Autopsy of pinnipeds incidentally caught in commercial fisheries, 2001/02

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ABSTRACT

Morphological characteristics, estimated age, gender, reproductive status, stomach contents, and cause of death were determined for 21 New Zealand sea lions (*Phocarctos hookeri*) and one New Zealand fur seal (*Arctocephalus forsteri*) killed incidentally in fishing operations. The sex ratio was biased, with a greater number of females than males examined. Stomach contents were examined for all animals. The stomach contents of the sea lions contained mixed vertebrate and invertebrate prey items, with squid predominating. The stomach of the fur seal was empty. An estimate of age was determined based on growth layer groups (GLGs) in the dentine of the lower left canine tooth. Where the actual age of the animals were known (n = 3) the estimated age was similar to the actual age. Male and female reproductive tracts were examined macroscopically and histologically to determine reproductive status. Female sea lions older than 3 years appear to have undergone oestrus. Of the 15 female sea lions examined, 11 were actively lactating, but two were not, suggesting that either they were not pregnant last season or had lost last season's pup. Two females were sexually immature. Although the data set is small, the results suggest that sea lions breed annually with a fecundity rate of 85%. Further research is required to elucidate the reproductive physiology of this species. Male sea lions and the male fur seal were all over 5 years of age and all had histologically mature gonads—which supports the previous finding that they reach sexual maturity well before behavioural maturity. All sea lions and the fur seal were retrieved from trawl 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. The occurrence of regurgitate in the airways, cranial trauma or moderate to severe blunt trauma suggests that 17 sea lions would have failed to survive capture. One sea lion was too decomposed and scavenged to determine if it would have survived capture.

Keywords: seals, sea lions, autopsy, stomach contents, estimated age, reproduction, pathology, New Zealand

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1. Introduction

The objective of this study was to fulfil the requirements of contract 01/3026 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 21 New Zealand sea lions (*Phocarctos hookeri*), and 1 New Zealand fur seal (*Arctocephalus forsteri)*.

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 centered on the Auckland Islands where major rookeries are located (Cawthorn et al. 1985; Crawley 1990). The sea lion was exploited commercially in the early 1800's 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 to be 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 other 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 was recently 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 (H. 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-miles 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.

2. Methods

2.1 NECROPSY PROTOCOL

Carcasses were delivered to Massey University, frozen and wrapped in clear plastic bags and woven nylon sacks. All animals 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 at –20°C until necropsy.

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:

SB02-07Ph

SB—seal bycatch, 02—year, 07—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 (mm) 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 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 reproductive organs were carefully dissected and stored in 10% buffered formalin. The mandible was dissected out, tagged and prepared for age determination.

2.2 PATHOLOGY

Assessment of survival prognosis was required to evaluate the Sea Lion Exclusion Device (SLED) which is being tested in the squid fishery. During the 2000/01 fishing season decision criteria for survival were based only on video evidence of animals in cover nets. It was felt that autopsies would not uncover differences in pathology between those animals ejected and those not rejected. When autopsies were conducted it became clear that there were differences in the extent of trauma between the two groups, and as a result in 2001 P.J. Duignan and I.S. Wilkinson revised the decision criteria to incorporate autopsy data for the 2001/02 season. Gross lesions consistent with acute trauma are classified based on criteria (Wilkinson 2001) as follows:

- Presence/absence of regurgitate in airways
- Presence/absence of cranial trauma
- Extent of blunt trauma

Trauma is classified as **mild** when limited to the abdomen, as **moderate** when limited to the thorax and abdomen unless it is extensive and involves haemorrhage from vital organs such as liver or kidney or perforation of the lungs in which case it is severe; and **severe** when lesions involve the head, neck, thorax and abdomen. In the view of the pathologist, the survival prognosis of animals suffering severe or moderate trauma would be poor. Likewise, regurgitate aspirated into the airways would indicate a poor prognosis if an animal were to be released after capture. Prior to the 2000/01 season, pathology findings were not included in the terms of the bycatch autopsy contracts and therefore the extent and severity of trauma was not recorded in as much detail as it has been since that season. Thus it will not be possible to classify the severity of trauma in animals that died prior to 1999 in a manner that is consistent with the methodology adopted and applied for the 2000/01 and 2001/02 seasons.

2.3 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. 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. Squid beaks and other relevant food material were also removed at this stage. Parasites were collected and preserved in 70% ethanol. Lesions in the gastric mucosa were described, counted, and examples were photographed.

2.4 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 and postcanine teeth were removed manually and cleaned. The teeth were weighed (Mettler PM 4800 Delta Range) and the length and greatest diameter measured using a Vernier calipers.

The canine teeth were then placed in sockets drilled into wooden blocks and mounted in place using Selley's Multipurpose Polymer Repair System (Selley's Chemical Company Ltd, Auckland). 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 neutralized by soaking for 4 hours in an ammonia solution (200 : l 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 (Stirling 1969). Reading was facilitated by wetting the surface of the cut section and by using a 10× magnifying loop.

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 –20°C, to produce 12 µm thick longitudinal sections from the center 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 without knowing which animals were tagged as pups.

2.5 REPRODUCTIVE STATUS

Females

The reproductive tracts were dissected out and examined grossly. The uterine horns were opened and examined for signs of pregnancy. The length, width and diameter of both ovaries were measured (mm) using Vernier calipers, and the ovaries weighed (g) using a Mettler PM 4800 Delta Range balance. 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 an ovary.

- ***Large CAs*** (mean diameter 7–10 mm) are clearly visible as a mass on the surface of the ovary and have a clearly defined stigma. Based on microscopic examination, there are few, if any, luteal cells, abundant fibrous connective tissue and numerous blood vessels. As the CA ages, the volume of connective tissue decreases relative to the number of vessels.
- ***Medium CAs*** (mean diameter 3.5–7 mm) protrudes less from the surface of the ovary. Histologically, most of the connective tissue is removed and the blood vessels are more prominent.

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

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

- ***Immature*** The endometrium 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.

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 calipers, 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.

3. Results

3.1 CATCH DATA AND OBSERVERS REPORTS

A total of 21 New Zealand sea lion carcasses were received consisting of 15 females and 6 males. There was one male fur seal. The CSL observer's data are recorded with the tag numbers, and the catch date and co-ordinates (see Appendix 1, Table A1.1). One seal lion was submitted without an orange CSL tag.

3.2 MORPHOMETRICS

An extensive set of standard measurements was taken from each carcass (Appendix 1, Table A1.2). These data will be further analysed in combination with data collected on incidentally caught pinnipeds from previous seasons (Gibbs, N.J., Duignan, P.J., Jones, G.W.: Age, sex, and reproductive status of bycaught New Zealand sea lions, *Phocarctos hookeri*. In prep.).

3.3 STOMACH CONTENTS

The stomach weight and the weight of its contents were recorded for each animal (Appendix 1, Table A1.3). Squid, probably the arrow squid and teleost fish were present in the stomachs of the sea lions. The stomach of the fur seal was empty. Most of the teleost fish were not sufficiently intact for gross identification to species level. However, otoliths and squid beaks were stored in 70% alcohol for more detailed analysis of diet at or immediately before the time of death. Less predominant items included stones and salps, which were found in the stomachs of three sea lions. Blubber samples were also stored for analysis of fatty acid signatures.

3.4 AGE DETERMINATION

The animals were aged using incremental growth layers (GLGs) in the dentine of canine teeth (Appendix 1, Table A1.4). Five female sea lions were tagged. Three of these animals were tagged as a pup and the tagging information and thus the actual age of the animal is presented in the table. For these animals, the estimated age is similar to the actual age, but the data set is too small for statistical analysis. The two other females were tagged as adults and, therefore, their tag number cannot determine their age.

The female sea lions (n = 15) had a mean age of approximately 6.7 years. Their age ranged from 1.5 to 12 years. For males (n = 6) the age range was from 5 to 14.5 years, and the mean age was approximately 8.5 years. The male fur seal was aged at 5 years.

3.5 REPRODUCTIVE STATUS

Females

Based on the presence of corpora albicantia or corpora lutea in serial ovarian sections, 13 of the 15 female sea lions were classed as having achieved reproductive maturity (Appendix 1, Table A1.5). These sexually mature females were aged between 3 and 12 years old. Eleven of the 13 (85%) mature females were lactating, thus had given birth in the summer they were caught, and had a CL in one ovary and sparse, inactive endometrial glands. This would suggest that implantation had not yet occurred. Of the two mature females with inactive mammary glands, both had a CL in one ovary and sparse, inactive endometrial glands. This suggests that that either they did not have a pup this season, or that they lost a pup and the mammary gland had involuted through lack of suckling. It also showed that implantation had not yet occurred. All females were caught in February, March, and April 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. Of the two remaining females that were aged as 1.5 and 3 years old, neither had CLs or CAs in either ovary, and both had poorly developed inactive mammary glands. The uterine wall was immature and it is most unlikely that these animals had undergone pregnancy and parturition.

Males

Based on examination of the testes, all six of the sea lions had histological features consistent with maturity (Appendix 1, Table A1.6). Only one animal was actively producing spermatozoa. The male fur seal was classed as mature-inactive based on testicular histology (Table A1.6). All the males were caught between February and April, thus the histological appearance of the testis is consistent with a regression of spermatogenesis outside the breeding season.

3.6 PATHOLOGY

Data on entanglement-related pathology is included in this report (Appendix 1, Table A1.7). It should be noted that freezing compromises the interpretation of subtle pathological changes.

All of the 21 New Zealand sea lions and the New Zealand fur seal entangled in commercial nets had moderate/severe pulmonary oedema and congestion. Ten sea lions and the fur seal also had pulmonary emphysema (Table A1.7). All the sea lions and the fur seal had myocardial hyper-contraction and hyper-eosinophilia; while some animals also had fibre fragmentation probably caused by acute stress and hypoxia. Two (9%) pinnipeds also had myopathy of the diaphragm. Twenty (95%) sea lions and the fur seal also had lesions indicative of acute blunt trauma. It was difficult to determine if there was blunt trauma in one animal because of the degree of scavenging and decomposition of the carcass. Regurgitation of stomach contents into the esophagus or airways was seen in eight (38%) sea lions. In all animals examined there were no other apparent pathological changes 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 necropsied.

For animals that had moderate to severe blunt trauma lesions, the trauma itself may have caused death either through concussion or release of catecholamines causing cardiac failure. Of the sea lions with trauma, the lesions were regarded as **mild**[1] and of limited extent over the abdomen or thorax for 4 (20%) of the animals. Lesions were classed as **moderate** when extensive areas of the thorax and abdomen of 3 (15%) animals were involved. Extensive lesions involving the thorax and abdomen for 2 (10%) animals were classed as **severe**, as were the lesions found in 11 (55%) of the sea lions where trauma involved the head, neck, thorax, and abdomen.

Of the 21 sea lions examined, 6 are known to have been ejected through Sea Lion Exclusion Devices (SLED) and subsequently caught in a cover net (Table A1.7). All of these six animals had traumatic lesions, two with **mild** lesions, and four with **severe** trauma. The three ejected female sea lions in this group with a severe classification also had regurgitate in the oesophagus or oral cavity, but not aspirated into the airways.

Of the 15 sea lions that were not ejected through a SLED, 5 (33%) had traumatic lesions and regurgitation; 7 (47%) had severe trauma without regurgitation; and 2 (13%) had mild to moderate trauma without regurgitation. One animal was too scavenged and decomposed to determine if there was blunt trauma.

A moderate level of acute blunt trauma was apparent in the fur seal examined.

The occurrence of regurgitated food in the airways (n = 1), or cranial trauma (n = 11), or moderate to severe trauma (n = 4) suggests that 16 sea lions would have failed to survive capture. Four sea lions had only mild contusions limited to either the thorax or abdomen, and no aspiration and may have survived the ejection. It is difficult to predict whether one animal (SB02-28Ph) would have survived the ejection process because of the degree of scavenging and

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[1] See Section 2.2 above for full definitions of the three trauma classifications.

decomposition. It is possible to say that the animal came to a sudden and unforeseen end in that it was in good body condition, was lactating, and had recently eaten. We do not know why this sea lion was badly scavenged, but it was presumably caught by another vessel and either disposed overboard without tagging, or ejected by a SLED that did not have a cover net, and was later caught by a second vessel. Further records on this animal may help decide what had happened to it.

3.6.1 Entanglement-related gross pathology for each pinniped

All the pathology reports are appended as Appendix 2.

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 an observer's report attached to the pectoral flipper with an orange plastic CSL tag. However, one sea lion did not have a CSL tag as the Independent Fisheries Ltd sent in this animal. 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 cross-check between animals shipped and those received. In that way, any animal that arrived without the observer's report or tag could be traced.

The number of sea lions submitted was less than that for previous contracts, with 21 animals examined in this study, compared to 23 examined from 1996 (Dickie 1999; Dickie & Dawson 2003), 27 from 1997/98 (Duignan 2003), 28 from 1999/2000 (Gibbs et al. 2003a) and 40 from 2000/01 (Gibbs et al. 2003b). The sex ratio was similar to that of a previous contract, with a bias towards females (71% female, 29% male) which is similar to 60% females and 40% males examined in 2000/01 (Gibbs et al. 2003b). This sex ratio was different to that of sea lions examined in other years with an equal sex ratio in 1996 and 1999/2000 (Dickie & Dawson 2003; Gibbs et al. 2003a) and a male bias in 1997/98 (Duignan 2003). Whether this reflects a skewed sex ratio in the total bycatch or just reflects the selection of animals 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 2003; Gibbs et al. 2003a, b). However, too few were examined to draw any conclusions.

The stomach contents of sea lions were similar to those examined by Dickie (1999), Duignan (2003) and Gibbs et al. (2003a, b). As in previous studies, the sea lion diet was more biased towards squid (Dickie 1999; Duignan 2003; Gibbs et al. 2003b). However, squid and teleost fish were equally represented in the stomachs of sea lions examined by Gibbs et al. (2003a). The difference may relate to the availability of squid during the early part of 2000 and in this regard, fisheries records may be informative. The stomach of the fur seal was empty.

Entire unidentified fish and numerous otoliths featured among the fish items present. However, specific identification of these prey items was beyond the scope of this contract. Eight sea lions 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 species under consideration, the number of known-age animals in the sample is too low to critically evaluate the ageing technique. In previous studies, a total of only 10 of 118 sea lions and 3 of 254 fur seals examined were known-aged (Dickie 1999; Duignan 2003; Gibbs et al. 2003a, b). In this study, 3 of 21 sea lions were known-age, which when combined with previous studies gives a total of 13 of 139 (9%) sea lions for which the age is known. Of the sea lions examined by Duignan (2003), Gibbs et al. (2003a, b), and this study, for which the tagging date was known, there was good agreement between the actual age and the estimated age.

Previous studies have used several methods of age determination including dentinal GLGs in canine teeth, root ridges of canine teeth, and both dentinal and cemental layers of post canine teeth. In a comparative study of age estimation techniques using tooth sections of known age South African fur seals (*A. pusillus pusillus*) it was found that the best correlation was between dentine layers in canine teeth and actual age. The post canine teeth of that species lacked dentinal layers and the cemental layers were not highly correlated with actual age (Oostuizen 1997). In this study we have used both canine and post canine teeth for age determination and all data are included in the table. However, as our preliminary data, and published data on other species (Oostuizen 1997) suggest that the dentine of canine teeth give the best estimate of age, we recommend using this estimate on New Zealand sea lions.

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 of age (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 two youngest animals (1.5 and 3 years) had histologically immature ovaries and had yet to undergo parturition. The remaining females ranged from 3 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). None of the females had a detectable fetus and were all caught in February and March, which if they had mated in December, would be too early for development of a fetus. More research is required into the reproductive cycle of the species. An interesting observation was that the uterus of one female (SB02-07Ph) contained the macerated or mummified remains of a foetus that would have been the pup for the 2001/02 season. The foetus died in utero and most of it had been resorbed, apart from one scapula and some unidentified remains. The cause of the foetal death is not known, but it is noteworthy that there was a marked decline in the number of pups born during the 2001/02 season (I. Wilkinson, DOC, unpublished observations). Two possible causes are an infectious agent such as *Campylobacter* sp. or *Salmonella* sp. causing foetal death or abortion. Alternatively, poor body condition of the female may have caused pregnancy to fail.

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 of age. 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 (*A. tropicalis*, Bester 1987), Australian fur seal (*A. pusillus doriferus*, Warneke 1979), and South American fur seal (*A. australis*, Reeves et al. 1992).

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 had sexually mature gonads at approximately 5 years of age. 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 (*A. galapagoensis*, Bonner 1981), South American fur seals (Bonner 1981), subantarctic fur seals (Bester 1987) and Antarctic fur seals (*A. gazella*, Duck 1990). This study supports these previous studies in that the male fur seal examined was 5 years old and had mature gonads.

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 however 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 (Szakacs 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 were 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. 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.

Two (9%) 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 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). Eight (36%) sea lions had regurgitated stomach contents in the oesophagus and oral cavity 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 aspiration (foreign-body) pneumonia if the animal survived the initial insult that caused reflux. Regurgitation was associated with other evidence of blunt trauma from the accumulation of blood in the abdomen to severe extensive contusion.

In conclusion, the data suggest that most pinnipeds caught during the 2001/02 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.

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Appendix 1

TABLES OF RESULTS

TABLE A1.1. CAPTURE DATA FOR NEW ZEALAND SEA LIONS AND FUR SEALS, 2001/02.

CODE	PATHOLOGY NO.	CSL NO.	DATE (D/M/Y)	LAT.(°S)	LONG. (°E)	DOC TAG NO.	BRAND	CHIP
New Zealand sea lion—Females								
SB02-07Ph	33038	1224	10 Feb 02	50	166	–	–	–
SB02-08Ph	33106	1012	3 Feb 02	50	166	–	–	–
SB02-10Ph	33108	1014	27 Feb 02	50	166	–	–	–
SB02-11Ph	33141	1342	28 Feb 02	50	166	–	–	–
SB02-13Ph	33192	902	21 Mar 02	49	166	3696	–	–
SB02-15Ph	33246	1108	17 Mar 02	50	166	dbl tag scars	–	00-05FE-7E79
SB02-16Ph	33247	1110	9 Apr 02	50	166	–	–	–
SB02-17Ph	33248	1647	21 Mar 02	50	166	–	–	–
SB02-18Ph	33293	1409	8 Apr 02	50	166	–	–	–
SB02-19Ph	33294	1408	10 Apr 02	50	166	dbl tag scars	–	00-01C2-DF2D
SB02-20Ph	33295	1407	10 Apr 02	50	166	–	–	–
SB02-21Ph	33296	1406	11 Apr 02	50	166	–	–	–
SB02-22Ph	33362	426	31 Mar 02	50	166	dbl tag scars	–	00-01C0-5389
SB02-23Ph	33363	427	1 Apr 02	50	166	B0646 o/r BF	–	00-01C7-F709
SB02-28Ph	33385	–	15 Mar 02	50	167	–	–	–
New Zealand sea lion—Males								
SB02-09Ph	33107	1013	6 Feb 02	50	166	–	–	–
SB02-12Ph	33184	702	23 Feb 02	48	167	–	–	–
SB02-24Ph	33366	430	1 Apr 02	50	166	–	–	–
SB02-25Ph	33370	429	1 Apr 02	50	166	–	–	–
SB02-26Ph	33371	428	1 Apr 02	50	166	–	–	–
SB02-27Ph	33372	1053	9 Apr 02	50	166	–	–	–
New Zealand fur seal—Males								
SB02-14Af	33245	1109	30 Mar 02	48 50S	167	–	–	–

– Indicates data is not available.

TABLE A1.2. MORPHOMETRIC DATA FOR NEW ZEALAND SEA LIONS AND FUR SEALS, 2001/02.

CODE	PATHOLOGY NO.	MATURITY	Wt (kg)	Std Lt (m)	Gt Pec (m)	Blub–V (m)
New Zealand sea lion—Females						
SB02-07Ph	33038	Adult	97	1.50	1.17	0.030
SB02-08Ph	33106	Adult	95	1.61	1.14	0.030
SB02-10Ph	33108	Adult	104	1.71	1.12	0.021
SB02-11Ph	33141	Adult	97	1.64	1.12	0.033
SB02-13Ph	33192	Adult	108	1.63	1.20	0.025
SB02-15Ph	33246	Adult	121	1.65	1.26	0.040
SB02-16Ph	33247	Adult	130	1.81	1.27	0.040
SB02-17Ph	33248	Adult	116	1.77	1.22	0.038
SB02-18Ph	33293	Adult	112	1.85	1.33	0.015*
SB02-19Ph	33294	Adult	127	1.66	1.29	0.030
SB02-20Ph	33295	Juvenile	49	1.39	0.86	0.030
SB02-21Ph	33296	Adult	85	1.57	1.12	0.025
SB02-22Ph	33362	Adult	121	1.73	1.26	0.030
SB02-23Ph	33363	Juvenile	69	1.42	0.98	0.027
SB02-28Ph	33385	Adult	–	1.69	1.14	0.025
New Zealand sea lion—Males						
SB02-09Ph	33107	SubAdult	125	1.82	1.21	0.030
SB02-12Ph	33184	Adult	215	2.18	1.48	0.052
SB02-24Ph	33366	SubAdult	134	1.87	1.22	0.025
SB02-25Ph	33370	SubAdult	121	1.74	1.19	0.023
SB02-26Ph	33371	Adult	167	1.94	1.37	0.030
SB02-27Ph	33372	Adult	226	2.23	1.57	0.045
New Zealand fur seals—Males						
SB02-14Af	33245	SubAdult	62.5	1.32	1.01	0.030

– Indicates data is not available.

* Decomposed.

TABLE A1.3. STOMACH CONTENTS OF NEW ZEALAND SEA LIONS AND FUR SEALS, 2001/02.

CODE	PATHOL-OGY NO.	FULL (kg)	EMPTY (kg)	CONTENTS (kg)	FISH AND FISH PARTS	SQUID AND INVERTEBRATES	OTHER	PARASITES (Y/N)	ULCERS*
New Zealand sea lion—Females									
SB02-07Ph	33038	3.10	0.98	2.13	Fish bones, otoliths, lenses	10 × squid, 8 mantles, beaks, lenses	–	Y	4
SB02-08Ph	33106	2.59	1.07	1.53	Fish pieces, bones, otoliths, lenses	2 × squid, beaks, lenses, salps, amphipods	–	N	N
SB02-10Ph	33108	6.42	1.40	5.01	Fish otoliths	16 × squid, 1 mantle, beaks, lenses	–	Y	1
SB02-11Ph	33141	2.37	1.43	0.94	3 × fish otoliths	1 × squid, 4 mantles, pieces, beaks, lenses	–	Y	N
SB02-13Ph	33192	2.56	1.67	0.90	Fish bones	2 × squid mantles	Fluid	Y	N
SB02-15Ph	33246	5.28	1.02	4.26	Fish otoliths, lenses	17 × squid, beaks, octopus beaks	Stones (273 g)	Y	N
SB02-16Ph	33247	3.67	2.03	1.64	Fish bones, otoliths, lenses	2 × squid, beaks, lenses	–	Y	N
SB02-17Ph	33248	6.85	1.36	5.49	Fish bones, otoliths, lenses	10 × squid, 4 heads, beaks, lenses, parts	–	Y	N
SB02-18Ph	33293	2.23	1.57	0.66	Fish otoliths	1 × squid, crab carapace	Stones	N	N
SB02-19Ph	33294	2.26	1.52	0.74	Fish bones, otoliths, lenses	1 × squid, beaks, lenses	–	Y	N
SB02-20Ph	33295	1.41	0.58	0.83	Fish bones, otoliths	2 × squid, beaks, parts	–	Y	N
SB02-21Ph	33296	2.57	1.06	1.51	Fish bones, otoliths, lenses	Squid parts, beaks, lenses, salps	Stones (209 g)	Y	N
SB02-22Ph	33362	2.23	1.68	0.55	Fish bones	Squid parts, beaks, lenses	–	Y	N
SB02-23Ph	33363	2.03	0.92	1.12	Fish bones, otoliths	4 × squid, beaks, lenses, octopus beaks	Fluid	Y	N
SB02-28Ph	33385	4.07	1.36	2.72	Fish parts, otoliths, lenses	4 × squid, parts, beaks, lenses, salps	–	Y	N
New Zealand sea lion—Males									
SB02-09Ph	33107	1.81	1.59	0.22	1 × small fish, otoliths	–	–	N	N
SB02-12Ph	33184	3.62	2.86	0.76	1 × fish, bones, otoliths, lenses	–	–	N	N
SB02-24Ph	33366	2.13	1.56	0.57	Fish otoliths	1 × squid, beaks, lenses, parts	–	Y	N
SB02-25Ph	33370	1.34	1.34	0.00	–	–	–	Y	N
SB02-26Ph	33371	2.18	1.81	0.38	–	1 × squid	–	Y	
SB02-27Ph	33372	5.19	2.59	2.60	Fish bones	4 × squid, parts, beaks, lenses	–	Y	
New Zealand fur seal—Males									
SB02-14Af	33245	0.853	0.853	–	–	–	–	N	N

– Indicates data is not available.

* N = no ulcers found.

TABLE A1.4. AGE ESTIMATION BASED ON DENTINAL GROWTH LAYER GROUPS OF CANINE TEETH FROM NEW ZEALAND SEA LIONS AND FUR SEALS, 2001/02.

CODE	PATH-OLOGY NO.	POST CANINE TEETH*				DENTINE LAYERS	CEMENTUM LAYERS	CANINE TEETH*				ROOT RIDGES	GLGS†	ACTUAL AGE‡
		Wt (g)	L (mm)	D (mm)	W (mm)			Wt (g)	L (mm)	D (mm)	W (mm)			
New Zealand sea lion—Females														
SB02-07Ph	33038	0.66	22.6	6.2	4.8	9.5	6.5	2.3	40.7	8.6	7.3		8	
SB02-08Ph	33106	0.81	25.6	6.6	4.7	6.0		2.08	48.5	10.3	8.7		6	
SB02-10Ph	33108	0.91	25.4	6.9	5.5	6.5	4	3.9	50.8	11.6	7.9		8	
SB02-11Ph	33141	0.79	27	6.3	5	4.0	3	3.75	49.2	11.3	8		4	
SB02-13Ph	33192	0.89	25.2	7.3	5.5	9.0	8	3.5	43.6	11.2	8		9	10
SB02-15Ph	33246	1.46	28.8	8.4	5.9	8.5	3.5	5.71	51	11.5	8.8	5	5	
SB02-16Ph	33247	0.84	27.3	6.5	4.5	5.5	4.5	5.53	50.4	10.7	9.3	4	6	
SB02-17Ph	33248	0.74	24	6.3	4.7	10.0	5	4.34	49.1	9.1	8	7	10	
SB02-18Ph	33293	1	25.4	6.8	5.2	9.0	8.5	7	52.2	12.6	9.6		9	
SB02-19Ph	33294	0.84	21.9	6.5	4.8	7.5	4	5.93	50.5	11.8	9.5		7	
SB02-20Ph	33295	0.53	21.4	5.8	4.2	13.5		2.43	40.4	8.6	7.2	8	2	
SB02-21Ph	33296	0.76	23.8	5.9	5.3	4.5	3	4.08	45	10.3	8.4		4	
SB02-22Ph	33362	1.46	10.8	3.3	2.3	4.0		5.29	21.3	4.9	3.4		9	10
SB02-23Ph	33363	0.84	9.8	2.6	1.9	5.5	2	2.53	16.2	4.5	2.6		3	3
SB02-28Ph	33385	0.89	22.2	7.0	5.4	6.0	3.5	5.48	48.1	11.5	9.5		12	
New Zealand sea lion—Males														
SB02-09Ph	33107	1.11	24	8.2	5.8	8.5	3	12.92	61.7	22.1	14.3	6	9	
SB02-12Ph	33184	1.32	22.3	7.5	5.9			6.14	62.3	15.2	9.8	8	9	
SB02-24Ph	33366	0.99	10.7	2.7	2.1	5.0	4.5	15.73	26.5	8.4	6		5	
SB02-25Ph	33370	0.78	8.7	2.5	1.8	6.5	3.5	12.21	25.1	7.9	5.6		6	
SB02-26Ph	33371	1.17	9.4	3.0	2.3	7.5	6.5	29.23	29.5	9.7	6.1		8	
SB02-27Ph	33372	1.78	11	3.5	3			34.4	31.4	10.1	7		15	
New Zealand fur seal—Males														
SB02-14Af	33245	0.36	14.8	5.0	4.1	5.5	5	8.75	57.9	15.7	9.8		5	

* Wt = Weight; L = Length from tip to root; D = depth from outside to inside at gum line; W = width.

† GLG = Growth layer groups in dentine.

‡ Actual age from tag data.

TABLE A1.5. FEMALE REPRODUCTIVE TRACT MORPHOMETRICS AND CHARACTERISTICS OF NEW ZEALAND SEA LIONS, 2001/02.

CODE	PATH-OLOGY NO.	RIGHT OVARY				LEFT OVARY				UTERUS MATUR-ITY†	UTERUS PREGNANT (Y/N)	MILK PRESENT (Y/N)
		WT (g)	L × W × D (mm)	CA*	CL*	WT (g)	L × W × D (mm)	CA*	CL*			
New Zealand sea lion												
SB02-07Ph	33038	30	42	–	–	41	46	–	22 × 22	ML	N	Y
SB02-08Ph	33106	23	40 × 37 × 28	–	27 × 18 × 16	20	38 × 35 × 24	–	–	ML	N	Y
SB02-10Ph	33108	34	45 × 34 × 29	–	–	34	40 × 38 × 30	–	17 × 17 × 12	ML	N	Y
SB02-11Ph	33141	33	41 × 37 × 32	19 × 17	–	33	42 × 36 × 31	–	18 × 17 × 15	ML	N	Y
SB02-13Ph	33192	27	41 × 33 × 27	–	–	43	49 × 44 × 35	–	26 × 23 × 22	ML	N	Y
SB02-15Ph	33246	42	47 × 42 × 35	–	27 × 24 × 19	28	42 × 35 × 28	–	–	ML	N	Y
SB02-16Ph	33247	18	32 × 32 × 24	–	36 × 28 × 19	35	41 × 38 × 34	–	–	ML	N	Y
SB02-17Ph	33248	52	53 × 45 × 34	–	24 × 20 × 24	37	44 × 36 × 31	–	–	MA	N	N
SB02-18Ph	33293	33	46 × 41 × 29	Moderate	–	43	53 × 42 × 33	–	23 × 21 × 22	ML	N	Y
SB02-19Ph	33294	18	31 × 30 × 25	–	–	34	40 × 42 × 30	–	21 × 21 × 16	ML	N	Y
SB02-20Ph	33295	8	28 × 24 × 20	–	–	12	29 × 28 × 20	–	–	IM	N	N
SB02-21Ph	33296	14	31 × 29 × 22	–	–	28	38 × 35 × 31	–	22 × 18 × 15	MA	N	N
SB02-22Ph	33362	34	46 × 38 × 28	–	20 × 20 × 18	21	39 × 36 × 21	–	–	ML	N	Y
SB02-23Ph	33363	19	38 × 35 × 23	–	–	21	37 × 33 × 25	–	–	P	N	N
SB02-28Ph	33385	26	42 × 36 × 26	–	22 × 17 × 12	19	34 × 35 × 22	–	–	ML	N	Y

* CA = Corpus albicans, CL = Corpus luteum.

† ML = Mature lactation, MA = Mature anoestrus, IM = Immature, P = Pubertal.

– Indicates data is not available.

TABLE A1.6. MALE REPRODUCTIVE MORPHOMETRICS AND CHARACTERISTICS, 2001/02.

CODE	PATH-OLOGY NO.	BACULUM Lt (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 MATURITY*
New Zealand sea lion									
SB02-09Ph	33107	170	39	26	80 × 30	37	26	85 × 30	MA
SB02-12Ph	33184	200	42	26	70 × 31	45	29	72 × 35	MIA
SB02-24Ph	33366	170	35	25	72 × 28	37	26	77 × 25	MIA
SB02-25Ph	33370	170	47	35	80 × 35	51	39	80 × 31	MIA
SB02-26Ph	33371	180	49	31	72 × 32	42	27	71 × 34	MIA
SB02-27Ph	33372	205	46	30	73 × 33	49	30	71 × 31	MIA
New Zealand fur seal									
SB02-14Af	33245	100	10	Moderate	37 × 23	11	7	41 × 24	MIA

* MA = Mature–active, MIA = Mature–inactive.

TABLE A1.7. PATHOLOGY OF NEW ZEALAND SEA LIONS AND FUR SEALS, 2001/02.

LEGEND TO SYMBOLS ON TABLE A1.7

1 = Respiratory congestion and oedema
2 = Pulmonary emphysema
3 = Cranial trauma (contusion)
4 = Other blunt trauma (contusion, free blood in abdomen)
5 = Regurgitate in oral cavity or oesphagus
6 = Regurgitate in airways
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
IX = Diaphragmatic hypercontraction

CODE	PATH-OLOGY NO.	ENTANGLEMENT-RELATED PATHOLOGY GROSS	ENTANGLEMENT-RELATED PATHOLOGY HISTOLOGICAL	SEVERITY TRAUMA	LIKELY TO SURVIVE	SLED	EJECT-ED
New Zealand sea lion—Females							
SB02-07Ph	33038	1, 4, 5	I, III, IV, VI, VII	Mild	Y	N	
SB02-08Ph	33106	1, 2, 4	IV, VI, VII	Mild	Y	Y	Y
SB02-10Ph	33108	1, 2, 3, 4, 5	I, IV, VI, VII	Severe	N	Y	Y
SB02-11Ph	33141	1, 2, 4	I, IV, VI	Mild	Y	Y	Y
SB02-13Ph	33192	1, 4	IV, VI	Moderate	N	N	
SB02-15Ph	33246	1, 2, 4, 5	IV, VI, VII, IX	Severe	N	Y	Y
SB02-16Ph	33247	1, 3, 4, 5	IV, VI	Severe	N	Y	Y
SB02-17Ph	33248	1, 3, 4, 5	I, IV, VI, VII	Severe	N	N	
SB02-18Ph	33293	1, 4, 5, 6	IV, VI	Moderate	N	Y	N
SB02-19Ph	33294	1, 4, 5	I, IV, VI, VII	Moderate	N	Y	N
SB02-20Ph	33295	1, 3, 4	I, IV, VI	Severe	N	Y	N
SB02-21Ph	33296	1, 2, 3, 4	IV, VI, VII	Severe	N	Y	N
SB02-22Ph	33362	1, 3, 4	IV, VI, VII	Severe	N	N	
SB02-23Ph	33363	1, 4	IV, VI, VII	Mild	Y	N	
SB02-28Ph	33385	1, 2	IV, VI	–	?	?	
New Zealand sea lion—Males							
SB02-09Ph	33107	1, 3, 4	IV, VI, VII	Severe	N	Y	Y
SB02-12Ph	33184	1, 2, 3, 4, 5	IV, VI, VII	Severe	N	N	
SB02-24Ph	33366	1, 2, 3, 4	IV, VI, VII	Severe	N	N	
SB02-25Ph	33370	1, 2, 3	I, IV	Severe	N	N	
SB02-26Ph	33371	1, 2, 3	IV, VI, VII	Severe	N	N	
SB02-27Ph	33372	1,4	I, IV, VI, IX	Severe	N	N	
New Zealand fur seal—Males							
SB02-14Af	33245	1, 2, 4	I, IV, VI, VII	Moderate	N	Y	

Appendix 2

ENTANGLEMENT-RELATED PATHOLOGY

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

SB02-07Ph (CSL 1224)

External No visible lesions.

Internal There was evidence of mild blunt trauma with haemorrhage of the muscle along the caudo-ventral sternum around the ziphoid cartilage (23 × 8 cm), and the dorsal aspect of the shoulder (12 × 8 cm). The animal was in excellent body condition with good fat reserves in the blubber and around the heart and kidneys.

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

Respiratory The pulmonary parenchyma had moderate diffuse congestion and oedema. There was a small volume of fluid in the airways.

Cardiovascular No visible gross lesions.

Urogenital There are the remains of a mummified or macerated foetus in the left uterine horn. The remains consist of a recognizable scapula 12 mm in width and some other degraded tissues.

Diagnosis Asphyxiation, mild trauma to thorax, and regurgitation. Intrauterine foetal death.

Prognosis Unlikely to survive.

SB02-08Ph (CSL 1012)

External No visible lesions.

Internal There was evidence of mild blunt trauma with erythema of the blubber and haemorrhage of the superficial muscle over the right shoulder (17 × 16 cm). The animal was in good body condition with good fat reserves in the blubber, around the heart and reniculi of the kidneys, and in the peritoneal wall.

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

Respiratory Bloody fluid was observed in the trachea and bronchi. The pulmonary parenchyma had severe diffuse congestion, interlobular oedema and alveolar emphysema. The cranial mediastinal lymph node was enlarged and active with large follicles apparent in the cortex.

Cardiovascular No visible lesions.

Diagnosis Asphyxiation and mild trauma to thorax.

Prognosis Likely to survive.

SB02-09Ph (CSL 1013)

External No visible lesions.

Internal There was evidence of moderate to severe blunt trauma with erythema of the blubber and deep haemorrhage of the muscle along the ventral sternum and left lateral thorax. There was also severe blunt trauma along the dorsal surface of the cranium along the cranial crest. There was free blood (approx. 1 L) in the abdominal cavity. The animal was in good body condition with good internal fat reserves and deep blubber.

Alimentary The stomach was mostly empty with contents consisting of one small whole fish, and some fish otoliths.

Respiratory Bloody fluid was observed in the lumen of the trachea, bronchi and bronchioles. The tracheal mucosa was congested. The pulmonary parenchyma had severe diffuse congestion. It was not possible to determine if there was emphysema.

Cardiovascular No visible lesions.

Urogenital There was subcapsular haemorrhage over the caudal half of both kidneys.

Diagnosis Asphyxiation and severe trauma to head, thorax and abdomen.

Prognosis Unlikely to survive.

SB02-10Ph (CSL 1014)

External There was a 10 mm perforation through the left side of the neck extending into the jugular vein. There was haemorrhage in the blubber and cervical muscle for 60 mm surrounding the perforation suggesting that it occurred pre-mortem.

Internal There was evidence of moderate to severe blunt trauma with erythema of the blubber and deep haemorrhage of the muscle along the ventral sternum and lateral thorax. There was also severe blunt trauma over the cranium extending over the dorsal surface from the first cervical vertebrae (C_1) to the nose, and laterally over the zygomatic arches. There was free blood in the thoracic and abdominal cavities. The animal was in good body condition with good internal fat reserves and a deep blubber layer.

Alimentary There was a whole squid in the thoracic oesophagus. The stomach was full with contents consisting of 16 whole squid, squid beaks, lenses, and pieces, and fish otoliths.

Respiratory Bloody fluid and stable froth was observed in the lumen of the trachea and bronchi. The tracheal and bronchial mucosae were congested. The pulmonary parenchyma had multi-focal bullous emphysema and diffuse interlobular oedema that was most severe at the periphery of the lung lobes.

Cardiovascular No visible lesions.

Renal There was focal subcapsular haemorrhage on both kidneys.

Diagnosis Asphyxiation;severe trauma to head, thorax and abdomen; regurgitation.

Prognosis Unlikely to survive.

SB02-11Ph (CSL 1342)

External The second inter-phalangeal joint of the fifth toe of the right pelvic flipper was ankylosed and associated with an external callus on the skin. There was faecal material staining the perianal hair.

Internal There was evidence of mild contusion along the ventral sternum consisting of erythema of blubber and haemorrhage of the muscle, extending from the manubrium to the ziphoid cartilage. The animal was in excellent body condition, with good fat reserves in the blubber, peritoneum, in the pericardium and along the coronary veins, and around the reniculi of the kidneys.

Alimentary The stomach was mostly empty with one whole squid, some squid pieces, beaks, lenses, and three fish otoliths.

Respiratory There was white froth in the buccal cavity and trachea, and blood stained froth in the bronchi and bronchioles. The pulmonary parenchyma had severe diffuse congestion and oedema. There was diffuse bullous emphysema with occasional lobular emphysema in the periphery of both lung lobes.

Cardiovascular No visible lesions.

Renal The right kidney had subcapsular haemorrhage along the dorsal surface.

Diagnosis Asphyxiation and mild trauma to the thorax and abdomen.

Prognosis Likely to survive.

SB02-12Ph (CSL 0702)

External No visible lesions.

Internal There was severe cranial trauma characterised by retro-bulbar and intra-ocular haemorrhage of the right eye and contusion along the dorsal surface of the skull extending caudally from the interocular area to the occipital bones, and laterally to the ear. The right side of the snout had subcutaneous haemorrhage and there was haemorrhage in the nasal sinuses. In addition, there was also evidence of mild blunt trauma with erythema of the blubber and haemorrhage of the superficial pectoral muscle along the ventral sternum extending at intervals from the manubrium to the ziphoid cartilage. There was free blood (approximately 1.5 L) in the abdomen. The animal was in excellent body condition with good fat reserves in the blubber, peritoneum, pericardium and epicardium of the heart, and between the reniculi of the kidneys.

Alimentary One whole fish was lodged in the pharyngeal cavity. The stomach was empty of digestible material, with contents consisting of fish bones and otoliths.

Respiratory Bloody fluid was observed in the trachea, bronchi and bronchioles. The pulmonary parenchyma had severe diffuse congestion and oedema. There was scattered sub-pleural bullous emphysema over all lung lobes.

Cardiovascular No visible lesions.

Urogenital There was sub-capsular haemorrhage along the dorsal surface of both kidneys. There was free blood in the scrotal sacs of both testes, and the epididymis was congested.

Diagnosis Asphyxiation; severe trauma to the cranium, thorax and abdomen; regurgitation.

Prognosis Unlikely to survive.

SB02-13Ph (CSL 0902)

External There was a round yellow tag in the right pectoral flipper only, numbered 3696. The fur was moulting around the flippers. There was sand around the flippers and the perianal hair.

Internal There was extensive, moderate blunt trauma with erythema of the blubber and deep haemorrhage of the pectoral muscle along the ventral sternum and left lateral thorax. There was free blood (approx. 1 L) in the abdomen. The animal was in good body condition with good internal fat reserves.

Alimentary The stomach was mostly empty with contents consisting of two partially digested squid mantles, some small fish bones, fluid and froth.

Respiratory There was mild laryngeal congestion. The tracheal and bronchial mucosae were congested, and there was bloody froth in the bronchi and lower airways. The pulmonary parenchyma had severe diffuse congestion, with marked interlobular and interstitial oedema.

Cardiovascular No visible lesions.

Urogenital No visible lesions.

Diagnosis Asphyxiation and moderate trauma to thorax and abdomen.

Prognosis Unlikely to survive.

SB02-14Af (CSL 1109)

External There was a scar on the dorsal surface of the right pelvic flipper, possibly from a shark bite.

Internal There was focal blunt trauma along the thorax and scapulae characterised by erythema of the blubber and deep muscular haemorrhage along the ventral thorax, and the ventral and dorsal aspects of both scapulae. There was free blood (approximately 0.5 L) in the abdomen. The animal was in excellent body condition with good fat reserves in the blubber.

Alimentary The oesophageal mucosa was stained yellow, which was likely to be caused by bile as the animal had not fed recently. The stomach was empty.

Respiratory Bloody fluid was observed in the trachea, bronchi and bronchioles. There was white stable froth, and blood-stained froth in the trachea and bronchi. The tracheal and bronchial mucosae were congested. The pulmonary parenchyma had severe diffuse congestion and oedema. There was occasional alveolar emphysema mostly around the periphery of the lobes.

Cardiovascular No visible lesions.

Urogenital There was sub-capsular haemorrhage extending from the cranial pole to midway along both kidneys.

Endocrine The adrenal medullae were congested.

Diagnosis Asphyxiation and moderate trauma to the thorax and abdomen.

Prognosis Unlikely to survive.

SB02-15Ph (CSL 1108)

External Both pectoral flippers had tag scars and the first lower left postcanine was missing. There was a small biopsy scar along the right dorsal pelvis, and the tip of the second digit of the right pelvic flipper was missing. All these features indicate the female was a study animal of the DOC sea lion population management team. Using an Allflex chip reader, a microchip was located in the dorsal pelvic area. It was removed but has yet to be identified using a Trovan chip reader, as the two systems are incompatible for chip identification. There was no inflammatory reaction of the tissues surrounding the microchip. The fur was moulting around the flippers.

Internal There was severe blunt trauma with erythema of the blubber extending for a depth of 2.5 cm, and deep haemorrhage of the pectoral muscle along the ventral thorax. There was also haemorrhage of the subscapular muscle along the ventral and dorsal aspects of the right scapula that extended caudally along the intercostal muscles of the thorax. The ventral abdominal blubber and mammary gland were congested and there was free blood (approx. 1 L) in the abdomen. The animal was in excellent body condition with good internal fat reserves.

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

Respiratory The tracheal and bronchial mucosae were congested. There was blood-stained froth and bloody fluid in the lumen of the trachea, bronchi and bronchioles. The pulmonary parenchyma had severe diffuse congestion, with marked interlobular and interstitial oedema. There was occasional alveolar emphysema in the periphery of the lobes.

Cardiovascular No visible lesions.

Urogenital There was mild subcapsular haemorrhage over the cranial poles of both kidneys. There was congestion around the cervix and in the left uterine endometrium.

Diagnosis Asphyxiation, severe trauma to thorax and abdomen, and regurgitation.

Prognosis Unlikely to survive.

SB02-16Ph (CSL 1110)

External Both eyes were congested and blood was oozing from the nose. The fur was moulting around the flippers and along the ventral thorax and abdomen. There was a small scar in the webbing between the second and third digits of the left pelvic flipper. A small (50 × 5 mm) open wound was observed on the ventral pad of the left pelvic flipper. The tip of the third digit of the right pelvic flipper was lacerated and attached by a small piece of tissue.

Internal There was severe extensive blunt trauma over the animal, characterised by erythema of the blubber extending up to a depth of 2.0 cm at some sites, and deep muscular haemorrhage. There was contusion along the

dorsal and lateral aspects of the skull, along the snout, and left lateral mandible. In addition, there was intraocular haemorrhage in both eyes. In the cervical region, the blubber, superficial ventral cervical muscles, ventral cervical spinal muscle (*Longissimus colli*) and the cervical oesophageal serosa were haemorrhagic. The ventral thorax, abdomen (including the mammary gland), and the cranial and dorsal aspects of the sub-scapular muscle of both shoulders were congested or haemorrhagic. There was free blood in the abdomen (approx. 1 to 2 L), and the internal cavities of the carcass appeared congested with free blood present.

Alimentary There was regurgitated food in the mouth and oesophagus. The stomach was mostly empty of digestible material with contents consisting of two whole squid, beaks, lenses and fish bones, otoliths and lenses.

Respiratory The tracheal and bronchial mucosae were severely congested. There was froth and bloody fluid in the airways. The pulmonary parenchyma was diffusely congested and oedematous. There was a single tapeworm larva in the left diaphragmatic lung lobe.

Cardiovascular No visible lesions.

Urogenital There was subcapsular haemorrhage along the medial aspect of the left kidney, and along the cranial pole of the right kidney.

Diagnosis Asphyxiation, severe trauma to cranium, thorax and abdomen, regurgitation.

Prognosis Unlikely to survive.

SB02-17Ph (CSL 1647)

External The hair was moulting around the flippers and along the ventral abdomen. There was a healing rip in the webbing between the first and second digits of the right pelvic flipper.

Internal There was severe blunt trauma characterised by erythema of the blubber and haemorrhage of the muscle along the dorsal aspect of the skull and neck and along the right lateral mandible. There was mild contusion along the ventral thorax. There was free blood (approx. 1 to 2 L) in the abdomen. The animal was in excellent body condition, with good internal fat reserves.

Alimentary There was a regurgitated squid in the oesophagus. The distal thoracic oesophageal mucosa had a small (15 mm) ulcer. The stomach was full of 10 whole squid, squid parts and fish bones, otoliths and lenses.

Respiratory The tracheal and bronchial mucosae were severely congested. There was froth and bloody fluid in the airways. The pulmonary parenchyma had severe diffuse congestion and oedema.

Cardiovascular No visible lesions.

Urogenital The dorsal and lateral aspects of both kidneys had subcapsular haemorrhage.

Diagnosis Asphyxiation, severe trauma to cranium, neck, thorax and abdomen; regurgitation.

Prognosis Unlikely to survive.

SB02-18Ph (CSL 1409)

External There were scavenger marks in the skin over the leading edges of the pectoral flippers and around the genital aperture. Both eyes were missing and the tips of the pelvic flippers were scavenged.

Internal The maxillary gingivae were scavenged and the remaining tissue was macerated and sloughing from the bone. There was moderate blunt trauma along the dorsal surface of the thorax characterised by haemorrhage of the subscapular muscle along the ventral and dorsal aspects of the scapulae. There was free blood in the abdomen. The animal was in moderate body condition.

Alimentary There were regurgitated stomach contents in the mouth, oesophagus and distal nasal passages. The stomach was mostly empty and contents consisted of one whole squid, fish bones and otoliths, a crab exoskeleton and two stones.

Respiratory There was a large (65 × 13 mm) fish fin in the lumen of the distal bronchus in the left caudal lung lobe. The tracheal mucosa was separating from the underlying lamina propria as a result of decomposition. The pulmonary parenchyma was moderately and diffusely congested and oedematous.

Cardiovascular No visible lesions.

Diagnosis Asphyxiation, moderate trauma to thorax and abdomen; aspiration.

Prognosis Unlikely to survive.

SB02-19Ph (CSL 1408)

External There was a scar caudal and ventral to the right ear that was probably from a fistula associated with a cervical abscess as seen during the 1998 epidemic. There was a small puncture wound (through blubber layer only) along the ventral thorax near the insertion of the right pectoral flipper. There were tag scars in both flippers and the first lower left postcanine tooth was missing. These features indicate the female was a study animal of the DOC sea lion population age-structure project. Using an Allflex chip reader, a microchip was located in the dorsal pelvic area. It was removed and has been identified as 00-01C2-DF2D. There was no inflammatory reaction of the tissues surrounding the microchip.

Internal There was blunt trauma along the ventral thorax and abdomen, characterised by moderate erythema of the blubber and haemorrhage of the muscle extending deeply to the muscle adjacent to the ribs. There was free blood in the abdomen. The animal was in excellent body condition, with good fat reserves in the blubber.

Alimentary There was regurgitated food in the mouth and oesophagus. The distal (thoracic) oesophageal mucosa had a small (35 x 7 mm) ulcer. The stomach was mostly empty of digestible material, with contents consisting of one whole squid, eye lenses and squid beaks, fish bones, otoliths and lenses, and some nematode worms.

Respiratory The tracheal mucosa was mildly congested. There was bloody fluid and froth in the airways. The pulmonary parenchyma had marked diffuse congestion and interlobular oedema.

Cardiovascular No visible lesions.

Urogenital There was subcapsular haemorrhage over both kidneys that extended over the hilar aspect and the cranial pole of the right kidney, and over the medial and cranial aspects of the left kidney.

Endocrine The thyroid was large and the left and right sides were connected ventrally by a thick isthmus. There was a large abscess along the right lateral and ventral aspects of the gland that exuded a thick white discharge on incision.

Diagnosis Asphyxiation, moderate trauma of the thorax and abdomen; regurgitation.

Prognosis Unlikely to survive.

SB02-20Ph (CSL 1407)

External There was a small puncture wound through the blubber along the ventral thorax near the insertion of the right pectoral flipper. There was a large (70 × 50 mm) subcutaneous haematoma on the dorsal aspect of the skull. Both eyes were congested.

Internal There was free blood in the abdominal cavity. The animal was in excellent body condition, with good fat reserves.

Alimentary There was a small (10 mm) ulcer in the distal (thoracic) oesophageal mucosa. The stomach was half full with contents consisting of squid, squid parts, and beaks, and fish bones, otoliths and nematode worms.

Respiratory There was bloody fluid and froth in the airways. The pulmonary parenchyma had severe diffuse congestion and oedema.

Cardiovascular No visible lesions.

Urogenital There was subcapsular haemorrhage over the cranial pole of the left kidney.

Lymphatic The thymus was present and well developed.

Diagnosis Asphyxiation and severe trauma to the cranium and abdomen.

Prognosis Unlikely to survive.

SB02-21Ph (CSL 1406)

External No visible lesions.

Internal There was moderate blunt trauma over the ventral thorax and along the cranial and dorsal aspects of both scapulae. There was also marked erythema of the blubber and haemorrhage of the muscle over the left mandible, and over the left lateral and dorsal aspects of the cranial crest. There was free blood in the abdomen (approx. 2 L). The animal was in good body condition.

Alimentary The stomach was half full of squid pieces, salps, stones, and fish bones, otoliths and lenses. The serosal surface of the intestines appeared congested.

Respiratory There was froth in the laryngeal cavity, bronchi and bronchioles. There was also bloody fluid in the airways. The pulmonary parenchyma had severe diffuse congestion and oedema. There was occasional alveolar and bullous emphysema, which was predominantly along the periphery of all the lung lobes.

Cardiovascular No visible lesions.

Urogenital Both kidneys had subcapsular haemorrhage over the cranial pole and dorsal aspects.

Lymphatic The spleen was congested and enlarged.

Diagnosis Asphyxiation and severe trauma to the cranium, thorax and abdomen.

Prognosis Unlikely to survive.

SB02-22Ph (CSL 0426)

External There were tag scars in both flippers and the first lower left postcanine tooth was missing. A microchip was found along the dorsal pelvic region, the number was 00-01C0-5389. There was no reaction by the surrounding tissue to the microchip. The eyes contained blood stained fluid. The fur was moulting around the pelvic and pectoral flippers.

Internal There was moderate trauma along the ventral thorax with erythema of the blubber and haemorrhage of the muscle that extended deep in the layers adjacent to the ribs. Trauma was also evident along the dorsal and cranial aspects of both scapulae. More severe trauma was observed with haemorrhage over the dorsal and left parietal aspects of the skull. The mammary gland was well-developed and actively secreting milk. The caudal half of the left gland and the cranial one-third of the right gland had extensive necrosis of the gland with accumulations of caseous exudate, which was yellow and granular or fluid in appearance. Some acini were dilated with apparently normal clotted milk. There was free blood in the abdomen. The animal was in excellent body condition, with good fat reserves in the blubber, as well as in the peritoneum, pericardium and greater and lesser omenta.

Alimentary The stomach had scant contents that consisted of squid pieces, beaks, lenses and a few fish bones.

Respiratory There was bloody fluid in the airways. The tracheal and bronchial mucosae were congested. The pulmonary parenchyma had severe diffuse congestion and oedema.

Cardiovascular No visible lesions.

Lymphatic The left axillary lymph node had a small white granular lesion in the parenchyma.

Diagnosis Asphyxiation, and moderate to severe trauma to the cranium and thorax. Necrotizing mastitis.

Prognosis Unlikely to survive.

SB02-23Ph (CSL 0427)

External There were tags in both pectoral flippers. The tags were round and orange and were numbered as B0646. A microchip was located in the pelvic region and identified as 00-01C7-F709. There was no reaction by the surrounding tissues to the microchip. The fur was moulting around the pelvic and pectoral flippers.

Internal There was mild blunt trauma along the ventral thorax with erythema of the blubber and haemorrhage of the superficial muscle only. There was scant free blood in the abdomen. The animal was in good body condition and had a deep blubber layer.

Alimentary There was clear froth in the mouth. There were scant stomach contents consisting of four whole squid, squid beaks, lenses, fish otoliths and bones, and fluid.

Respiratory The tracheal and bronchial mucosae were mildly congested. There was bloody fluid and froth in the airways. The pulmonary parenchyma had marked diffuse congestion and oedema.

Cardiovascular No visible lesions.

Urogenital No visible lesions.

Diagnosis Asphyxiation and mild trauma to the thorax and abdomen.

Prognosis Likely to survive.

SB02-24Ph (CSL 0430)

External The fur is moulting around the flippers. The eyes appear congested.

Internal There was blunt trauma along the ventral thorax with erythema of the blubber and haemorrhage of the superficial muscle layers. There was also contusion over the parietal lobes of the skull that extended deeply into the masseter muscle adjacent to the cranium. There was free blood (approx. 2 L) in the abdominal cavity. The animal was in good body condition and had good internal fat reserves.

Alimentary There were scant stomach contents consisting of one whole squid, beaks, lenses, pieces and two fish otoliths.

Respiratory There was bloody fluid and froth in the airways. The tracheal and bronchial mucosae were congested. The pulmonary parenchyma had severe diffuse congestion and oedema. There was occasional alveolar emphysema around the periphery of the cranial and medial lobes.

Cardiovascular No visible lesions.

Urogenital There was free blood in the tunica vaginalis surrounding the left testes. There was subcapsular haemorrhage over the dorsal, cranial and caudal aspects of the right kidney, and over the dorsal and medial aspects of the left kidney.

Lymphatic The spleen was enlarged and congested. The thymus was present but residual.

Diagnosis Asphyxiation and severe trauma to the cranium, thorax and abdomen.

Prognosis Unlikely to survive.

SB02-25Ph (CSL 0429)

External There was a large scar along the dorsal surface of the first and second digits of the right pelvic flipper, which may be the result of a shark bite. There was froth in the nasal passages.

Internal There was severe blunt trauma over the left and right parietal lobes of the skull. There was free blood in the abdomen. The animal was in good body condition.

Alimentary The oesophageal mucosa was stained yellow and there was pale yellow liquid in the lumen that is likely to be sea-water stained by bile. The stomach was empty.

Respiratory There was froth in the distal nasal passages, bronchi and bronchioles. There was also bloody fluid in the airways. The bronchial mucosa was congested. The pulmonary parenchyma was severely and diffusely congested and oedematous. There was diffuse alveolar emphysema in all the lobes.

Cardiovascular No visible lesions.

Urogenital Both kidneys had subcapsular haemorrhage with haemorrhage over the cranial pole and medial aspect of the right kidney, and over the dorsal aspect of the left kidney. There was free blood in the tunica vaginalis surrounding both testes, and the testes and epididymis were congested.

Diagnosis Asphyxiation and severe trauma to the cranium and abdomen.

Prognosis Unlikely to survive.

SB02-26Ph (CSL 0428)

External The eyes were distended, opaque and apparently blood-filled. An unusually large volume of blood leaked from the nares while the animal was thawing (approx. 4 L over a 12-hour period).

Internal There was evidence of blunt trauma with erythema of the blubber and haemorrhage of the muscle and subcutaneous tissues over the left side of the snout. There was also intraocular haemorrhage of the left eye. There was free blood (approx. 2 L) in the abdomen. The animal was in excellent body condition, with good fat reserves in the blubber, behind the eyes, peritoneum, and pericardium, between the reniculi of both kidneys and in the greater and lesser omenta.

Alimentary There were 12 circular impressions (ranging from 5 to 10 mm in diameter) in the mucosa along the length of the oesophagus. There was also a small (17 × 5 mm) ulcer in the mucosa of the thoracic section of the oesophagus. The stomach was mostly empty with contents consisting of one whole squid and some nematode worms.

Respiratory There was bloody fluid and froth in the airways. The pulmonary parenchyma had severe diffuse congestion and oedema. There was occasional lobular emphysema in all the lobes.

Cardiovascular No visible lesions.

Urogenital Both kidneys had subcapsular haemorrhage with haemorrhage over the cranial pole of the right kidney and over the dorsal aspect of the left kidney. There was free blood in the tunica vaginalis surrounding both testes.

Diagnosis Asphyxiation and severe trauma to the cranium and abdomen.

Prognosis Unlikely to survive.

SB02-27Ph (CSL 1053)

External This male had a well-developed mane. The fur is moulting over the flippers. There is scarring around the lips, and over the chin, snout and body, likely from fighting with conspecific animals.

Internal There was evidence of blunt trauma with erythema of the blubber and haemorrhage of the muscle over the ventral thorax and over the cranial aspect of the left scapula. There was also trauma over both sides of the snout and over the left parietal lobe of the skull. There was free blood (approx. 2 L) in the abdomen. The animal was in excellent body condition, with good fat reserves in the blubber, behind the eyes, in the peritoneum, pericardium and connective tissues around lymph nodes, between the reniculi of both kidneys and in the greater and lesser omenta.

Alimentary All the teeth were moderately worn and stained. The stomach caontained four whole squid, squid pieces, beaks, lenses, fish bones and some nematode worms.

Respiratory There was bloody fluid and froth in the airways. The pulmonary parenchyma had severe, diffuse, congestion and oedema.

Cardiovascular No visible lesions.

Urogenital Both kidneys had subcapsular haemorrhage with haemorrhage over the ventral, caudal and medial aspects of the right kidney and over the dorsal and cranial aspects of the left kidney. There was free blood in the tunica vaginalis surrounding both testes, and the testes and epididymis were congested.

Lymphatic There was a large (51 × 45 × 29 mm) solid mass in the parenchyma at the cranial pole of the spleen and protruding from the parietal surface. This may be a tumour or organized haematoma but diagnosis awaits histological examination.

Diagnosis Asphyxiation and severe trauma to the cranium, thorax and abdomen.

Prognosis Unlikely to survive.

SB02-28Ph (No tag)

External Small amphipods and possibly fish had been scavenging on the carcass. Both eyes have been scavenged and were missing. The tongue was missing and the buccal cavity had been scavenged. The skin was intact around the cranial and cervical region, but the tissues have been scavenged from the inside leaving exposed bone such as the cranium, vertebrae and hyoid bones once the skin was removed. There were scavenger marks around the genital and anal apertures and around the nipples. Some intestinal coils were projecting out of the anus. There was a shark scar along the right side of the ventral surface of the abdomen, just caudal to the second nipple. There was also damage to the right pelvic flipper, also presumably caused by an old shark bite. The webbing between the third and fourth digits was lacerated, and the first phalange of the fourth digit has been severed from the remainder of the digit and is attached only through the webbing between the fourth and fifth digits.

Internal There was no evidence of blunt trauma. The mammary gland was well developed and actively secreting milk. There are a large number of amphipods in the abdomen, and around the cervical and cranial regions, which is where most of the scavenger damage can be found. The internal organs are intact. The animal was in good body condition, with good fat reserves in the blubber, in the peritoneum and pericardium, and between the reniculi of both kidneys.

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

Respiratory There was bloody fluid in the airways. The pulmonary parenchyma had severe, diffuse, congestion and oedema. There was occasional alveolar emphysema.

Cardiovascular No visible lesions.

Urogenital No visible lesions. Most of the reproductive tract had been scavenged, with only parts of the uterine horns and the ovaries remaining.

Diagnosis Asphyxiation. The state of the carcass precludes the detection of further injuries that may have incurred as a result of incidental capture in the fishing net.

Prognosis Unknown likelihood of survival.