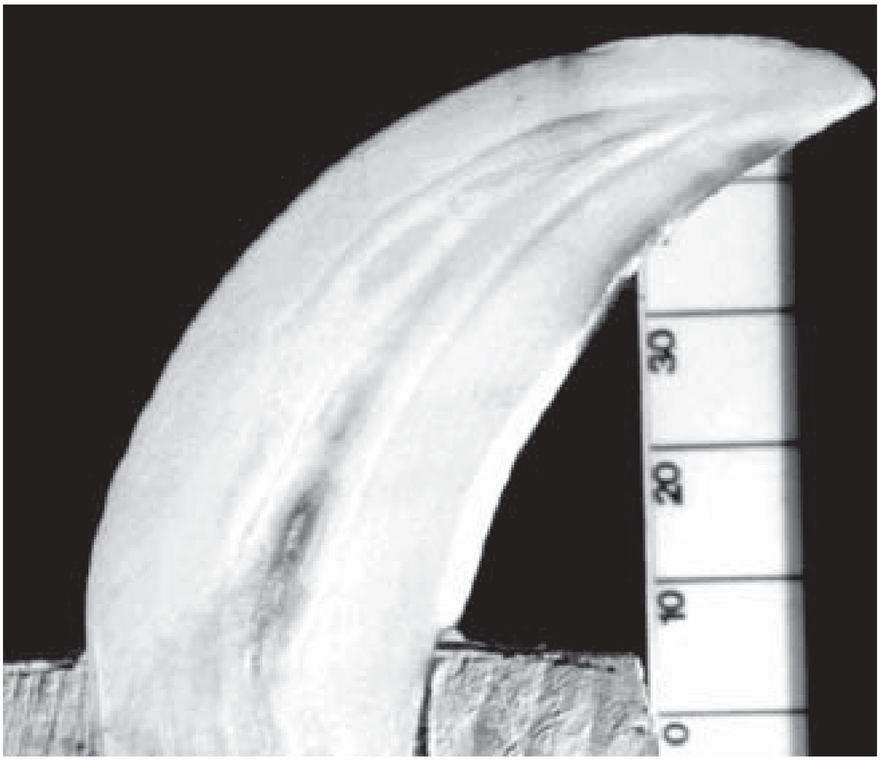


Figure 1.2. Section through the pulp cavity of a lower canine tooth from a male sea lion.

Figure 1.3. Lower canine tooth of a male sea lion (left) and a male fur seal showing root ridges.

the canine tooth grows throughout life and one RR is added annually (McCann 1993). Where apparent, the ridges on the teeth of New Zealand fur seals and sea lions were recorded by two observers as above.

2.2.4 Reproductive status

Females

The reproductive tracts were dissected out and examined grossly. The ovaries were sliced parallel to the attachment of the ovarian ligament at 2 mm intervals 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 then fixed in 10% buffered formalin, embedded in paraffin, sectioned at 3 mm, stained with hematoxylin and eosin and examined microscopically. Sexual maturity is defined as the age at which a female has ovulated at least once, and is seen by the presence of at least one *corpus* in the ovaries. The uterine horns were opened and examined for signs of pregnancy. The length, width and diameter of both ovaries were measured (mm) using Vernier callipers, and the ovaries weighed (g) using a Mettler PM 4800 Delta Range balance. Histological sections of the uterine horns were classified as follows (Lockyer & Smellie 1985; Bacha & Wood 1990):

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

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

Mature-lactating Similar to the previous except that the endometrium appears more vascular post parturition and the mammary gland is active.

Mature-lactating-gravid Similar to mature-anoestrus except the glands are more convoluted and active and the endometrium appears more vascular. It is also characterised by an active corpus luteum and mammary gland.

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

Foetuses were weighed (g) and the curvilinear and standard crown to rump lengths (mm) were recorded. Specimens were photographed and stored in 10% buffered formalin for future research.

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 stored frozen at –80°C for future research.

Males

The length and midline diameter of the testes (excluding epididymis) were measured (mm) using Vernier callipers, and the testes weighed (g) using a Mettler PM 4800 Delta Range balance. The testes were sectioned at 5 mm intervals and examined for evidence of pathological changes. Histological samples were taken from the centre of the testes and epididymis, embedded in paraffin wax, sectioned at 3 mm, mounted on glass slides and stained with haematoxylin and eosin. The sections were then examined microscopically at 40–100× 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 gonads were classified as immature, pubertal, mature-inactive, or mature-active based on the predominant cell association in 75% of the tubules in a section.

Immature The seminiferous tubules/cords are narrow and often have no apparent lumen. Sertoli cells and spermatogonia line the tubules but no further differentiation of germinal cells is apparent. There are abundant interstitial cells. The duct of the epididymis has a completely empty lumen.

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

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

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

The baculum was collected and stored frozen at –20°C for comparative anatomical studies.

2.3 STATISTICAL ANALYSES

Analyses of association between morphometric parameters were tested using linear correlation. Paired t-tests or unpaired t-tests were used to compare age determination methods. Statistical analyses were carried out using InStat software (Graph Pad Software, Inc., San Diego California, U.S.A.).

3. Results

3.1 CATCH DATA AND OBSERVERS REPORTS

A total of 27 New Zealand sea lion carcasses were received consisting of eight females and 19 males. There were 111 fur seals including 28 females and 83 males, and one male leopard seal. The CSL observer's data are recorded with the catch date, time and approximate coordinates (Appendix 1, Table 1.1). The sea lions appear to have been captured at two locations in close proximity to the Auckland Islands The majority (n = 20) were captured to the north of the Auckland Islands, while the remaining animals were caught further south and to the east of the Islands (Fig. 1.4).

The fur seals appear to have been captured at five primary locations: off the west coast of the South Island (Cape Foulwind), around the Snares Islands and Bounty Islands, northeast of Campbell Island, and off Kaikoura. The 20 females, for which catch coordinates were available, were caught at the first location. Males were distributed between all locations (Fig. 1.5). The CSL observer data sheet was not available for four fur seals and the coordinates were not recorded for a further five fur seals.

The leopard seal was captured near the Bounty Islands.

Figure 1.4. Capture locations for New Zealand sea lions, 1997/1998. *Inset*: The area near Auckland Islands, showing the capture locations in greater detail.

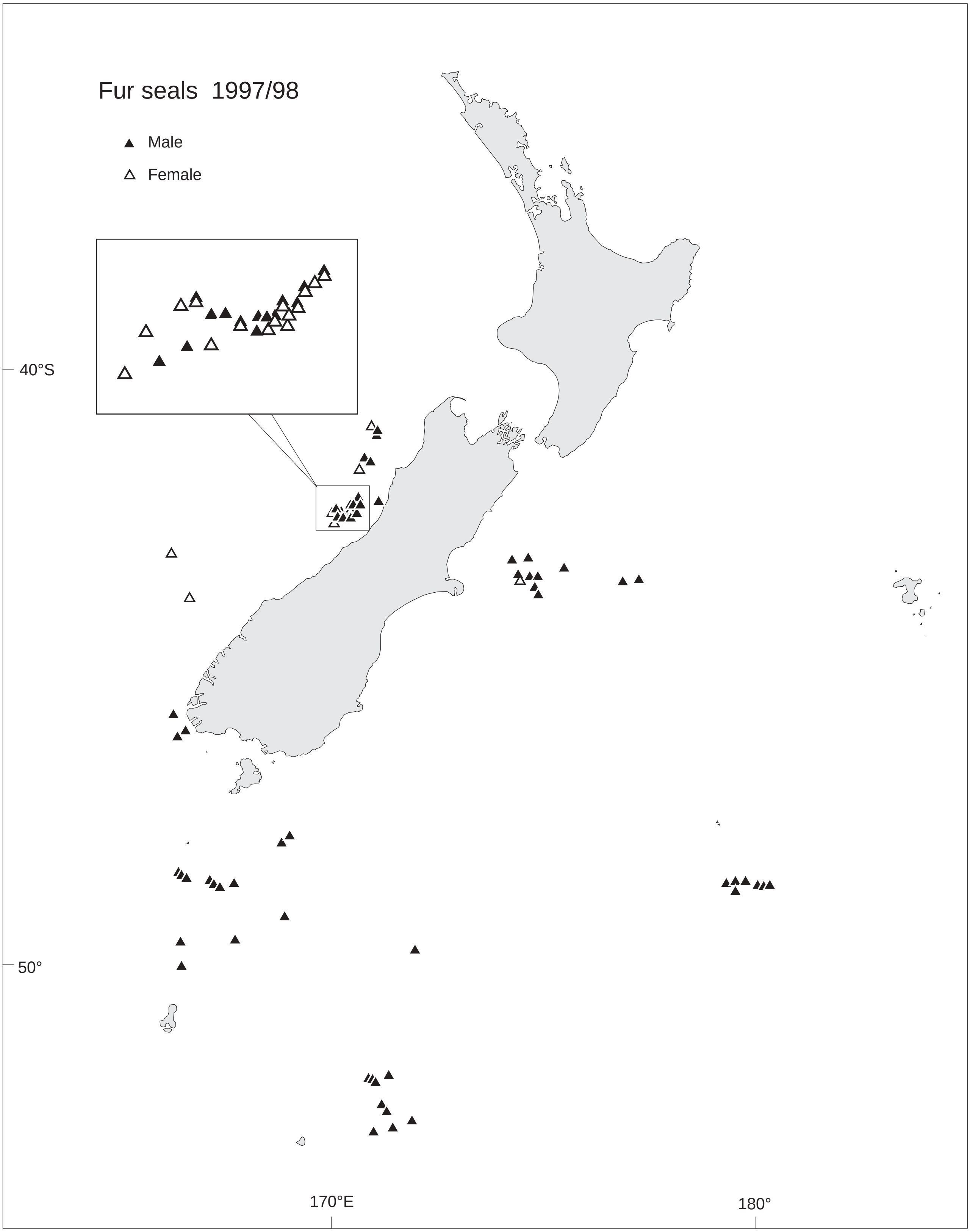


Figure 1.5. Capture locations for New Zealand fur seals, 1997/1998. *Inset*: The area off the west coast of the South Island, showing capture locations in greater detail.

3.2 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table 1.2).

For female sea lions and fur seals there was a highly significant association between body weight and axillary girth ($n = 8$, $r = 0.9$, $P = 0.0017$; $n = 28$, $r = 0.8$, $P < 0.0001$). For female fur seals only, there was a significant but weaker association between standard body length (SBL) and body weight ($n = 28$, $r = 0.5$, $P = 0.01$).

Male sea lions ($n = 19$) had a significant association between body weight and axillary girth ($r = 0.8$, $P < 0.0001$) and between SBL and body weight ($r = 0.9$, $P < 0.0001$). However, neither body weight nor axillary girth was significantly correlated with the blubber depth.

Male fur seals ($n = 83$) had significant associations between SBL and body weight ($r = 0.8$, $P < 0.0001$) and between body weight and axillary girth ($r = 0.9$, $P < 0.0001$). There was a significant association in male fur seals between body weight the depth of the blubber layer ($r = 0.6$, $P < 0.0001$), axillary girth and blubber depth ($r = 0.6$, $P < 0.0001$) and SBL and blubber depth ($r = 0.6$, $P = 0.0012$).

3.3 STOMACH CONTENTS

The stomach weight and the weight of its contents were recorded for each animal (Appendix 1, Table 1.3). The contents, where identifiable, are given in the tables by the common name. Squid, probably the arrow squid (*Nototodarus sloanii*) was present in the stomachs of both sea lions and fur seals. Semi digested and digested fragments of teleost fish were also present. Invertebrates such as Spider crabs (*Maja squinado*) and anthropods were also present in the stomach of some sea lions. Most of the teleost fish were not sufficiently intact for gross identification to species. Squid predominated in the stomach of the sea lion, while teleost fish predominated in the fur seal stomachs. Otoliths and squid beaks have been stored in alcohol for more detailed analysis of diet at or immediately before the time of death. Eight of the sea lions, at least 35 of the fur seals, and the leopard seal had no identifiable remains in the stomach. Blubber samples are also in storage for analysis of fatty acid signatures.

3.4 AGE DETERMINATION

The canine teeth of four fur seals were either too worn or broken for age determination, and for some animals it was not possible to distinguish either the RRs or the GLGs (Appendix 1, Table 1.4). The actual age was known for four sea lions that were tagged as pups. The estimated age was within two years of the actual age for these animals as determined by the number of GLGs and RRs. Too few animals were tagged for statistical analysis.

The female sea lions had a mean age of approximately 5 years based on GLGs (4.9 years) and root ridges (5.2 years). Their age range was from 3 years to 8 years of age. For male sea lions, the age range was from 3 years to 11.5 years of age, and the mean age was approximately 5 years (5 years, GLGs; 5.6 years, RRs).

Female fur seals ranged in age from 1 year to 6 years old, while the mean age was approximately 3 years (3.2 years, GLGs; 3.1 years, RRs). The male fur seals spanned a greater age range, from 2 years to 14 years, with a mean of approximately 8 years (9.9 years, GLGs; 8.2 years, RRs).

For animals where both RRs and GLGs were clearly readable, statistical analysis was carried out to determine whether there was an association between the estimated age derived from RRs and that derived from GLGs. Paired t-tests found a significant association between the number of GLGs and RRs in male sea lions ($n = 17$, $r = 0.7$, $P = 0.0006$), female fur seals ($n = 24$, $r = 0.5$, $P = 0.005$), and male fur seals ($n = 48$, $r = 0.7$, $P < 0.0001$). The association was not significant for female sea lions, however, there were only six data points to test.

For male sea lions there was a significant association between SBL and the number of GLGs ($n = 17$, $r = 0.8$, $P = 0.0002$). Similarly, SBL was significantly associated with the number of RRs ($n = 19$, $r = 0.8$, $P < 0.0001$). There were too few data points for female sea lions to conduct these analyses.

For female fur seals there was a significant association between SBL and number of GLGs ($n = 26$, $r = 0.8$, $P = 0.0013$) but not between SBL and number of RRs. In male fur seals, both SBL and number of GLGs ($n = 42$, $r = 0.7$, $P = 0.0001$), and SBL and number of RRs ($n = 47$, $r = 0.7$, $P < 0.0001$) were significantly associated.

The leopard seal was not able to be aged.

3.5 REPRODUCTIVE STATUS

Females

Based on the absence of a CA or CL in serial ovarian sections, one female sea lion (SB97-28Ph) was classed as immature (Appendix 1, Table 1.5). This female was one of the youngest of the group with an estimated age of 3 years based on GLGs. Six females were classified as sexually mature but anoestrus. Five of them had a CL in one ovary, although there was no detectable embryo in their uterus; but since all were caught in either February or March, it would be early in pregnancy assuming that they had been mated in December. One female had an ovarian structure more similar to a CA suggesting she was not pregnant that season. The remaining female was classified as mature lactating, she had both a CL and a CA, and the mammary gland was active, indicating she had given birth to a pup in the summer and was nursing the pup at the time of death.

Of the 28 fur seals, seven (25%) had no histological features consistent with *corpora* visible in serial ovarian sections. Three of these females were classified as immature, and four as mature anoestrus based on external and reproductive morphometrics (Appendix 1, Table 1.5). Seventeen of the 28 females (61%) were pregnant with a single foetus that ranged from 7 g to 1520 g in weight

(Appendix 1, Table 1.5). Eleven of these females were also lactating. All of the pregnant females were caught in the months between March and September and each had an easily identifiable CL. The four remaining females had a CL present in one ovary but no detectable embryo or foetus even though they were also caught in the months of June, July or August. Thirteen (46%) of the 28 females were lactating.

Males

Based on examination of the testes, all of the sea lions had histological features consistent with sexual maturity (Appendix 1, Table 1.6). Seven (37%) were actively producing spermatozoa while the gonads of the remaining animals were inactive. Of the males classed as mature active, all were caught between 30 January and 28 February, while of the 12 males classed as mature inactive, seven were caught in March and five in February.

Of 83 male fur seals, four (5%) had small immature gonads, 31 (37%) were classed as mature inactive and the remaining 48 (58%) were classed as mature active (Appendix 1, Table 1.6). Males classed as mature active were captured between January and October but the greatest number were caught in August (n = 16) and September (n = 17). Males with inactive gonads were captured between March and October with the greatest number in July (n = 6) (Fig. 1.5).

The leopard seal (Appendix 1, Table 1.6) was sexually immature.

4. Discussion

The pinnipeds examined for this contract were received frozen and double bagged. In general the packaging was of a high standard and an observer data sheet inserted into the oral cavity usually identified the animals. However, there were no observer sheets with four of the fur seals and for a further five animals all of the data were not recorded on the sheet. From a health and safety aspect, the packaging was sufficient to prevent contamination of the environment by the seal carcass provided it remained frozen. In terms of record keeping, it would be of benefit to the contractor if a list of animals being shipped could be forwarded by post or e-mail to allow a crosscheck between animals shipped and those received. In that way, any animal that arrives without the observer's report could be traced.

The number of sea lions examined for this contract was not dissimilar from that examined in the first contract (Dickie & Dawson 1997). However, the sample studied here was more strongly biased towards males than in the previous data set. Whether that reflects a skewed sex ratio in the total bycatch or just reflects the selection of animal for examination is unknown. A similar male bias was present in the sample of fur seals submitted for examination. For the latter species, the skewed sex ratio may reflect the apparent difference in distribution of foraging males and females. Thus, females tended to predominate in catches off the west coast of the South Island, but males are found in all of the locations from which animals were submitted.

The stomach contents of sea lions were similar to those examined by Dickie & Dawson (1997) with squid predominant among the items identifiable in the stomachs of sea lions. However, approximately half of the animals also appear to have a variety of teleost fish and invertebrates other than squid. Although squid were also present in the stomachs of some fur seals, the latter were more likely to have consumed teleost fish. Entire hoki and hoki otoliths featured among the fish items present. However, specific identification of these prey items was beyond the scope of this contract. Eight of the sea lions, at least 35 fur seals and the leopard seal had no identifiable remains in their stomach which might suggest that prey items were regurgitated on capture. This is but one of the biases inherent in the use of stomach contents or faeces as an indicator of diet in pinnipeds (Jobling & Brieby 1986; Bowen & Harrison 1996). Recently, blubber fatty acid signature analysis has been advanced as a more sensitive method of investigating diet among pinnipeds (Iverson 1993; Iverson et al. 1997). This technique is currently under development at Massey University for future studies on foraging ecology of sea lions and fur seals.

Age determination in pinnipeds is based on counting growth layers or annuli in teeth and is commonly used on a variety of species (Laws 1952; Stirling 1969; Anas 1970; Payne 1978; Bengtson & Siniff 1981; Arnbom et al. 1992; Oosthuisen 1997). 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). For the species under consideration the number of known-aged animals in the sample is probably too low to critically evaluate the ageing technique. In the previous study, only one of 23 sea lions were known age, and none of 129 fur seals. In this study, four of 27 sea lions and one of 111 fur seals had tags. Of the sea lions for which the author knows the tagging date, there is good agreement between the known age and the estimated age of the animal as determined by two readers who did not know the actual age of the animals. In two cases the GLGs best estimated the actual age, the RRs gave the best estimate in one case, and both GLGs and RRs gave the same estimate in the remaining animal. Given that it was often difficult or impossible to read dentinal annuli or RRs for a given individual, it is fortuitous that there is a good correlation between the techniques. Whether either of these techniques correlates with actual age is unknown and should not be assumed (cf. Dapson 1980). Although further validation is required, a count of RRs in an extracted canine tooth probably gives a reasonably accurate estimate of age. It is also noteworthy that for all groups (male sea lion, female fur seal, male fur seal) in which the sample size was sufficient, there were significant correlations between SBL and the indices of growth in teeth. This suggests that at least for animals, which have not yet achieved full body length, the SBL may be a reasonably good indicator of age.

Among the northern sea lion species, female Steller's sea lion (*Eumetopias jubatus*) and California sea lion (*Zalophus californianus*) reach sexual maturity between 3 and 8 years (Reeves et al. 1992). The southern sea lion (*Otaria byronia*) reaches maturity at 4 years (Reijnders et al. 1993) and New Zealand sea lions apparently become sexually mature at 3 years old and produce their first pup at 4 years (Cawthorn et al. 1985). This study supports those observations, in that the youngest animal at 3 years, had sexually immature ovaries while the remaining females (3–8 years old) had sexually mature ovaries. Embryonic diapause has not been reported for the New Zealand sea lion but is likely to occur as it does so in most other pinnipeds (Gales 1995). The fact that none of the mature females had detectable embryos would support a period of diapause as these animals would likely had bred in December and were not caught until February or March. More research is required into the reproductive cycle of New Zealand sea lions.

Mattlin (1978) suggested that New Zealand fur seal females appear to come into oestrus at 4 years and produce their first pup at about 5 years. An age at sexual maturity of 3 to 6 years is consistent with several other fur seal species such as the subantarctic fur seal, *Arctocephalus tropicalis* (Bester 1987), Australian fur seal*, A. pusillus doriferus* (Warneke 1979), and South American fur seal, *A. australis* (Reeves et al. 1992). Based on these accounts, it would appear likely that the estimated ages of pregnant females in this study are an underestimate of the actual age. Future analysis of known aged females would provide a better insight on this question.

Cawthorn et al. (1985) reported that male New Zealand sea lions become sexually mature at 5 years old but do not hold territories or breed for another 3 to 5 years. Similarly Australian sea lions (*Neophoca cinerea*) are thought to achieve sexual maturity at 6 years (Reijnders et al. 1993). The data presented here support that observation, in that the youngest male in which active spermatogenesis was detected was a known age tagged animal that was 4 years old at the time of death. The remaining animals with active spermatogenesis were between 5 and 7 years as estimated by GLGs and RRs. The oldest male in the sample (SB97-03Ph) had sexually mature but inactive testes.

For New Zealand fur seals, it has been suggested that sexual maturity in males is attained at approximately 7 years but that social maturity is not achieved until 10 years of age (Mattlin 1978). Similar data have been reported for Australian fur seals (Shaughnessy & Warneke 1987), Galapagos fur seals, *Arctocephalus galapagoensis* (Bonner 1981), South American fur seals (Bonner 1981), subantarctic fur seals (Bester 1987), and Antarctic fur seals (Duck 1990). This study supports the pattern for the genus, in that the four males classed as immature were 4.5 years old or younger, while the animals classed as mature active ranged from 5 to 14 years old. The temporal distribution of mature males with active or inactive testes suggests that there is a seasonal peak in spermatogenesis in spring. Further data would be required to test this hypothesis.

5. References

For details of references quoted in Part 1, see the combined reference list at the end of Part 3 (pp. 96–99).

Appendix 1

TABLES OF RESULTS

TABLE 1.1. CSL OBSERVER CAPTURE DATA FOR PINNIPEDS, 1997/98.

CODE	PATHOLOGY NO.	DATE	TIME (24 h)	LAT.	LONG.	TAG NO.
New Zealand sea lion—Females						
SB97-04Ph	27992	14 Feb 97	0920	50°S	166°E	
SB97-10Ph	28006	1 Feb 97	1010	50°S	167°E	
SB97-27Ph	28041	5 Mar 97	2200	50°S	166°E	
SB97-28Ph	28051	7 Mar 97	2030	50°S	166°E	
SB97-30Ph	28055	10 Feb 97	1325	50°S	166°E	3488
SB97-36Ph	28106	7 Mar 97	1710	50°S	166°E	
SB97-39Ph	28137	5 Mar 97	1030	50°S	166°E	
SB97-40Ph	28138	8 Feb 97	1850	50°S	166°E	
New Zealand sea lion—Males						
SB97-01Ph	27982	8 Mar 97	–	50°S	166°E	
SB97-03Ph	27983	7 Feb 97	1120	50°S	167°E	
SB97-02Ph	27984	10 Mar 97	0845	49°S	167°E	
SB97-07Ph	27997	6 Mar 97	1431	50°S	166°E	3705
SB97-08Ph	28001	30 Jan 97	1920	50°S	167°E	
SB97-09Ph	28002	28 Feb 97	1005	49°S	166°E	
SB97-11Ph	28007	6 Mar 97	0920	50°S	166°E	
SB97-12Ph	28010	19 Feb 97	0810	50°S	168°E	
SB97-13Ph	28013	4 Feb 97	1230	50°S	167°E	
SB97-16Ph	28018	14 Feb 97	0920	50°S	167°E	
SB97-18Ph	28023	7 Feb 97	1330	50°S	166°E	4201
SB97-19Ph	28024	1 Mar 97	0615	49°S	167°E	
SB97-20Ph	28025	13 Mar 97	1320	50°S	166°E	3700
SB97-21Ph	28026	26 Feb 97	2205	50°S	167°E	
SB97-22Ph	28027	28 Feb 97	1005	49°S	167°E	
SB97-25Ph	28039	4 Mar 97	1000	50°S	167°E	
SB97-26Ph	28040	26 Feb 97	2145	50°S	167°E	
SB97-34Ph	28098	10 Feb 97	1325	50°S	166°E	
SB97-41Ph	28139	4 Feb 97	1230	50°S	167°E	
New Zealand fur seal—Females						
SB97-37Af	28107	–	–	–	–	
SB97-42Af	28145	10 Apr 97	0835	49°S	168°E	
SB97-47Af	28173	3 Mar 97	1109	43°S	166°E	
SB97-49Af	28179	16 Jul 97	1555	42°S	170°E	
SB97-50Af	28180	1 Jun 97	1800	44°S	166°E	
SB97-51Af	28195	6 Jul 97	0910	42°S	170°E	
SB97-54Af	28205	16 Jun 97	0025	42°S	170°E	
SB97-56Af	28207	6 Jul 97	0440	42°S	170°E	
SB97-59Af	28234	15 Jun 97	2029	42°S	170°E	
SB97-61Af	28242	–	–	–	–	
SB97-63Af	28265	20 Jun 97	1699	42°S	170°E	
SB97-65Af	28268	6 Jul 97	0910	42°S	170°E	
SB97-77Af	28315	28 Jul 97	2249	43°S	170°E	

TABLE 1.1. *Continued.*

CODE	PATHOLOGY NO.	DATE	TIME (24 h)	LAT.	LONG.	TAG NO.
SB97-81Af	28345	11 Aug 97	2115	42ºS	170ºE	
SB97-83Af	28353	27 Aug 97	1800	42ºS	170ºE	
SB97-84Af	28363	16 Jul 97	0700	42ºS	170ºE	
SB97-87Af	28381	17 Jul 97	0250	42ºS	171ºE	
SB97-106Af	28669	8 Aug 97	0625	42ºS	170ºE	
SB97-107Af	28681	25 Aug 97	0640	42ºS	170ºE	
SB97-109Af	28683	30 Jul 97	0943	41ºS	170ºE	
SB97-110Af	28684	16 Jul 97	0700	42ºS	170ºE	
SB97-112Af	28690	4 Sept 97	2345	42ºS	170ºE	
SB97-114Af	28692	12 Aug 97	0059	42ºS	170ºE	
SB97-118Af	28698	14 Sept 97	2230	41ºS	170ºE	
SB97-119Af	28702	20 Aug 97	0317	41ºS	171ºE	
SB97-121Af	28704	14 Sept 97	2230	–	–	
SB97-126Af	28709	14 Sept 97	0130	41ºS	170ºE	
SB98-32Af	29023	3 Sept 97	1915	42ºS	170ºE	
New Zealand fur seal—Males						
SB97-05Af	27995	2 May 97	2129	43ºS	177ºE	
SB97-06Af	27996	3 Mar 97	1435	49ºS	166ºE	
SB97-14Af	28014	19 Sept 96	0516	52ºS	171ºE	
SB97-15Af	28017	7 Oct 96	1245	43ºS	174ºE	
SB97-17Af	28022	6 Apr 97	1530	49ºS	168ºE	
SB97-23Af	28028	4 Apr 97	1030	49ºS	168ºE	
SB97-24Af	28038	15 Mar 97	1205	46ºS	171ºE	
SB97-31Af	28075	7 Mar 97	1310	50ºS	166ºE	
SB97-33Af	28097	1 Apr 97	2000	49ºS	167ºE	
SB97-43Af	28152	20 Jun 97	1700	42ºS	170ºE	
SB97-44Af	28153	14 Jun 97	0620	44ºS	174ºE	
SB97-45Af	28171	6 Jul 97	0910	42ºS	170ºE	
SB97-46Af	28172	29 Jun 97	0400	–	–	
SB97-48Af	28174	4 Jul 97	0400	42ºS	170ºE	
SB97-52Af	28196	2 Jul 97	1630	42ºS	170ºE	
SB97-53Af	28204	6 Jul 97	0910	42ºS	170ºE	
SB97-55Af	28206	–	–	–	–	
SB97-57Af	28227	15 Jun 97	0830	42ºS	170ºE	
SB97-58Af	28228	6 Jul 97	0910	42ºS	170ºE	
SB97-60Af	28235	–	–	–	–	
SB97-62Af	28243	13 Feb 97	0250	49ºS	167ºE	
SB97-64Af	28266	10 Mar 97	0845	49ºS	166ºE	
SB97-66Af	28269	20 May 97	0640	43ºS	174ºE	
SB97-67Af	28270	1 Feb 97	1930	48ºS	167ºE	
SB97-68Af	28292	12 May 97	0345	44ºS	176ºE	
SB97-69Af	28293	15 Apr 97	2320	43ºS	175ºE	
SB97-70Af	28294	23 Apr 97	1258	48ºS	168ºE	
SB97-72Af	28302	11 Apr 97	0835	48ºS	168ºE	
SB97-74Af	28309	11 May 97	1730	44ºS	174ºE	
SB97-75Af	28310	12 May 97	1100	43ºS	174ºE	
SB97-76Af	28311	28 Jul 97	1734	43ºS	174ºE	
SB97-78Af	28316	28 Jul 97	2249	43ºS	174ºE	
SB97-79Af	28317	7 Mar 97	0750	50ºS	166ºE	
SB97-80Af	28344	17 Jul 97	0250	42ºS	171ºE	

TABLE 1.1. *Continued.*

CODE	PATHOLOGY NO.	DATE	TIME (24 h)	LAT.	LONG.	TAG NO.
SB97-82Af	28346	11 Aug 97	2115	42°S	170°E	
SB97-86Af	28380	27 Aug 97	1800	42°S	170°E	
SB97-88Af	28388	2 Sept 97	1542	42°S	170°E	
SB97-89Af	28414	30 Aug 97	1105	48°S	179°E	
SB97-90Af	28415	30 Aug 97	1105	48°S	179°E	
SB97-91Af	28471	10 Sept 97	0537	48°S	166°E	
SB97-92Af	28472	11 Sept 97	0340	48°S	166°E	
SB97-93Af	28473	6 Sept 97	0535	46°S	166°E	
SB97-94Af	28474	11 Sept 97	0340	48°S	166°E	
SB97-97Af	28519	6 Sept 97	0310	46°S	167°E	
SB97-98Af	28520	3 Sept 97	0030	46°S	171°E	
SB97-100Af	28584	30 Aug 97	0700	48°S	179°E	
SB97-101Af	28636	31 Aug 97	0830	48°S	179°E	
SB97-103Af	28666	16 Sept 97	0545	42°S	171°E	
SB97-104Af	28667	24 Aug 97	0600	42°S	170°E	
SB97-105Af	28668	14 Sept 97	2230	41°S	170°E	
SB97-108Af	28682	11 Aug 97	2115	42°S	170°E	
SB97-111Af	28689	18 Sept 97	1440	46°S	166°E	
SB97-113Af	28691	31 Aug 97	0830	48°S	179°E	
SB97-115Af	28695	31 Aug 97	0805	48°S	179°E	
SB97-116Af	28696	30 Aug 97	1105	48°S	179°E	
SB97-117Af	28697	29 Aug 97	1205	48°S	179°E	
SB97-120Af	28703	12 Aug 97	0059	42°S	170°E	
SB97-122Af	28705	30 Aug 97	1105	48°S	179°E	
SB97-123Af	28706	29 Aug 97	1200	48°S	179°E	
SB97-124Af	28707	14 Sept 97	2230	–	–	
SB97-125Af	28708	14 Jul 97	0535	42°S	170°E	
SB98-12Af	28951	27 Jan 98	0750	49°S	167°E	
SB98-13Af	28957	18 Oct 97	1600	49°S	168°E	
SB98-14Af	28958	2 Sept 97	–	–	–	
SB98-15Af	28959	4 Oct 97	2320	52°S	172°E	
SB98-16Af	28960	2 Sept 97	2147	49°S	171°E	
SB98-17Af	28961	2 Oct 97	2020	52°S	170°E	
SB98-18Af	28962	7 Oct 97	1817	52°S	171°E	
SB98-19Af	28963	18 Sept 97	1845	52°S	171°E	
SB98-20Af	28964	29 Aug 97	–	–	–	
SB98-21Af	28965	11 Sept 97	0015	51°S	170°E	
SB98-23Af	28969	29 Aug 97	–	–	–	
SB98-24Af	29015	11 Sept 97	0015	51°S	170°E	
SB98-25Af	29016	29 Aug 97	0830	48°S	179°E	
SB98-26Af	29017	3 Sept 97	1915	42°S	170°E	
SB98-27Af	29018	30 Aug 97	0740	48°S	179°E	
SB98-28Af	29019	2 Sept 97	1343	41°S	171°E	
SB98-29Af	29020	30 Aug 97	0740	48°S	179°E	
SB98-30Af	29021	–	1915	41°S	171°E	148/20
SB98-31Af	29022	11 Sept 97	0015	51°S	170°E	
SB98-33Af	29024	29 Aug 97	0840	48°S	179°E	
SB98-34Af	29025	12 Sept 97	2055	51°S	171°E	
SB98-35Af	29026	11 Sept 97	0015	51°S	170°E	
SB98-22Hl	28966	1 Oct 97	1309	52°S	170°E	

TABLE 1.2. MORPHOMETRIC DATA FOR PINNIPEDS, 1997/98. (See end of table for abbreviations.)

CODE	PATHOLOGY NO.	Wt (kg)	St L (m)	Pc Fl L (m)	Pv Fl L (m)	N-Eye L (m)	N-Ear L (m)	N-Fl L (m)	N-Gen L (m)	N-Anus L (m)	Gt Eye (m)	Gt Ax (m)	Gt Pv (m)	Blub S (m)
New Zealand sea lion—Females														
SB97-04Ph	27992	73.6	1.61	0.50	0.34	0.10	0.18	0.61	1.55	1.55	0.54	1.05	0.68	0.015
SB97-10Ph	28006	108.0	1.70	0.55	0.36	0.10	0.19	0.67	1.62	1.63	0.52	1.11	0.75	0.016
SB97-27Ph	28041	107.0	1.67	0.48	0.37	0.11	0.18	0.66	1.57	1.58	0.53	1.12	0.61	0.017
SB97-28Ph	28051	57.5	1.34	0.43	0.33	0.09	0.15	0.50	1.21	1.21	0.47	0.89	0.61	0.022
SB97-30Ph	28055	74.0	1.61	0.56	0.38	0.10	0.18	0.66	1.48	1.51	0.54	1.05	0.72	0.015
SB97-36Ph	28106	85.0	1.52	0.48	0.33	0.08	0.16	0.61	1.40	1.41	0.52	0.98	0.62	0.013
SB97-39Ph	28137	117.0	1.75	0.59	0.38	0.11	0.19	0.69	1.64	1.67	0.53	1.17	0.71	0.017
SB97-40Ph	28138	118.0	1.70	0.57	0.39	0.11	0.18	0.77	1.63	1.64	0.52	1.19	0.76	0.015
New Zealand sea lion—Males														
SB97-01Ph	27982	89.5	1.56	0.55	0.39	0.12	0.18	0.58	1.27	1.48	0.61	1.07	0.74	0.025
SB97-02Ph	27984	89.7	1.55	0.56	0.39	0.12	0.20	0.65	1.30	1.48	0.59	1.12	0.72	0.024
SB97-03Ph	27983	185.0	2.06	0.67	0.52	0.13	0.20	0.74	1.75	1.98	0.84	1.51	0.91	0.028
SB97-07Ph	27997	135.5	1.82	0.53	0.40	0.12	0.21	0.71	1.53	1.74	0.59	1.21	0.78	0.040
SB97-08Ph	28001	128.3	1.89	0.67	0.44	0.11	0.19	0.76	1.57	1.76	0.61	1.22	0.84	0.029
SB97-09Ph	28002	74.4	1.45	0.56	0.37	0.09	0.17	0.64	1.23	1.38	0.55	1.04	0.73	0.031
SB97-11Ph	28007	91.2	1.60	0.52	0.37	0.13	0.17	0.66	1.33	1.52	0.56	1.06	0.68	0.025
SB97-12Ph	28010	94.6	1.67	0.58	0.40	0.12	0.21	0.64	1.35	1.57	0.57	1.01	0.74	0.024
SB97-13Ph	28013	118.0	1.77	0.59	0.41	0.14	0.21	0.69	1.45	1.68	0.59	1.21	0.78	0.020
SB97-16Ph	28018	192.0	2.12	0.65	0.43	0.14	0.24	0.90	1.69	1.92	0.68	1.25	0.82	0.020
SB97-18Ph	28023	115.5	1.74	0.59	0.43	0.13	0.20	0.69	1.50	1.68	0.62	1.12	0.72	0.025
SB97-19Ph	28024	116.0	1.78	0.78	0.40	0.13	0.23	0.78	1.51	1.73	0.61	1.22	0.73	0.018
SB97-20Ph	28025	137.0	1.84	0.62	0.47	0.13	0.22	0.81	1.55	1.78	0.63	1.14	0.85	0.020
SB97-21Ph	28026	106.2	1.74	0.58	0.41	0.11	0.19	0.73	1.43	1.65	0.56	1.06	0.71	0.015
SB97-22Ph	28027	120.0	1.73	0.59	0.41	0.11	0.20	0.69	1.42	1.62	0.59	1.22	0.77	0.018
SB97-25Ph	28039	87.8	1.52	0.49	0.33	0.09	0.17	0.59	1.29	1.42	0.51	1.03	0.73	0.036
SB97-26Ph	28040	84.6	1.57	0.51	0.40	0.11	0.19	0.57	1.34	1.52	0.52	0.97	0.63	0.016
SB97-34Ph	28098	83.0	1.58	0.55	0.36	0.12	0.19	0.70	1.36	1.50	0.52	0.96	0.71	0.020
SB97-41Ph	28139	88.8	1.63	0.54	0.40	0.12	0.19	0.68	1.33	1.58	0.56	1.09	0.66	0.014
New Zealand fur seal—Females														
SB97-37Af	28107	44.5	1.28	0.39	0.28	0.08	0.16	0.60	1.22	1.23	0.45	0.86	0.53	0.011
SB97-42Af	28145	27.3	1.14	0.34	0.26	0.09	0.15	0.53	1.05	1.07	0.41	0.70	0.49	0.026
SB97-47Af	28173	34.6	1.12	0.36	0.29	0.10	0.16	0.49	1.09	1.09	0.43	0.78	0.49	0.020
SB97-49Af	28179	36.2	121.0	0.38	0.28	0.08	0.15	0.58	1.15	1.15	0.46	0.78	0.48	0.010
SB97-50Af	28180	26.0	1.01	0.31	NA	0.09	0.15	0.45	0.97	0.97	0.40	0.77	0.44	0.015
SB97-51Af	28195	43.5	1.29	0.43	0.31	0.09	0.17	0.53	1.21	1.22	0.45	0.86	0.59	0.013
SB97-54Af	28205	29.2	1.21	0.37	0.29	0.08	0.15	0.52	1.13	1.14	0.47	0.77	0.55	0.018
SB97-56Af	28207	38.1	1.22	0.37	0.29	0.09	0.15	0.51	1.12	1.13	0.46	0.82	0.61	0.017
SB97-59Af	28234	40.7	1.23	0.39	0.29	0.10	0.17	0.54	1.14	1.15	0.47	0.86	0.62	0.040
SB97-61Af	28242	33.2	1.18	0.37	0.29	0.10	0.17	0.52	1.07	1.08	0.78	0.59	0.59	0.010
SB97-63Af	28265	41.7	1.17	0.41	0.30	0.09	0.16	0.52	1.16	1.13	0.49	0.87	0.60	0.036
SB97-65Af	28268	36.3	1.19	0.40	0.30	0.09	0.14	0.46	1.11	1.13	0.44	0.83	0.58	0.020
SB97-77Af	28315	48.4	1.31	0.43	0.31	0.08	0.15	0.50	1.15	1.16	0.45	0.90	0.70	0.030
SB97-81Af	28345	46.9	1.25	0.39	0.30	0.10	0.16	0.52	1.19	1.20	0.54	0.92	0.71	0.018
SB97-83Af	28353	41.1	1.22	0.39	0.29	0.07	0.14	0.44	1.16	1.17	0.61	0.86	0.66	0.031
SB97-84Af	28363	46.5	1.27	0.39	0.31	0.11	0.17	0.55	1.20	1.21	0.51	0.90	0.60	0.032
SB97-87Af	28381	34.6	1.18	0.36	0.26	0.08	0.14	0.51	1.11	1.12	0.47	0.83	0.59	0.029
SB97-106Af	28669	43.6	1.25	0.39	0.28	0.09	0.14	0.54	1.13	1.15	0.52	0.86	0.67	0.019
SB97-107Af	28681	25.2	1.04	0.35	0.24	0.10	0.16	0.46	0.94	0.96	0.48	0.73	0.51	0.015
SB97-109Af	28683	33.3	1.19	0.39	0.29	0.10	0.17	0.52	1.10	1.12	0.49	0.80	0.56	0.015

TABLE 1.2. *Continued.* (See end of table for abbreviations.)

CODE	PATHOL-OGY NO.	Wt (kg)	St L (m)	Pc Fl L (m)	Pv Fl L (m)	N-Eye L (m)	N-Ear L (m)	N-Fl L (m)	N-Gen L (m)	N-Anus L (m)	Gt Eye (m)	Gt Ax (m)	Gt Pv (m)	Blub S (m)
SB97-110Af	28684	39.4	1.16	0.40	0.30	0.08	0.11	0.49	1.03	1.05	0.58	0.89	0.57	0.033
SB97-112Af	28690	37.1	1.12	0.39	0.25	0.08	0.16	0.50	1.09	1.10	0.54	0.88	0.63	0.018
SB97-114Af	28692	50.4	1.26	0.37	0.30	0.10	0.17	0.49	1.17	1.18	0.62	0.94	0.65	0.030
SB97-118Af	28698	43.6	1.29	0.37	0.31	0.09	0.18	0.46	1.20	1.22	0.53	0.86	0.70	0.019
SB97-119Af	28702	29.2	1.15	0.37	0.27	0.08	0.16	0.50	1.06	1.08	0.49	0.77	0.54	0.020
SB97-121Af	28704	38.0	1.25	0.35	0.29	0.10	0.17	0.48	1.13	1.15	0.49	0.83	0.70	0.028
SB97-126Af	28709	49.4	1.25	0.39	0.29	0.09	0.16	0.50	1.17	1.19	0.57	0.95	0.68	0.032
SB98-32Af	29023	54.3	1.28	0.40	0.30	0.09	0.16	0.50	1.16	1.18	0.62	1.01	0.79	0.040
New Zealand fur seal—Males														
SB97-05Af	27995	76.3	1.61	0.45	0.37	0.11	0.18	0.71	1.40	1.54	0.62	1.02	0.70	0.035
SB97-06Af	27996	88.5	1.68	0.49	0.36	0.13	0.19	0.69	1.45	1.61	0.56	1.15	0.69	0.020
SB97-14Af	28014	113.8	1.57	0.44	0.34	0.10	0.18	0.71	1.36	1.52	0.63	1.26	0.74	0.075
SB97-15Af	28017	128.5	1.78	0.52	0.37	0.15	0.22	0.76	1.56	1.68	0.66	1.27	0.93	0.055
SB97-17Af	28022	84.2	1.71	0.49	0.37	0.11	0.18	0.66	1.50	1.64	0.63	1.04	0.80	0.029
SB97-23Af	28028	94.5	1.60	0.46	0.36	0.11	0.19	0.68	1.38	1.54	0.58	1.27	0.78	0.035
SB97-24Af	28038	86.0	1.68	0.49	0.39	0.13	0.21	0.70	1.43	1.55	0.63	1.07	0.74	0.020
SB97-31Af	28075	88.2	1.60	0.48	0.36	0.12	0.18	0.68	1.37	1.51	0.58	1.14	0.71	0.016
SB97-33Af	28097	81.8	1.54	0.47	0.37	0.12	0.19	0.61	1.34	1.48	0.65	1.06	0.69	0.022
SB97-43Af	28152	89.0	1.61	0.49	0.41	0.11	0.23	0.74	1.42	1.55	0.62	1.16	0.64	0.020
SB97-44Af	28153	110.0	1.78	0.49	0.39	0.13	0.23	0.78	1.52	1.70	0.72	1.17	0.78	0.013
SB97-45Af	28171	90.4	1.59	0.47	0.35	0.11	0.18	0.67	1.40	1.51	0.65	1.17	0.81	0.030
SB97-46Af	28172	74.0	1.59	0.48	0.35	0.12	0.18	0.67	1.33	1.49	0.58	0.92	0.59	0.010
SB97-48Af	28174	60.0	1.39	0.44	0.34	0.12	0.18	0.63	1.22	1.36	0.65	1.00	0.62	0.020
SB97-52Af	28196	101.5	1.59	0.51	0.35	0.10	0.18	0.66	1.39	1.50	0.64	1.25	0.81	0.045
SB97-53Af	28204	37.5	1.24	0.41	0.31	0.09	0.15	0.56	1.07	1.24	0.53	0.82	0.56	0.026
SB97-55Af	28206	30.0	1.20	0.39	0.31	0.09	0.15	0.54	1.07	1.14	0.47	0.78	0.55	0.020
SB97-57Af	28227	62.6	1.44	0.46	0.32	0.10	0.19	0.64	1.27	1.39	0.59	1.00	0.71	0.020
SB97-58Af	28228	44.0	1.30	0.43	0.32	0.10	0.18	0.57	1.14	1.26	0.51	0.89	0.61	0.021
SB97-60Af	28235	46.8	1.29	0.37	0.29	0.09	0.18	0.57	1.10	1.22	0.56	0.90	0.60	0.050
SB97-62Af	28243	84.0	1.68	0.51	0.36	0.10	0.18	0.73	1.42	1.60	0.61	1.07	0.67	0.024
SB97-64Af	28266	74.5	1.40	0.46	0.35	0.13	0.20	0.63	1.18	1.32	0.64	1.11	0.64	0.016
SB97-66Af	28269	40.7	1.17	0.44	0.32	0.10	0.16	0.50	0.99	1.09	0.46	0.91	0.56	0.035
SB97-67Af	28270	47.9	1.33	0.51	0.33	0.01	0.16	0.52	1.10	1.23	0.52	0.95	0.55	0.015
SB97-68Af	28292	94.9	1.60	0.49	0.33	0.11	0.18	0.63	1.36	1.51	0.58	1.37	0.73	0.035
SB97-69Af	28293	60.1	1.38	0.43	0.31	0.12	0.21	0.65	1.13	1.28	0.57	1.03	0.67	0.015
SB97-70Af	28294	67.9	1.49	0.43	0.33	0.11	0.18	0.73	1.29	1.42	0.54	0.98	0.68	0.033
SB97-72Af	28302	39.4	1.26	0.45	0.34	0.11	0.18	0.51	1.07	1.16	0.46	0.89	0.49	0.011
SB97-74Af	28309	59.7	1.48	0.45	0.35	0.11	0.18	0.60	1.26	1.38	0.49	0.98	0.66	0.022
SB97-75Af	28310	64.9	1.48	0.48	0.34	0.08	0.16	0.59	1.28	1.40	0.62	1.05	0.72	0.030
SB97-76Af	28311	35.1	1.16	0.36	0.28	0.09	0.15	0.61	0.99	1.11	0.48	0.82	0.52	0.035
SB97-78Af	28316	101.5	1.58	0.52	0.38	0.11	0.20	0.66	1.39	1.48	0.57	1.09	0.72	0.040
SB97-79Af	28317	86.5	1.66	0.52	0.34	0.13	0.20	0.70	1.44	1.56	0.63	1.14	0.73	0.020
SB97-80Af	28344	70.9	1.44	0.45	0.33	0.11	0.19	0.66	1.23	1.39	0.65	1.09	0.71	0.032
SB97-82Af	28346	40.8	1.26	0.39	0.32	0.12	0.18	0.57	1.06	1.20	0.58	0.87	0.66	0.023
SB97-86Af	28380	106.3	1.63	0.46	0.37	0.14	0.21	0.74	1.42	1.57	0.64	1.45	0.78	0.039
SB97-88Af	28388	34.5	1.17	0.38	0.30	0.10	0.16	0.53	0.99	1.11	0.54	0.80	0.60	0.026
SB97-89Af	28414	64.3	1.41	0.46	0.35	0.12	0.20	0.57	1.21	1.33	0.54	1.03	0.66	0.022
SB97-90Af	28415	79.3	1.58	0.44	0.35	0.12	0.21	0.78	1.35	1.51	0.59	1.09	0.74	0.030
SB97-91Af	28471	120.5	1.70	0.48	0.37	0.14	0.22	0.85	1.50	1.62	0.68	1.26	0.75	0.042
SB97-92Af	28472	93.8	1.62	0.44	0.37	0.11	0.21	0.67	1.37	1.55	0.64	1.21	0.80	0.044

TABLE 1.2. *Continued.*

CODE	PATHOLOGY NO.	Wt (kg)	St L (m)	Pc Fl L (m)	Pv Fl L (m)	N-Eye L (m)	N-Ear L (m)	N-Fl L (m)	N-Gen L (m)	N-Anus L (m)	Gt Eye (m)	Gt Ax (m)	Gt Pv (m)	Blub S (m)
SB97-93Af	28473	89.7	1.44	0.45	0.35	0.08	0.15	0.64	1.27	1.37	0.71	1.11	0.90	0.055
SB97-94Af	28474	81.7	1.54	0.45	0.34	0.10	0.17	0.66	1.31	1.46	0.68	1.05	0.78	0.044
SB97-97Af	28519	58.3	1.42	0.41	0.34	0.10	0.17	0.67	1.21	1.35	0.53	0.96	0.68	0.047
SB97-98Af	28520	59.6	1.36	0.41	0.31	0.11	0.18	0.60	1.20	1.32	0.60	1.04	0.63	0.020
SB97-101Af	28636	67.2	1.40	0.48	0.36	0.10	0.16	0.56	1.18	1.33	0.70	1.07	0.64	0.027
SB97-103Af	28666	20.6	1.04	0.31	0.25	0.09	0.15	0.45	0.89	0.98	0.46	0.65	0.49	0.008
SB97-104Af	28667	18.2	1.00	0.31	0.26	0.07	0.13	0.45	0.83	0.90	0.45	0.66	0.45	0.017
SB97-105Af	28668	13.1	0.92	0.30	0.23	0.09	0.16	0.45	0.79	0.88	0.39	0.57	0.40	0.010
SB97-108Af	28682	31.1	1.05	0.35	0.25	0.08	0.14	0.47	0.88	0.98	0.50	0.84	0.57	0.020
SB97-111Af	28689	58.5	1.33	0.35	0.33	0.12	0.20	0.56	1.13	1.26	0.72	1.03	0.68	0.025
SB97-113Af	28691	67.6	1.46	0.44	0.37	0.13	0.21	0.60	1.24	1.38	0.73	1.01	0.62	0.025
SB97-115Af	28695	52.3	1.44	0.44	0.33	0.10	0.18	0.60	1.12	1.34	0.55	0.96	0.60	0.027
SB97-116Af	28696	53.6	1.42	0.46	0.33	0.09	0.17	0.57	1.17	1.34	0.70	0.63	0.61	0.030
SB97-117Af	28687	70.6	1.47	0.48	0.37	0.11	0.19	0.64	1.25	1.34	0.64	1.13	0.77	0.022
SB97-120Af	28703	37.7	1.29	0.38	0.27	0.10	0.17	0.52	1.04	1.13	0.50	0.82	0.67	0.027
SB97-122Af	28705	43.0	1.34	0.44	0.34	0.10	0.17	0.60	1.14	1.27	0.56	0.80	0.61	0.015
SB97-123Af	28706	85.0	1.48	0.45	0.32	0.12	0.19	0.61	1.29	1.40	0.67	1.22	0.77	0.040
SB97-124Af	28707	21.1	1.00	0.34	0.24	0.09	0.15	0.47	0.87	0.94	0.46	0.70	0.50	0.010
SB97-125Af	28708	27.0	1.05	0.37	0.28	0.08	0.14	0.48	0.88	0.98	0.50	0.74	0.52	0.020
SB98-12Af	28951	86.6	1.60	0.50	0.40	0.15	0.21	0.63	1.37	1.51	0.72	1.18	0.75	0.017
SB98-13Af	28957	43.5	1.20	0.42	0.31	0.11	0.17	0.52	1.04	1.17	0.62	0.88	0.58	0.025
SB98-14Af	28958	62.6	1.27	0.47	0.35	0.12	0.20	0.48	1.17	1.08	0.68	1.06	0.94	0.024
SB98-15Af	28959	129.0	1.49	0.48	0.37	0.12	0.19	0.62	1.36	1.44	0.72	1.41	0.85	0.060
SB98-16Af	28960	74.8	1.50	0.46	0.35	0.13	0.19	0.72	1.30	1.46	0.71	1.07	0.66	0.018
SB98-17Af	28961	106.8	1.61	0.56	0.37	0.13	0.19	0.65	1.35	1.51	0.66	1.27	0.76	0.032
SB98-18Af	28962	140.5	1.64	0.57	0.39	0.13	0.19	0.69	1.42	1.58	0.56	1.44	0.78	0.040
SB98-19Af	28963	81.9	1.59	0.49	0.37	0.13	0.21	0.68	1.36	1.51	0.65	1.08	0.75	0.040
SB98-20Af	28964	45.4	1.24	0.48	0.33	0.09	0.16	0.53	1.02	1.15	0.58	0.93	0.60	0.024
SB98-21Af	28965	70.7	1.69	0.51	0.36	0.12	0.19	0.74	1.36	1.52	0.60	0.95	0.67	0.027
SB98-23Af	28969	68.3	1.57	0.52	0.38	0.13	0.19	0.68	1.33	1.48	0.61	0.92	0.67	0.025
SB98-24Af	29015	111.9	1.57	0.50	0.37	0.10	0.15	0.62	1.27	1.43	0.76	1.31	0.86	0.042
SB98-25Af	29016	86.4	1.48	0.46	0.32	0.09	0.17	0.66	1.32	1.42	0.71	1.24	0.76	0.043
SB98-26Af	29017	80.9	1.38	0.46	0.33	0.13	0.23	0.61	1.17	1.30	0.65	1.19	0.76	0.054
SB98-27Af	29018	45.9	1.15	0.40	0.32	0.07	0.15	0.49	0.96	1.09	0.67	0.97	0.66	0.026
SB98-28Af	29019	34.5	1.13	0.36	0.28	0.08	0.15	0.43	0.96	1.08	0.64	0.86	0.59	0.019
SB98-29Af	29020	49.2	1.30	0.46	0.33	0.01	0.19	0.54	1.10	1.22	0.58	0.99	0.65	0.020
SB98-30Af	29021	30.1	1.19	0.37	0.28	0.07	0.16	0.52	0.96	1.11	0.51	0.87	0.61	0.022
SB98-31Af	29022	65.5	1.48	0.47	0.34	0.12	0.21	0.68	1.25	1.40	0.61	1.12	0.75	0.040
SB98-33Af	29024	51.1	1.29	0.44	0.34	0.09	0.16	0.56	1.10	1.20	0.65	1.02	0.67	0.033
SB98-34Af	29025	115.4	1.56	0.50	0.39	0.11	0.18	0.67	1.37	1.49	0.83	1.33	0.89	0.055
SB98-35Af	29026	82.5	1.40	0.54	0.36	0.10	0.17	0.56	1.16	1.32	0.72	1.18	0.75	0.032
SB98-100Af	28584	75.2	1.58	0.56	0.38	0.10	0.18	0.79	1.37	1.53	0.63	0.99	0.68	0.032
Leopard seal—Male														
SB98-22Hl	28966	110.0	2.11	0.48	0.42	0.13	NA	0.70	1.47	1.85	0.71	1.26	0.69	0.021

Abbreviations to Table 1.2:

Wt = body weight; St L = standard body length (SBL); Pc Fl L = pectoral flipper length; Pv Fl L = pelvic flipper length; N-Eye L = nose to eye length; N-Ear L = nose to ear length; N-Fl L = nose to insertion of pectoral flipper length; N-Gen L = nose to genital aperture length; N-Anus L = nose to anus length; Gt Eye = girth at eye; Gt Ax = girth at axilla; Gt Pv = girth at pelvis; Blub S = blubber depth at sternum.

TABLE 1.3. STOMACH MORPHOMETRICS AND CONTENTS FOR PINNIPEDS, 1997/98.

CODE	PATHOLOGY NO.	FULL WT (kg)	EMPTY WT (kg)	CONTENTS WT (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES
New Zealand sea lion—Females						
SB97-04Ph	27992	1.22	0.92	0.30	*Trachurus* sp., otoliths, bones, flesh	-
SB97-10Ph	28006	1.89	1.25	0.64	-	-
SB97-27Ph	28041	3.90	1.00	2.90	-	Small squid pieces. Beaks.
SB97-28Ph	28051	1.29	0.50	0.79	Digested fragments and fluid.	-
SB97-30Ph	28055	1.20	0.94	0.26	Otoliths, fluid	-
SB97-36Ph	28106	2.13	0.76	1.37	1 *Trachurus murphyi*	1 Spider crab
SB97-39Ph	28137	4.54	1.56	2.99	-	1 squid and digested material
SB97-40Ph	28138	1.84	1.39	0.45	-	-
New Zealand sea lion—Males						
SB97-01Ph	27982	1.58	1.29	0.29	-	-
SB97-02Ph	27984	1.24	1.05	0.19	Fish (83 g, 179 mm)	-
SB97-03Ph	27983	2.70	2.30	0.40	-	3 Semi-digested squid
SB97-07Ph	27997	2.75	1.52	1.24	*Trachurus* otoliths	Squid beaks and pieces
SB97-08Ph	28001	4.00	1.42	2.58	Fish (410 g, 140 mm)	2 Squid (490 mm, 550 mm)
SB97-09Ph	28002	1.11	0.92	0.19	-	-
SB97-11Ph	28007	1.61	0.93	0.68	Digested material only	-
SB97-12Ph	28010	3.73	1.33	2.40	-	3 Squid (416g, 450g, 293g)
SB97-13Ph	28013	7.34	1.41	5.93	Fish pieces, Otoliths, fluid	2 Squid fragments, beaks.
SB97-16Ph	28018	4.48	1.73	2.75	Chilean mackerel (560 mm, 1544 g)	2 Arrow squid (380 mm, 220 g)
SB97-18Ph	28023	3.45	1.23	2.22	-	2 Squid (294 g, 470mm; 264 g, 420 mm)
SB97-19Ph	28024	1.47	1.16	0.31	1 Semi-digested fish	Squid beaks
SB97-20Ph	28025	2.42	1.46	0.96	-	2 Squid (420 mm, 440 mm)
SB97-21Ph	28026	1.37	1.24	0.13	-	Arthropod pieces
SB97-22Ph	28027	1.67	1.26	0.41	Few bones only	Beaks only
SB97-25Ph	28039	2.81	0.82	1.99	Fish fragments	Squid fragments
SB97-26Ph	28040	2.53	0.89	1.64	-	-
SB97-34Ph	28098	1.92	0.95	0.97	-	6 squid (92–173 g) 1 octopus
SB97-41Ph	28139	1.80	1.27	0.52	Bones only	-
New Zealand fur seal—Females						
SB97-37Af	28107	0.87	0.73	0.14	-	Squid fragment
SB97-42Af	28145	0.98	0.53	0.45	Digested fragments	Coral fragment 31g
SB97-47Af	28173	0.78	0.57	0.21	Digested fragments	-
SB97-49Af	28179	0.92	0.81	0.10	-	-
SB97-50Af	28180	0.86	0.30	0.57	-	2 squid (146 g, 320 mm; 128 g, 180 mm)
SB97-51Af	28195	1.94	0.60	1.34	-	-
SB97-54Af	28205	0.97	0.44	0.53	-	-
SB97-56Af	28207	3.20	0.48	2.72	Digested fragments	-
SB97-59Af	28234	0.68	0.64	0.04	-	-
SB97-61Af	28242	0.58	0.52	0.06	-	-
SB97-63Af	28265	1.01	0.63	0.38	Few small bones only	-
SB97-65Af	28268	0.88	0.49	0.39	-	-
SB97-77Af	28315	2.30	0.94	1.36	Fish (330 mm, 88 g)	Squid (590 mm, 199 g); 1 fragment
SB97-81Af	28345	1.29	0.77	0.52	Fish (450 g, 450 mm)	-
SB97-83Af	28353	2.06	0.82	1.24	Digested fragments	-
SB97-84Af	28363	1.10	0.72	0.38	Digested fragments	-

TABLE 1.3. *Continued.*

CODE	PATHOL-OGY NO.	FULL WT (kg)	EMPTY WT (kg)	CONTENTS WT (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES
SB97-87Af	28381	3.54	0.57	2.97	Several fragments of ling-like fish	–
SB97-106Af	28669	1.53	0.91	0.62	Digested fragments	–
SB97-107Af	28681	0.95	0.39	0.56	Digested fragments	–
SB97-109Af	28683	0.89	0.46	0.43	Digested fragments	–
SB97-110Af	28684	0.61	0.52	0.10	Digested fragments	–
SB97-112Af	28690	0.97	0.47	0.50	Digested fragments	–
SB97-114Af	28692	1.18	0.75	0.43	Digested fragments	–
SB97-118Af	28698	2.47	0.82	1.65	5 fish (2 Jack mackerel, 1 pink cod, 2 unk)	–
SB97-119Af	28702	0.66	0.58	0.08	–	–
SB97-121Af	28704	2.30	0.63	1.67	Digested fragments	–
SB97-126Af	28709	3.99	0.76	3.24	Digested fragments	–
SB98-32Af	29023	1.97	1.73	0.24	–	3 semi-digested
New Zealand fur seal—Males						
SB97-05Af	27995	2.36	1.11	1.25	Fish (960 g, 450 mm), Several fragments	–
SB97-06Af	27996	2.54	1.27	1.27	–	2 Squid (416 g, 620 mm; 295 g, 550 mm)
SB97-14Af	28014	2.59	1.04	1.55	5 Semi-digested fish	–
SB97-15Af	28017	2.08	1.91	0.17	–	–
SB97-17Af	28022	2.50	1.55	0.95	–	1 squid
SB97-23Af	28028	1.87	1.52	0.35	Hoki bones and otoliths	–
SB97-24Af	28038	3.72	1.55	2.17	4 fish (346 g, 320 mm, 293 g, 300 mm, 413 g, 335 mm, 376 g, 340 mm)	–
SB97-31Af	28075	8.37	1.36	7.01	–	21 squid (400–720 mm; 125–679 g)
SB97-33Af	28097	1.40	1.16	0.24	–	1 squid
SB97-43Af	28152	2.23	1.38	0.86	3 fish	–
SB97-44Af	28153	1.99	1.49	0.50	1 *Trachurus* sp.	–
SB97-45Af	28171	3.21	1.28	1.93	Digested material only	–
SB97-46Af	28172	1.35	1.08	0.27	–	–
SB97-48Af	28174	2.10	0.73	1.37	Digested fragments	1 semi-digested
SB97-52Af	28196	2.30	1.52	0.79	–	2 squid (beaks missing)
SB97-53Af	28204	0.98	0.53	0.45	Digested fragments	–
SB97-55Af	28206	1.36	0.45	0.91	–	1 squid 713 g
SB97-57Af	28227	1.82	0.69	1.13	–	–
SB97-58Af	28228	0.88	0.50	0.39	–	–
SB97-60Af	28235	0.87	0.65	0.21	–	–
SB97-62Af	28243	1.28	1.04	0.24	–	Squid beaks and tissue fragments
SB97-64Af	28266	1.38	1.12	0.26	–	Squid beaks and fragments
SB97-66Af	28269	0.53	0.44	0.09	–	–
SB97-67Af	28270	2.95	0.82	2.13	–	10 squid (360–490 mm, 99–588 g)
SB97-68Af	28292	9.40	1.41	7.99	12 hoki fragments (288 g to 407g)	–
SB97-69Af	28293	1.24	0.96	0.29	–	–
SB97-70Af	28294	1.17	1.09	0.08	–	–
SB97-72Af	28302	0.69	0.64	0.06	Few bones and otoliths only	–
SB97-74Af	28309	1.07	0.85	0.22	Fish flesh, otoliths and liquid only	–
SB97-75Af	28310	1.02	0.86	0.17	Liquid, seal hairs, otoliths.	–
SB97-76Af	28311	0.48	0.48	0.00	–	–
SB97-78Af	28316	3.24	1.32	1.92	Digested fragments	–
SB97-79Af	28317	2.70	1.26	1.44	Digested fragments	–
SB97-80Af	28344	1.73	0.84	0.89	Five small fish fragments	1 squid (612 g, 700 mm)

TABLE 1.3. *Continued.*

CODE	PATHOL-OGY NO.	FULL WT (kg)	EMPTY WT (kg)	CONTENTS WT (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES
SB97-82Af	28346	0.69	0.53	0.17	Digested fragments	–
SB97-86Af	28380	1.62	1.45	0.18	Digested fragments	–
SB97-88Af	28388	0.48	0.46	0.02	–	–
SB97-89Af	28414	1.95	0.64	1.31	Digested fragments	–
SB97-90Af	28415	2.54	1.04	1.49	3 fish (450 mm, 532 g; 305 mm, 192 g; 355 mm, 199 g)	–
SB97-91Af	28471	1.46	1.35	0.11	–	–
SB97-92Af	28472	1.20	1.17	0.03	–	–
SB97-93Af	28473	2.99	1.20	1.80	Digested fragments	–
SB97-94Af	28474	1.06	0.94	0.13	–	–
SB97-97Af	28519	3.54	0.76	2.79	Digested fragments	–
SB97-98Af	28520	1.84	0.63	1.21	Digested fragments	–
SB97-100Af	28584	2.50	1.45	1.04	Digested fragments	–
SB97-101Af	28636	2.52	0.97	1.55	1 Fish (470 mm, 807 g)	16 semi-digested squid
SB97-103Af	28666	0.46	0.27	0.19	–	–
SB97-104Af	28667	0.60	0.31	0.29	–	–
SB97-105Af	28668	0.18	0.18	0.00	–	–
SB97-108Af	28682	0.73	0.47	0.26	–	–
SB97-111Af	28689	3.15	0.82	2.33	Digested fragments	–
SB97-113Af	28691	2.67	0.93	1.74	Bones and tissue fragments	–
SB97-115Af	28695	1.17	0.65	0.52	–	–
SB97-116Af	28696	1.21	0.56	0.65	Digested fragments	–
SB97-117Af	28687	4.60	0.75	3.85	Digested fragments	–
SB97-120Af	28703	2.09	0.46	1.63	Digested fragments	–
SB97-122Af	28705	1.97	0.55	1.42	Digested fragments	–
SB97-123Af	28706	1.68	0.82	0.86	Digested fragments	–
SB97-124Af	28707	1.01	0.29	0.71	4 jack mackerel tails	1 semi-digested
SB97-125Af	28708	0.44	0.39	0.05	Few bones and otoliths only	–
SB98-12Af	28951	1.04	0.86	0.18	Digested fragments	–
SB98-13Af	28957	1.20	0.50	0.70	2 fish fragments	–
SB98-14Af	28958	1.82	1.08	0.74	–	–
SB98-15Af	28959	1.62	1.38	0.24	–	–
SB98-16Af	28960	1.35	1.06	0.29	Digested fragments	–
SB98-17Af	28961	3.53	1.88	1.65	Digested fragments	–
SB98-18Af	28962	2.40	1.95	0.45	–	–
SB98-19Af	28963	2.29	1.06	1.23	Hoki otoliths, Fish fragments	–
SB98-20Af	28964	2.57	0.49	2.08	Part of fish (420 mm, 357 g)	4 squid
SB98-21Af	28965	0.87	0.82	0.05	2 hoki otoliths	–
SB98-23Af	28969	2.15	0.90	1.25	Fish fragments, Hoki otoliths	1 Squid beak
SB98-24Af	29015	1.24	1.17	0.07	–	–
SB98-25Af	29016	1.52	1.06	0.46	–	–
SB98-26Af	29017	0.91	0.83	0.08	–	1 semi digested
SB98-27Af	29018	1.26	0.55	0.72	1 fish (294 g, 390 mm), 1 digested fish	–
SB98-28Af	29019	0.54	0.47	0.07	Bones only	1 squid beak
SB98-29Af	29020	1.54	0.57	0.97	3 fish (292 g, 380 mm; 259 g, 370 mm; 235 g, 370 mm)	–
SB98-30Af	29021	0.49	0.46	0.03	–	–
SB98-31Af	29022	1.57	0.86	0.70	1 fish (250 g, 400 mm)	–
SB98-33Af	29024	0.92	0.73	0.19	Fluid, flesh fragments, otoliths	–
SB98-34Af	29025	7.50	1.30	6.20	16 hoki (partly digested)	–
SB98-35Af	29026	1.09	1.05	0.04	–	–
SB98-22Hl	28966	3.15	1.21	1.94	–	–

TABLE 1.4. AGE ESTIMATION FOR PINNIPEDS, 1997/98.

CODE	PATHOLOGY NO.	CANINE TEETH* L (mm)	D (mm)	W (mm)	GLG†	ROOT RIDGES	TAG NO.	ACTUAL AGE
New Zealand sea lion—Females								
SB97-04Ph	27992	43	8	6	3.0	4.0		
SB97-10Ph	28006	49	8	6	6.0	5.0		
SB97-27Ph	28041	40	10	7	3.0	-		
SB97-28Ph	28051	32	7	5	3.0	-		
SB97-30Ph	28055	46	8	5	7.0	7.0	3488	5
SB97-36Ph	28106	32	8	5	4.0	3.0		
SB97-39Ph	28137	43	9	7	8.0	5.0		
SB97-40Ph	28138	43	9	5	5.0	7.0		
New Zealand sea lion—Males								
SB97-01Ph	27982	56	12	12	4.5	4.0		
SB97-02Ph	27984	57	17	6	3.0	4.0		
SB97-03Ph	27983	73	17	22	10.5	11.5		
SB97-07Ph	27997	65	21	13	4.5	7.0	3705	5
SB97-08Ph	28001	69	23	13	6.0	6.0		
SB97-09Ph	28002	50	15	12	2.0	4.0		
SB97-11Ph	28007	53	20	12	3.5	4.0		
SB97-12Ph	28010	57	21	13	5.5	6.5		
SB97-13Ph	28013	66	22	15	6.5	5.5		
SB97-16Ph	28018	69	21	12	7.0	8.0		
SB97-18Ph	28023	55	20	12	5.5	4.5	4201	4
SB97-19Ph	28024	65	17	-	-	6.0		
SB97-20Ph	28025	61	18	11	5.0	6.0	3700	5
SB97-21Ph	28026	55	18	11	-	5.0		
SB97-22Ph	28027	56	18	12	5.0	5.0		
SB97-25Ph	28039	47	13	9	3.0	6.0		
SB97-26Ph	28040	43	17	10	3.0	3.5		
SB97-34Ph	28098	54	11	12	3.0	5.0		
SB97-41Ph	28139	55	20	13	7.5	4.0		
New Zealand fur seals—Females								
SB97-37Af	28107	26	5	3	4.5	-		
SB97-42Af	28145	32	5	3	4.0	6.0		
SB97-47Af	28173	35	5	2	3.0	2.0		
SB97-49Af	28179	33	6	3	7.0	5.0		
SB97-50Af	28180	31	6	3	2.5	2.0		
SB97-51Af	28195	32	5	3	1.5	1.0		
SB97-54Af	28205	33	6	3	2.5	2.5		
SB97-56Af	28207	36	5	2	3.0	4.0		
SB97-59Af	28234	31	6	3	2.0	2.5		
SB97-61Af	28242	36	5	4	2.5	4.0		
SB97-63Af	28265	38	5	4	2.0	4.5		
SB97-65Af	28268	35	6	3	2.5	3.0		
SB97-77Af	28315	44	12	6	4.5	3.5		
SB97-81Af	28345	39	5	3	4.5	2.0		
SB97-83Af	28353	31	5	3	2.5	2.0		
SB97-84Af	28363	34	6	3	2.5	2.0		

* L = length; D = diameter; W = width

† GLG = growth layer group

TABLE 1.4. *Continued.*

CODE	PATHOLOGY NO.	CANINE TEETH* L (mm)	D (mm)	W (mm)	GLGS†	ROOT RIDGES	TAG NO.	ACTUAL AGE
SB97-87Af	28381	33	6	3	3.5	3.0		
SB97-106Af	28669	41	8	5	3.5	4.0		
SB97-107Af	28681	-	-	-	-	-		
SB97-109Af	28683	35	5	2	4.5	2.5		
SB97-110Af	28684	38	5	2	4.5	3.5		
SB97-112Af	28690	33	5	3	-	5.0		
SB97-114Af	28692	35	5	3	2.5	3.0		
SB97-118Af	28698	16	5	2	1.0	1.0		
SB97-119Af	28702	31	6	2	2.0	3.0		
SB97-121Af	28704	32	5	3	3.0	3.0		
SB97-126Af	28709	34	7	5	4.0	3.0		
SB98-32Af	29023	18	4	2	4.5	-		
New Zealand fur seals—Males								
SB97-05Af	27995	53	12	6	13.0	10.0		
SB97-06Af	27996	60	14	7	7.5	12.0		
SB97-14Af	28014	56	13	6	-	12.0		
SB97-15Af	28017	52	13	7	11.0	11.0		
SB97-17Af	28022	49	12	6	8.5	8.0		
SB97-23Af	28028	53	14	8	-	10.0		
SB97-24Af	28038	39	12	7	12.0	7.0		
SB97-31Af	28075	50	12	6	6.0	7.0		
SB97-33Af	28097	55	12	7	-	9.0		
SB97-43Af	28152	55	13	7	6.5	8.0		
SB97-44Af	28153	57	12	7	8.0	11.0		
SB97-45Af	28171	49	13	7	8.0	7.0		
SB97-46Af	28172	53	12	6	9.0	9.0		
SB97-48Af	28174	54	12	6	8.0	8.0		
SB97-52Af	28196	53	12	7	7.0	7.0		
SB97-53Af	28204	45	10	6	7.5	8.0		
SB97-55Af	28206	48	12	6	4.5	4.0		
SB97-57Af	28227	46	12	6	-	7.0		
SB97-58Af	28228	45	6	6	9.5	6.0		
SB97-60Af	28235	48	7	12	8.0	-		
SB97-62Af	28243	51	15	5	10.5	9.0		
SB97-64Af	28266	53	13	5	9.5	7.0		
SB97-66Af	28269	48	13	6	6.0	6.0		
SB97-67Af	28270	51	12	6	6.0	6.0		
SB97-68Af	28292	48	12	6	9.5	8.0		
SB97-69Af	28293	45	10	5	-	7.5		
SB97-70Af	28294	46	11	6	6.0	6.0		
SB97-72Af	28302	-	-	-	6.5	-		
SB97-74Af	28309	42	13	8	7.0	7.0		
SB97-75Af	28310	51	12	7	7.0	8.0		
SB97-76Af	28311	45	13	6	4.5	5.5		
SB97-78Af	28316	46	14	7	11.5	11.0		
SB97-79Af	28317	50	11	6	10.0	11.0		
SB97-80Af	28344	48	11	6	8.5	8.0		
SB97-82Af	28346	44	12	6	3.5	4.5		
SB97-86Af	28380	49	14	7	5.0	7.0		

TABLE 1.4. *Continued.*

CODE	PATHOLOGY NO.	CANINE TEETH* L (mm)	D (mm)	W (mm)	GLGS†	ROOT RIDGES	TAG NO.	ACTUAL AGE
SB97-88Af	28388	48	12	5	6.5	8.5		
SB97-89Af	28414	45	13	8	7.0	5.0		
SB97-90Af	28415	52	10	5	10.0	8.5		
SB97-91Af	28471	52	13	7	8.0	10.5		
SB97-92Af	28472	51	11	5	5.5	8.0		
SB97-93Af	28473	52	11	6	8.0	8.0		
SB97-94Af	28474	48	11	6	9.5	9.0		
SB97-97Af	28519	–	–	–	–	–		
SB97-98Af	28520	46	10	7	7.0	5.0		
SB97-100Af	28583	50	14	7	11.0	9.5		
SB97-101Af	28636	56	15	6	9.0	10.0		
SB97-103Af	28666	39	9	6	4.0	3.5		
SB97-104Af	28667	40	10	5	4.0	4.0		
SB97-105Af	28668	35	10	6	3.0	2.0		
SB97-108Af	28682	42	11	11	4.5	4.5		
SB97-111Af	28689	50	13	12	7.0	7.0		
SB97-113Af	28691	53	13	7	9.0	–		
SB97-115Af	28695	42	11	6	7.0	7.0		
SB97-116Af	28696	49	8	13	5.0	–		
SB97-117Af	28687	48	13	8	9.0	9.0		
SB97-120Af	28703	45	11	4	8.0	8.0		
SB97-122Af	28705	58	15	7	11.0	12.0		
SB97-123Af	28706	55	12	5	9.0	10.0		
SB97-124Af	28707	46	12	11	4.5	4.0		
SB97-125Af	28708	44	11	5	5.0	4.0		
SB98-12Af	28951	50	14	8	11.0	8.0		
SB98-13Af	28957	–	–	–	–	–		
SB98-14Af	28958	51	14	7	9.0	12.0		
SB98-15Af	28959	59	14	8	–	13.0		
SB98-16Af	28960	59	13	7	9.5	14.0		
SB98-17Af	28961	59	14	6	10.5	13.0		
SB98-18Af	28962	59	9	16	9.0	–		
SB98-19Af	28963	57	16	8	9.5	11.0		
SB98-20Af	28964	49	13	7	6.5	6.0		
SB98-21Af	28965	56	13	7	13.0	13.0		
SB98-23Af	28969	53	14	8	10.0	10.0		
SB98-24Af	29015	58	14	8	11.0	11.0		
SB98-25Af	29016	50	13	6	10.5	10.0		
SB98-26Af	29017	53	14	7	7.5	8.0		
SB98-27Af	29018	46	12	6	6.5	7.0		
SB98-28Af	29019	42	9	5	6.0	6.0		
SB98-29Af	29020	46	11	6	7.0	7.0		
SB98-30Af	29021	44	10	11	–	6.0	148-20 green	
SB98-31Af	29022	50	12	11	6.0	8.0		
SB98-33Af	29024	48	11	5	–	9.0		
SB98-34Af	29025	55	15	6	11.0	11.0		
SB98-35Af	29026	–	–	–	–	–		

* L = length; D = diameter; W = width

† GLG = growth layer group

TABLE 1.5. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS OF PINNIPEDS, 1997/98.

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*	SEXUAL MATUR-ITY†	UTERUS PREG-NANT	MILK	FOETUS WT (g)	FOETUS L (mm)	FOETUS SEX
New Zealand sea lion															
SB97-04Ph	27992	31.0	48 × 41 × 27	-	1	25.0	39 × 39 × 35	-	-	MA	N	N	-	-	-
SB97-10Ph	28006	31.0	47 × 36 × 42	1	-	34.0	50 × 41 × 41	-	-	MA	N	N	-	-	-
SB97-27Ph	28041	20.0	40 × 38 × 30	-	1	16.0	39 × 32 × 27	-	-	MA	N	N	-	-	-
SB97-28Ph	28051	5.3	23 × 15 × 12	-	-	4.7	22 × 18 × 14	-	-	IM	N	N	-	-	-
SB97-30Ph	28055	25.0	38 × 32 × 39	1	-	26.0	39 × 35 × 37	-	1	ML	N	Y	-	-	-
SB97-36Ph	28106	17.0	30 × 28 × 30	-	-	17.0	39 × 29 × 27	-	1	MA	N	N	-	-	-
SB97-39Ph	28137	37.0	40 × 35 × 37	-	1	37.0	39 × 47 × 37	-	-	MA	N	N	-	-	-
SB97-40Ph	28138	37.0	40 × 35 × 37	-	-	37.0	39 × 47 × 37	-	1	MA	N	N	-	-	-
New Zealand fur seal															
SB97-37Af	28107	2.0	22 × 18 × 12	-	-	3.0	21 × 14 × 10	-	-	MA	N	N	-	-	-
SB97-42Af	28145	2.0	15 × 13 × 13	-	-	2.0	17 × 15 × 12	-	-	IM/MA	N	N	-	-	-
SB97-47Af	28173	2.0	16 × 13 × 12	-	-	3.0	21 × 18 × 14	-	1	MG	Y	N	7	50	-
SB97-49Af	28179	2.0	18 × 16 × 12	-	-	2.0	20 × 16 × 12	-	1	MA	N	N	-	-	-
SB97-50Af	28180	0.8	14 × 10 × 9	-	-	0.7	12 × 12 × 9	-	-	IM	N	N	-	-	-
SB97-51Af	28195	3.0	21 × 18 × 13	-	-	6.0	29 × 25 × 20	-	1	MG	Y	N	151	164	-
SB97-54Af	28205	2.0	18 × 18 × 15	-	1	3.0	20 × 16 × 12	-	-	ML	N	Y	-	-	-
SB97-56Af	28207	6.0	25 × 21 × 19	-	1	3.0	19 × 14 × 19	-	-	MLG	Y	Y	129	148	-
SB97-59Af	28234	4.0	23 × 19 × 18	-	1	2.7	19 × 15 × 15	-	-	ML	N	Y	-	-	-
SB97-61Af	28242	3.0	11 × 17 × 13	-	-	6.0	26 × 20 × 20	-	1	MLG	Y	Y	73	125	-
SB97-63Af	28265	3.9	20 × 18 × 16	-	-	3.5	21 × 17 × 17	-	-	MA	N	N	-	-	-
SB97-65Af	28268	4.0	22 × 18 × 15	-	1	3.0	17 × 15 × 13	1	-	MLG	Y	Y	77	127	-
SB97-77Af	28315	4.0	19 × 20 × 14	-	-	10.0	28 × 23 × 20	-	1	MLG	Y	Y	467	215	-
SB97-81Af	28345	1.9	16 × 16 × 12	1	-	4.1	23 × 19 × 16	-	1	MA	N	N	-	-	-
SB97-83Af	28353	3.4	22 × 21 × 15	-	1	2.8	17 × 19 × 19	-	-	MG	Y	N	770	-	M
SB97-84Af	28363	4.1	22 × 14 × 20	-	1	2.9	21 × 12 × 16	-	-	MG	Y	N	407	202	M
SB97-87Af	28381	3.0	17 × 15 × 17	-	-	7.0	28 × 22 × 28	-	1	MLG	Y	Y	265	195	F
SB97-106Af	28669	2.4	15 × 13 × 10	-	-	8.7	27 × 23 × 17	-	1 (degenerate)	MG	Y	N	965	300	F
SB97-107Af	28681	0.9	9 × 8 × 7	-	-	1.0	9 × 9 × 8	-	-	IM	N	N	-	-	-
SB97-109Af	28683	7.2	22 × 21 × 15	-	1	2.8	15 × 13 × 14	-	-	MLG	Y	Y	492	215	F
SB97-110Af	28684	4.6	13 × 12 × 7	-	1	2.2	11 × 10 × 5	-	-	MLG	Y	Y	99	140	F
SB97-112Af	28690	1.4	16 × 11 × 9	-	-	3.3	19 × 14 × 13	-	1	MG	Y	N	689	295	F
SB97-114Af	28692	1.3	28 × 20 × 18	-	-	1.5	21 × 15 × 13	1	-	MLG	Y	Y	411	240	F
SB97-118Af	28698	3.7	21 × 14 × 12	-	-	8.2	27 × 23 × 14	-	1 (degenerate)	MLG	Y	Y	1243	380	M
SB97-119Af	28702	1.7	15 × 12 × 18	-	-	1.6	11 × 12 × 9	-	-	IM	N	N	-	-	-
SB97-121Af	28704	2.5	16 × 14 × 7	-	-	7.0	27 × 19 × 16	-	1	MLG	Y	Y	1520	400	M
SB97-126Af	28709	2.6	18 × 13 × 11	-	-	7.1	26 × 20 × 18	-	1 (degenerate)	MLG	Y	Y	1277	350	F
SB98-32Af	29023	3.5	21 × 17 × 11	-	-	3.3	22 × 16 × 9	-	-	MA	N	N	-	-	-

* CA = Corpus albicens; CL = Corpus lutem.

† IM = Immature; MA = Mature anoestrus; ML = Mature lactating; MG = Mature gravid; MLG = Mature lactating gravid.

TABLE 1.6. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS OF PINNIPEDS, 1997/98.

CODE	PATHOLOGY NO.	RIGHT TESTIS WT (g)	RIGHT TESTIS L × D (mm)	LEFT TESTIS WT (g)	LEFT TESTIS L × D (mm)	TESTIS* MATURITY
New Zealand sea lion						
SB97-01Ph	27982	59	64 × 19	57	62 × 19	MI
SB97-02Ph	27984	40	62 × 17	29	66 × 18	MI
SB97-03Ph	27983	62	115 × 34	58	109 × 35	MI
SB97-07Ph	27997	39	64 × 21	48	62 × 19	MI
SB97-08Ph	28001	51	92 × 22	57	95 × 23	MA
SB97-09Ph	28002	20	70 × 17	27	74 × 16	MI
SB97-11Ph	28007	30	64 × 21	37	67 × 21	MI
SB97-12Ph	28010	29	67 × 22	28	66 × 22	MA
SB97-13Ph	28013	48	88 × 23	36	80 × 20	MA
SB97-16Ph	28018	57	84 × 27	52	80 × 26	MA
SB97-18Ph	28023	35	78 × 17	37	83 × 19	MA
SB97-19Ph	28024	33	76 × 21	35	77 × 21	MI
SB97-20Ph	28025	38	79 × 22	36	74 × 23	MI
SB97-21Ph	28026	37	75 × 20	32	74 × 19	MA
SB97-22Ph	28027	32	62 × 22	41	65 × 23	MA
SB97-25Ph	28039	16	93 × 15	16	90 × 15	MI
SB97-26Ph	28040	14	80 × 12	12	70 × 12	MI
SB97-34Ph	28098	25	90 × 17	25	84 × 18	MI
SB97-41Ph	28139	27	95 × 18	30	89 × 18	MI
New Zealand fur seal						
SB97-05Af	27995	12	53 × 18	11	49 × 18	MI
SB97-06Af	27996	12	67 × 17	14	69 × 17	MI
SB97-14Af	28014	15	49 × 16	16	52 × 16	MA
SB97-15Af	28017	16	43 × 16	16	42 × 15	MA
SB97-17Af	28022	15	51 × 15	14	51 × 16	MA
SB97-23Af	28028	16	40 × 15	16	41 × 16	MI
SB97-24Af	28038	12	49 × 13	14	49 × 15	MI
SB97-31Af	28075	17	52 × 17	18	51 × 19	MI
SB97-33Af	28097	14	42 × 15	13	41 × 15	MA
SB97-43Af	28152	9	62 × 16	9	61 × 14	MI
SB97-44Af	28153	10	58 × 16	13	62 × 14	MI
SB97-45Af	28171	15	56 × 22	16	57 × 19	MA
SB97-46Af	28172	12	44 × 18	16	51 × 16	MI
SB97-48Af	28174	13	42 × 12	13	45 × 17	MI
SB97-52Af	28196	14	40 × 15	16	46 × 16	MI
SB97-53Af	28204	9	38 × 13	12	44 × 17	MA
SB97-55Af	28206	10	46 × 15	12	50 × 14	MI
SB97-57Af	28227	9	57 × 13	10	58 × 13	MI
SB97-58Af	28228	10	42 × 13	11	46 × 12	MI
SB97-60Af	28235	12	52 × 14	11	50 × 15	MI
SB97-62Af	28243	8	48 × 17	9	46 × 15	MA
SB97-64Af	28266	14	45 × 15	15	46 × 13	MI
SB97-66Af	28269	4	31 × 14	4	35 × 12	MI
SB97-67Af	28270	12	42 × 14	10	40 × 13	MA
SB97-68Af	28292	17	52 × 15	17	51 × 15	MI
SB97-69Af	28293	13	52 × 16	12	51 × 17	MI
SB97-70Af	28294	11	46 × 17	11	17 × 15	MI
SB97-72Af	28302	9	61 × 16	10	64 × 16	MI
SB97-74Af	28309	11	42 × 16	10	49 × 14	MA
SB97-75Af	28310	9	34 × 10	9	36 × 9	MI
SB97-76Af	28311	9	44 × 11	10	42 × 11	MI
SB97-78Af	28316	9	46 × 13	12	50 × 14	MI

* IM = Immature; MI = Mature inactive; MA = Mature active.

TABLE 1.6. *Continued.*

CODE	PATHOLOGY NO.	RIGHT TESTIS WT (g)	RIGHT TESTIS L × D (mm)	LEFT TESTIS WT (g)	LEFT TESTIS L × D (mm)	TESTIS* MATURITY
SB97-79Af	28317	14	63 × 13	14	58 × 14	MA
SB97-80Af	28344	17	63 × 17	18	66 × 18	MA
SB97-82Af	28346	13	59 × 13	15	62 × 14	MA
SB97-86Af	28380	11	50 × 13	13	50 × 15	MA
SB97-88Af	28388	11	51 × 15	13	57 × 14	MA
SB97-89Af	28414	11	58 × 13	10	55 × 14	MA
SB97-90Af	28415	9	57 × 12	9	58 × 13	MA
SB97-91Af	28471	18	82 × 20	16	71 × 20	MA
SB97-92Af	28472	17	76 × 16	15	65 × 16	MA
SB97-93Af	28473	17	72 × 18	16	70 × 17	MA
SB97-94Af	28474	19	71 × 20	18	74 × 18	MA
SB97-97Af	28519	15	65 × 15	16	65 × 15	MA
SB97-98Af	28520	10	61 × 14	10	66 × 15	MA
SB97-100Af	28584	22	69 × 19	24	71 × 20	MA
SB97-101Af	28636	10	53 × 13	12	58 × 13	MA
SB97-103Af	28666	7	43 × 9	7	40 × 11	IM
SB97-104Af	28667	7	40 × 9	7	39 × 9	IM
SB97-105Af	28668	2	43 × 5	2	32 × 3	IM
SB97-108Af	28682	7	52 × 8	7	50 × 7	IM
SB97-111Af	28689	13	53 × 14	13	60 × 11	MA
SB97-113Af	28691	15	65 × 19	15	64 × 15	MA
SB97-115Af	28695	9	60 × 13	9	62 × 14	MA
SB97-116Af	28696	8	61 × 15	7	58 × 13	MA
SB97-117Af	28687	13	51 × 16	12	54 × 16	MA
SB97-120Af	28703	10	51 × 12	13	56 × 13	MI
SB97-122Af	28705	10	62 × 14	10	63 × 15	MI
SB97-123Af	28706	14	73 × 16	14	66 × 14	MA
SB97-124Af	28707	9	48 × 12	9	49 × 13	MI
SB97-125Af	28708	8	48 × 13	8	41 × 14	MI
SB98-12Af	28951	14	65 × 17	14	59 × 18	MA
SB98-13Af	28957	17	74 × 17	17	72 × 15	MA
SB98-14Af	28958	17	63 × 14	17	70 × 15	MA
SB98-15Af	28959	18	81 × 17	18	77 × 12	MA
SB98-16Af	28960	15	67 × 18	14	53 × 17	MA
SB98-17Af	28961	15	65 × 19	15	64 × 15	MI
SB98-18Af	28962	13	56 × 24	13	42 × 21	MA
SB98-19Af	28963	6	32 × 13	7	36 × 15	MA
SB98-20Af	28964	9	47 × 13	11	43 × 14	MA
SB98-21Af	28965	14	66 × 15	14	61 × 15	MI
SB98-23Af	28969	15	52 × 18	15	51 × 16	MA
SB98-24Af	29015	16	52 × 16	16	54 × 17	MA
SB98-25Af	29016	14	56 × 16	15	57 × 17	MI
SB98-26Af	29017	11	51 × 14	11	54 × 14	MA
SB98-27Af	29018	11	51 × 14	11	54 × 13	MA
SB98-28Af	29019	15	80 × 16	13	84 × 15	MI
SB98-29Af	29020	14	60 × 16	17	62 × 17	MA
SB98-30Af	29021	9	53 × 13	11	62 × 13	MA
SB98-31Af	29022	15	56 × 15	13	58 × 20	MA
SB98-33Af	29024	11	40 × 15	11	40 × 15	MA
SB98-34Af	29025	14	50 × 16	16	55 × 22	MA
SB98-35Af	29026	15	51 × 18	15	49 × 17	MA
Leopard seal						
SB98-22Hl	28966	9	78 × 12	10	66 × 12	IM

* IM = Immature; MI = Mature inactive; MA = Mature active.

Appendix 2

SEA LION DATA SHEET

Specimen # SB00-__________
Pathology # _______________
Date of Capture: _____________ Necropsy Date: ____________
Sex: ________ Age: Juv., SubAd., Ad.

Weight: _____kg Std.Length: _____m Girth: _____m Blubber: ____mm

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, gall bladder, pancreas, peritoneum, lymph nodes).

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

Cardiovascular (Heart, pericardium, great vessels)

1

Cardiovascular (Heart, pericardium, great vessels)

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

Lymphatic (thymus, spleen, lymph nodes)

Endocrine (thyroids, 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 × diameter (mm).
Left.
Right.

Baculum length (mm)

2

STOMACH

Weight with contents:______kg
Weight empty: ___________kg
Contents: ______________kg
Composition: fish, squid, other inverts, squid beaks, otoliths, rocks.

Parasites collected: Yes / No
Ulcers: Number ________ Size range: ______________
Other lesions: ____________________________________

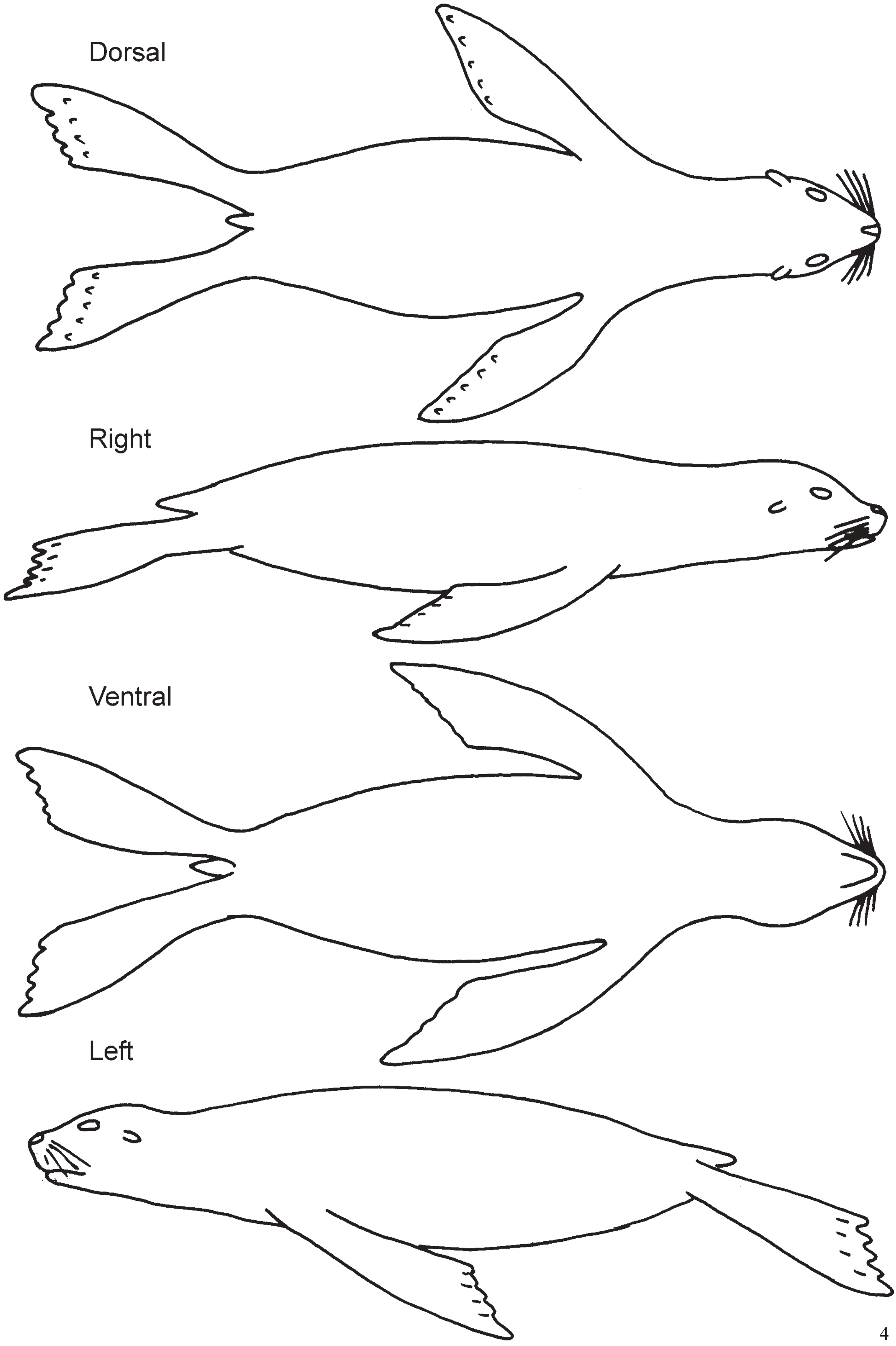
SAMPLE CHECKLIST

Discipline	Tissue	Storage	Check
Serology	Blood	–80 freezer	
Genetics	Skin	Freezer	
Histopathology	Lung, Heart, Liver, Spleen,Thyroid, Trachea, Kidney, Diaphragm, Adrenals, CNS, Any lesion, Gonads, Mammary gland, foetus.	Formalin	
Growth study	Baculum	In "all samples bag"	
Toxicology/Diet	Blubber	Freezer (300 g, whirlpack)	
Age determination	Jaw	Label - bucket	
Museum	Skull	Big freezer	
Parasitology	Intestine/stomach/lung	To Barb	
Bacteriology	Lesion	pottle	

DIAGNOSIS

Examiner(s): (Please sign)

3



4

Note: No CSL autopsy contract was let during 1998/99 because of the New Zealand sea lion mortality event in January–February of 1998 (see Baker 1999). 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 28 New Zealand sea lions (*Phocarctos hookeri*) and 6 New Zealand fur seals (*Arctocephalus forsteri*) killed incidentally in fishing operations. The sea lions were caught in the vicinity of the Auckland Islands and Snares Islands shelves; and the fur seals off Banks Peninsula and the Snares Islands shelf. The stomach contents of both sea lions and fur seals contained mixed vertebrate and invertebrate prey items, with squid and teleost fish present in the stomachs of both pinniped species. An estimate of age was determined based on growth layer groups (GLGs) in the dentine and cementum of the lower left first post-canine tooth. Where the actual age of the animals were known (n = 1) the estimated age was the same as the actual age. Male and female reproductive tracts were examined to determine reproductive status. Female sea lions older than 4 years appear to have undergone oestrus. Of the 14 female sea lions examined, 11 were actively lactating, but 3 were not, suggesting that they were not pregnant last season or had lost last season's pup. Further research is required to elucidate the reproductive physiology of this species. Male sea lions and fur seals were sexually mature from 4 years, while a 4–5-year-old male fur seal was still pubescent. All sea lions and fur seals were known to have been entangled in nets, and all had lesions consistent with death from asphyxiation. There were no pathological findings that would suggest an alternate cause of death.

Keywords: seals, sea lions, autopsy, stomach contents, estimated age, reproduction, Auckland Islands, Snares Island, New Zealand

Gibbs, N.J.; Duignan, P.J.; Jones, G.W. 2003. Part 2: Autopsy report for 1999/2000. Pp. 41–60 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. Autopsy of pinnipeds incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 118*. Department of Conservation, Wellington. 106 p.

1. Introduction

The primary objective of this study was to fulfil the requirements of contract 99/3026 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 28 New Zealand sea lions (*Phocarctos hookeri*), and 6 New Zealand fur seals (*Arctocephalus forsteri)*.

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: Autopsy Report for 1997/98.

The introduction to Part 1 (see above) contains general information on the New Zealand sea lion and fur seal.

2. Materials and methods

2.1 MATERIALS

The carcasses of the New Zealand sea lions and fur seals had all been caught in commercial fishing operations and were delivered to Massey University in batches of between 3 and 5 animals. The carcasses were frozen and wrapped in thick plastic bags and woven nylon sacks. Most were identified by Conservation Services Levy (CSL) observer data sheets attached to the pectoral flipper with an orange plastic CSL tag, but two sea lions were missing documentation and four sea lions did not have CSL tags. On receipt, the seals were unwrapped, and stored frozen at –20°C until necropsy.

2.2 METHODS

See Part 1: Autopsy report for 1997/1998 (above) for details.

2.2.1 Age determination

The animals were aged using a different technique to that reported in Part 1. In this study, incremental growth layers (GLGs) in the dentine and cementum of post-canine teeth were used to estimate age.

The post-canine teeth were processed using a method adapted from Stewart et al. (1996). Briefly, the teeth were decalcified in 5% nitric acid for 24 hours, rinsed in distilled water, and trimmed to expose the plane of the section. Decalcification continued for 48–65 hours in a solution of 10 parts formic acid to 90 parts 10% formalin, and followed by rinsing for several hours in water. The teeth were embedded in O.C.T (Tissue-Tek) embedding compound, frozen, and sectioned on a Reichert-Jung Cryocut 1800 cryostat at approximately

–20ºC, to produce 12 µm thick longitudinal sections from the centre of the tooth. Sections were floated on slightly basic water (pH 8.5) for several minutes, mounted on 60% P.V.A coated glass slides and air-dried. The slides were stained for 4–10 minutes in a filtered 0.032% aqueous solution of toluidine blue made with slightly basic water (pH 8.5). They were moistened with xylene and mounted under a glass cover slip using DPX mounting medium. The slides were examined using a compound microscope at 40–100× magnification. Light and dark bands were seen which corresponded to incremental growth layers deposited during the year. Each pair of light and dark bands was interpreted as equivalent to one year's growth (Perrin & Myrick 1980). Two observers read the teeth and did not know the actual age of any tagged animals.

3. Results

3.1 CATCH DATA AND OBSERVERS REPORTS

A total of 28 New Zealand sea lion carcasses were received consisting of 14 females and 14 males. There were six fur seals including one female and five males. The observer data are recorded with the catch date, time and coordinates (Appendix 1, Table 2.1). The majority of the sea lions (n = 18) were captured to the north of the Auckland Islands, while the remaining animals were caught further south and to the east of the Islands (Fig. 2.1).

The fur seals were captured off Banks Peninsula (n = 2) and the Snares Islands, shelf (Fig. 2.2).

3.2 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table 2.2).

3.3 STOMACH CONTENTS

The stomach weight and the weight of the contents were recorded for each animal (Appendix 1, Table 2.3). Squid, probably the arrow squid (*Nototodarus sloanii*), and teleost fish were present in the stomachs of both sea lions and fur seals, but fish predominated in the fur seal stomachs. Most of the teleost fish were not sufficiently intact for gross identification to species level. However, otoliths and squid beaks have been stored in 70% alcohol for more detailed analysis of diet at or immediately before the time of death. One seal lion and one fur seal had no identifiable remains in the stomach. Blubber samples are also in storage for analysis of fatty acid signatures. Less predominant items included stones, which were found in the stomachs of two sea lions and comprised 8% and 43% of the total contents weight. The remains of a seal was found in the stomach of one male sea lion.

Figure 2.1. Capture locations for New Zealand sea lions, 1999/2000.

Figure 2.2. Capture locations for New Zealand fur seals, 1999/2000.

3.4 AGE DETERMINATION

The animals were aged using incremental growth layers in the dentine and cementum of post-canine teeth (Appendix 1, Table 2.4). Two readers with prior experience in this technique examined each tooth. The tagging information was not available to the readers. The actual age, assuming the animal was tagged as a pup, is also presented in the table for one sea lion (SB00-21Ph). For this animal, the estimated age appeared to agree with the actual age. The other two sea lions were tagged as adults and therefore their tag number cannot determine their age. Too few animals were tagged for statistical analysis.

The female sea lions (n = 14) had a mean age of approximately 9.4 years based respectively on dentinal layers (7.6 years) and cementum layers (11.2 years). The age range was from 4 to 12 years. For males (n = 14) the age range was from 4 to 15 years and the mean age was approximately 8.4 years (7.9 years based on dentinal, and 8.9 years based on cementum).

The female fur seal was aged at 6.5 years (6 years based on dentine, and 7 years based on cementum). The males spanned a greater range from 4 to 10 years with a mean of approximately 6.8 years (6.4 years based on dentine, and 7.2 years based on cementum).

3.5 REPRODUCTIVE STATUS

Females

Based on the presence of a CA or CL in serial ovarian sections, all female sea lions were classed as mature (Appendix 1, Table 2.5). Eleven of 14 (79%) females were lactating, thus had given birth in the summer they were caught, and of these, all had a CL in one ovary and sparse, inactive endometrial glands. This would suggest that implantation had not yet occurred. Of three females with inactive mammary glands, all had a CL in one ovary. This suggests that they did not have a pup this season and that implantation had not yet occurred. All females were caught in February, March or April, which would be early in pregnancy assuming that they had been mated in December. Freezing of the carcasses precludes the identification of blastocysts in the oviducts or early implantation embryos in the endometrium.

An active CL was present in one ovary of the female fur seal and the uterine endometrial glands were convoluted and actively secreting. The mammary gland was also active (Appendix 1, Table 2.5). These findings suggest she had given birth to a pup this season and was suckling a pup at the time of death. Implantation had not yet occurred, and there was no detectable embryo, as would be expected as she was caught in March which would be pre-implantation.

Males

Based on examination of the testes, all of the sea lions had histological features consistent with maturity (Appendix 1, Table 2.6). Five (36%) were actively producing spermatozoa, but at a low level, while the gonads of the remaining animals were inactive. All the males were caught between February and March, thus the histological appearance of the testis is consistent with a regression of spermatogenesis outside the breeding season.

Of the five male fur seals, one had pubescent gonads, three were classed as mature inactive and the remaining animal was classed as mature active although with decreased spermatogenesis (Appendix 1, Table 2.6). As these animals were also caught in February and March, the histology is consistent with decreased spermatogenesis outside the breeding season.

3.6 PATHOLOGY

Pathological findings were covered by the terms of the contract for the first time this year, therefore, data on entanglement-related pathology and incidental findings is included in this report (Appendix 1, Table 2.7). It should be noted that freezing compromises 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). This can include superficial skin lesions encircling the rostrum, head or any extremity, cleanly cut pieces from extremities; or deep puncture wounds. However, in pinnipeds these changes are probably masked to a large extent by the dense pelage and tough epidermis of fur seals and sea lions. 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, ecchymotic hemorrhages 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 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. In all cases, all organ systems should be examined by a pathologist competent in the diagnosis of disease in pinnipeds to rule out all possibilities.

All of the 28 New Zealand sea lions and 6 New Zealand fur seals entangled in commercial nets had moderate/severe pulmonary oedema, congestion and emphysema (Appendix 1, Table 2.7). Most sea lions (n = 27, 96%) and fur seals (n = 5, 83%) had myocardial hypercontraction, fibre fragmentation or fibre vacuolation. Twenty three (82%) sea lions and three (50%) fur seals also had trauma indicative or suggestive of entanglement. In all animals examined there were no other apparent pathological changes that could have caused death. These data support the conclusion that asphyxiation or drowning was the primary cause of death in all the New Zealand sea lions and fur seals necropsied.

Many of the sea lions and fur seals had incidental pathologies including gastrointestinal ulcers, genital vesicles and ulcers (n = 5Ph), cystic changes in the thyroid (n = 8Ph, 1Af) and adrenal (n = 1Ph) glands, urinary bladder plaques (n = 1Ph), lung worms (n = 4Ph), mastitis (n = 2Ph), and external puncture wounds (n = 3Ph). Some animals also had wounds from previous trauma such as diaphragmatic hernia (n = 1), scarred spleen (n = 4), and bone fractures (n = 1).

3.6.1 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 nematode, e.g. *Anisakis* sp., *Contracaecum osculatum*, *Pholeter gastrophilus* and *Phocanema decipiens*. A typical ulcer associated with the attachment of parasites may be small and focal or extensive and coalescing. Usually the anterior ends of one or more immature worms are buried in the bed of the ulcer. 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 of marine mammals (Geraci & St Aubin 1987). Non-parasitic ulceration can be attributed to histamine toxicosis where high concentrations of histamine as part of a herring diet may cause excessive gastric acid secretion. The latter is only documented for captive cetaceans. Alternatively, starvation, stress or trauma may possibly result in gastric ulceration.

In this study, all 28 sea lions and 6 fur seals had parasites present in the stomach. Twenty three (82%) sea lions and four (67%) fur seals also had mild ulceration of the stomach mucosa. This indicates that parasitic infection is a contributing factor to stomach ulceration in these animals. However, the ulcers were all very superficial and this along with the absence of perforation of the stomach wall suggests the ulceration was not a contributing cause of death.

3.6.2 Genital vesicles and ulcers

Four female sea lions and one male sea lion were observed to have genital vesicles or ulcers. In the females, the lesions were seen as small scars or fresh vesicles on the skin around the genital opening, while in the male sea lion it was seen as two small white cysts (2 × 2 mm) on the ventral and dorsal surface of the penis. The aetiology may be viral infection but further research is required to establish the cause

3.6.3 Thyroid and adrenal cysts

Eight sea lions and one fur seal had cystic changes in their thyroid gland, and one sea lion had similar changes in the left adrenal gland. The right and left thyroid glands were equally affected, with one case (SB00-20Ph) of both glands affected. Endocrine pathology is associated with physiological stress in other species. The significance of these changes for New Zealand sea lions are unknown but indicate that studies on endocrine function are required.

3.6.4 Urinary bladder plaques

One male sea lion (SB00-11Ph) had 9–10 slightly raised coalescing white plaques in the bladder mucosa. The aetiology was not established.

3.6.5 External puncture wounds

Three sea lions had external puncture wounds that were relatively superficial extending only so far as the subcutaneous blubber layer. These wounds are probably caused by bites from other sea lions, particularly as they were around the head and neck regions where sea lions commonly bite.

3.6.6 Trauma

One animal (SB00-28Af) had a hole in the diaphragm approximately 1 × 1 cm. The gastric omentum had projected through the hole into the thoracic cavity and the diaphragm had healed around it. The omentum was attached to the left lateral liver lobe and the spleen was scarred dorsal to the diaphragmatic hernia. These lesions suggest that the fur seal had suffered trauma to the abdominal region, causing a rupture of the diaphragm, liver and spleen that had since healed before entanglement.

One animal (SB00-09Ph) had a cystic structure on the parietal surface of the spleen with irregular omental attachments to both the parietal and visceral surfaces. The spleen also had a shortened longitudinal length. The aetiology is probably scarring of the capsule following an injury that ruptured the spleen at some time in the past. In the remaining three sea lions with scars on their spleen, the scars were small and were probably caused by some trauma to the organ in the past.

A female sea lion (SB00-25Ph) had a broken sternum at the level where the sixth fixed rib fuses to the sternum. The caudal part of the sternum had overlapped the cranial extension by 4–5 cm and fused. The aetiology is probably fracture of the sternum following an injury such as falling from a distance onto rocks or rough treatment by a male sea lion on rocks.

4. Discussion

The pinnipeds 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 attached to the pectoral flipper with a tag. However, there were no observer sheets with two of the sea lions and no CSL tags with four sea lions. The missing details were obtained from R. Blezard (DOC Observer Program). From a health and safety perspective, the packaging was sufficient to prevent contamination of the environment by the seal carcass provided it remained frozen. In terms of animal identification, the orange CSL tags were very effective. It was beneficial having a list of animals being shipped forwarded by e-mail to allow a crosscheck between animals shipped and those received. In that way, any animal that arrived without the observer's report or tag could be traced.

The number of sea lions examined for this contract was similar to that examined in previous contracts (Dickie & Dawson 1997; Part 1 above). The sex ratio for this contract was similar to the first (Dickie & Dawson 1997), but not with the second contract in which there was a strong bias towards males (see Part 1 above). Whether that reflects a skewed sex ratio in the total bycatch or just reflects the selection of animal for examination is unknown. In this study, a similar male bias was present in the sample of fur seals submitted for examination to that examined in a previous contract (see Part 1). However, too few were examined to draw any conclusions.

The stomach contents of sea lions were similar to those examined by Dickie & Dawson (1997) and Part 1. However, the remains of squid and a variety of teleost fish were equally represented in the stomachs of sea lions examined in this contract. In previous studies, the sea lion diet was more biased towards squid (Dickie & Dawson 1997; see Part 1). The difference may relate to the availability of squid during the early part of this 2000 and in this regard, fisheries records may be informative. Although squid were also present in the stomachs of some fur seals, teleost fish predominated. Entire barracouta and mackerel and numerous otoliths featured among the fish items present. However, specific identification of these prey items was beyond the scope of this contract. One sea lion and one fur seal had no identifiable remains in the stomach which might suggest that prey items were regurgitated on capture. This is but one of the biases inherent in the use of stomach contents or faeces as an indicator of diet in pinnipeds (Jobling & Brieby 1986; Bowen & Harrison 1996). Recently, blubber fatty acid signature analysis has been advanced as a more sensitive method of investigating diet among pinnipeds (Iverson 1993; Iverson et al. 1997). This technique is currently under development at Massey University for future studies on foraging ecology of sea lions and fur seals.

Age determination in pinnipeds is based on counting growth layers or annuli in teeth and is commonly used on a variety of species (Laws 1952; Stirling 1969; Anas 1970; Payne 1978; Bengtson & Siniff 1981; Arnbom et al. 1992; Oosthuizen 1997). Although widely used the technique is subject to difficulties in methodology, interpretation, reader variability, variability among teeth, variability between species, and the lack of known age animals (Dapson 1980). For the pinnipeds examined in this study, the number of tagged animals (n = 1) is too low to critically evaluate the ageing technique. In a previous study, of four sea lions examined by Duignan (see Part 1) for which the tagging date was known, there was good agreement between the known age and the estimated age as determined by two readers who did not have the tagging data. In two cases the dentinal GLGs of the lower canine tooth best estimated the true age whereas in the other the root ridges of the same tooth was the best estimate. In this study, for the animal in which tagging date was known, there was agreement on known and estimated age and the post-canine dentinal and cemental GLGs yielded the same estimate.

The principal difference between this study and the two previous contracts is that the age determination method is different. The previous studies used longitudinal sections of canine teeth to determine dentinal GLGs. The same canine teeth were also used by Duignan (see Part 1) to count root ridges. For the current contract it was hoped to estimate by the same methodology and also by sectioning the first left post-canine tooth. The reason for choosing the latter was that it was the tooth of choice for estimating the age of live adult female sea lions by the DOC sea lion population management research team. However, the tight budget precluded using two methods so only the post-canines were processed. This is unfortunate in that for proper statistical analysis, a significant number of teeth should be aged using all three methods.

We reserve judgment on GLGs in post-canines as a method age determination for either New Zealand sea lions or fur seals until further work is done to validate the method. We are concerned that one researcher reported not finding cemental GLGs in New Zealand sea lion post-canine teeth (Dickie 1999), since both cemental and dentinal layers were visible in the sections examined for this study. In a comparative study of age estimation techniques using tooth sections of known age South African fur seals (*Arctocephalus pusillus pusillus*) it was found that the best correlation was between dentine layers in canine teeth and true age. The post-canine teeth of that species lacked dentinal layers and the cemental layers were not highly correlated with true age (Oostuizen 1997). Clearly, further research is required to validate methods used for New Zealand pinnipeds. We would suggest incorporating this into the next bycatch contract.

Among the northern sea lion species, female Steller's sea lion (*Eumetopias jubatus*) and California sea lion (*Zalophus californianus*) reach sexual maturity between 3 and 8 years (Reeves et al. 1992). The Southern sea lion (*Otaria byronia*) reaches maturity at 4 years (Reijnders et al. 1993) and New Zealand sea lions apparently become sexually mature at 3 years old and produce of their first pup at 4 years (Cawthorn et al. 1985). This study supports those observations in that the youngest animal (4–6 years) had histologically mature ovaries and had produced a pup the summer that she had been caught, indicating that she had been 3–5 years old when she last conceived. This is likely to have been her first pregnancy. The remaining females ranged from 5 to 12 years old and had mature ovaries.

Embryonic diapause has not been reported for New Zealand sea lions but is likely to occur as it does so in most other pinnipeds (Gales 1995). The fact that none of the mature females had detectable embryos would support a period of diapause as these animals were likely to have been mated in December and were not caught until February or March. More research is required into the reproductive cycle of New Zealand sea lions.

Mattlin (1978) suggested that New Zealand fur seal females appear to come into oestrus at 4 years and produce a first pup at about 5 years. An age at sexual maturity of 3 to 6 years is consistent with several other fur seal species such as the subantarctic fur seal, *Arctocephalus tropicalis* (Bester 1987), Australian fur seal, *A. pusillus doriferus* (Warneke 1979), and South American fur seal, *A. australis* (Reeves et al. 1992). The present study supports these observations in that the single female New Zealand fur seal autopsied was sexually mature at 6–7 years old.

Cawthorn et al. (1985) reported that male New Zealand sea lions become sexually mature at 5 years old but do not hold territories or breed for another 3–5 years. Similarly Australian sea lions (*Neophoca cinerea*) are thought to achieve sexual maturity at 6 years (Reijnders et al. 1993). The data presented here support these observations in that the youngest male in which active spermatogenesis was approximately 7 years. For New Zealand fur seals, it has been suggested that sexual maturity in males is attained at approximately 7 years but that social maturity is not achieved until approximately 10 years of age (Mattlin 1978). Similar data have been reported for Australian fur seals (Shaughnessy & Warneke 1987), Galapagos fur seals, *Arctocephalus galapagoensis* (Bonner 1981), South American fur seals (Bonner 1981), subantarctic fur seals (Bester 1987), and Antarctic fur seals (Duck 1990). This study supports previous studies in that the youngest male (4–5 years) was pubertal while older males had evidence of testicular maturity.

The pathological findings indicate there is a high probability that entanglement caused the deaths of all the 28 New Zealand sea lions and 6 New Zealand fur seals examined. 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 in the results Section 3.6 and Appendix 1, Table 2.7. Briefly, most 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, fragmentation and vacuolation of myofibres 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 reference list at the end of Part 3 (pp. 96–99).

Appendix 1

TABLES OF RESULTS

TABLE 2.1. CSL OBSERVER CAPTURE DATA FOR PINNIPEDS, 1999/2000.

CODE	PATH-OLOGY NO.	CSL TAG NO.	DATE	TIME (24 h)	LATI-TUDE	LONGI-TUDE	TAG	BRAND	CHIP
New Zealand sea lion—Females									
SB00-05Ph	31066	424	22 Feb 00	2025	50ºS	167ºE			
SB00-06Ph	31065	547	3 Mar 00	1030	50ºS	166ºE	1415	1415	
SB00-07Ph	31071	336	3 Feb 00	0533	50ºS	166ºE			
SB00-14Ph	31101	974	24 Feb 00	2100	50ºS	166ºE			
SB00-21Ph	31165	542	13 Mar 99	0930	50ºS	166ºE	4191		
SB00-22Ph	31167	543	14 Mar 99	1240	49ºS	166ºE			
SB00-23Ph	31166	545	22 Mar 99	1023	50ºS	166ºE			
SB00-24Ph	31154	821	2 Mar 00	2130	50ºS	166ºE			
SB00-25Ph	31155	822	3 Mar 00	1348	50ºS	166ºE			
SB00-31Ph	31177	461	3 Mar 00	0625	50ºS	166ºE			
SB00-32Ph	31182	462	3 Mar 00	0625	50ºS	166ºE			
SB00-33Ph	31178	43	8 Apr 99	0400	50ºS	166ºE			
SB00-36Ph	31290	214	3 Mar 00	1700	50ºS	166ºE			
SB00-37Ph	31291	213	3 Mar 00	0923	50ºS	166ºE	Scars		00-01 F1-3022
New Zealand sea lion—Males									
SB00-08Ph	31072	841	9 Mar 99	2023	50ºS	166ºE			
SB00-09Ph	31075	339	2 Mar 00	1228	50ºS	166ºE			
SB00-10Ph	31076	338	1 Mar 00	1127	50ºS	166ºE			
SB00-11Ph	31077	337	9 Feb 00	1340	50ºS	166ºE			
SB00-13Ph	31100	971	8 Feb 00	1300	50ºS	166ºE			
SB00-15Ph	31102	972	8 Feb 00	2045	50ºS	166ºE			
SB00-16Ph	31108	–	3 Feb 00	0800	48ºS	167ºE			
SB00-17Ph	31111	–	19 Feb 00	1105	50ºS	166ºE			
SB00-18Ph	31112	–	2 Mar 00	0425	50ºS	166ºE			
SB00-19Ph	31115	973	19 Feb 00	0735	50ºS	166ºE			
SB00-20Ph	31116	975	4 Mar 00	0935	50ºS	166ºE			
SB00-29Ph	31168	463	5 Mar 00	1805	50ºS	166ºE			
SB00-34Ph	31183	–	21 Feb 99	2254	50ºS	166ºE			
SB00-35Ph	31289	3	17 Mar 00	0915	48ºS	167ºE			
New Zealand fur seal—Females									
SB00-26Af	31159	824	12 Mar 00	0015	48ºS	166ºE			
New Zealand fur seal—Males									
SB00-03Af	31058	792	20 Feb 99	2140	48ºS	167ºE			
SB00-04Af	31059	763	19 Feb 99	0958	48ºS	166ºE			
SB00-27Af	31156	825	25 Mar 00	0336	43ºS	173ºE			
SB00-28Af	31160	826	25 Mar 00	0336	43ºS	173ºE			
SB00-30Af	31176	741	17 Mar 99	2022	48ºS	167ºE			

TABLE 2.2. MORPHOMETRIC DATA FOR PINNIPEDS, 1999/2000.

CODE	PATHOLOGY NO.	Wt (kg)	St L (m)	Gt Ax (m)	Blub S (m)
New Zealand sea lion—Females					
SB00-05Ph	31066	81.1	1.56	1.45	0.025
SB00-06Ph	31065	91.9	1.56	1.12	0.038
SB00-07Ph	31071	95.0	1.63	1.03	0.031
SB00-14Ph	31101	123.0	1.81	1.17	0.036
SB00-21Ph	31165	85.0	1.65	1.06	0.022
SB00-22Ph	31167	101.0	1.70	1.15	0.030
SB00-23Ph	31166	101.0	1.65	1.15	0.028
SB00-24Ph	31154	89.0	1.48	1.14	0.026
SB00-25Ph	31155	118.0	1.72	1.22	0.032
SB00-31Ph	31177	105.0	1.63	1.17	0.040
SB00-32Ph	31182	89.0	1.62	1.10	0.030
SB00-33Ph	31178	111.0	1.72	1.25	0.028
SB00-36Ph	31290	95.0	1.49	1.18	0.025
SB00-37Ph	31291	122.0	1.73	1.29	0.032
New Zealand sea lion—Males					
SB00-08Ph	31072	154.4	1.86	1.25	0.025
SB00-09Ph	31075	151.2	1.66	1.24	0.036
SB00-10Ph	31076	129.4	1.74	1.20	0.030
SB00-11Ph	31077	139.0	1.78	1.21	0.035
SB00-13Ph	31100	99.0	1.69	1.14	0.035
SB00-15Ph	31102	166.0	2.00	1.35	0.037
SB00-16Ph	31108	124.0	1.76	1.28	0.040
SB00-17Ph	31111	104.0	1.75	1.10	0.030
SB00-18Ph	31112	112.0	1.76	1.18	0.030
SB00-19Ph	31115	125.0	1.75	1.13	0.035
SB00-20Ph	31116	242.0	2.27	1.45	0.028
SB00-29Ph	31168	250.0	2.11	1.52	0.030
SB00-34Ph	31183	160.0	1.91	1.42	0.028
SB00-35Ph	31289	116.0	1.65	1.21	0.025
New Zealand fur seal—Females					
SB00-26Af	31159	39.5	1.28	0.79	0.022
New Zealand fur seal—Males					
SB00-03Af	31058	67.4	1.36	0.99	0.020
SB00-04Af	31059	78.0	1.45	1.07	0.024
SB00-27Af	31156	96.0	1.69	1.14	0.028
SB00-28Af	31160	94.0	1.61	1.08	0.020
SB00-30Af	31176	55.0	1.38	0.87	0.020

Abbreviations to Table 2.2:

Wt = body weight
St L = standard body length (SBL)
Gt Ax = girth at axilla
Blub S = blubber depth at sternum

TABLE 2.3. STOMACH MORPHOMETRICS AND CONTENTS OF PINNIPEDS, 1999/2000.

CODE	PATHOLOGY NO.	FULL WT (kg)	EMPTY WT (kg)	CONTENTS Wt (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES	OTHER	PARASITES (Y/N)	ULCERS
New Zealand sea lion—Females									
SB00-05Ph	31066	1.15	0.74	0.41	Otoliths, Fish bones	Squid beaks	Stones (0.176 kg)	Y	–
SB00-06Ph	31065	3.93	1.09	2.84	Otoliths, Fish bones	Squid parts, beaks	–	Y	2
SB00-07Ph	31071	1.34	1.06	0.28	Otoliths, Fish bones	Squid beaks	–	Y	–
SB00-14Ph	31101	2.57	1.60	0.97	Otoliths, Fish bones	Squid parts, beaks	–	Y	3
SB00-21Ph	31165	1.84	1.08	0.76	Otoliths, Fish bones	squid beak	–	Y	1
SB00-22Ph	31167	2.42	1.27	1.15	Otoliths, Fish bones	squid beaks	–	Y	17
SB00-23Ph	31166	2.62	1.29	1.33	2 whole fish, Otoliths, Fish bones	1 whole squid, beaks	–	Y	–
SB00-24Ph	31154	6.64	0.90	5.74	Otoliths, Fish bones	29 whole squid, 9 mantles	–	Y	–
SB00-25Ph	31155	7.79	1.50	6.29	Otoliths, Fish bones, lenses	7 whole squid, beaks, lenses	–	Y	5
SB00-31Ph	31177	2.25	1.40	0.85	–	2 whole squid	–	Y	4
SB00-32Ph	31182	1.18	0.97	0.21	Otoliths, Fish bones	Squid beaks	–	Y	3
SB00-33Ph	31178	1.77	1.35	0.43	Otoliths	Squid beaks	Stones (0.036 kg)	Y	5
SB00-36Ph	31290	1.60	0.88	0.73	Fish bones, parts	1 whole squid	–	Y	1
SB00-37Ph	31291	3.45	1.62	1.83	Otoliths, Fish bones, lenses	3 whole squid	–	Y	2
New Zealand sea lion—Males									
SB00-08Ph	31072	1.95	1.79	0.16	–	–	–	Y	2
SB00-09Ph	31075	3.41	1.29	2.12	Otoliths, Fish bones	6 whole squid	–	Y	–
SB00-10Ph	31076	7.51	1.52	5.99	Otoliths, Fish bones, lenses	26 whole squid, beaks, lenses	–	Y	3
SB00-11Ph	31077	12.50	1.25	11.25	10 whole fish, Otoliths, bones, lenses	Squid beaks	–	Y	–
SB00-13Ph	31100	2.58	1.20	1.38	Otoliths, Fish bones	Squid beaks	1 Anthropod	Y	5
SB00-15Ph	31102	5.62	2.15	3.48	–	Squid parts, beaks, lenses	Fluid	Y	1
SB00-16Ph	31108	3.07	1.64	1.43	1 whole fish, Otoliths, Fish bones	Squid beaks	Seal skin, fur, nails	Y	5
SB00-17Ph	31111	2.02	1.47	0.55	Otoliths, Fish bones, lenses	–	–	Y	–
SB00-18Ph	31112	1.66	1.39	0.28	Otoliths, Fish bones	Squid beaks	1 Anthropod	Y	6
SB00-19Ph	31115	8.62	1.50	7.12	Otoliths, Fish bones	7 whole squid	–	Y	5
SB00-20Ph	31116	5.91	2.91	3.01	Otoliths, Fish bones	5 whole squid, beaks	–	Y	–
SB00-29Ph	31168	5.00	3.00	2.00	Otoliths, Fish bones	1 whole squid, beaks, lenses	–	Y	20
SB00-34Ph	31183	5.77	1.94	3.83	–	5 whole squid, beaks	–	Y	–
SB00-35Ph	31289	8.14	1.40	6.74	1 barracouta, 2 mackerel, 1 unknown, Otoliths, Fish bones, lenses, parts	Squid beaks	–	Y	1
New Zealand fur seal—Females									
SB00-26Af	31159	1.12	0.85	0.26	–	–	Fluid	Y	–
New Zealand fur seal—Males									
SB00-03Af	31058	1.75	1.18	0.57	–	2 whole squid	–	Y	–
SB00-04Af	31059	8.35	1.17	7.18	Otoliths	30 whole squid	–	Y	12
SB00-27Af	31156	2.95	1.70	1.25	Otoliths, Fish bones	3 whole squid, beaks	–	Y	24
SB00-28Af	31160	7.16	1.44	5.73	2 barracouta, Otoliths, Fish bones, parts	Squid beaks	–	Y	25
SB00-30Af	31176	3.99	0.87	3.13	8 whole fish, Otoliths, Fish bones, parts	1 whole squid, beaks, lenses	–	Y	3

TABLE 2.4. AGE ESTIMATION FOR PINNIPEDS, 1999/2000.

CODE	PATHOLOGY NO.	POST-CANINE TEETH* Wt (g)	L (mm)	D (mm)	W (mm)	DENTINE GLGs†	CEMENTUM GLGs†	TAG NO.	ACTUAL AGE
New Zealand sea lion—Females									
SB00-05Ph	31066	0.69	20	3	5	8	8		
SB00-06Ph	31065	0.67	23	2	2	6	6	1415	-
SB00-07Ph	31071	0.76	20	3	2	7.5	7		
SB00-14Ph	31101	1.04	25	4	4	9–10	9–10		
SB00-21Ph	31165	0.78	24	2	5	6	6	4191	6 (1993)
SB00-22Ph	31167	0.70	19	3	4	6.5	7		
SB00-23Ph	31166	0.78	24	3	3	8	8		
SB00-24Ph	31154	0.75	23	3	3	7	7		
SB00-25Ph	31155	0.81	23	3	2	9	10		
SB00-31Ph	31177	0.81	20	4	4	12	8		
SB00-32Ph	31182	0.66	23	2	3	5	6		
SB00-33Ph	31178	0.91	21	4	4	6	4		
SB00-36Ph	31290	0.69	22	2	4	5	5		
SB00-37Ph	31291	0.80	23	3	5	9–12	11–12	B1189	-
New Zealand sea lion—Males									
SB00-08Ph	31072	0.96	22	3	3	5	5		
SB00-09Ph	31075	1.08	21	4	5	6–7	14–15		
SB00-10Ph	31076	1.08	23	3	5	9	10		
SB00-11Ph	31077	1.14	23	5	5	12	8		
SB00-13Ph	31100	0.96	22	3	4	8	9		
SB00-15Ph	31102	1.12	24	4	5	8	10		
SB00-16Ph	31108	1.14	22	4	5	4	7		
SB00-17Ph	31111	0.90	21	3	5	6.5	7		
SB00-18Ph	31112	0.89	22	3	6	11.5	12		
SB00-19Ph	31115	0.97	20	3	5	9–10	9.5		
SB00-20Ph	31116	0.98	22	4	5	7–8	7–8		
SB00-29Ph	31168	1.70	24	5	6	6	9		
SB00-34Ph	31183	1.11	20	4	5	10–11	8		
SB00-35Ph	31289	1.56	21	3	5	7	8		
New Zealand fur seal—Females									
SB00-26Af	31159	0.29	12	2	3	6	7		
New Zealand fur seal—Males									
SB00-03Af	31058	0.35	11	3	3	7	8		
SB00-04Af	31059	0.36	12	2	2	6	4		
SB00-27Af	31156	0.40	13	3	1	6.5–7	8–9.5		
SB00-28Af	31160	0.33	10	2	2	8–9	10		
SB00-30Af	31176	0.32	13	2	1	4	5		

* Wt = weight; L = length; D = diameter; W = width

† GLG = growth layer group

TABLE 2.5. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS OF PINNIPEDS, 1999/2000.

CODE	PATHOLOGY 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*	UTERUS MATURITY†	UTERUS PREGNANT	MILK PRESENT
New Zealand sea lion												
SB00-05Ph	31066	24	33 × 30 × 30	–	–	15	37 × 36 × 28	–	1	MA	N	N
SB00-06Ph	31065	25	40 × 31 × 27	1	–	24	41 × 31 × 26	–	18 × 14 × 16	ML	N	Y
SB00-07Ph	31071	41	44 × 41 × 36	–	1	41	43 × 41 × 34	–	–	ML	N	Y
SB00-14Ph	31101	41	49 × 43 × 39	–	16 × 24 × 16	44	50 × 41 × 40	1	–	ML	N	Y
SB00-21Ph	31165	29	41 × 33 × 29	–	–	35	47 × 40 × 31	–	19 × 18 × 13	ML	N	Y
SB00-22Ph	31167	25	38 × 33 × 31	–	–	33	43 × 38 × 31	–	16 × 18 × 20	ML	N	Y
SB00-23Ph	31166	26	36 × 39 × 27	–	–	32	40 × 37 × 32	–	18 × 23 × 18	ML	N	Y
SB00-24Ph	31154	24	36 × 36 × 28	–	23 × 19 × 16	19	37 × 35 × 25	1	–	MA	N	N
SB00-25Ph	31155	32	44 × 38 × 32	–	–	28	40 × 38 × 27	–	29 × 29 × 12	ML	N	Y
SB00-31Ph	31177	22	37 × 31 × 30	–	15 × 12 × 15	17	34 × 34 × 25	–	–	ML	N	Y
SB00-32Ph	31182	29	40 × 39 × 35	–	20 × 19 × 17	24	37 × 34 × 30	–	–	ML	N	Y
SB00-33Ph	31178	16	31 × 28 × 24	–	–	33	42 × 37 × 33	–	24 × 26 × 20	ML	N	Y
SB00-36Ph	31290	26	41 × 38 × 32	–	–	34	49 × 39 × 31	–	15 × 20 × 16	MA	N	N
SB00-37Ph	31291	34	46 × 40 × 32	–	26 × 20 × 18	27	42 × 36 × 28	19 × 14 × 15		ML	N	Y
New Zealand fur seal												
SB00-26Af	31159	4	19 × 19 × 12			5	20 × 20 × 13		10 × 10 × 8	ML	N	Y

* CA = Corpus albicans, CL = Corpus luteum,

† MA = Mature-anoestrus, ML = Mature-lactating

TABLE 2.6. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS OF PINNIPEDS, 1999/2000.

CODE	PATH-OLOGY NO.	BACULUM L (mm)	RIGHT TESTIS Wt + epid. (g)	RIGHT TESTIS Wt – epid. (g)	RIGHT TESTIS L × D (mm)	LEFT TESTIS Wt + epid. (g)	LEFT TESTIS Wt – epid. (g)	LEFT TESTIS L × D (mm)	TESTIS MATUR-ITY*
New Zealand sea lion									
SB00-08Ph	31072	184	44	30	79 × 34	42	27	80 × 32	MI
SB00-09Ph	31075	145	31	26	74 × 29	33	27	79 × 30	MI
SB00-10Ph	31076	172	28	21	74 × 27	33	23	70 × 30	MI
SB00-11Ph	31077	168	36	29	88 × 39	37	30	87 × 39	MI
SB00-13Ph	31100	142	38	25	71 × 26	33	22	67 × 26	MA
SB00-15Ph	31102	190	43	34	80 × 32	51	29	83 × 31	MA
SB00-16Ph	31108	165	40	27	66 × 28	45	30	72 × 30	MA
SB00-17Ph	31111	146	31	21	74 × 26	32	21	72 × 25	MI
SB00-18Ph	31112	160	42	31	80 × 31	44	34	79 × 32	MA
SB00-19Ph	31115	150	42	27	68 × 29	37	27	67 × 27	MA
SB00-20Ph	31116	204	40	32	88 × 34	49	36	88 × 38	MI
SB00-29Ph	31168	210	39	28	76 × 35	40	32	78 × 35	MI
SB00-34Ph	31183	170	38	26	78 × 30	42	28	80 × 32	MI
SB00-35Ph	31289	148	36	26	66 × 29	37	26	65 × 30	MI
New Zealand fur seal									
SB00-03Af	31058	103	11	7	34 × 24	11	6	34 × 24	MI
SB00-04Af	31059	103	13	7	53 × 20	13	6	53 × 21	MI
SB00-27Af	31156	103	12	7	47 × 21	12	8	48 × 20	MA
SB00-28Af	31160	104	9	6	41 × 18	9	6	41 × 18	MI
SB00-30Af	31176	89	11	6	37 × 17	10	5	37 × 17	P

* P = Pubertal, MA = Mature-active, MI = Mature-inactive.

TABLE 2.7. PATHOLOGY OF PINNIPEDS, 1999/2000.

LEGEND TO SYMBOLS ON TABLE 2.7

1 = Respiratory congestion and oedema
2 = Pulmonary emphysema
3 = Trauma (contusion, free blood in abdomen)

I = Tracheal & bronchial congestion/haemorrhage
II = Bronchiole congestion/ haemorrhage
III = Bronchiole excessive mucus
IV = Pulmonary interlobular/ lobular oedema/ congestion
V = Pulmonary aveolar emphysema
VI = Cardiac myofibre hypercontraction
VII = Cardiac myofibre fragmentation
VIII = Cardiac myofibre vacuolation

A = Gastrointestinal ulcers
B = Genital vesicles and ulcers
C = External puncture wounds—bites
D = Thyroid cysts
E = Scarred spleen
F = Urinary bladder plaques
G = Adrenal cysts
H = Previous trauma (bone fractures)
I = Diaphragmatic hernia

AI = Pulmonary multi-focal inflammation
AII = Bronchiole focal supprative inflammation
AIII = Pyogranulomatous parasitic bronchiolitis
BI = Myocardial nuclear rowing
CI = Hepatic focal inflammation
DI = Tracheal multi-focal lymphoid infiltrations
EI = Mastitis

CODE	PATHOLOGY NO.	ENTANGLEMENT-RELATED PATHOLOGY		INCIDENTAL FINDINGS	
		GROSS	HISTOLOGICAL	GROSS	HISTOLOGICAL
New Zealand sea lion—Females					
SB00-05Ph	31066	1, 2, 3	I, II, IV, V, VI	–	–
SB00-06Ph	31065	1, 2, 3	I, III, IV, V, VI, VII, VIII	A, B	–
SB00-07Ph	31071	1, 2, 3	I, II, IV, V, VI	C, D	EI
SB00-14Ph	31101	1, 2, 3	IV, V, VI	A, B, C	AII, CI
SB00-21Ph	31165	1, 2	I, IV, V, VI	A	–
SB00-22Ph	31167	1, 2, 3	II, III, IV, V *	A	–
SB00-23Ph	31166	1, 2, 3	I, II, IV, V, VI	A, D	–
SB00-24Ph	31154	1, 2	IV, V, VI, VII	A	AIII
SB00-25Ph	31155	1, 2, 3	I, IV, V, VI	A, E, H	–
SB00-31Ph	31177	1, 2, 3	II, IV, V, VI	A, D	EI
SB00-32Ph	31182	1, 2	II, IV, V, VI	A	AI
SB00-33Ph	31178	1, 2, 3	II, IV, V, VI	A	–
SB00-36Ph	31290	1, 2, 3	IV, V, VI	A, B	AIII
SB00-37Ph	31291	1, 2, 3	III, IV, V, VI	A, B	–
New Zealand sea lion—Males					
SB00-08Ph	31072	1, 2, 3	IV, V, VI	A, B, D	–
SB00-09Ph	31075	1, 2, 3	I, II, IV, V, VI	A, D, C, E	–
SB00-10Ph	31076	1, 2, 3	I, II, IV, V, VI	A, D	–
SB00-11Ph	31077	1, 2, 3	IV, V, VI, VII	F, G	BI
SB00-13Ph	31100	1, 2, 3	I, IV, V, VI, VII	A	–
SB00-15Ph	31102	1, 2, 3	IV, VI, VII	A	–
SB00-16Ph	31108	1, 2, 3	III, IV, V, VI, VII	A	–
SB00-17Ph	31111	1, 2, 3	I, IV, V, VI	A, D	–
SB00-18Ph	31112	1, 2, 3	I, IV, VI, VII	A, D, E	–
SB00-19Ph	31115	1, 2, 3	IV, V, VI, VII	A	AIII
SB00-20Ph	31116	1, 2, 3	I, IV, V, VI, VII	–	–
SB00-29Ph	31168	1, 2	IV, V, VI, VII	A	AIII
SB00-34Ph	31183	1, 2, 3	III, IV, V, VI	–	–
SB00-35Ph	31289	1, 2	IV, V, VI, VII	A	–
New Zealand fur seal—Females					
SB00-26Af	31159	1, 2, 3	I, IV, V	–	DI
New Zealand fur seal—Males					
SB00-03Af	31058	1, 2	IV, V, VI	–	–
SB00-04Af	31059	1, 2	I, IV, V, VI	A	–
SB00-27Af	31156	1, 2, 3	I, II, IV, V, VI	A, D	–
SB00-28Af	31160	1, 2	I, IV, V, VI, VII	A, E, I	–
SB00-30Af	31176	1, 2, 3	IV, V, VI, VII	A	–

* Heart and trachea not examined histologically.

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 have been determined for 40 New Zealand sea lions (*Phocarctos hookeri*) and 8 New Zealand fur seals (*Arctocephalus forsteri*) killed incidentally in fishing operations. The sea lions were caught in the vicinity of the Auckland and Snares Islands shelf, and the fur seals at various locations off the South Island, and in the subantarctic. The stomach contents of both sea lions and fur seals contained mixed vertebrate and invertebrate prey items, with squid predominating in the stomach of sea lions and teleost fish in the stomach of fur seals. An estimate of age was determined based on growth layer groups (GLGs) in the dentine and cementum of the lower left first post-canine tooth. Where the actual age of the animals were known (n = 6) the estimated age was similar to the actual age. Male and female reproductive tracts were examined to determine reproductive status. Female sea lions older than 3 years appear to have undergone oestrus. Of the 24 female sea lions examined, 17 were actively lactating, but seven were not, suggesting that they were not pregnant last season or had lost last season's pup. One sea lion and one fur seal caught late in the season were pregnant. Further research is required to elucidate the reproductive physiology of this species. Male sea lions and fur seals over 4 years of age had sexually mature gonads, which supports the previous finding that that they reach sexual maturity well before behavioural maturity. All sea lions and fur seals were retrieved from nets and all had lesions consistent with death from asphyxiation. Lesions were consistently observed in the respiratory tract and heart indicative of hypoxia and possibly excessive catecholamine release. Other significant findings included severe acute blunt trauma in 75% of individuals from each species and evidence of gastric reflux in 30% of sea lions and 25% of fur seals. One sea lion had pulmonary tuberculosis as an incidental finding.

Keywords: seals, sea lions, autopsy, stomach contents, estimated age, reproduction, Auckland Islands, Snares Islands, New Zealand

Gibbs, N.J.; Duignan, P.J.; Jones, G.W. 2003. Part 3: Autopsy report for 2000/01. Pp. 61–106 in Duignan, P.J.; Gibbs, N.J.; Jones, G.W. Autopsy of pinnipeds incidentally caught in fishing operations 1997/98, 1999/2000, and 2000/01. *DOC Science Internal Series 118*. Department of Conservation, Wellington. 106 p.

1. Introduction

The primary objective of this study was to fulfil the requirements of contract 00/3026 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 40 New Zealand sea lions (*Phocarctos hookeri*), and 8 New Zealand fur seals (*Arctocephalus forsteri)*.

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: Autopsy report for 1997/98.

The introduction to Part 1 (see above) contains general information on the New Zealand sea lion and fur seal.

2. Materials and methods

2.1 MATERIALS

The carcasses of the New Zealand sea lions and fur seals had all been caught in commercial fishing operations and were delivered to Massey University. The carcasses were frozen and wrapped in thick plastic bags and woven nylon sacks. Most animals, apart from one fur seal, were identified by Conservation Services Levy (CSL) observer data sheets attached to the pectoral flipper with an orange plastic CSL tag. On receipt, the seals were unwrapped and stored frozen at –20°C until necropsy.

2.2 METHODS

See Parts 1 and 2 (above) for details of Methods.

2.2.1 Age determination

The animals were aged using both techniques described in Parts 1 and 2 of this report, using GLG's in the dentine and cementum of lower canine and post-canine teeth, and root ridges of the canine teeth.

3. Results

3.1 CATCH DATA AND OBSERVER'S REPORTS

A total of 40 New Zealand sea lion carcasses were received consisting of 24 females and 16 males. There were 8 fur seals including 2 females and 6 males. The CSL observer data are recorded with the CSL tag numbers, and the catch date and coordinates (Appendix 1, Table 3.1). The sea lions appear to have been captured on the Auckland and Snares Islands shelf. The majority were captured to the north of the Auckland Islands, while the remaining animals were caught further south and to the east of the islands (Fig. 3.1).

The fur seals were captured at several locations off the west and south coasts of the South Island, and around the Snares, Auckland Islands, and Campbell Island (Fig. 3.2).

3.2 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table 3.2). These data will be further analysed in combination with data collected on bycatch pinnipeds from previous seasons.

3.3 STOMACH CONTENTS

The stomach weight and the weight of the contents were recorded for each animal (Appendix 1, Table 3.3). Squid, probably the arrow squid (*Nototodarus sloanii*), and teleost fish were present in the stomachs of both sea lions and fur seals, but fish predominated in the fur seal stomachs. Most of the teleost fish were not sufficiently intact for gross identification to species level. However, otoliths and squid beaks have been stored in 70% alcohol for more detailed analysis of diet at or immediately before the time of death. Blubber samples are also in storage for analysis of fatty acid signatures.

3.4 AGE ESTIMATION

The animals were aged using incremental growth layers (GLGs) in the dentine and cementum of canine and post-canine teeth and root ridges of canine teeth (Appendix 1, Table 3.4). The actual age was known for four sea lions and two fur seals that were tagged as pups. For these animals, the estimated age is similar to the actual age but the data set is too small for statistical analysis. More detailed analysis will be conducted when data from three or more seasons are combined.

Figure 3.1. Capture locations for New Zealand sea lions, 2000/01.

Figure 3.2. Capture locations for New Zealand fur seals, 2000/01.

The different techniques came up with quite variable results for age estimates, and it is not possible to determine the ages of the animals using all the techniques. The following is a summary of age estimates derived from counting canine GLGs, since this technique has been used by Duignan in Part 1.

The female sea lions (n = 24) had a mean age of 5 years. Their age ranged from 3 to 10 years. For males (n = 16) the age range was from 3 to 14 years, and the mean age was 8 years.

The teeth of one female fur seal were damaged during preparation and the canine tooth of the other female was difficult to read, with an age estimate of greater than 3 years. This animal's actual age was 6.5 years. The male fur seals had a mean age of 7 years, and their ages ranged from 5 to 8 years.

3.5 REPRODUCTIVE STATUS

Females

Based on the presence of a CA or CL in serial ovarian sections, all 24 female sea lions were classed as having achieved reproductive maturity (Appendix 1, Table 3.5). Seventeen of 24 (71%) females were lactating, thus had given birth in the summer they were caught, and of these, all had a CL in one ovary and sparse, inactive endometrial glands. This would suggest that implantation had not yet occurred. Of six females with inactive mammary glands, five had a CL in one ovary, and one female had no CLs or CAs, but all had sparse, inactive endometrial glands. This suggests that that they did not have a pup this season and that implantation had not yet occurred. Most females were caught in February and March, which would be pre-implantation or early pregnancy, assuming they had been mated in December. Freezing of the carcasses precludes the identification of blastocysts in the oviducts or early implantation embryos in the endometrium. The remaining female had a more active CL in one ovary, active convoluted endometrial glands and was pregnant with a male foetus in the right uterine horn. This female was caught in May, which is when a female would be expected to have a first trimester foetus. She did not have an active mammary gland suggesting she had not given birth in the summer she was caught.

One female fur seal was pregnant with a male foetus. There was a CL in one ovary, active endometrial glands and inactive mammary gland. The foetus was well-developed which is expected as she was caught in September when a fur seal female should have a third trimester foetus. The remaining female fur seal did not have *corpora* in either ovary and the mammary gland was poorly developed. However she was a known age animal (6.5 years) and the uterine horns were sexually mature. She may not have given birth in the previous summer, or had lost her pup, and was not pregnant at the time she was caught in October.

Males

Based on examination of the testes, 14 of the sea lions had histological features consistent with maturity and two were pubertal (Appendix 1, Table 3.6). None of the animals were actively producing spermatozoa. All the males were caught between January and April, thus the histological appearance of the testis is consistent with a regression of spermatogenesis outside the breeding season.

The six male fur seals were classed as mature inactive based on testicular histology (Appendix 1, Table 3.6). Animals were caught in January, February, July, and September, and the histology is consistent with decreased spermatogenesis outside the breeding season.

3.6 PATHOLOGY

Data on entanglement-related pathology is included in this report (Appendix 1, Table 3.7). It should be noted that freezing compromises the interpretation of subtle pathological changes.

All of the 40 New Zealand sea lions and eight New Zealand fur seals entangled in commercial nets had moderate/severe pulmonary oedema, congestion and emphysema (Appendix 1, Table 3.7). Most sea lions (n = 36, 90%) and fur seals (n = 7, 88%) had myocardial hyper-contraction, hyper-eosinophilia and fibre fragmentation probably caused by acute stress and hypoxia. Thirty (75%) sea lions and six (75%) fur seals also had lesions indicative of acute blunt trauma. Regurgitation of stomach contents into the oesophagus or trachea was seen in 12 (30%) sea lions and two (25%) fur seals. In all animals examined there was no other apparent pathological change that could have caused death. These data support the conclusion that asphyxiation was likely the primary cause of death in all the New Zealand sea lions and fur seals examined.

For animals that had severe blunt trauma lesions, the trauma itself may have caused death either through concussion or release of catecholamines causing cardiac failure. Thirty five of 48 (73%) animals (both species combined) had evidence of blunt trauma before death as indicated by erthyema of the blubber, oedema and haemorrhage of the muscle (Fig. 3.3, see p. 80) and fractures of the skull. Of the animals with trauma, the lesions were regarded as 'mild' and limited to the abdomen for six (17%) animals, 'moderate' and limited to thorax and abdomen for 11 (31%) animals, and 'severe' in which extensive lesions involved the head, neck, thorax, and abdomen in 18 (51%) animals.

Of the 40 sea lions examined, five are known to have been ejected through Sea Lion Exclusion Devices (SLED) and subsequently caught in a cover net (Appendix 1, Table 3.7). Three (60%) of these had traumatic lesions, one with 'mild' lesions and two with 'severe' trauma. One of the traumatised animals had regurgitated stomach contents into the oro-pharynx. The two remaining animals had also regurgitated stomach contents. Of the 35 sea lions that were not ejected through a SLED, six (17%) had both traumatic lesions and regurgitation, 21 (60%) had severe trauma without regurgitation, and three (9%) had regurgitated stomach contents but trauma was not apparent. Acute blunt trauma was therefore apparent in 21 of 35 (74%) animals that had not been ejected and 9 of 35 (26%) had regurgitated.

Of eight fur seals examined, acute blunt trauma with regurgitation was apparent in one animal, trauma alone was present in four seals, and regurgitation alone was seen in one.

3.6.1. Entanglement-related pathology for each caught pinniped

In the codes used below 'Af' designates a fur seal and 'Ph' a sea lion.

SB01-01Af (CSL 0864)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves.

Alimentary The stomach was mostly empty, with contents consisting of 7 small fish.

Respiratory On gross examination, bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. On histology, there were no visible lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was also diffuse lobular emphysema.

Cardiovascular No visible lesions.

Diagnosis Consistent with asphyxiation

SB01-02Af (CSL 1220)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves in the blubber and around major organs such as the heart and kidneys.

Alimentary The stomach was full, with contents consisting of whole squid.

Respiratory On gross examination, bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. On histology, there were no visible lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was also diffuse lobular emphysema in the peripheral parenchyma.

Cardiovascular On histology, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia. The changes were limited to the left ventricle.

Diagnosis Consistent with asphyxiation and acute cardiomyopathy.

SB01-03Ph (CSL 1221)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves.

Alimentary The stomach was full, with contents consisting of fish parts, bones and otoliths.

Respiratory On gross examination, bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. On histology, there were no visible lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was also diffuse lobular emphysema with occasional bullae in the peripheral parenchyma.

Cardiovascular No visible lesions.

Diagnosis Consistent with asphyxiation

SB01-04Ph (CSL 1222)

External The webbing between the fourth and fifth digits of the left pelvic flipper was torn. The last phalanx of the fifth digit of the same flipper was fractured.

Internal No gross indication of trauma in the blubber, muscle or skeleton, however, there was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with good fat reserves.

Alimentary There was regurgitated food in the oral cavity and oesophagus. The stomach was full of fish parts, otoliths, whole squid, squid beaks, lenses and parts.

Respiratory Bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. There were no visible histological lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion, interstitial and alveolar oedema, and alveolar and bullous emphysema.

Cardiovascular On histology, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia. The changes were limited to the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy. Probable abdominal trauma.

SB01-05Ph (CSL 1223)

External There was a deep wound through the skin, blubber and muscle near the right axilla. The skin around the right caudal teat was torn.

Internal No gross indication of trauma in the blubber, muscle or skeleton, however, there was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the oral cavity and oesophagus. The stomach was full of fish bones, otoliths, squid beaks and parts and a rock.

Respiratory Bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. There were no visible histological lesions in the tracheal mucosa. The diaphragm had mild, focal fibre fragmentation, hyper-contraction and hyper-eosinophilia of the muscle. The pulmonary parenchyma had moderate to severe diffuse congestion, interstitial and alveolar oedema, and alveolar and bullous emphysema. The congestion was more severe in the cranial lobes.

Cardiovascular On histology, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia. The changes were limited to the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, acute cardiomyopathy and diaphragmatic spasm. Probable abdominal trauma.

SB01-06Ph (CSL 12 18)

External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with moderate fat reserves in the blubber and around major organs such as the heart and kidneys.

Alimentary There was regurgitated food in the oesophagus. The stomach was half-full, with contents consisting of fish otoliths, lenses, whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the bronchi. There were no histological lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had gross and histological changes consistent with moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the left lobes. The distal left pulmonary parenchyma had moderate bullous emphysema, while the right had severe, diffuse lobulated and bullous emphysema.

Cardiovascular There was mild multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy.

SB01-07Ph (CSL 1219)

External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton, however, there was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with a thick blubber layer.

Alimentary There was regurgitated food in the oesophagus. The stomach was half-full, with contents consisting of fish otoliths, lenses, whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, there was multi-focal sub-mucosal congestion of the wall of the tracheal and bronchial mucosa with marked vascular dilatation. No visible lesions were detected in the diaphragm. Based on gross and microscopic examination the pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. The peripheral pulmonary parenchyma in all lobes had bullous emphysema.

Cardiovascular On histology there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy. Probable abdominal trauma.

SB01-08Ph (CSL 1103)

External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with a thick blubber layer and fat around the heart and kidneys.

Alimentary There was regurgitated food in the oesophagus. The stomach was full, with contents consisting of fish otoliths, lenses, bones and parts, whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. There were no histological lesions in the tracheal mucosa or diaphragm. Based on gross and microscopic examination the pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. The peripheral pulmonary parenchyma in all lobes had bullous emphysema, with occasional lobular emphysema in the left cranial lobe.

Cardiovascular On histology there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy.

SB01-09Ph (CSL 1165)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with excellent fat reserves in the blubber and around the heart.

Alimentary The stomach was empty, with contents consisting of a pair of fish otoliths.

Respiratory On histology, the sub-mucosal blood vessels in the wall of the trachea were congested. No visible lesions were detected in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. There was diffuse pulmonary alveolar and bullous emphysema.

Cardiovascular There was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation and acute cardiomyopathy.

SB01-10Ph (CSL 1164)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with a thick blubber layer and fat around the heart.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, lenses and bones, whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the bronchi and bronchioles. On histology, there were no histological lesions in the tracheal mucosa or diaphragm. Based on gross and microscopic examination the pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. The peripheral pulmonary parenchyma in the cranial lobes had diffuse bullous and lobular emphysema, while the medial and caudal lobes had bullous emphysema.

Cardiovascular On histology there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation and acute cardiomyopathy.

SB01-11Ph (CSL 1163)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves in the blubber and around the kidneys.

Alimentary There was regurgitated food in the mouth. The stomach was half-full, with contents consisting of fish parts, otoliths, lenses, whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. The sub-mucosal blood vessels were dilated in the wall of the trachea. The diaphragm had mild, focal fibre fragmentation, hyper-contraction and hyper-eosinophilia of the skeletal muscle. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. There was diffuse pulmonary alveolar and bullous emphysema.

Cardiovascular There was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy.

SB01-12Ph (CSL 1104)
External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. However, there was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the mouth and oesophagus. The stomach was half-full, with contents consisting of whole squid, squid beaks, lenses and parts.

Respiratory There was focal erosion of the tracheal mucosa near the bifurcation of the bronchi. There were no lesions in the tracheal mucosa or the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. There was mild to moderate bullous emphysema of all the lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia bilaterally of the ventricles.

Diagnosis Consistent with asphyxiation, regurgitation, acute cardiomyopathy. Probable abdominal trauma.

SB01-13Ph (CSL 0911)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. There was also evidence of blunt trauma along the lateral aspects of the cranium and the zygomatic arch was fractured. Blunt trauma was also observed along the mandible and ventral surface of the neck and around the testes. Free blood-stained fluid was present in the abdominal cavity. The animal was in excellent body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, lenses and bones, squid beaks, lenses and parts.

Respiratory On histology, there was sub-mucosal dilation of blood vessels in the wall of the trachea. There were no lesions in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the right cranial lobe. There was diffuse bullous and occasional lobulated emphysema of all the lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with severe trauma, asphyxiation, acute cardiomyopathy.

SB01-14Af (CSL 1241)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. The animal was in good body condition with good fat reserves in the blubber and around the heart.

Alimentary The stomach was full, with contents consisting of fish otoliths, lenses, whole squid, squid beaks and lenses.

Respiratory There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. The peripheral parenchyma had diffuse bullous emphysema of all the lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation, and acute cardiomyopathy.

SB01-15Ph (CSL 1330)
External The webbing between the fourth and fifth digits of the left pelvic flipper was torn. The distal phalanx of the fifth digit of the same flipper was fractured.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the oesophagus. The stomach was full, with contents consisting of fish otoliths, lenses, bones and parts, whole squid, squid beaks, and lenses.

Respiratory There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. There was diffuse bullous emphysema in the medial and caudal lobes, and occasional bullous emphysema in the cranial lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, acute cardiomyopathy.

SB01-16Ph (CSL 1381)

External No visible lesions.

Internal There was evidence of blunt trauma consisting of haemorrhage and oedema of the muscle and connective tissue layers overlying the right parietal aspect of the cranium. The animal was in good body condition with moderate fat reserves in the blubber and around the kidneys.

Alimentary The stomach was half-full, with contents consisting of fish bones, otoliths, lenses and one whole squid.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology the tracheal and bronchial mucosa was moderately congested and oedematous and there was acute interstitial haemorrhage. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. There was mild to moderate bullous emphysema bilaterally of the caudal and medial lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, acute cardiomyopathy and cranial trauma.

SB01-17Ph (CSL 1156)

External No visible lesions.

Internal There was evidence of blunt trauma consisting of haemorrhage and oedema of the muscle and connective tissue layers overlying the dorsal aspect of the snout and cranium. Blunt trauma also consisted of haemorrhage around the testes. There was free blood-stained fluid in the abdomen. The animal was in excellent body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was relatively empty, with contents consisting of fish otoliths, lenses, squid parts, beaks, and lenses.

Respiratory Lesions were limited to the pulmonary parenchyma, which was moderately congested throughout but more marked in the right lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was diffuse alveolar emphysema and occasional large bullae in the peripheral parenchyma of all lobes.

Cardiovascular No visible lesions.

Diagnosis Consistent with cranial and abdominal trauma, asphyxiation.

SB01-18Ph (CSL 1157)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the dorsal aspect of the scapula and the ventro-lateral aspects of the neck. Blunt trauma was also evident with haemorrhage of the testes. Free blood-stained fluid was present in the abdominal cavity. The animal was in good body condition with moderate fat reserves in the blubber and around the heart.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, bones, whole squid and squid beaks.

Respiratory There was a regurgitated squid mantle in the trachea near the bifurcation of the bronchi. There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal dilation of the blood vessels in the wall of the trachea. There were no lesions in the diaphragm. The pulmonary parenchyma was moderately congested throughout but more marked in the cranial and medial lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was occasional bullous emphysema in the peripheral parenchyma of all lobes.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with cervical, thoracic and abdominal trauma, asphyxiation and acute cardiomyopathy.

SB01-19Ph (CSL 1331)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. Free blood-stained fluid was present in the abdominal cavity. The animal was in good body condition with moderate fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was moderately full, with contents consisting of one partially digested fish, fish bones, otoliths, lenses, five whole squid, squid parts, beaks, and lenses.

Respiratory Lesions were limited to the pulmonary parenchyma, which was moderately congested throughout but more marked in the cranial lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was mild pulmonary bullous emphysema in the peripheral parenchyma of all lobes.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic and abdominal trauma, asphyxiation and acute cardiomyopathy.

SB01-20Ph (CSL 1601)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema and haemorrhage in the blubber and muscle layers along the ventral sternum and right thorax extending from the manubrium to the ziphoid cartilage. There was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish bones, otoliths, lenses, squid beaks, parts and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology the mucosa of the trachea and bronchi was mildly congested. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. There was mild pulmonary bullous emphysema in the same lobes, while the medial and caudal lobes were mildly emphysematous.

Cardiovascular No visible lesions

Diagnosis Consistent with thoracic and abdominal trauma and asphyxiation.

SB01-21Ph (CSL 1329)
External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. Blunt trauma was also evident by haemorrhage in the testes. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around major organs such as the heart and kidneys.

Alimentary The stomach was mostly empty, with contents consisting of fish otoliths and bones.

Respiratory On gross examination, there was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. The peripheral parenchyma had diffuse lobular emphysema and occasional bullous emphysema of the medial and caudal lobes. There was occasional bullous emphysema of the cranial lobes.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with thoracic and abdominal trauma, asphyxiation and acute cardiomyopathy.

SB01-22Ph (CSL 1213)

External No visible lesions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of whole fish, fish otoliths, lenses, bones, whole squid, squid beaks and lenses.

Respiratory On histology, there was sub-mucosal congestion of blood vessels in the wall of the bronchi. There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation, acute cardiomyopathy.

SB01-23Ph (CSL 1217)

External The last phalanx of the fifth digit on the right pelvic flipper was fractured.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the dorsal aspect of the scapula. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart, kidneys and peritoneum.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, lenses, bones, whole squid, squid beaks and lenses.

Respiratory There was bloody stable froth in the bronchi. There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. The peripheral parenchyma had diffuse bullous emphysema of the medial and caudal lobes. The cranial lobes had occasional bullous emphysema.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation, acute cardiomyopathy.

SB01-24Ph (CSL 1216)

External The webbing between the first and second digits of the right pelvic flipper was torn. The last phalanx of the first digits of both the left and right pelvic flippers were fractured. There were curved scars along the abdomen possibly caused by a shark attack.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral sternum extending from the manubrium to the ziphoid cartilage. Blunt trauma was also evident by haemorrhage along the dorsal aspect of the snout and cranium. There was free blood-stained fluid in the abdomen. The animal was in excellent body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, lenses, bones, squid beaks, lenses and parts.

Respiratory There was bloody stable froth in the nares. The bronchial mucosa had multi-focal lymphoid infiltrations. There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. The peripheral parenchyma had diffuse bullous emphysema of the medial and caudal lobes. The cranial lobes had occasional bullous emphysema.

Cardiovascular There was extensive multi-focal myopathy on histological examination characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia, of the left ventricle.

Diagnosis Consistent with cranial and thoracic trauma, asphyxiation, acute cardiomyopathy.

SB01-25Ph (CSL 1215)

External No visible lesions.

Internal There was marked erythema of the blubber of the ventral and later aspects of the thorax. Deep to this there was haemorrhage and oedema of the thoracic muscle extending from the manubrium to the mid point of the sternum. There was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of one partially digested fish, fish bones, otoliths, lenses, and squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi, but there were no histological lesions in the mucosae. The diaphragm had mild diffuse fibre fragmentation, hyper-contraction and hyper-eosinophilia of the muscle. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. There was mild bullous emphysema of the cranial lobes, while the medial and caudal lobes had diffuse lobular emphysema with occasional larger bullae.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic and abdominal trauma, asphyxiation, acute cardiomyopathy and diaphragmatic spasm.

SB01-26Ph (CSL 0901)

External No visible lesions.

Internal There was marked erythema of the blubber of the ventral and later aspects of the thorax. Deep to this there was haemorrhage and oedema of the thoracic muscle extending from the manubrium to the ziphoid cartilage. Blunt trauma was also observed along the ventrolateral aspect of the mandible, along the dorsal aspect of the snout, and the left ventral cheek. There was also blunt trauma along the dorsal aspect of the left scapula. There was free blood-stained fluid in the abdominal cavity. The animal was in good body condition with moderate fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was mostly empty, with contents consisting of fish bones, otoliths, and some fluid.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, there was submucosal congestion in the wall of the trachea and bronchi. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. There was diffuse bullous emphysema of the caudal and medial lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left and right ventricles.

Diagnosis Consistent with thoracic and cranial trauma, asphyxiation, acute cardiomyopathy.

SB01-27Ph (CSL 1214)

External No visible lesions.

Internal There was marked erythema of the blubber of the ventral and later aspects of the thorax. Deep to this there was haemorrhage and oedema of the thoracic muscle extending from the manubrium to the ziphoid cartilage. Blunt trauma was also observed along the ventro-lateral aspect of the mandible, and along the dorsal aspect of the snout and cranium. The animal was in good body condition with good fat reserves in the blubber and around the kidneys.

Alimentary The stomach was full, with contents consisting of whole squid, squid beaks, lenses, one partially digested fish, fish bones, otoliths and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, there was submucosal congestion in the wall of the trachea and bronchi. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema. There was diffuse bullous emphysema of all the lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic and cranial trauma, asphyxiation, acute cardiomyopathy.

SB01-28Ph (CSL 1319)

External The right ear had been severed at the base.

Internal There was evidence of severe blunt ventro-lateral trauma with erythema, haemorrhage and oedema of the blubber and muscle layers that extended continuously from the mandibles to the pelvis (Fig. 3.3). There was also blunt trauma along the left dorso-lateral surface from the scapula to the caudal end of the ribs. Blunt trauma was also observed along the dorsal surface of the snout and the right dorso-lateral surface of the skull, around the right orbit. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

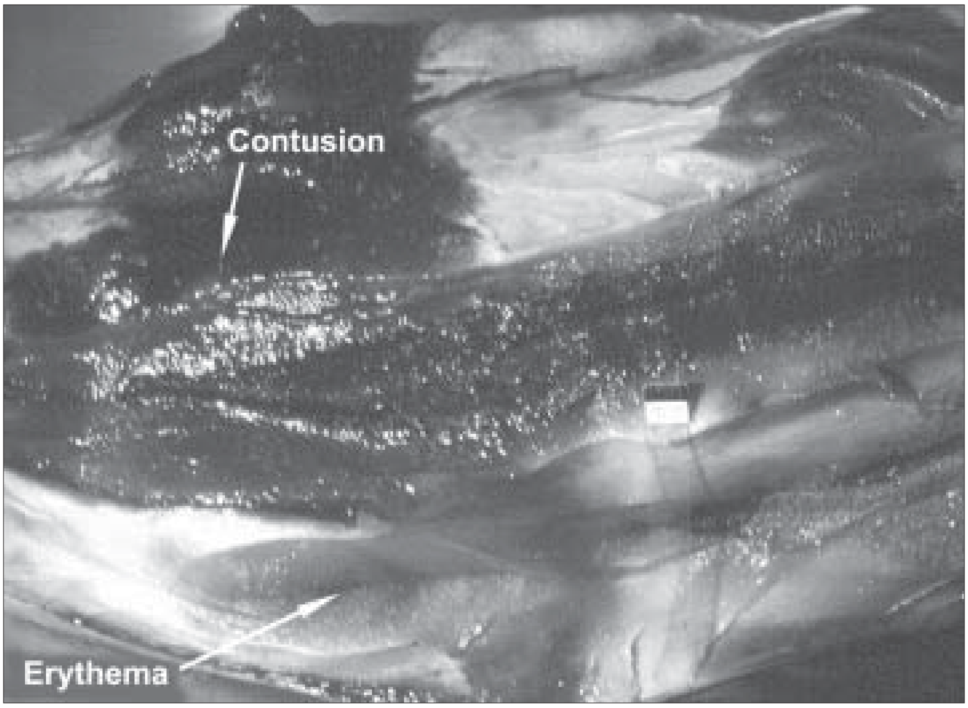

Figure 3.3. Sea lion SB01-28Ph (CSL 1319). Ventral view with incision along ventral midline. The head is located to the left and the pelvis to the right. Contusion over the left shoulder is indicated with extensive haemorrhage and oedema. There is blood staining of the blubber as indicated by erythema.

Alimentary The stomach was full, with contents consisting of fish otoliths, lenses, 47 whole squid, squid beaks and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea, bronchi and bronchioles. The tracheal and bronchial mucosa had severe congestion and haemorrhage in the lamina propria. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe diffuse congestion and interstitial and alveolar oedema, which was more severe in the cranial lobes. There was multi-focal bullous emphysema of the medial and caudal lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with severe trauma, asphyxiation and acute cardiomyopathy.

SB01-29Ph (CSL 1162)

External No visible lesions.

Internal There was evidence of severe blunt trauma with erythema, haemorrhage and oedema in the ventral blubber and muscle extending almost continuously from the manubrium to the pelvis. Blunt trauma was also observed along the lateral and ventral surfaces of the mandibles and sclerosal surface of the trachea. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish bones, otoliths, lenses, and one whole squid.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, the tracheal and bronchial mucosa was markedly congested. The diaphragm had multi-focal myopathy, characterised by fibre fragmentation, hyper-contraction and hyper-eosinophilia. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was mild focal bullous emphysema of the caudal lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with severe extensive blunt trauma, asphyxiation, acute cardiomyopathy and diaphragmatic spasm.

SB01-30Ph (CSL 1155)

External There was an old healed wound on the ventral abdomen possibly caused by a shark bite.

Internal No gross indication of trauma in the blubber, muscle or skeleton. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was mostly empty, with contents consisting of squid beaks, parts, and fish otoliths.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, the tracheal and bronchial submucosal blood vessels were dilated. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse bullous emphysema of the caudal lobes, and occasional bullae in the cranial and medial lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left and right ventricles.

Diagnosis Consistent with asphyxiation, acute cardiomyopathy. Probable abdominal trauma.

SB01-31Ph (CSL 1161)

External No visible lesions.

Internal There was evidence of severe blunt trauma with erythema, haemorrhage and oedema of the blubber and muscle layers along the ventro-lateral aspects of the mandible extending caudally to the shoulders. Blunt trauma was also evident along the left ventro-lateral abdomen, and the ventro-lateral aspects of both hind flippers. The cranium was fractured in two places, one fracture was along the dorsal ridge just caudal to the left eye and the second was along the cranio-medial edge of the orbit. The right mandible had a healed non-union fracture close to the angle of the bone. There was free blood-stained fluid in the abdomen. The animal was in poor body condition with some fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish bones, otoliths, lenses, squid beaks, and one whole octopus.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. On histology, the tracheal and bronchial submucosal blood vessels were dilated. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse alveolar emphysema and occasional bullous emphysema in the medial and caudal lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with severe cranial and abdominal trauma, asphyxiation, acute cardiomyopathy. Pre-existing mandibular non-union fracture.

SB01-32Af (CSL 0938)

External No visible lesions.

Internal There was evidence of severe blunt trauma with erythema, haemorrhage and oedema of the blubber and muscle layers along the ventral aspects of the thorax, extending from the manubrium to the ziphoid cartilage. Blunt trauma was also evident along the dorsal surface of the cranium. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the oral cavity and oesophagus. The stomach was mostly empty, with contents consisting of fish bones, otoliths and lenses.

Respiratory Bloody stable froth was observed in the lumen of the trachea and bronchi. There was foreign debris that appeared to be fish parts, in the left bronchi. On histology, there was submucosal congestion in the wall of the trachea and bronchi. There was multi-focal fibre fragmentation, hyper-contraction and hyper-eosinophilia in the wall of the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse alveolar emphysema and occasional bullous emphysema in all the lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left and right ventricles.

Diagnosis Consistent with thoracic trauma, asphyxiation, acute cardiomyopathy and diaphragmatic spasm. Probable abdominal trauma.

SB01-33Af (CSL 0288)

External No visible lesions.

Internal There was evidence of severe blunt trauma with erythema, haemorrhage and oedema of the blubber and muscle layers along the right ventro-lateral aspect of the thorax. Blunt trauma was also evident along the dorsal aspect of the snout and cranium. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was mostly empty, with contents consisting of fish bones, otoliths and lenses.

Respiratory On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no lesions in the diaphragm. The pulmonary parenchyma had mild to moderate congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse alveolar emphysema in the caudal lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with severe cranial and thoracic trauma, asphyxiation, acute cardiomyopathy. Probable abdominal trauma.

SB01-34Af (CSL 0935)

External No visible lesions.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in excellent body condition with good fat reserves in the blubber and around the heart.

Alimentary There was regurgitated food in the oral cavity and oesophagus. The stomach was full, with contents consisting of whole fish, partially digested fish and one squid mantle.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion and dilation of blood vessels in the wall of the trachea and bronchi. There was multi-focal fibre fragmentation, hyper-contraction and hyper-eosinophilia of the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. The right caudal lobe had a large haematoma. There was diffuse alveolar emphysema in the left caudal lobe, while there were occasional bullae in the other lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, acute cardiomyopathy and diaphragmatic spasm.

SB01-35Af (CSL 1159)

External There was a 6.5 cm-long barb in the pad of the right pectoral flipper. There was also a deep open laceration, possibly post-mortem that extended through the blubber.

Internal There was evidence of blunt trauma with erthyema in the blubber and haemorrhage and oedema in the muscle along the ventral neck, thorax and abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart.

Alimentary The stomach was full, with contents consisting of fish bones, whole squid, squid beaks, lenses, and fluid.

Respiratory On histology, there was sub-mucosal congestion in the wall of the trachea. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with cervical, thoracic and abdominal trauma, asphyxiation, acute cardiomyopathy.

SB01-36Af (No tag)

External The penis and baculum had prolapsed and were extruding from the prepuce.

Internal There was evidence of blunt trauma with erthyema of the blubber and haemorrhage and oedema of the muscle along the right ventro-lateral thorax, extending from the manubrium to the ziphoid cartilage. Blunt trauma was also evident along the right lateral aspect of the mandible. The upper left first and second incisors were broken and the left maxillary gingiva was lacerated and haemorrhagic due to penetration by the lower left canine. There was free blood-stained fluid in the abdomen. The animal was in excellent body condition with excellent fat reserves in the blubber and around major organs such as the heart and kidneys.

Alimentary The stomach was full, with contents consisting of thirteen whole fish.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no visible lesions of the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was multifocal bullous emphysema in the right lobes, with occasional bullae in the left lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left and right ventricles.

Diagnosis Consistent with facial, thoracic, and abdominal trauma, asphyxiation, acute cardiomyopathy.

SB01-37Ph (CSL 0554)
External No visible lesions.

Internal There was evidence of blunt trauma with haemorrhage and oedema of the muscle along the right side of the snout and cheek. There was free blood-stained fluid in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around major organs such as the heart and kidneys.

Alimentary The stomach was mostly empty, with contents consisting of fish bones, otoliths and squid beaks.

Respiratory There were no lesions in the tracheal mucosa or diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse bullous emphysema in all the lobes. The pulmonary parenchyma had multi-focal granulomatous pneumonia affecting approximately 15% of the lung volume. The mediastinal lymph nodes were enlarged and active.

Cardiovascular No visible lesions

Diagnosis Consistent with facial trauma and asphyxiation. Multifocal granulomatous pneumonia consistent with tuberculosis.

SB01-38Ph (CSL 0556)
External No visible lesions.

Internal There was evidence of blunt trauma with erthyema of the blubber, and haemorrhage and oedema of the muscle along the ventral surface, extending from the manubrium to the ziphoid cartilage. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the nasal passages, the oral cavity and oesophagus. The stomach was half-full, with contents consisting of fish bones, otoliths, lenses, parts, squid beaks, lenses, and one partially digested crustacean.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal dilation of the blood vessels in the wall of the trachea and bronchi. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. The left caudal lobe had small multi-focal areas of haemorrhage. There was occasional bullous emphysema in all the lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation, regurgitation and acute cardiomyopathy.

SB01-39Ph (CSL 1211)

External No visible lesions.

Internal There was evidence of blunt trauma with erthyema of the blubber, and haemorrhage and oedema of the muscle along the ventro-lateral aspect of the sternum, extending from the manubrium to the ziphoid cartilage. There was free blood-stained blood in the abdomen. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the oral cavity and oesophagus. The stomach was full, with contents consisting of fish bones, otoliths, whole squid, squid lenses and parts.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no visible lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was multifocal bullous emphysema in all the lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation, regurgitation and acute cardiomyopathy. Probable abdominal trauma.

SB01-40Ph (CSL 0557)

External There were faeces around the perianal hair.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in moderate body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of whole squid.

Respiratory The tracheal mucosa had multi-focal, firm, raised nodules that appeared to involve the cartilage in the wall of the trachea. There were no lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. All lobes had diffuse alveolar emphysema and occasional bullous emphysema.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, acute cardiomyopathy.

SB01-41Ph (CSL 1210)

External There were three scars along the leading edge of the right pectoral flipper that are likely to be healed shark bites.

Internal No gross indication of trauma in the blubber, muscle or skeleton. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was mostly empty except for some squid beaks.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was occasional bullous emphysema in all the lobes.

Cardiovascular The tricuspid valve in the left ventricle was thickened and oedematous. On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, acute cardiomyopathy.

SB01-42Ph (CSL 0552)
External No visible lesions.

Internal There was evidence of blunt trauma with erthyema, haemorrhage and oedema of the blubber and muscle layers along the ventral sternum. The animal was in moderate body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of fish bones, otoliths, parts, squid beaks and lenses.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. There was diffuse alveolar emphysema in the caudal lobes, with occasional bullae in the medial and cranial lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left and right ventricles.

Diagnosis Consistent with thoracic trauma, asphyxiation, acute cardiomyopathy.

SB01-43Ph (CSL 0553)
External No visible lesions.

Internal There was evidence of blunt trauma with haemorrhage and oedema of the muscle along the right dorso-lateral aspect of the snout and cranium. There was free blood-stained fluid in the abdomen. The animal was in moderate body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of two partially digested fish, fish bones, otoliths, whole squid, and squid beaks.

Respiratory On histology, there was sub-mucosal congestion in the wall of the trachea and bronchi. There were no lesions in the diaphragm. The pulmonary parenchyma had moderate to severe congestion and interstitial and alveolar oedema diffusely distributed. The peripheral parenchyma of the caudal lobes had diffuse alveolar emphysema, while there was occasional bullae in the cranial lobes.

Cardiovascular On histology, there was extensive multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with cranial trauma, asphyxiation, acute cardiomyopathy.

SB01-44Ph (CSL 0555)

External No visible lesions.

Internal There was evidence of blunt trauma with muscle haemorrhage and oedema along the left temporal area of the cranium. The animal was in good body condition with moderate fat reserves in the blubber and around the heart and kidneys.

Alimentary There was regurgitated food in the oesophagus. The stomach was mostly empty, with contents consisting of one whole fish and squid beaks.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. There were no lesions in the tracheal mucosa or the diaphragm. The pulmonary parenchyma was severely congested throughout but more marked in the cranial lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was diffuse alveolar emphysema and occasional bullae in the peripheral parenchyma of the medial and caudal lobes. The cranial lobes had occasional bullous emphysema.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with cranial trauma, asphyxiation, regurgitation and acute cardiomyopathy.

SB01-45Ph (CSL 1212)

External There were a few small open wounds around the neck that are likely to be from bites from other sea lions.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventro-lateral aspect of the sternum, extending from the manubrium to the ziphoid cartilage. Blunt trauma was also evident along the left temporal area. Free blood-stained fluid was present in the abdominal cavity. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of whole squid.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. There were no lesions in the tracheal mucosa or the diaphragm. The pulmonary parenchyma was moderately congested throughout but more marked in the cranial lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was multifocal bullous emphysema in the peripheral parenchyma of the caudal lobes.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic, cranial and abdominal trauma, asphyxiation and acute cardiomyopathy.

SB01-46Ph (CSL 1124)

External There were many small scars around the shoulders and leading edges of the pectoral flippers that are likely to be from bites from other sea lions. The penis had prolapsed from the prepuce.

Internal No gross evidence of trauma in the blubber, muscle or skeleton. Free blood-stained fluid was present in the abdominal cavity. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was half-full, with contents consisting of fish otoliths, bones, lenses, two whole squid, squid beaks and lenses.

Respiratory There was bloody stable froth in the trachea, bronchi and bronchioles. On histology, there was sub-mucosal congestion in the wall of the trachea. There were no lesions in the diaphragm. The pulmonary parenchyma was severely congested throughout but more marked in the cranial lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was occasional bullous emphysema in the peripheral parenchyma of the cranial lobes. The caudal lobes had diffuse alveolar emphysema.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation and acute cardiomyopathy. Probable abdominal trauma.

SB01-47Ph (CSL 1661)

External There were three deep cuts (post-mortem) through the blubber near the cranial projection of the sternum.

Internal There was evidence of blunt trauma with erythema of the blubber and muscle haemorrhage along the ventral aspect of the sternum. The animal was in good body condition with good fat reserves in the blubber and around the heart and kidneys.

Alimentary The stomach was full, with contents consisting of whole fish, fish otoliths, bones, whole squid, squid beaks, lenses and two stones.

Respiratory On histology, there was sub-mucosal dilation of the blood vessels in the wall of the trachea. There were no lesions in the diaphragm. The pulmonary parenchyma was severely congested in all the lobes. On histology, there was vascular congestion and interstitial and alveolar oedema. There was occasional bullous emphysema in the peripheral parenchyma of all lobes.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with thoracic trauma, asphyxiation and acute cardiomyopathy.

SB01-48Ph (CSL 1662)

External No visible lesions.

Internal There was no gross indication of trauma in the blubber, muscle or skeleton. The animal was in excellent body condition with moderate fat reserves in the blubber and around the kidneys and in the greater omentum.

Alimentary There was regurgitated food in the mouth and oesophagus. The stomach was full, with contents consisting of partially digested fish, fish otoliths, lenses, whole squid, and squid beaks.

Respiratory On gross examination, the tracheal and bronchial mucosa was congested. On histology this was indicated by severe sub-mucosal congestion in the mucosa. There were no lesions in the diaphragm. The pulmonary parenchyma was severely congested throughout all the lobes. On histology, there was vascular congestion and interstitial and alveolar oedema.

Cardiovascular Based on histological examination, there was multi-focal myopathy, characterised by myocardial fibre fragmentation, hyper-contraction and hyper-eosinophilia of the left ventricle.

Diagnosis Consistent with asphyxiation, regurgitation, and acute cardiomyopathy.

4. Discussion

The pinnipeds 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 attached to the pectoral flipper with an orange plastic CSL tag. One fur seal did not have a CSL tag. From a health and safety perspective, the packaging was sufficient to prevent contamination of the environment by the seal carcass provided it remained frozen. In terms of animal identification, the orange CSL tags were very effective. It was beneficial having a list of animals being shipped forwarded by e-mail to allow a crosscheck between animals shipped and those received. In that way, any animal that arrived without the observer's report or tag could be traced.

The number of sea lions submitted was greater than for previous contracts with 40 animals examined compared to 23 examined by Dickie & Dawson (1997), 27 by Duignan (see Part 1) and 28 by Gibbs et al. (see Part 2). The sex ratio was also different to that of sea lions examined in previous years with a bias towards females (60% female, 40% male), compared with either an equal sex ratio (Dickie & Dawson 1997; Gibbs et al. see Part 2) or a male bias (Duignan Part 1). Whether that reflects a skewed sex ratio in the total bycatch or just reflects the selection of animal for examination is unknown. In this study, a similar male bias was present in the sample of fur seals to that examined in previous contracts (Duignan Part 1; Gibbs et al. Part 2). However, too few were examined to draw any conclusions.

Stomach contents of sea lions were similar to those examined by Dickie & Dawson (1997), Duignan (Part 1) and Gibbs et al. (Part 2). As in previous studies, the sea lion diet was more biased towards squid (Dickie & Dawson 1997; Duignan Part 1). However, squid and teleost fish were equally represented in the stomachs of sea lions examined by Gibbs et al. (Part 2). The difference may relate to the availability of squid during the early part of 2000 and in this regard, fisheries records may be informative. Although squid were also present in the stomachs of some fur seals, teleost fish predominated. Entire unidentified fish and numerous otoliths featured among the fish items present. Specific identification of these prey items was beyond the scope of this contract. Twelve sea lions and two fur seals had regurgitated food in the mouth and oesophagus or respiratory tract. Most of these animals had full stomachs, which suggests that if the animal had recently fed there is an increased risk of regurgitation on capture. Regurgitation of semi-liquid stomach contents could result in aspiration and death from foreign body pneumonia if the animal survived the immediate capture process. A second implication of regurgitation is that it is but one of the biases inherent in the use of stomach contents or faeces as an indicator of diet in pinnipeds (Jobling & Brieby 1986; Bowen & Harrison 1996). Recently, blubber fatty acid signature analysis has been advanced as a more sensitive method of investigating diet among pinnipeds (Iverson 1993; Iverson et al. 1997). This technique is currently under development at Massey University for future studies on foraging ecology of sea lions and fur seals.

Age determination in pinnipeds is based on counting growth layers or annuli in teeth and is commonly used on a variety of species (Laws 1952; Stirling 1969; Anas 1970; Payne 1978; Bengtson & Siniff 1981; Arnbom et al. 1992; Oosthuizen 1997). Although widely used the technique is subject to difficulties in methodology, interpretation, reader variability, variability among teeth, variability between species, and the lack of known age animals (Dapson 1980). For the animals examined in this study, the number of known age animals in the sample is too low to critically evaluate the ageing technique. However, of the sea lions examined in this study and those in previous contracts by Duignan (Part 1) and Gibbs et al. (Part 2), for which the actual age was known, there was good agreement between the known age and the estimated age.

In this study we have used several methods of age determination including dentinal GLGs and RRs of canine teeth, and both dentinal and cemental GLGs of post-canine teeth. We have also started a retrospective study to re-examine the canine and post-canine teeth of sea lions from previous years. Once this has been completed we should have a better perspective on age estimation and be able to recommend which method gives the best estimate of the true age. In a comparative study of age estimation techniques using tooth sections of known age South African fur seals (*Arctocephalus pusillus pusillus*) it was found that the best correlation was between dentine layers in canine teeth and true age. The post-canine teeth of that species lacked dentinal layers and the cemental layers were not highly correlated with true age (Oosthuizen 1997). Our preliminary data suggest a similar result will be forthcoming for New Zealand sea lions. In the meantime, caution should be exercised when considering the ages documented in this and previous reports. The documented ages (excluding known age animals) are only estimates and may not reflect the true age of the animals.

Among the northern sea lion species, female Steller's sea lion (*Eumetopias jubatus*) and California sea lion (*Zalophus californianus*) reach sexual maturity between 3 and 8 years (Reeves et al. 1992). The southern sea lion (*Otaria byronia*) reaches maturity at 4years (Reijnders et al. 1993) and New Zealand sea lions apparently become sexually mature at 3 years old and produce their first pup at 4 years (Cawthorn et al. 1985). This study supports those observations in that the youngest animals (3 years old) had sexually mature ovaries and had produced what was probably their first pup the summer that they were caught, or had been mated and would produce their first pup the following summer if they had survived capture. The estimated ages of these females are likely to be an underestimate based on morphological data. The remaining females ranged from 4 to 10 years old and had mature ovaries.

Embryonic diapause has not been reported for New Zealand sea lions but is likely to occur as it does so in most other pinnipeds (Gales 1995). The fact only one of the mature females had a detectable foetus would support a period of diapause as this animal was caught in May, whereas the other animals were likely to have been mated in December and were caught early in the year during January to April. More research is required into the reproductive cycle of the species.

Mattlin (1978) suggested that New Zealand fur seal females appear to come into oestrus at 4 years and produce a first pup at about 5 years. An age of sexual maturity of between 3 and 6 years is consistent with several other fur seal species such as the subantarctic fur seal, *Arctocephalus tropicalis* (Bester 1987), Australian fur seal, *A. pusillus doriferus* (Warneke 1979), and South American fur seal, *A. australis* (Reeves et al. 1992). The present study supports these observations in that the single female New Zealand fur seal autopsied was sexually mature at 6–7 years old.

Cawthorn et al. (1985) reported that male New Zealand sea lions become sexually mature at 5 years old but do not hold territories or breed for another 3 to 5 years. Similarly Australian sea lions (*Neophoca cinerea*) are thought to achieve sexual maturity at 6 years (Reijnders et al. 1993). The data presented here support these observations in that the youngest male that had sexually mature testes was approximately 4 years old. This is likely to be an underestimate of the true age of the animal.

For New Zealand fur seals, it has been suggested that sexual maturity in males is attained at approximately 7 years but that social maturity is not achieved until approximately 10 years of age (Mattlin 1978). Similar data have been reported for Australian fur seals (Shaughnessy & Warneke 1987), Galapagos fur seals, *Arctocephalus galapagoensis* (Bonner 1981), South American fur seals (Bonner 1981), subantarctic fur seals (Bester 1987), and Antarctic fur seals (Duck 1990). The youngest male fur seal in this study was 5 years old and showed some evidence of testicular maturity.

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. 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. However, such superficial lesions in pinnipeds are rarely seen and probably masked to a large extent by the dense pelage and tougher keratinised epidermis. Acute blunt trauma to the body may result in contusions, haemorrhage, and skeletal fractures that are apparent at necropsy. However, it is not possible to unequivocally attribute these lesions to a specific aetiology unless there is a history of entanglement for the animal in question. 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). 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 animal survives long enough. Similar changes, called coagulative myocytolysis, are associated with excessive endogenous catecholamine (adrenaline) release typical of trapped and stressed animals (Scazaks et al. 1959; Pack et al. 1994). This lesion also occurs in people who have suffered 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 therefore likely in traumatised and drowned pinnipeds.

A consistent finding in all animals examined for this study was acute pulmonary change indicative of asphyxiation. 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. Obstruction of airflow often resulted in bullous and lobular emphysema. Most animals 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. The former is due to endogenous catecholamine release while the latter can be induced by hypoxia (Szakacs et al. 1959; Lunt & Rose 1987; Pack et al. 1994). Both lesions are morphologically similar particularly in the peracute to acute stage of lesion development as seen in these sea lions. 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 sea lion myocardium and the death of the animal. Freezing may also induce changes that can be confused with true lesions. This problem needs to be addressed by conducting necropsies on a sample of sea lions as soon as possible after death and before they are frozen. Thus, they would need to be sampled on board the vessel as soon as they are hauled aboard. This should be conducted during the next fishing season.

Six (13%) pinnipeds also appeared to have myopathy of the diaphragm that was likely caused by agonal spasm of the muscle associated with asphyxia. As with the possible myopathy in the cardiac muscle, the diaphragmatic lesions should be further investigated by sampling fresh carcasses.

The severe trauma described for many of the animals would likely have compromised their survival had they not asphyxiated (Bakay & Glasau 1980; Cebelin & Hirsch 1980; Szakacs et al. 1959). Fifteen (31%) pinnipeds had also regurgitated stomach contents in the oesophagus and pharynx or respiratory tract. It is not possible to determine when regurgitation occurred relative to the exact time of death. However, regurgitated gastric contents in the upper alimentary tract could pose a risk of inhalation pneumonia if the animal survived the initial insult that caused reflux. Regurgitation was not always associated with other evidence of blunt trauma but nine of the 15 individuals with reflux exhibited some form of trauma ranging from the accumulation of blood in the abdomen to severe extensive contusion.

Only one previous CSL contract report has specifically addressed the pathological findings in New Zealand sea lions and fur seals (see Gibbs et al. Part 2). The causes of death in pinnipeds examined for this contract are similar to those found by Gibbs et al. (see Part 2) who reported that all 34 pinnipeds exhibited acute pulmonary change indicative of asphyxiation, and most animals also had acute cardiomyopathy (32 of 34, 94%). The number of animals with trauma and the severity of trauma appear to be slightly greater in 2000/01 compared to that reported by Gibbs et al. (see Part 2). The latter investigation found that 62% (n = 21) of animals had evidence of blunt trauma as compared to 73% (n = 35) in 2000/01. The lesions were judged to be severe in 38% (n = 8) of the animals caught in 1999/2000 but 51% (n = 18) of the animals caught in 2000/01 had severe lesions. The significance of this difference, if any, is not known.

In conclusion, the data suggest that most pinnipeds caught during the 2000/01 season died of acute pulmonary asphyxiation and cardiomyopathy. Many animals were also subjected to moderate to severe trauma that would likely have compromised survival had they not asphyxiated. Such trauma can result in severe muscular and abdominal haemorrhage. Trauma to the head may result in concussion that cannot be diagnosed in frozen carcasses. Head trauma can also result in endogenous catecholamine release from the adrenal glands that is known, at least in people, to cause lesions in 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 gastric reflux that, if aspirated, can cause foreign-body or aspiration pneumonia in animals that survive the initial impact.

5. Acknowledgements

Carcasses were submitted by government observers (Ministry of Fisheries). Assistance with necropsies was provided on occasion by Assoc. Prof. Maurice Alley, David Bolton, Simon Childerhouse, Urthe Engel, Jane E.B. Hunter, Per Madie, and Matthew Perrot. Assistance with sorting and identifying stomach contents was provided by Bruce Dix, Urthe Engel, Jane E.B. Hunter, and Per Madie. Workshop assistance for teeth preparation was provided by Barry Evans and Alton McDonald and team in Soil Sciences. Martin Cawthorn assisted with age determination. Barb Adlington processed intestinal contents for parasitology, and Kylie Walker carried out bacteriological culturing. Pat Davey prepared the histological slides. John Lumsden provided assistance with statistical analysis. Wendy Graham and Christine Bond provided secretarial assistance. Chris Edkins and Christine Vaughan mapped the catch locations. Reg Blezard was very helpful with access to information from the CSL observer program. We acknowledge the good will of the Department of Pathology in provision of facilities, storage space, use of the chiller, space for freezers, and for the inconvenience of having the post mortem room taken over by seals. Mike Hogan, Noel Rutherford and Faris Sharpe were particularly helpful in assisting with carcasses and disposal. Ian Wilkinson, Helen O'Leary, and Ian Mackenzie provided comments on the draft reports.

This is a client report funded from the Conservation Services Levy (DOC investigation nos. 96/3040, 99/3026, 00/3026).

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Appendix 1

TABLES OF RESULTS

(On following pages)

TABLE 3.1. CSL OBSERVER CAPTURE DATA FOR PINNIPEDS, 2000/01.

CODE	PATHOLOGY NO.	CSL TAG NO.	DATE	TIME (24 h)	LATITUDE	LONGITUDE	TAG* NO.	BRAND NO.	CHIP NO.
New Zealand sea lion—Females									
SB01-03Ph	32056	1221	Feb 01	2000	50°S	166°E	Scars BF		00-01 F0-9020
SB01-04Ph	32062	1222	Feb 01	2010	50°S	167°E			
SB01-05Ph	32063	1223	Feb 01	2100	50°S	166°E			
SB01-06Ph	32064	1218	Feb 01	0855	50°S	166°E			
SB01-09Ph	32079	1165	Feb 01	0700	50°S	166°E			
SB01-10Ph	32080	1164	Feb 01	0930	50°S	167°E			
SB01-11Ph	32081	1163	Feb 01	2000	50°S	166°E			
SB01-12Ph	32109	1104	Feb 01	0840	50°S	166°E			
SB01-15Ph	32126	1330	Mar 01	1220	50°S	166°E	Scars BF		00-01 F0-6099
SB01-16Ph	32129	1381	Feb 01	2148	50°S	166°E			
SB01-19Ph	32136	1331	Mar 01	1300	50°S	166°E			
SB01-20Ph	32137	1601	Mar 01	1435	47°S	166°E			
SB01-28Ph	32175	1319	Feb 01	0900	50°S	166°E	Scars BF	1421	00-02 10-26DA
SB01-29Ph	32176	1162	Feb 01	2000	50°S	167°E			
SB01-30Ph	32177	1155	Feb 01	1400	50°S	166°E			
SB01-31Ph	32178	1161	Jan 01	0840	50°S	166°E			
SB01-38Ph	32258	0556	Mar 01	1730	50°S	166°E			
SB01-39Ph	32259	1211	Apr 01	1855	50°S	166°E			
SB01-40Ph	32260	0557	Mar 01	0815	50°S	166°E			
SB01-42Ph	32270	0552	Mar 01	1500	49°S	166°E	0960 BF		
SB01-43Ph	32271	0553	Mar 01	2000	50°S	166°E			
SB01-44Ph	32277	0555	Mar 01	0805	50°S	166°E			
SB01-47Ph	32353	1661	May 01	2200	50°S	167°E			
SB01-48Ph	32373	1662	Jun 01	2200	50°S	166°E	Scars BF	1365	
New Zealand sea lion—Males									
SB01-07Ph	32077	1219	Feb 01	0855	50°S	166°E			
SB01-08Ph	32078	1103	Feb 01	1800	50°S	166°E			
SB01-13Ph	32110	0911	Feb 01	2035	50°S	166°E			
SB01-17Ph	32130	1156	Feb 01	0922	50°S	166°E			
SB01-18Ph	32131	1157	Feb 01	2030	48°S	167°E			
SB01-21Ph	32138	1329	Mar 01	1115	48°S	166°E			
SB01-22Ph	32156	1213	Mar 01	0740	50°S	166°E			
SB01-23Ph	32157	1217	Mar 01	0839	50°S	166°E	3580 RFO		
SB01-24Ph	32158	1216	Mar 01	0740	50°S	166°E			
SB01-25Ph	32165	1215	Mar 01	1217	50°S	166°E			
SB01-26Ph	32166	0901	Jan 01	1215	50°S	166°E			
SB01-27Ph	32167	1214	Mar 01	1935	50°S	166°E			
SB01-37Ph	32219	0554	Mar 01	0925	50°S	166°E			
SB01-41Ph	32261	1210	Apr 01	1305	49°S	166°E	2672 RFO		
SB01-45Ph	32278	1212	Apr 01	1855	49°S	166°E			
SB01-46Ph	32279	1124	Mar 01	1110	48°S	167°E			
New Zealand fur seal—Females									
SB01-01Af	31764	0864	Sept 00	0220	41°S	170°E	0658		
SB01-32Af	32195	0938	Oct 00	0555	46°S	165°E			
New Zealand fur seal—Males									
SB01-02Af	32055	1220	Feb 01	0830	50°S	166°E			
SB01-14Af	32111	1241	Feb 01	0800	48°S	166°E			
SB01-33Af	32196	0288	Jul 01	0410	42°S	169°E	0744		
SB01-34Af	32203	0935	Sept 01	0725	52°S	170°E			
SB01-35Af	32204	1159	Jan 01	1201	47°S	169°E			
SB01-36Af	32205	–	Sept 01	1620	52°S	171°E			

* BF = both flippers
RFO = right flipper only

TABLE 3.2. MORPHOMETRIC DATA FOR PINNIPEDS, 2000/01.

CODE	PATHOLOGY NO.	Wt (kg)	St L (m)	Gt Ax (m)	Blub S (m)
New Zealand sea lion—Females					
SB01-03Ph	32056	104.0	1.62	1.20	0.029
SB01-04Ph	32062	127.0	1.74	1.28	0.030
SB01-05Ph	32063	117.0	1.73	1.27	0.020
SB01-06Ph	32064	110.0	1.73	1.17	0.015
SB01-09Ph	32079	75.0	1.46	1.16	0.032
SB01-10Ph	32080	108.0	1.74	1.14	0.021
SB01-11Ph	32081	128.0	1.76	1.32	0.034
SB01-12Ph	32109	88.0	1.71	1.06	0.018
SB01-15Ph	32126	106.0	1.76	1.11	0.018
SB01-16Ph	32129	111.0	1.80	1.16	0.015
SB01-19Ph	32136	100.0	1.78	1.15	0.017
SB01-20Ph	32137	116.0	1.71	1.31	0.028
SB01-28Ph	32175	112.0	1.72	1.19	0.028
SB01-29Ph	32176	90.0	1.64	1.12	0.018
SB01-30Ph	32177	102.0	1.73	1.18	0.025
SB01-31Ph	32178	113.0	1.90	1.14	0.011
SB01-38Ph	32258	98.0	1.70	1.20	0.018
SB01-39Ph	32259	81.0	1.57	1.09	0.025
SB01-40Ph	32260	115.0	1.73	1.25	0.016
SB01-42Ph	32270	90.5	1.66	1.06	0.017
SB01-43Ph	32271	91.0	1.64	1.10	0.016
SB01-44Ph	32277	108.0	1.71	1.15	0.021
SB01-47Ph	32353	102.0	1.52	1.23	0.025
SB01-48Ph	32373	140.0	1.68	1.33	0.026
New Zealand sea lion—Males					
SB01-07Ph	32077	146.0	1.87	1.30	0.025
SB01-08Ph	32078	99.0	1.59	1.15	0.024
SB01-13Ph	32110	83.0	1.49	1.05	0.032
SB01-17Ph	32130	137.0	1.86	1.45	0.030
SB01-18Ph	32131	>230.0	2.20	1.43	0.011
SB01-21Ph	32138	235.0	2.44	1.60	0.020
SB01-22Ph	32156	171.0	1.94	1.40	0.025
SB01-23Ph	32157	178.0	2.04	1.36	0.025
SB01-24Ph	32158	110.0	1.73	1.21	0.030
SB01-25Ph	32165	170.0	2.03	1.40	0.025
SB01-26Ph	32166	120.0	2.11	1.43	0.018
SB01-27Ph	32167	110.0	1.83	1.20	0.028
SB01-37Ph	32219	148.0	2.21	1.55	0.021
SB01-41Ph	32261	167.0	2.02	1.40	0.021
SB01-45Ph	32278	227.5	2.21	1.50	0.028
SB01-46Ph	32279	277.0	2.51	1.58	0.028
New Zealand fur seal—Females					
SB01-01Af	31764	35.2	1.09	0.77	0.026
SB01-32Af	32195	37.0	1.14	0.83	0.024
New Zealand fur seal—Males					
SB01-02Af	32055	91.5	1.64	1.05	0.028
SB01-14Af	32111	71.0	1.48	0.99	0.018
SB01-33Af	32196	39.0	1.19	0.87	0.020
SB01-34Af	32203	110.0	1.57	1.22	0.028
SB01-35Af	32204	90.0	1.60	1.06	0.022
SB01-36Af	32205	128.0	1.63	1.32	0.067

Abbreviations in Table 3.2:
Wt = body weight
St L = standard body length (SBL)
Gt Ax = girth at axilla
Blub S = blubber depth at sternum

TABLE 3.3. STOMACH MORPHOMETRICS AND CONTENTS OF PINNIPEDS, 2000/01.

CODE	PATHOLOGY NO.	FULL WT (kg)	EMPTY WT (kg)	CONTENTS Wt (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES	PARASITES (Y/N)	ULCERS
New Zealand sea lion—Females								
SB01-03Ph	32056	3.15	1.03	2.13	Fish bones, otoliths, parts	–	Y	0
SB01-04Ph	32062	8.00	1.49	6.50	Fish otoliths, parts	Squid × 15, beaks, lenses, parts	Y	6
SB01-05Ph	32063	6.57	1.29	5.28	Fish bones, otoliths	Squid beaks, parts	Y	2
SB01-06Ph	32064	2.46	1.30	1.16	Fish otoliths, lenses	Squid × 3, beaks, lenses	Y	6
SB01-09Ph	32079	1.78	0.96	0.82	Fish otoliths × 2	–	Y	1
SB01-10Ph	32080	2.31	1.32	0.99	Fish bones, otoliths, lenses	Squid × 1, beaks, lenses	Y	0
SB01-11Ph	32081	4.67	1.81	2.86	Fish otoliths, lenses, parts	Squid × 2, beaks, lenses	Y	3
SB01-12Ph	32109	3.46	1.19	2.26	–	Squid × 2, beaks, lenses, parts	Y	5
SB01-15Ph	32126	3.90	1.48	2.41	Fish bones, otoliths, lenses, parts	Squid × 6, beaks, lenses	Y	0
SB01-16Ph	32129	2.66	1.36	1.30	Fish bones, otoliths, lenses	Squid × 1	Y	8
SB01-19Ph	32136	3.92	1.25	2.67	Fish × 1, bones, otoliths, lenses	Squid × 5, beaks, lenses, parts	Y	7
SB01-20Ph	32137	3.00	1.66	1.34	Fish bones, otoliths, lenses	Squid beaks, lenses, parts	Y	13
SB01-28Ph	32175	8.08	1.81	6.27	Fish otoliths, lenses	Squid × 47, beaks, lenses	Y	0
SB01-29Ph	32176	2.38	1.16	1.22	Fish bones, otoliths, lenses	Squid × 1	Y	0
SB01-30Ph	32177	2.10	1.60	0.50	Fish otoliths	Squid beaks, parts	Y	0
SB01-31Ph	32178	2.72	1.39	1.33	Fish bones, otoliths, lenses	Squid beaks. Octopus × 1	Y	0
SB01-38Ph	32258	3.90	1.22	2.68	Fish bones, otoliths, lenses, parts	Squid beaks, lenses, parts. Crayfish × 1	Y	0
SB01-39Ph	32259	3.90	0.80	3.10	Fish bones, otoliths	Squid × 28, lenses, parts	Y	0
SB01-40Ph	32260	7.70	1.70	6.00	–	Squid × 7	Y	9
SB01-42Ph	32270	5.50	1.10	4.40	Fish bones, otoliths, parts	Squid beaks, lenses	Y	6
SB01-43Ph	32271	8.40	1.30	7.10	Fish × 2, bones, otoliths	Squid × 13, beaks	Y	0
SB01-44Ph	32277	2.30	2.00	0.30	Fish × 1	Squid beaks	Y	0
SB01-47Ph	32353	8.10	1.20	6.90	Fish × 12, bones, otoliths	Squid × 5, beaks, lenses	Y	2
SB01-48Ph	32373	10.10	1.70	8.40	Fish × 5, otoliths, lenses	Squid × 9, beaks, parts	Y	0
New Zealand sea lion—Males								
SB01-07Ph	32077	2.82	1.59	1.23	Fish bones, lenses, parts	Squid × 2	Y	2
SB01-08Ph	32078	7.11	1.19	5.92	Fish bones, otoliths, lenses, parts	Squid × 11, beaks, lenses	Y	3
SB01-13Ph	32110	2.13	1.13	1.00	Fish bones, otoliths, lenses	Squid beaks, lenses, parts	Y	2
SB01-17Ph	32130	1.73	1.47	0.26	Fish otoliths, lenses	Squid beaks, parts	Y	5
SB01-18Ph	32131	3.66	2.81	0.84	Fish bones, otoliths	Squid × 1, beaks	Y	6
SB01-21Ph	32138	3.63	3.01	0.62	Fish bones, otoliths	–	Y	6
SB01-22Ph	32156	6.61	2.04	4.57	Fish × 2, bones, otoliths, lenses	Squid × 2, beaks, lenses, parts	Y	0
SB01-23Ph	32157	2.48	1.94	0.54	Fish bones, otoliths, lenses	Squid × 1, beaks, lenses	Y	4
SB01-24Ph	32158	1.75	1.21	0.54	Fish bones, otoliths, lenses	Squid beaks, lenses, parts	Y	1
SB01-25Ph	32165	3.24	2.24	1.00	Fish bones, otoliths, lenses, parts	Squid beaks, lenses	Y	28
SB01-26Ph	32166	2.22	1.95	0.27	Fish bones, otoliths	–	Y	0
SB01-27Ph	32167	5.52	1.26	4.27	Fish bones, otoliths, lenses, parts	Squid × 11, beaks, lenses	Y	2
SB01-37Ph	32219	4.17	2.80	1.37	Fish bones, otoliths	Squid beaks	Y	5
SB01-41Ph	32261	2.20	1.90	0.30	–	Squid beaks	Y	1
SB01-45Ph	32278	7.40	3.00	4.40	–	Squid × 61	Y	0
SB01-46Ph	32279	5.00	3.10	1.90	Fish bones, otoliths, lenses	Squid × 2, beaks, lenses	Y	0
New Zealand fur seal—Females								
SB01-01Af	31764	0.74	0.44	0.30	Fish × 7	–	Y	10
SB01-32Af	32195	0.98	0.73	0.25	Fish bones, otoliths, lenses	–	Y	8
New Zealand fur seal—Males								
SB01-02Af	32055	2.34	1.22	1.12	–	Squid	Y	8
SB01-14Af	32111	3.48	1.11	2.37	Fish otoliths, lenses	Squid × 10, beaks, lenses	Y	8
SB01-33Af	32196	0.64	0.52	0.12	Fish bones, otoliths, lenses	–	N	4
SB01-34Af	32203	7.81	1.82	5.98	Fish × 13, parts × 2	Squid part × 1	Y	3
SB01-35Af	32204	4.23	1.45	2.78	Fish bones	Squid × 5, beaks, lenses	Y	12
SB01-36Af	32205	7.91	1.52	6.39	Fish × 13	–	Y	24

TABLE 3.4. AGE ESTIMATION FOR PINNIPEDS, 2000/01. (For meanings of abbreviations see Table 2.4 on p. 56)

CODE	PATHOLOGY NO.	POST-CANINE TEETH Wt (g)	L (mm)	D (mm)	W (mm)	DENTINE GLGs	CEMENTUM GLGs	CANINE TEETH Wt (g)	L (mm)	D (mm)	W (mm)	ROOT RIDGES	GLGs	ACTUAL AGE
New Zealand sea lion—Females														
SB01-03Ph	32056	1.1	2.2	0.4	0.6	4	4	6.1	4.9	0.7	1.2	2	6	–
SB01-04Ph	32062	0.9	2.2	0.4	0.5	5	5	4.8	5.1	0.6	0.7	–	5–6	
SB01-05Ph	32063	0.8	2.3	0.3	0.4	3	4	5.0	5.1	0.6	0.9	–	3	
SB01-06Ph	32064	0.9	2.3	0.3	0.4	5	–	4.0	4.6	0.6	0.7	–	6	
SB01-09Ph	32079	0.7	2.2	0.3	0.4	8	4	3.8	4.4	0.6	0.8	–	4	
SB01-10Ph	32080	0.7	2.2	0.3	0.3	6	11	4.9	5.7	0.6	0.8	4	5	
SB01-11Ph	32081	1.2	2.3	0.5	0.6	5	4	5.8	5.0	0.8	1.0	–	5–6	
SB01-12Ph	32109	0.6	2.3	0.4	0.2	3	4	3.5	4.6	0.7	0.5	–	5	
SB01-15Ph	32126	0.8	2.4	0.3	0.5	8	13	4.2	4.8	0.6	0.9	–	6	8 (1993)
SB01-16Ph	32129	1.0	1.9	0.4	0.6	10	5	5.9	5.3	0.7	1.1	–	6–7	
SB01-19Ph	32136	0.7	2.2	0.3	0.4	8	7	4.4	4.9	0.6	0.9	–	3	
SB01-20Ph	32137	0.8	1.9	0.3	0.5	4	5	3.6	4.4	0.6	0.8	–	6	
SB01-28Ph	32175	1.0	2.1	0.3	0.5	8	6	4.4	5.0	0.7	0.7	–	>5	10 (1991)
SB01-29Ph	32176	0.8	2.4	0.3	0.4	5	5	4.2	4.8	0.7	0.8	–	5	
SB01-30Ph	32177	1.2	2.3	0.5	0.5	5	3	6.5	5.1	0.8	1.1	–	6	
SB01-31Ph	32178	0.9	2.1	0.3	0.5	7	5	4.1	4.9	0.7	1.0	–	6	
SB01-38Ph	32258	0.7	2.0	0.4	0.4	8	9	4.5	4.6	0.6	0.8	4	5–6	
SB01-39Ph	32259	0.7	2.1	0.2	0.3	5	6	2.7	4.2	0.5	0.9	–	3	
SB01-40Ph	32260	0.7	2.1	0.3	0.4	7	7	3.7	4.1	0.7	1.0	–	8	
SB01-42Ph	32270	0.8	2.3	0.3	0.5	9	2	4.0	4.4	0.6	0.9	–	5–6	–
SB01-43Ph	32271	0.7	2.4	0.3	0.4	2.5	3	2.8	4.3	0.5	0.9	–	3	
SB01-44Ph	32277	0.8	2.4	0.3	0.5	7		3.9	4.7	0.6	1.0	–	5–6	
SB01-47Ph	32353	0.6	2.4	0.6	0.7	9	7	2.9	4.2	0.4	0.8	–	>3	
SB01-48Ph	32373	0.8	4.2	0.5	0.7	6	7	3.9	4.4	0.5	0.8	–	4–5	–
New Zealand sea lion—Males														
SB01-07Ph	32077	0.9	2.2	0.4	0.4	5	5	13.8	6.3	1.2	2.1	6	6	
SB01-08Ph	32078	0.9	2.1	3.5	0.5	5	4	8.9	5.4	1.3	2.2	–	4	
SB01-13Ph	32110	0.9	2.4	0.3	0.5	8	6	8.3	5.5	1.5	2.2	–	3	
SB01-17Ph	32130	1.0	2.4	0.4	0.6	8	6	12.8	6.7	1.1	2.0	–	5–6	
SB01-18Ph	32131	1.1	2.0	0.4	0.5	9	8	26.1	7.4	1.2	2.3	7	10–11	
SB01-21Ph	32138	1.5	2.3	0.5	0.7	7	8	29.6	7.6	1.3	3.0	–	14	
SB01-22Ph	32156	1.1	2.2	0.4	0.6	4	4	16.0	6.5	1.3	2.0	3	9	
SB01-23Ph	32157	1.0	2.0	0.4	0.5	11	8	18.4	6.6	1.3	2.1	6	10	9 (1992)
SB01-24Ph	32158	1.0	2.2	0.4	0.5	5	5	9.9	5.8	1.1	1.9	3	5	
SB01-25Ph	32165	1.2	2.2	0.5	0.6	9	7	23.5	7.3	1.3	2.1	9–10	10	
SB01-26Ph	32166	0.9	1.9	0.4	0.5	9	9	24.7	7.2	1.5	2.5	–	9–10	
SB01-27Ph	32167	0.9	2.2	0.3	0.5	5	4	8.3	5.7	1.2	1.7	6	4	
SB01-37Ph	32219	1.2	2.2	0.4	0.5	9	9	17.9	6.7	1.3	1.9	–	10–11	
SB01-41Ph	32261	1.0	2.2	0.4	0.5	9	8	19.4	6.5	1.4	2.2	6	10	10 (1991)
SB01-45Ph	32278	1.6	2.4	0.5	0.6	7	7	30.0	7.7	1.5	2.4	9.5	10–11	
SB01-46Ph	32279	1.2	1.8	0.5	0.5	8	9	33.6	8.3	1.5	2.7	10	13–14	
New Zealand fur seal—Females														
SB01-01Af	31764(teeth damaged in preparation—to be repeated with reserved teeth)													
SB01-32Af	32195	0.3	1.4	0.3	0.1	2	1	1.1	3.5	0.3	0.5	–	>3	6.5
New Zealand fur seal—Males														
SB01-02Af	32055	0.9	2.1	0.3	0.5	4	5	9.0	5.7	1.9	2.2	–	5	
SB01-14Af	32111	0.3	1.2	0.2	0.1	7	8	5.1	4.4	0.6	1.0	7	8	
SB01-33Af	32196	0.2	1.2	2.0	2.0	4	3	4.0	4.6	0.5	1.2	4	5–6	
SB01-34Af	32203Tooth broke during preparation							7.8	6.0	0.8	1.5	10	9	6.5
SB01-35Af	32204	0.5	1.3	0.2	0.3	9	4	6.4	4.8	0.7	1.3	8	8	
SB01-36Af	32205	0.3	1.2	0.2	0.3	6	7.5	5.4	4.9	0.7	1.3	–	7–8	

TABLE 3.5. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS FOR PINNIPEDS, 2000/01 SEASON.

CODE	PATHOLOGY 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*	UTERUS MATURITY†	UTERUS PREGNANT	MILK PRESENT
New Zealand sea lion												
SB01-03Ph	32056	27	39 × 31 × 27	–	–	32	43 × 34 × 34	–	–	MA	N	N
SB01-04Ph	32062	17	34 × 33 × 20	–	19 × 16 × 10	26	41 × 39 × 22	27 × 18 × 19	–	MA	N	N
SB01-05Ph	32063	42	44 × 43 × 29	–	24 × 18 × 20	36	45 × 44 × 25	–	–	ML	N	Y
SB01-06Ph	32064	42	53 × 41 × 32	–	18 × 17 × 13	46	53 × 48 × 28	–	–	ML	N	Y
SB01-09Ph	32079	22	42 × 37 × 25	–	23 × 20 × 13	16	38 × 31 × 21	–	–	MA	N	N
SB01-10Ph	32080	37	45 × 44 × 33	24 × 22 × 18	–	30	44 × 40 × 27	–	19 × 14 × 12	ML	N	Y
SB01-11Ph	32081	27	40 × 36 × 27	Yes	–	35	44 × 41 × 31	–	15 × 12 × 13	ML	N	Y
SB01-12Ph	32109	20	36 × 35 × 28	Yes	–	28	41 × 35 × 28	–	21 × 19 × 17	ML	N	Y
SB01-15Ph	32126	21	33 × 30 × 25	Yes	–	27	40 × 36 × 28	–	20 × 17 × 13	ML	N	Y
SB01-16Ph	32129	24	35 × 35 × 26	–	–	28	38 × 34 × 28	–	17 × 17 × 14	ML	N	Y
SB01-19Ph	32136	36	50 × 38 × 29	–	26 × 23 × 16	27	41 × 40 × 25	–	–	MA	N	N
SB01-20Ph	32137	27	38 × 37 × 28	–	–	33	41 × 37 × 31	–	24 × 18 × 17	ML	N	Y
SB01-28Ph	32175	34	43 × 31 × 26	–	–	37	48 × 39 × 29	–	15 × 15 × 14	ML	N	Y
SB01-29Ph	32176	40	42 × 41 × 35	26 × 15 × 15	–	33	38 × 37 × 29	–	14 × 11 × 13	ML	N	Y
SB01-30Ph	32177	49	47 × 45 × 31	–	20 × 15 × 13	59	52 × 48 × 35	–	–	ML	N	Y
SB01-31Ph	32178	28	44 × 39 × 27	–	15 × 15 × 12	31	45 × 37 × 24	–	–	ML	N	Y
SB01-38Ph	32258	23	35 × 33 × 24	–	22 × 17 × 15	30	43 × 38 × 28	21 × 17 × 17	–	ML	N	Y
SB01-39Ph	32259	17	34 × 30 × 28	–	–	30	43 × 38 × 31	–	25 × 23 × 20	MA	N	N
SB01-40Ph	32260	26	43 × 39 × 23	–	–	32	40 × 35 × 30	–	21 × 20 × 19	ML	N	Y
SB01-42Ph	32270	28	40 × 39 × 30	–	18 × 16 × 14	25	39 × 36 × 31	–	–	ML	N	Y
SB01-43Ph	32271	26	37 × 36 × 30	–	19 × 17 × 13	28	39 × 34 × 26	–	–	MA	N	N
SB01-44Ph	32277	24	38 × 37 × 24	–	–	33	43 × 41 × 29	–	23 × 19 × 19	ML	N	Y
SB01-47Ph	32353	27	43 × 36 × 29	–	32 × 22 × 21	19	40 × 31 × 31	–	–	MG	Y	N
SB01-48Ph	32373	35	40 × 38 × 36	–	–	52	51 × 44 × 38	–	29 × 24 × 21	ML	N	Y
New Zealand fur seals												
SB01-01Af	31764	5	25 × 19 × 15	–	19 × 17 × 13	2	17 × 17 × 8	–	–	MG	Y	N
SB01-32Af	32195	3	18 × 15 × 11	–	–	2	16 × 15 × 10	–	–	MA	N	N

* CA = Corpus albicens; CL = Corpus lutem.

† IM = Immature; MA = Mature anoestrus; ML = Mature lactating; MG = Mature gravid; MLG = Mature lactating gravid.

TABLE 3.6. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS FOR PINNIPEDS, 2000/01.

CODE	PATH-OLOGY NO.	BACULUM L (mm)	RIGHT TESTIS			LEFT TESTIS			TESTIS MATUR-ITY*
			Wt + epid. (g)	Wt – epid. (g)	L × D (mm)	Wt + epid. (g)	Wt – epid. (g)	L × D (mm)	
New Zealand sea lion									
SB01-07Ph	32077	174	43	31	86 × 34	38	30	94 × 32	MI
SB01-08Ph	32078	140	31	25	71 × 28	34	27	72 × 30	MI
SB01-13Ph	32110	123	29	22	66 × 26	35	25	70 × 27	P
SB01-17Ph	32130	180	35	21	65 × 27	40	25	66 × 27	MI
SB01-18Ph	32131	186	64	53	107 × 38	49	36	84 × 35	MI
SB01-21Ph	32138	196	46	36	80 × 32	50	38	81 × 37	MI
SB01-22Ph	32156	170	53	38	72 × 35	56	40	80 × 37	MI
SB01-23Ph	32157	190	52	34	79 × 34	60	44	83 × 35	MI
SB01-24Ph	32158	160	25	16	56 × 26	32	21	63 × 26	MI
SB01-25Ph	32165	200	62	38	90 × 34	81	52	95 × 35	MI
SB01-26Ph	32166	190	49	33	75 × 30	55	38	77 × 31	MI
SB01-27Ph	32167	146	25	19	68 × 28	22	17	69 × 26	P
SB01-37Ph	32219	190	45	36	76 × 41	51	39	92 × 39	MI
SB01-41Ph	32261	195	35	22	71 × 31	38	25	73 × 30	MI
SB01-45Ph	32278	180	38	27	70 × 31	36	28	75 × 33	MI
SB01-46Ph	32279	195	55	38	80 × 36	59	40	78 × 36	MI
New Zealand fur seals									
SB01-02Af	32055	145	43	24	69 × 31	44	25	69 × 29	MI
SB01-14Af	32111	100	13	7	40 × 22	12	7	39 × 20	MI
SB01-33Af	32196	90	16	10	54 × 20	12	9	50 × 21	MI
SB01-34Af	32203	115	17	11	45 × 23	16	11	50 × 23	MI
SB01-35Af	32204	119	17	11	51 × 20	17	10	50 × 20	MI
SB01-36Af	32205	117	15	10	41 × 24	15	9	41 × 23	MI

* P = Pubertal, MA = Mature-active, MI = Mature-inactive.

LEGEND TO SYMBOLS ON TABLE 3.7

1 = Respiratory congestion and oedema

2 = Pulmonary emphysema

3 = Trauma (contusion, free blood in abdomen)

4 = Regurgitate in oral cavity or oesphagus

5 = Regurgitate in airways

I = Tracheal & bronchial congestion/haemorrhage

II = Bronchiole congestion/ haemorrhage

III = Bronchiole - catarrhal exudate

IV = Pulmonary interlobular/ lobular oedema/ congestion

V = Pulmonary aveolar emphysema

VI = Cardiac myofibre hypercontraction

VII = Cardiac myofibre fragmentation

VIII = Tricuspid valve oedematous and hemorrhagic

IX = Diaphragmatic myofibre hypercontraction

X = Diaphragmatic myofibre fragmentation

XI = Haemorrhage in aortic wall

TABLE 3.7. PATHOLOGY OF PINNIPEDS, 2000/01.

CODE	PATHOLOGY NO.	ENTANGLEMENT-RELATED PATHOLOGY		SLED
		GROSS	HISTOLOGICAL	
New Zealand sea lion—Females				
SB01-03Ph	32056	1, 2	IV, V	Not ejected
SB01-04Ph	32062	1, 2, 3, 4	IV, V, VI, VII	Not ejected
SB01-05Ph	32063	1, 2, 3, 4	IV, V, VI, VII, IX, X	Ejected
SB01-06Ph	32064	1, 2, 4	IV, V, VI, VII	Ejected
SB01-09Ph	32079	1, 2	I, IV, V, VI, VII	Ejected
SB01-10Ph	32080	1, 2	IV, V, VI, VII	Ejected
SB01-11Ph	32081	1, 2, 4	I, IV, V, VI, VII, IX, X	Ejected
SB01-12Ph	32109	1, 2, 3, 4	IV, V, VI, VII	Ejected
SB01-15Ph	32126	1, 2, 4	IV, V, VI, VII	Ejected
SB01-16Ph	32129	1, 2, 3	I, IV, V, VI, VII	Not ejected
SB01-19Ph	32136	1, 2, 3	IV, V, VI, VII	Not ejected
SB01-20Ph	32137	1, 2, 3	I, IV, V	Not ejected
SB01-28Ph	32175	1, 2, 3	I, IV, V, VI, VII	Not ejected
SB01-29Ph	32176	1, 2, 3	I, IV, V, VI, VII, IX, X	Ejected
SB01-30Ph	32177	1, 2, 3	I, IV, V, VI, VII	Ejected
SB01-31Ph	32178	1, 2, 3	I, II, IV, V, VI, VII	Ejected
SB01-38Ph	32258	1, 2, 3, 4	IV, V, VI, VII	Ejected
SB01-39Ph	32259	1, 2, 3, 4	I, IV, V, VI, VII	Ejected
SB01-40Ph	32260	1, 2	IV, V, VI, VII	Ejected
SB01-42Ph	32270	1, 2, 3	I, IV, V, VI, VII	Ejected
SB01-43Ph	32271	1, 2, 3	I, IV, V, VI, VII	Ejected
SB01-44Ph	32277	1, 2, 3, 4	IV, V, VI, VII, VIII	Ejected
SB01-47Ph	32353	1, 2, 3	IV, V, VI, VII	Scampi
SB01-48Ph	32373	1, 4	I, II, IV, V, VI, VII	Scampi
New Zealand sea lion—Males				
SB01-07Ph	32077	1, 2, 3, 4	I, IV, V, VI, VII	Ejected
SB01-08Ph	32078	1, 2, 4	IV, V, VI, VII	Ejected
SB01-13Ph	32110	1, 2, 3	I, IV, V, VI, VII	Ejected
SB01-17Ph	32130	1, 2, 3	IV, V	Ejected
SB01-18Ph	32131	1, 2, 3, 5	I, IV, V, VI, VII	No sled
SB01-21Ph	32138	1, 2, 3	IV, V, VI, VII	No sled
SB01-22Ph	32156	1, 3	II, IV, VI, VII	Ejected
SB01-23Ph	32157	1, 2, 3	IV, V, VI, VII	Ejected
SB01-24Ph	32158	1, 2, 3	IV, V, VI, VII	Ejected
SB01-25Ph	32165	1, 2, 3	IV, V, VI, VII, IX, X	Ejected
SB01-26Ph	32166	1, 2, 3	I, II, IV, V, VI, VII	Ejected
SB01-27Ph	32167	1, 2, 3	I, IV, V, VI, VII	Ejected
SB01-37Ph	32219	1, 2, 3	IV, V	Ejected
SB01-41Ph	32261	1, 2	I, IV, V, VI, VII, VIII	Ejected
SB01-45Ph	32278	1, 2, 3	IV, V, VI, VII	Ejected
SB01-46Ph	32279	1, 2, 3	I, IV, V, VI, VII	No sled
New Zealand seal—Females				
SB01-01Af	31764	1, 2	IV, V	Unknown
SB01-32Af	32195	1, 2, 3, 4, 5	I, II, IV, V, VI, VII, IX, X	Unknown
New Zealand seal—Females				
SB01-02Af	32055	1, 2, 3	I, IV, V, VI, VII	Unknown
SB01-14Af	32111	1, 2, 3	IV, V, VI, VII, XI	Unknown
SB01-33Af	32196	1, 2, 3	I, IV, V, VI, VII	Unknown
SB01-34Af	32203	1, 2, 4	I, IV, V, VI, VII, IX	Unknown
SB01-35Af	32204	1, 2, 3	I, IV, VI, VII	Unknown
SB01-36Af	32205	1, 2, 3	I, II, IV, V, VI, VII, XI	Unknown