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Necropsy of marine mammals captured in New Zealand fisheries in the 2008–09 fishing year

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EXECUTIVE SUMMARY

Roe, W.D. (2010). Necropsy of marine mammals captured in New Zealand fisheries in the 2007–08 fishing year.

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Necropsies were performed on three New Zealand sea lions (*Phocarctos hookeri*) returned from the SQU 6T fishery in the 200809 fishing season. All were caught between 21 February and 24 April 2009. No other pinnipeds were returned for necropsy. Confirmation of species and sex, and morphometric characteristics, age class, stomach contents, reproductive status, and entrapment-related pathology are described.

Two of the sea lions were females and one was male. Both females were sexually mature and had corpora lutea (evidence of a current pregnancy) in their ovaries. Neither had milk in their mammary glands, hence they did not have a pup at the time of capture. The male was sexually mature, with active spermatogenesis evident on histological examination of his testes.

All three sea lions had lesions consistent with drowning/asphyxia, including pulmonary congestion and oedema, and foam in the airways. All had lesions consistent with blunt trauma to the body, comprising bruising involving 5% or less of the surface area of the trunk. None had any skeletal fractures, and none had evidence of body cavity trauma. Two had focal areas of bruising in the muscles of the head or neck: these were the only lesions found that were thought likely to affect survivability, had these animals been able to escape the net. The overall severity of trauma was therefore assessed as minor in one animal and moderate in two.

1. INTRODUCTION

This report details findings from the 2008–09 fishing season, during which three New Zealand sea lions (*Phocarctos hookeri*) were returned for examination. The objectives of this study were as follows.

Overall objectives

1. To necropsy marine mammals captured incidentally to New Zealand fishing operations during the 2008–09 fishing year to determine life-history characteristics such as sex, reproductive status, and the likely cause of mortality, and to determine the species and sex of captured animals returned for necropsy.

Specific objectives

1. To determine, through examination of returned carcasses, the species, sex, reproductive status, and age-class of sea lions and fur seals captured in New Zealand fisheries.

2. To detail any injuries and, where possible, the cause of mortality of sea lions and fur seals returned from New Zealand fisheries, and examine relationships between injuries and body condition, breeding status, and other associated demographic characteristics.

2. METHODS

2.1 General necropsy protocol

Carcasses were delivered to Massey University, frozen and wrapped in clear plastic bags and woven nylon phages (sacks). Conservation Services Programme (CSP) data sheets (completed by on-board observers in the SQU 6T fishery), are usually returned with the bodies. On receipt, the carcasses were frozen at –20 °C until necropsy could be undertaken.

The species and sex of each animal were determined based on external morphology using the expertise of the examiner. Each animal was assigned three codes: the CSP code as submitted, a Massey University pathology code (five digits), and a unique code to identify the animal's provenance and species as follows:

SB05-01Ph:
SB—Seal bycatch, 05 — year, 01 — animal number, and Ph — abbreviation of species scientific name (*Phocarctos hookeri*).

Pathological examination and sampling was conducted according to a standard protocol (Roe, W. 2009). The procedure includes recording the body weight (kg) and external measurements (m), followed by examination of the carcass for external lesions indicative of trauma, for example, skin wounds or fractures. Significant lesions were documented on a body map diagram. The body was then opened along the ventral midline and the blubber depth (mm) was recorded over the mid-sternum. A small skin sample was collected from the pectoral or pelvic flipper and stored in 70% ethanol for future genetic analysis. The skin and hair were removed, and any bruising was noted on a body map diagram, with an assessment of the amount of the body involved, location, and depth of the bruising. Blubber samples were collected from the dorsal aspect of the pelvis and from the ventral sternum/pectoral area and stored at –80 °C as part of an ongoing research project assessing the use of fatty acid signature analysis for dietary investigation. In females the mammary gland was sliced at 5–10 mm intervals along its length to evaluate the presence of milk, and samples were collected into buffered formalin for microscopic analysis.

The body cavity was then opened. Abdominal fluid was removed and measured. Tissue samples were collected from lung, liver, spleen, and kidneys and frozen at –20 °C. These tissues can be used for virology, bacteriology, and toxicology at a later date. All organs were examined for evidence of trauma or disease as they were removed. The tongue, trachea, and oesophagus were dissected out and removed along with the lungs. The trachea and lower airways were opened and examined, and multiple incisions were made into the lung tissue. The heart was opened and all chambers and walls examined. The stomach was removed, tied off, and frozen at –20 °C until the contents could be examined. The liver, spleen, kidneys, hepatic sinus, and large blood vessels were carefully examined for evidence of tears or rupture prior to dissection or removal. In females, the reproductive tract was dissected out and the uterine horns were opened and examined for signs of pregnancy. A sample of uterus was collected into buffered formalin. The length, width, and depth of the ovaries were measured (mm), and the ovaries weighed (g). The ovaries were examined grossly for the presence of corpora lutea (CL; evidence of a current pregnancy) and corpora albicantia (CA; evidence of a previous pregnancy). Both ovaries were saved in buffered formalin. In males, the testes were removed, weighed, and measured and a sample was saved in buffered formalin. Kidney capsules were removed and the kidney was examined for evidence of trauma or disease.

The head was carefully skinned and examined for bruising and fractures. The mandible was dissected out, tagged, and frozen at –20 °C for future ageing by cementum or dentine analysis of teeth. The brain was then removed by sectioning the head with a band-saw and carefully breaking down attachments between the skull and brain tissue. The surface of the brain was examined grossly and the brain was then fixed in buffered formalin for at least two weeks. Once adequately fixed, the brain was removed and again examined grossly for detection of bruising (contusions).

2.3 Pathology

During the necropsy particular note was taken of any lesions that might be attributable to trauma.

The aim of this was to assist in monitoring the effectiveness of sea lion exclusion devices (SLEDs) deployed in vessels in order to exclude sea lions and other large non-target species from nets. These lesions can include fractures, bruising, and damage to internal organs.

Traumatic lesions were assessed in three categories: body wall subcutaneous/skeletal, cranial, and body cavity. The severity of trauma in each category was then subjectively assessed as follows:

-subcutaneous/skeletal trauma was classified as mild, moderate, or severe based on the amount of tissue involved, the depth of bruising, and the presence or absence of ante-mortem skeletal fractures.
-cranial trauma was assessed as mild, moderate, or severe based on extent of tissue involved and depth of bruising. If haemorrhage was present within the skull or in the brain tissue, trauma was classified as severe.
-body cavity haemorrhage was classified as moderate or severe based on the presence and volume of blood present in these cavities and the specific organs involved (e.g., liver, spleen, large vessels).

A subjective assessment of the overall severity of trauma (mild, moderate, or severe) was then given based on the assumed combined effect of trauma in each category. These results are included in Appendix 1.

2.4 Stomach content analysis

The stomachs were weighed (kg), opened using scissors and all material was washed into a 1 mm sieve. The stomach was then re-weighed to determine the weight of the stomach contents. Large, relatively undigested material was then removed. Smaller, more digested material was gradually sorted using a black-bottomed tray. Otoliths, squid beaks, eye lenses, fish bones, and other relevant food material were collected and stored in 70% alcohol for more detailed analysis of diet.

2.5 Histological (microscopic) analysis

Tissues were fixed in 10% buffered formalin before preparation for microscopic analysis. Briefly, this involved trimming tissues into 2 mm blocks, then embedding them in paraffin for routine histochemical processing. Processed tissues were sectioned at 5 µm intervals using a microtome, mounted on glass slides, and stained with haematoxylin and eosin before being examined under a light microscope.

Testes were examined microscopically to assess the maturity of the seminiferous tubule epithelium and evaluate the presence of spermatozoa. The microscopic characteristics of the testicular and epididymal tissue, in conjunction with the combined weight of the testes (summed testicular mass), of an individual male enable its classification as sexually mature (with active or inactive spermatozoa production as appropriate), immature, or pubertal.

Ovaries were examined to confirm the presence of corpora lutea or albicantia as assessed grossly. The uterine horns were also examined to assess the maturity of the reproductive tract, and mammary tissue was assessed for the presence of milk and for evidence of disease.

Sections of lung were examined to determine the presence or absence of pulmonary congestion and oedema (excessive blood in vessels and excessive fluid in the airways) as these are indicators of drowning/asphyxia. Sections of trachea, oesophagus, spleen, adrenal, gland, liver, heart, diaphragm, and kidney, as well as the whole brain, were saved for histological analysis as indicated.

3. RESULTS

3.1 Catch data and observers' reports

CSP data sheets were included with two of the three animals. One sea lion was captured on 21 February and one on 24 April. Vessel details and capture date (11 April) were written on the packaging of the third animal (SB09-02Ph). One vessel returned two sea lions, and a second vessel returned one.

Capture data are summarised in Table 1.

3.2 Morphometrics

An extensive set of measurements was taken from each individual (Table 2). All the pinnipeds examined were healthy and in good body condition. Pectoral blubber depths (22 mm for the male; 22 and 26 mm for the females) were similar to those recorded previously (Duignan et al. 2003a; Duignan et al. 2003b; Roe, W. 2009; Roe, W.D. 2007), with past results indicating a range of 10–40 mm for females (mean = 25; n = 98) and 11–59 for males (mean = 27; n = 69). (See also the general comments for each animal in Appendix 1.)

3.3 Stomach contents

Analysis of the stomach contents showed that only one animal ingested some arrow squid shortly before dying. The stomach contents of the other two animals had no fresh squid.

Additional details are given in Table 3.

3.4 Age determination

This year none of the animals returned had Department of Conservation tags, so none could be accurately aged at necropsy. The mandibular teeth have been collected from all animals to enable ageing by microscopic analysis of cementum/dentine layers at a later date.

3.5 Reproductive status

3.5.1 Females

One female (SB09-03Ph) had a dilated section in the left uterine horn, which grossly appeared to have a thin layer of adherent membrane. Histologically, the glands in the wall of the horn in this region were elongated and tortuous, but damage due to freezing precluded further histological interpretation. Both females had corpora lutea in one of their ovaries, indicating a current early stage pregnancy. SB09-02Ph had well developed mammary tissue, but no milk was present on gross or histological examination. SB09-03Ph had immature appearing mammary tissue (thin, discontinuous glandular tissue) with no milk present. Thus the gross and histological findings for these females indicate that each had become pregnant in this season, but that neither currently had a pup.

3.5.2 Male

Histological examination of the testes of the male sea lion showed well developed seminiferous tubules with spermatozoa in tubular lumina and in the epididymis (indications of sexual maturity). The summed testicular mass (combined weight of both testes with epididymi removed) was 74 g, which is within the range previously established to indicate sexual maturity (55–105 g; P. Duignan, currently University of Melbourne, Australia, unpublished data).

Details are provided in Tables 4 and 5.

3.6 PATHOLOGY

This report describes gross lesions associated with capture and with freezing and storage of bodies. Details of gross lesions and head injuries are given in Tables 6 and 7, and diagrams for each animal are given in Appendix 2.

3.6.1 Cause of death

Each animal had lung lesions consistent with death due to drowning/asphyxia, comprising severe bilateral pulmonary congestion and oedema, with the presence of fluid and foam in the trachea and bronchi.

3.6.2 Body wall trauma (bruising and/or skeletal fractures)

Each animal had lesions consistent with blunt trauma to the soft tissues of the body in the form of areas of dark red gelatinous discoloration of blubber and/or muscle, interpreted as bruising. In some cases this apparent bruising was discrete and well demarcated and confined to the blubber (for example the bruises in the region of the left pectoral flipper and shoulder of SB09-03Ph). In other cases the lesions were more diffuse and frequently affected borders between tissues (for example the junction between blubber and underlying superficial muscle layer) without any evidence of haemorrhage (bruising) into overlying tissues. Irrespective of the gross appearance of this bruising, none of the three animals had lesions affecting more than 5% of their body surface.

No animals had bone fractures.

3.6.3 Lesions of the head and brain

Two animals (SB09-01Ph and SB09-02Ph) had apparent bruising of neck or head muscles. In both animals the lesions were bilaterally symmetrical. In SB09-01Ph the affected tissue formed two narrow strips in the longitudinal muscles that extend along the neck vertebrae. In SB09-02Ph there was a crescent-shaped area of bruising within the muscle directly at the back of the skull.

All three animals had irregular areas of dark red discoloration over the surface of the cerebral cortex and the cerebellum. This pattern was most prominent along meningeal blood vessels, along the bisecting saw cuts, and at the margins of the lateral lobes of the cerebellum and the occipital lobes of the cortex. None of the animals had distinct focal contusions that would suggest true haemorrhage into the brain surface, and none had skull fractures or haemorrhage of the meninges.

Findings are summarised in Table 7.

3.6.4 Body cavity lesions

All animals had blood-stained fluid in the abdominal cavity. The volume varied from 220 to 600 ml. None of the bodies had any evidence of blunt trauma to abdominal organs, and none had evidence of rupture of any major blood vessels. In each case the hepatic sinus was intact.

In each animal the lumbar surface and poles of each kidney appeared dark red and gelatinous. When the capsules were removed this discoloration was shown to be confined to the capsule itself, and the kidneys were grossly normal. All animals also had dark "bruised" appearing (i.e., dark red gelatinous) suspensory ligaments of the urogenital tract. In SB09-01Ph and SB09-03Ph the serosal surfaces of the intestines and the mesentery (suspensory ligaments of the intestinal tract) were similarly discoloured.

4. DISCUSSION

4.1 General comments and life history parameters

Female New Zealand sea lions apparently become sexually mature at 3 years old and can produce their first pup at 4 years (Cawthorn et al. 1985). Many females do not enter the breeding population for several more years, with first reproduction occurring in animals up to 9 years old (I. Wilkinson, New Zealand Department of Conservation, pers. comm.). In this study, neither of the two sexually mature females were lactating (i.e. had produced offspring this season). Both females were adult, and each had evidence of a current pregnancy in the form of a corpus luteum in one ovary. As found previously (Duignan et al. 2003a; Duignan et al. 2003b; Roe, W. 2009; Roe, W.D. 2007), neither of these females had grossly or microscopically visible embryos. This is believed to be a consequence of embryonic diapause, a phenomenon which seems to occur in most pinniped species (Gales 1995), whereby embryos undergo delayed implantation at a very early stage of development, making them difficult or impossible to detect. The significance of the dilated section of uterine horn in SB09-03Ph is unknown. Although this appearance can be seen in pregnant females of other species, and might also be expected to occur after implantation in pinnipeds, it has not previously been noted in New Zealand sea lions at this time of year. Unfortunately the damage caused by freezing made it difficult to interpret the microscopic detail of these tissues, so further evaluation was not possible.

Male New Zealand sea lions become sexually mature at 5 years old but do not tend to hold territories or breed for a further 3 to 5 years (Cawthorn et al. 1985). The single male sea lion returned this year was sexually mature, based on the histological appearance of the testes and on the summed testicular mass.

4.2 Pathology

This section considers determination of general health and cause of death, as well as lesions that may be associated with trauma. It also discusses the likely effect of traumatic lesions on the potential for survival of a sea lion, should it have been able to escape the net. In addition, some of the problems inherent in performing and interpreting necropsy findings in frozen bodies are considered.

4.2.1 Interpretation of lesions in frozen bodies

Freezing of bodies can result in lesions that can be misinterpreted as bruising or haemorrhage. This occurs because ice crystals that form during freezing will expand as a tissue thaws, causing cells to rupture. When red blood cells rupture in this way, haemoglobin, the pigment that is responsible for the red coloration of these cells, leaks out and stains surrounding tissues dark red. Red-stained fluid will accumulate in spaces such as body cavities, and stained soft tissues can take on the appearance of a bruise. If a bruise was present before freezing, it can appear larger after thawing due to staining of normal tissue at the margins of the bruise. Ideally, particularly when investigating potential trauma cases, bodies should be examined in a fresh state, rather than being frozen. Alternatively, a thorough understanding of the type of artefacts that can result from freezing could help to avoid misinterpretation of artefacts. Because there are currently no published studies that detail the gross changes caused by freezing a body, a study is currently underway at Massey University to compare fresh and frozen pinnipeds (Roe, unpublished data). The results of this study strongly suggest that blood-tinged abdominal fluid and "bruised" appearing kidneys and suspensory ligaments are a result of freezing. The likelihood that freezing can also cause lesions that resemble bruises in subcutaneous tissues is also being examined.

4.2.2 Cause of death

In each animal examined this year death was attributed to drowning/asphyxia, based on the characteristic signs of airway foam and pulmonary congestion and oedema in all bodies examined, in conjunction with an absence of any other potential cause of death. These characteristics are based on criteria established for cetaceans (Kuiken 1994, Kuiken et al. 1994).

4.2.3 Lesions of trauma and assessing survivability

For SLEDs to be considered fully effective, animals that escape from a net after encountering a SLED should not sustain trauma that would be significant enough to impair their survival. In practice, direct assessment of the chance of survival of a pinniped that has successfully exited a net is difficult, if not impossible; these animals, by definition, will not appear in the net at hauling. The animals that are recovered from the net are presumably there because they were, for some undetermined reason, unable to escape. This could be due to animal factors (for example, young inexperienced divers that are unable to negotiate the SLED exit hole; animals entering the net at the end of their dive duration when they have insufficient oxygen to escape; animals that are severely injured by their encounter with the SLED) or to gear factors (failure of the proper functioning of the SLED). In the absence of a viable method of observing or tagging sea lions that pass through a SLED and then monitoring their survival over subsequent hours to days, however, these bycaught animals are arguably our best chance of assessing the degree of trauma caused by transit through the SLED. It must also be noted, however, that the necessity of freezing the bodies before necropsy will confound this assessment to some extent.

The protocol used in this project assesses trauma in three categories: subcutaneous/skeletal (body wall), body cavity, and head. For each category, the severity of trauma is categorised as none, mild, moderate, or severe, based on the nature and extent of lesions. An overall grade of trauma can then be assigned based on a more subjective assessment of the likely combined effect of trauma in each category. The following paragraphs describe traumatic lesions, and discuss these in the context of trauma severity and likely effects on survival, should the animal have been able to escape the net.

This year all animals had evidence of bruising to the subcutaneous tissues and/or muscle. In two animals this bruising affected less than 5% of the trunk of the body, while in the third about 5% was affected. The bruising was confined to the superficial tissue layers. A common pattern of bruising seen in previous seasons as well as in the current animals involves the sternum and shoulders. This pattern also occurs in frozen pinnipeds that have been recovered from vessels without SLEDs, so does not result directly from SLED encounters. A similar distribution of bruising was noted in frozen bycaught fur seals but not in chilled bycaught fur seals (Roe, unpublished data), raising the possibility that these lesions are also artefactual rather than true bruises. Whilst not ignoring the importance of this finding however, the true genesis of these lesions in the body wall is not significant to the survival prognosis for animals from the present season, since the amount of tissue involved would not have an impact on potential for survival. The severity of body wall/skeletal subcutaneous trauma was therefore assessed as mild in all three sea lions.

The second category assessed is that of body cavity trauma. As in previous years, each animal examined this year had dark red fluid in the abdominal cavity, and bruised appearing kidneys and suspensory ligaments of the reproductive tract. The consistent presence of these lesions in frozen pinnipeds has made it increasingly apparent that these lesions are likely to be an artefact of freezing and thawing the bodies. The results of the Massey University fur seal trial strongly support this conclusion, with these changes being present in all frozen bodies (n = 5) and no non-frozen bodies (n = 5) (Roe, unpublished data). Accordingly, these lesions are not considered to affect survival. None of the three animals had any abdominal or thoracic cavity lesions that might be expected in cases of severe blunt trauma such as rib fractures or ruptured organs or blood vessels. Body cavity trauma was therefore assessed as ‘none’ in each case.

There are several types of lesions that can occur as a result of an impact to the head, some of which can be recognised at necropsy. Firstly, severe impacts may cause fractures of the skull, jaws, or teeth. None of these changes were observed in the sea lions examined this year. Secondly, impacts can result in bruising to soft tissues such as the muscles and connective tissues of the face, head, or neck. While the severity of brain damage occurring as a result of an impact is not always directly related to the degree of bruising, the fact remains that the presence of soft tissue bruises is an indication that some form of impact has occurred. In turn, there is therefore a possibility that there has been some degree of damage to the brain which could impair consciousness. For this reason, where animals have bruising to the head or neck, a trauma severity of at least ‘moderate’ is assigned. In the current study, two animals (SB09-01Ph and SB09-02Ph had apparent bruising to the back or the head or neck, and so were assessed as having moderate trauma. The third sea lion had no bruising of the head or neck. A complicating factor that should be noted at this point, however, is that in both cases the bruises that were seen were bilaterally symmetrical, a pattern which would be considered uncommon as a result of naturally occurring head impact such as might occur between a swimming sea lion and a rigid object. Similar bruises were seen in frozen, but not non-frozen, fur seals in the Massey trial. There is, therefore, the possibility that these changes are also some form of artefact, and this possibility warrants further investigation.

Head impacts can also result in bleeding in the brain itself. Contusions are bruises on the surface of the brain, and are relatively common in cases of head trauma in mammalian species. All three sea lions examined this year had mottled patterns of dark red discoloration of the surface of the brain, being more pronounced along the tracks of meningeal blood vessels, along the saw cut margins, and at the lateral edges of the cerebellum and occipital lobes of the brain. The brains of the frozen fur seals in the trial mentioned above also had this appearance, and I have observed a similar pattern of discoloration in frozen pinnipeds that died of causes other than incidental capture in fishing gear, including a fur seal that died recently in captivity. This appearance is not consistent with the lesions I usually see in cases of blunt head trauma in other species. On balance, I do not believe that these lesions represent true brain contusions, therefore their presence is not relevant to the assessment of severity of trauma.

In considering the assignment of an overall category of severity to each animal, I have taken into account the likely combined effect of the lesions found in each of the three designated body systems. Although this method is subjective by nature, the assessment is based on my experience in veterinary clinical practice (10 years) and as a pathologist (10 years). I believe that animals assessed as having a mild degree of trauma would have a good to excellent chance of survival, those having moderate trauma would be likely to have a decreased survival prognosis, while those with severe trauma would have a markedly decreased chance of survival. This year two animals (SB09-01Ph and SB09-02Ph) were considered to have moderate trauma while the third (SB09-03Ph) had mild trauma. In both of the 'moderate' cases, the lesions that were considered most significant with respect to survival prognosis were bruises to the head, as these could be a result of a head impact. However, determining the severity of that impact, and therefore assessing the likely degree of compromise to survival, is problematic. The current approach results in some uncertainty as to the true origin of soft tissue 'bruises', and may overestimate the occurrence of these. This problem could only be avoided by examining heads and brains of bycaught pinnipeds before freezing, an approach which has considerable logistical difficulties. Furthermore, even if we were able to determine that true bruising is present, correlating the severity of clinical brain damage with severity of gross lesions is notoriously difficult, even in forensic human medicine where tissues have not been frozen, and where survival time allows for the use of sophisticated diagnostic techniques that are not currently available for non-human species. In some species, biomechanical modelling can be used to determine the likely effect of an ijmpact to the head (Finnie 2001; Ommaya et al. 2002). This modelling, however, requires that the forces and direction of impact are known, and relies on known thresholds of damage for the species in question. It may be possible that biomechanical analysis could be used in a "worst case scenario" approach to determine whether the maximum forces likely to be involved in an impact between a sea lion and the grid of a SLED would be sufficient to impair consciousness. Until such information is available, I do not believe that it is possible to accurately quantify the chances of survival of a pinniped assessed as having moderate head trauma beyond saying that this would be impaired.

4.5 Conclusions

The data presented here indicate that the three New Zealand sea lions returned during the 2008–09 season died as a result of drowning, were in good body condition, and did not have any concurrent diseases. All sea lions had some evidence of blunt trauma. Body wall trauma was mild in each animal, and none had significant body cavity trauma. Two had focal bruises to the head or neck, which are indications of a possible impact to the head. Because trauma to the head could conceivably result in a decreased chance of survival of a pinniped, should it have been able to escape the net, these two animals were given an overall rating of 'moderate' trauma severity. It should be noted, however, that there is a high degree of uncertainty associated with determining the origins of these head and neck lesions (and consequently interpreting their potential impact on survival) given that I believe there is a strong possibility that these lesions were a result of freezing the sea lions before to the necropsies. This means that the rating of 'moderate' trauma must be interpreted with caution. The third sea lion had an overall rating of 'mild' body trauma, and would likely have had a good to excellent chance of survival. The nature of the lesions present in this animal means that the 'mild' rating can be given with a greater degree of confidence.

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Table 1: Capture data.

Code	CSP tag	Date captured	Vessel code	Location	Age class	Observer notes
Males						
SB09-01Ph	8392	21/02/2009	A	50.59S 166 31E	adult	male, in rigor
Females						
SB09-02Ph	none	11/04/2009	A	no CSP form	adult	none
SB09-03Ph	8476	24/04/2009	B	50.37S 167.10E	adult	female, in SLED

Key:
CSP = Conservation Services Programme;

Table 2: Morphometric data.

Code	Weight (kg)	Std lgth (m)	Head Girth (mm)	Head Depth (mm)	Head Width (mm)	Shoulders Girth (mm)	Shoulders Depth (mm)	Shoulders Width (mm)	Girth @ axilla (mm)	PecBD (mm)	PelBD (mm)
Males											
SB09-01Ph	133	2.18	614	170	195	1428	225	585	1239	22	12
Females											
SB09-02Ph	135	1.81	564	155	190	1295	260	500	1255	26	18
SB09-03Ph	101	1.75	505	158	170	1150	212	432	1078	22	18

Key:
Std lgth = standard length; PecBD = pectoral blubber depth; PelBD = pelvic blubber depth;

Table 3: Stomach contents.

Code	Mass of Content (kg)	Composition
Males		
SB09-01Ph	0.531	few otoliths and vertebrae which look like toadfish, parasites
Females		
SB09-02Ph	4.700	2 partially digested fish (possibly ling), fresh octopus, bones, fish flesh, otoliths of red cod, opalfish and ling, beaks of arrow squid
SB09-03Ph	1.337	2 partially digested arrow squid, 1 partially digested octopus, beaks of arrow squid, otoliths of hoki and rattail, bones

Table 4: Reproductive status, females.

		Right				Left				
Code	Age class	ovary (g)	horn diameter (mm)	CA (no.)	CL (mm)	ovary (g)	horn diameter (mm)	CA (no.)	CL (mm)	Milk present?
SB09-02Ph	adult	22.1	17	none	none	37.9	18	none	31	no
SB09-03Ph	adult	17.0	16	1	none	38.0	11	none	28	no

Key:
CA = corpus albicans
CL = corpus luteum

Table 5: Reproductive status, males.

		Left testis			Right testis			
Code	Age class	with ep (g)	minus ep (g)	length x diam (mm)	with ep (g)	minus ep (g)	length x diam (mm)	Summed testicular mass
SB09-01Ph	adult	46.3	37.9	92 x 30	44.5	36.1	98 x 28	74.0

Key:
ep = epididymis, diam = diameter

Table 6: Pathology.

Code	Gross lesions	Severity of trauma
Male		
SB09-01Ph	1,2,4,5,6	Moderate
Females		
SB09-02Ph	1,2,4,5,6	Moderate
SB09-03Ph	1,4,5,6	Mild

Key:
1. Pulmonary congestion and oedema
2. Trauma to soft tissues of head
3. Brain contusions
4. Discolouration of renal capsule
5. Bruising of body wall
6. Blood-tinged fluid in abdominal cavity

Table 7: Head and brain examination.

	Focal contusions	**Diffuse discolouration**	**Head/face bruising**
Male			
SB09-01Ph	none	yes	back of head
Female			
SB09-02Ph	none	yes	back of neck
SB09-03Ph	none	yes	no

Appendix 1: Gross pathology notes for each animal

SB09-01Ph

General: Male in good body condition. Assessed as sexually mature at gross post mortem based on summed testicular mass; later confirmed histologically. Small bilaterally symmetrical abrasions (not fresh wounds) on chin.
Alimentary system and abdominal cavity: Nematodes but no ingesta in oesophagus. 220 ml dark red fluid in abdominal cavity. Dark red gelatinous appearance of kidneys (especially lumbar surfaces and poles), intestinal serosa and mesenteries, and suspensory ligaments of genital tract.
Respiratory system: Abundant fluid and froth in trachea and lower airways. Lungs very heavy and dark red (pulmonary congestion and oedema).
Traumatic lesions:

Head: Bilaterally symmetrical pattern of apparent bruising to dorsal neck muscles
Body wall/skeletal: Narrow bands of apparent bruising along ventral sternum, in axillae and over dorsal part of pelvis. Sternal bruising affects superficial muscle layer; overlying blubber not affected. Axillary and pelvic bruising is below superficial muscle layer, with no involvement of overlying muscle or blubber. Involves approximately 5% of body surface
Abdominal cavity: [abdominal fluid + kidney and suspensory ligament lesions]

Cause of death: Drowning/asphyxia
Assessment of traumatic lesions:

Head: Moderate
Subcutaneous/skeletal: Mild
Body cavities: None
Overall assessment of trauma severity: **Moderate**

SB09-02Ph

General: Adult female in good body condition. Assessed as pregnant at gross post mortem based on presence of corpus luteum in ovary. Mammary tissue sparse and no milk evident. Extensive abrasions on chin (not fresh wounds).
Alimentary system and abdominal cavity: 250 ml dark red fluid in abdominal cavity. Dark red gelatinous appearance of kidney poles and lumbar surfaces, and of suspensory ligaments of ovaries and uterus/bladder.
Respiratory system: Lungs bilaterally dark red and heavy. Frozen clear fluid in airways; foam present in thawed areas.
Traumatic lesions:

Head: Symmetrical area of dark red gelatinous muscle on dorsal neck just behind skull
Body wall/skeletal: Two distinct small (10–15 mm diameter) in blubber of caudal lumbar area. Also poorly distinct red gelatinous tissue at border between muscle and blubber in strip along sternum and at shoulders/axillae, involving < 5% of body surface
Abdominal cavity: None [abdominal fluid + kidney and suspensory ligament lesions]

Cause of death: Drowning/asphyxia
Assessment of traumatic lesions:

Head: Moderate
Subcutaneous/skeletal: Mild
Body cavities: None
Overall assessment of trauma severity: **Moderate**

SB09-03Ph

General: Adult female in good body condition. Assessed as pregnant at gross post mortem based on presence of corpus luteum in ovary (confirmed histologically). No milk evident (confirmed histologically). Healed abrasion-like wounds on chin.
Alimentary system and abdominal cavity: 600 ml red fluid in abdominal cavity. Red gelatinous appearance of poles and lumber surfaces of kidneys as well as suspensory ligaments of intestines and urogenital tract.
Respiratory system: Dark red heavy lungs. Moderate amounts of red fluid in airways, with froth evident in bronchioles and mainstem bronchi.
Traumatic lesions:

Head: None

Body wall/skeletal: Small (approximately 20–30 mm diameter) distinct bruises confined to blubber at cranial left shoulder and ventral surface of left flipper close to body). Strip of apparent bruising involving deep aspect of blubber (surface against underlying muscle) along sternum, and similar appearance of deeper muscle layers in axillary regions. Total involvement < 5% of body surface.

Abdominal cavity: None [abdominal fluid + kidney lesions]

Cause of death: Drowning/asphyxia
Assessment of traumatic lesions:

Head: None

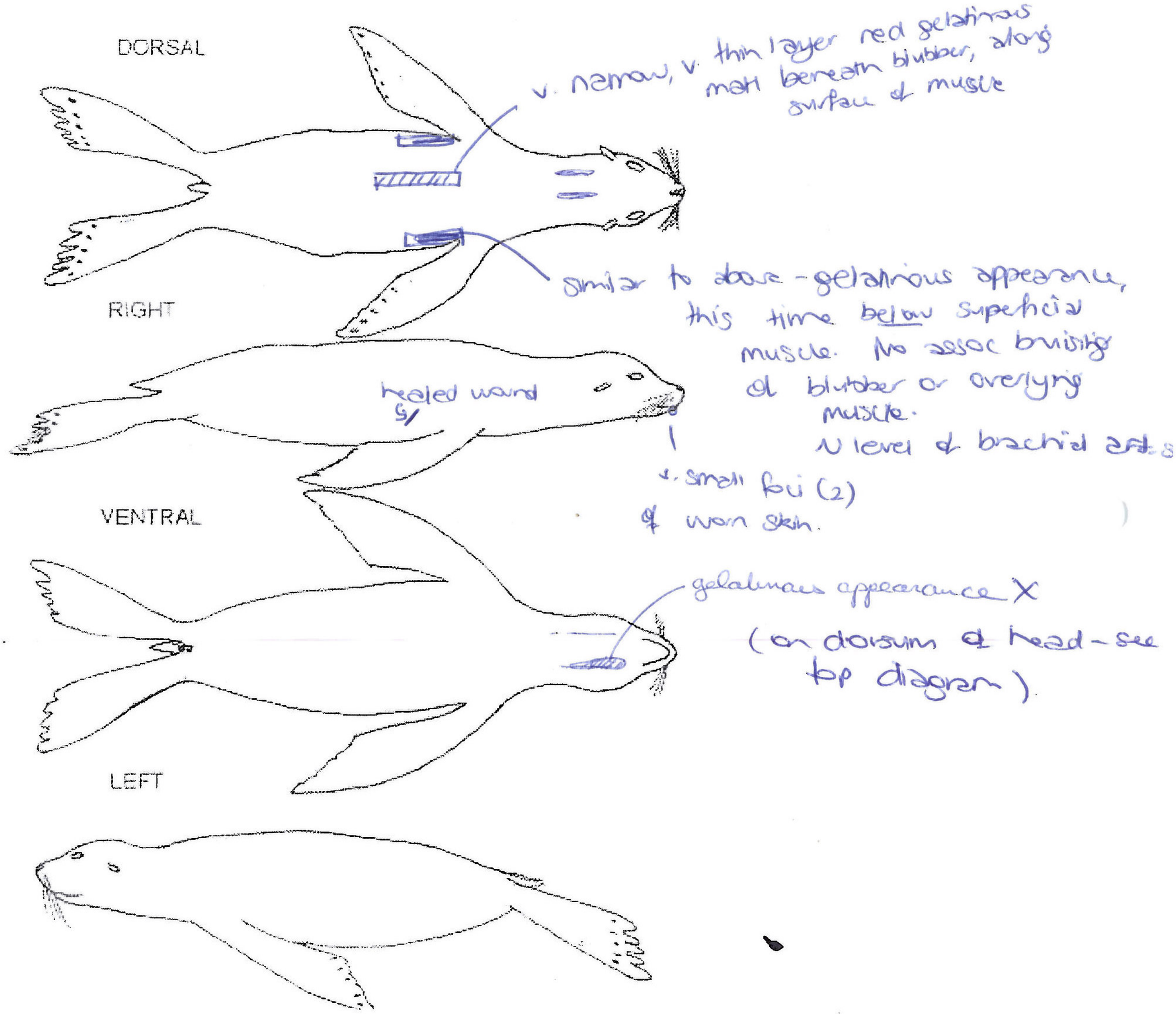
Subcutaneous/skeletal: Mild

Body cavities: None

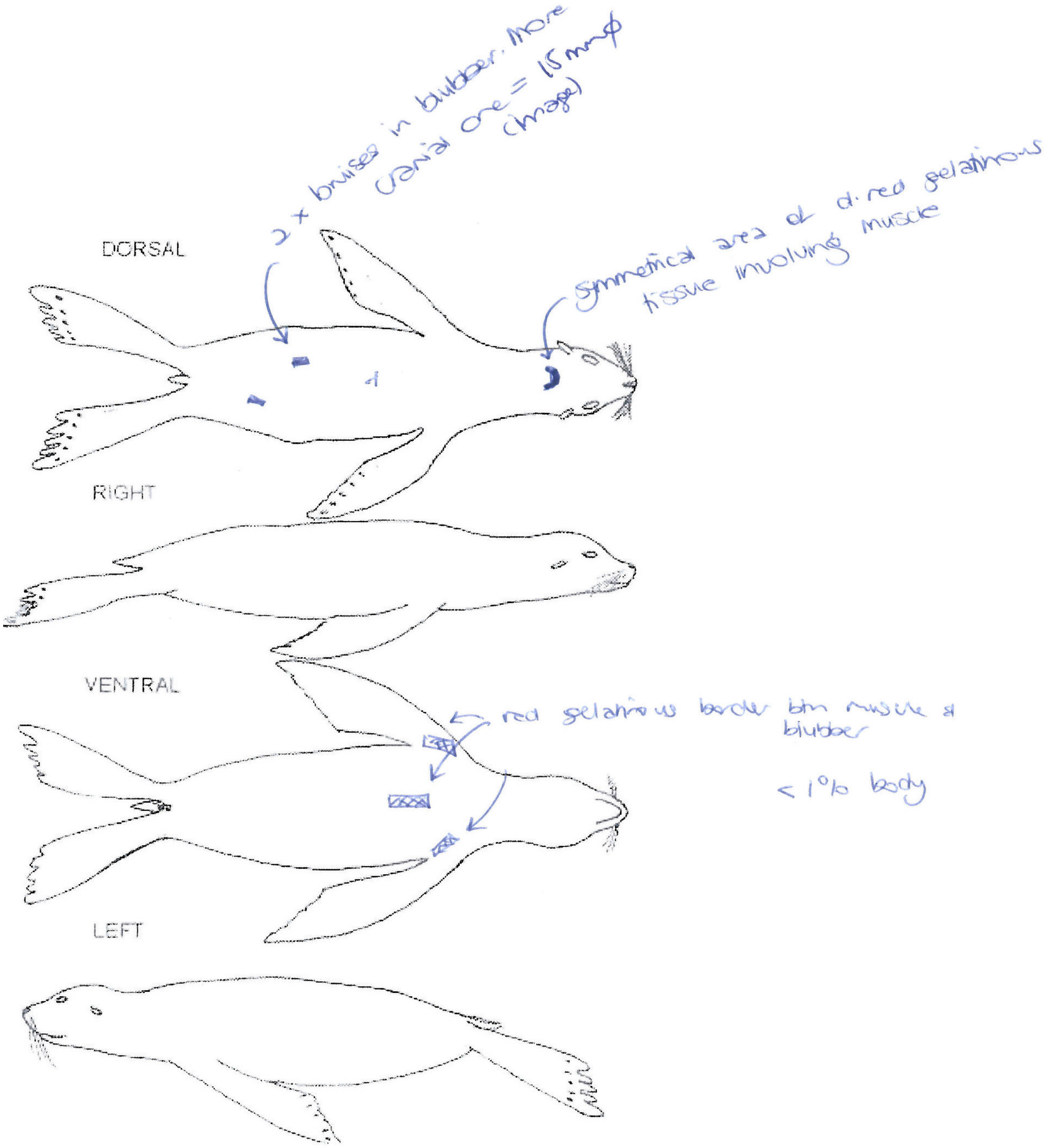
Overall assessment of trauma severity: **Mild**

Appendix 2: Diagrams depicting body wall trauma.

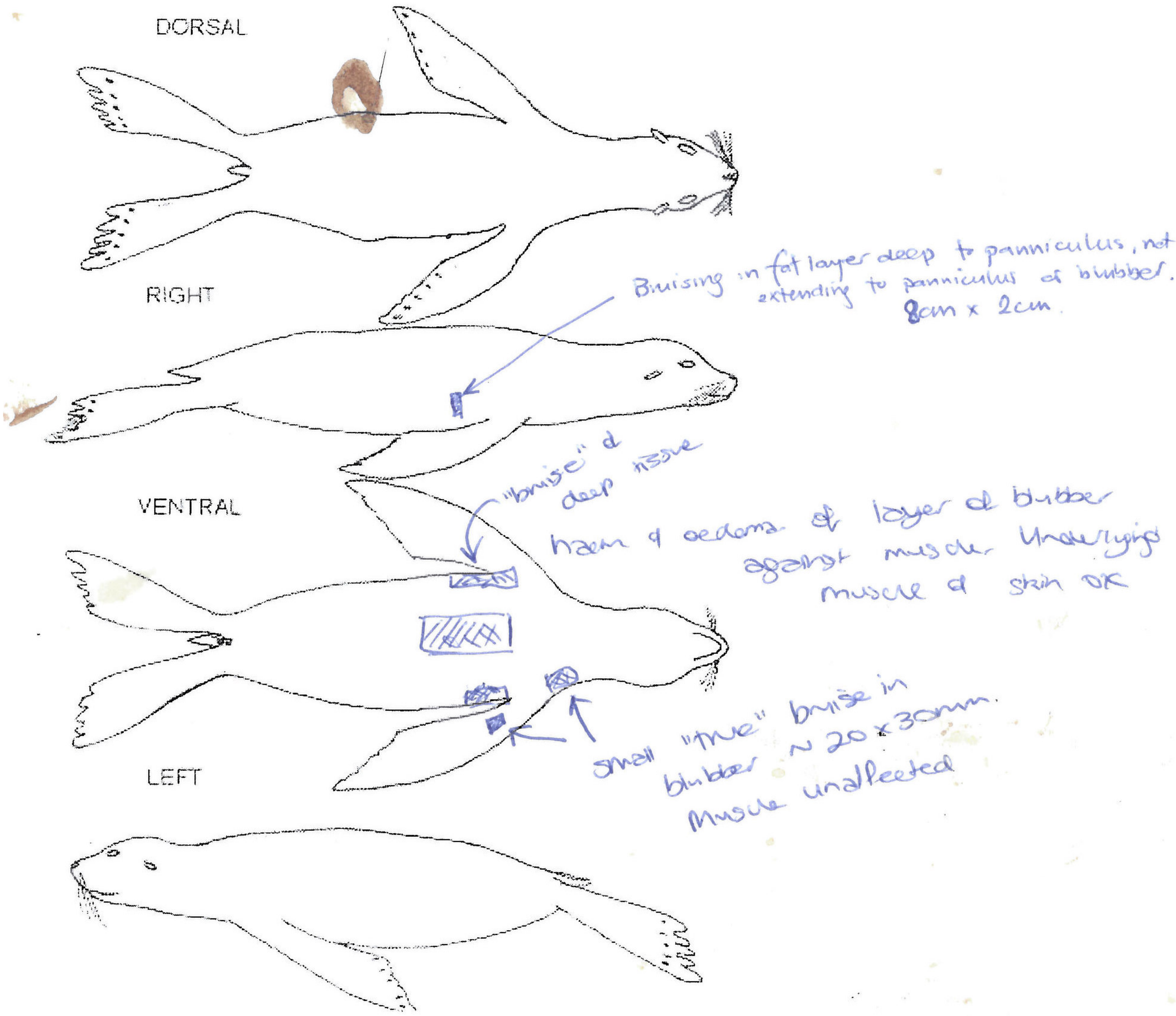
SB09-01Ph



SB09-02Ph


2 x bruises in blubber. More cranial one = 15 mm ø (image)
symmetrical area of d. red gelatinous tissue involving muscle
DORSAL
RIGHT
VENTRAL
red gelatinous border btn muscle & blubber
< 1% body
LEFT

SB09-03Ph



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