AN ANTEMORTEM GUIDE FOR THE ASSESSMENT OF STRANDED AUSTRALIAN SEA SNAKES (HYDROPHIINAE)

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AN ANTEMORTEM GUIDE FOR THE ASSESSMENT OF STRANDED AUSTRALIAN SEA SNAKES (HYDROPHIINAE)

Amber K. Gillett, B.V.Sc., Mark Flint, B.V.Sc., Ph.D., and Paul C. Mills, B.V.Sc., Ph.D.

Abstract: Marine snakes of the subfamily Hydrophiinae are obligate ocean dwellers, unlike their amphibious counterparts, the sea kraits (Laticaudinae), and as such they are often referred to as ‘true’ sea snakes. This specialization means that the presence of a true sea snake on a beach is atypical and likely indicates disease or injury. Traumatic injuries such as eye, jaw, and spinal lesions have been observed in stranded sea snakes and may present as acute injury or progress to chronic debilitation. Diseases, such as neoplasia, leukemia, and parasite overburden, have also been seen in wild sea snakes, and these animals may present similarly. Sick, moribund, or deceased sea snakes are intermittently found washed ashore along Australian beaches, and these specimens may prove valuable as bioindicators of marine health. This review is intended as a guide to the diagnostic investigation of sick or injured sea snakes by suitably qualified people.

Key words: Disease, examination, Hydrophiinae, injury, sea snake, stranded.

INTRODUCTION

Sea snakes are distributed throughout tropical and subtropical waters of the Indian and Pacific oceans, with the highest diversity reported from the central Indo-Pacific. Species diversity reduces east and west of this region, and only one species (yellow-bellied sea snake, Pelamis platurus) is known to occur throughout the breadth of the Indo-Pacific, east to parts of the Americas and west to Africa. Australia boasts the world’s richest diversity of sea snakes, with almost 60% of the 70 described species inhabiting its rich and diverse marine habitats. The diverse array of species inhabiting Australian waters belong to the subfamily Hydrophiinae and never leave the ocean, unlike their amphibious counterparts, the sea kraits (Laticaudinae), and for this reason they are often referred to as ‘true’ sea snakes.

Almost all species of Hydrophiinae are venomous. Their presence on a beach is not only atypical in light of their completely marine lifestyle but may also put naïve beachgoers at risk of envenomation. Their venom is regarded as neurotoxic and myotoxic, affecting the victim similarly to a bite from their terrestrial elapid relatives. Although not generally aggressive in nature, bites with envenomation have been reported in Australia, occurring almost exclusively on trawling vessels. Sea snake-specific antivenin is available for sea snake envenomation (e.g., available from CSL [www.csl.com.au] in Australia or regulated by the Food and Drug Administration [www.fda.gov] in the United States). If not available, tiger snake antivenin can be used.

Along with iconic megafauna such as marine turtles, dugongs, and dolphins, sea snakes are recognized as important bioindicators of marine health and as valuable tourist attractions in places such as Australia’s Great Barrier Reef. Despite legislative protection, some sea snake species in parts of Australia are reported to be declining, with local extinctions recorded. The largely negative impacts of trawling on sea snakes in Australian waters is well documented, with net entrapment often causing significant physiologic stress (e.g., oxygen deprivation), physical injury, or death from such effects. Marine debris has been reported to cause injury in sea snakes, and in some areas there is anecdotal evidence to suggest a link between trawling activity and some traumatic injuries, such as eye, jaw, and spinal lesions (Gillett, pers. obs.). Sick, moribund, or deceased sea snakes are intermittently found washed ashore along Australian beaches and provide an opportunity to conduct diagnostic analyses and to collect other information that may assist with conservation and management. The reasons for which sea snakes strand are still to be fully defined; however, preliminary histopathologic investigation has identified diseases such as localized neoplasia and leukemia, parasite overburden, and, potentially, physical exhaustion due to senescence or wild weather as potential factors (Gillett, unpubl. data).
The absence of a standardized guideline for assessing and examining sea snakes, lack of knowledge and resources, and the hesitation of untrained personnel to handle sea snakes have resulted in a situation in which previous stranded animals have often been returned to the water, left to die on the beach, or have not received appropriate treatment at veterinary facilities. In these situations the injury sustained by the animal or the disease process occurring within the animal is often missed or overlooked, leaving the animal to suffer and die, with the opportunity to learn from the event lost. This article has been designed to assist marine, governmental, or other personnel who may respond to sea snake strandings and to assist veterinarians by outlining the examination, diagnosis, and management of stranded sea snakes. This article will also enhance scientific understanding of these unique creatures and the roles they play as bioindicators in the marine environment by proposing protocols for the collection of standardized data.

RESTRAINT AND ANESTHESIA

Handling of any venomous snakes, including sea snakes, should only be undertaken by experienced personnel trained in correct restraint techniques. Various techniques exist for handling venomous snakes, although some methods for sea snakes provide additional safety for the handler compared to accepted practices for terrestrial snakes. The simplest and safest method for examining sea snakes is to use the technique known as 'tube restraint,' in which the head and approximately one-third of the body caudal to the head are held in a clear plastic restraint tube. This technique is well documented as a successful method for restraining venomous terrestrial snakes but has not been specifically outlined for use in handling sea snakes. This method is extremely useful when restraining sea snakes for examination, as it allows the examiner to easily visualize the snake’s head and body without risk of envenomation. Sea snakes generally remain calm in the restraint tube but have been known to rotate their bodies in the handler’s grasp in an attempt to free themselves (Jackson, reptile handler, Australia Zoo, Beerwah, Queensland, Australia, pers. comm.). The skin of some species is highly keeled and this motion may be uncomfortable to handlers. It is important that handlers be aware of this behavior, and it is recommended that the snakes be allowed to rotate while the handler still maintains a safe grip on the snake’s body. The process of getting a sea snake into the tube can be more challenging than with a terrestrial species as a result of their laterally compressed bodies and a lack of flattened ventral scales, which restricts forward locomotion. It is this forward locomotion that is often harnessed when handling terrestrial snakes to facilitate getting them into the restraint tube. The handler must therefore modify this technique so that the restraint tube is fed over the snake’s head rather than having the snake move into the tube of its own volition (Fig. 1). This can pose some danger to the handler because of the closer proximity of the handler’s hands to the snake’s head and body, and extra care should be taken when using this technique in sea snakes. Applying water to the end of the tube for lubrication may assist with feeding the tube over the snake.

Other methods of handling sea snakes for close examination and for examination of the oral cavity include ‘head holding.’ This method of restraint poses a greater risk to the handler, whose fingers are in close proximity to the mouth and fangs. Extreme care must be taken when examining the oral cavity, and it is advisable that the snake’s mouth only be touched with a tapered blunt object, such as a tongue depressor or blunt forceps, and never with fingers. Care should also be taken to avoid injury to the snake during head holding. Without proper handling the cervical spine can be disarticulated from the skull if the snake knots itself and pulls its body away from its head. Supporting the length of the snake’s body while holding the head and preventing the animal from knotting itself will reduce the risk of injury to the snake. The authors do not recommend the head holding technique in sea snakes with very small heads and highly robust bodies, such as
Acalyptophis peronii, as these snakes can coil firmly around the handler’s arm and readily disarticulate their necks while trying to pull their heads free (Gillett, pers. obs.).

For long-term restraint or surgical procedures sea snakes should be anesthetized. Anesthesia can be challenging in sea snakes, and recovery can be prolonged (Gillett, pers. obs.). Anesthesia has been successfully induced using Alfaxan® (Jurox Pty Limited, Rutherford, New South Wales, 2320 Australia; 10 mg/kg i.v. or i.m.) (Gillett, pers. obs.). Administration at the suggested dose provides general anesthesia within about 30–60 sec (i.v.) or approximately 10 min (i.m.); however, time to recovery can vary greatly, from 30 min to several hours, and reentry of anesthesia has been observed in one sea snake more than 12 hr after apparent recovery (Gillett, pers. obs.). Intubation is advised to provide ventilation and for lengthy procedures or those involving surgery. Sea snakes should be recovered in a securely locking ventilated container lined with a moist towel and out of water for at least 24 hr postanesthesia. Before returning permanently to water sea snakes should be observed to swim vigorously and dive normally in a test tank. Accidental drowning has been observed in sea snakes placed in very shallow water even when they had apparently recovered from anesthesia 12 hr prior (Gillett, pers. obs.).

DATA COLLECTION

Collecting information surrounding the stranding of sea snakes is an important component of assessment. The absence of long-term histories when dealing with wildlife (vs. pet dogs and cats) emphasizes the importance of collecting an accurate acute history, including stranding location (GPS coordinates, where possible), a record of clinical signs, environmental history (i.e., unusual weather events, recent oil spills, coastal trawling or ghost netting, area of restoration-erosion, etc.), and photographic records of the rescue site, animal in situ, and close-up images of any external injuries.

Once restrained, other useful details to collect include species identification, description of injuries, snout to vent length (SVL), total body length (TL), maturity (juvenile or adult only), sex (if able to be determined), and body condition. Species identification can be difficult for those not familiar with sea snakes, although keys to identifying species are readily available.4,26 Correct species identification enables the examiner to determine the usual marine habitat and distribution range and the species conservation status (i.e., rare, endangered, least concern, etc.). Species identification is also useful for determining food requirements if the animals are hospitalized and for blood analysis, as some blood reference ranges have been calculated for specific species (Gillett, unpubl. data).

It is recommended that deceased specimens (or individuals to be euthanatized) of rare or endangered status be offered to museum collections. Animals suitable for release but that are rare or endangered should be thoroughly photographed, and such records should be provided to state or national museums in the area.

Much of this information is a requirement for coastal management authorities, information that should be completed for every marine stranding. Specific data collection requirements may exist under different marine authorities worldwide, and the authors recommend contacting the local marine authority for advice on reporting a marine stranding in a given area.

PHYSICAL ASSESSMENT

A thorough physical assessment is crucial when investigating the health of any stranded sea snake and should include a locomotory evaluation in and out of water; external examination for the presence of wounds, physical abnormalities, and the presence of epibiota; determination of body condition; attainment of morphometric measurements; determination of sex and maturity; and physical palpation for abnormalities. Without a comprehensive assessment, neurologic and physical abnormalities can be missed and the health status of an individual misinterpreted. In order to standardize data collection and make examination easier, a Sea Snake Health Assessment Form (Appendix A) has been developed.

Locomotory evaluation

A normal locomotory response from a sea snake placed in water is to swim forward or immediately dive, simulating the snake’s natural behavior to escape danger. This action varies little among species; however, some noteworthy behavioral variations do exist. Pelamis platurus, (yellow-bellied sea snake), for example, spend their lives in deep oceanic waters and drift with the current. As part of a predatory tactic they often employ a ‘float-and-wait’ technique rather than an active pursuit of prey.1 They also utilize backward swimming on occasion (which can also be exhibited on land, particularly if the animal is threatened) and appear to tie themselves in knots when
shading. When undergoing an in-water assessment (IWA), therefore, they can appear lifeless on the surface or even swim backwards, and this should not necessarily be interpreted as abnormal in this species.

Examples of abnormal neurologic behaviors on an IWA include rolling of the body (from left to right), weakness in one or more portions of the body, stargazing-vertical orientation of the head and neck, floating of the midbody with the head hanging (except in *P. platurus*), dorsal or lateral recumbency (in all or part of the body), and head tilt and extreme lethargy, all of which warrant veterinary attention. In addition to an IWA, an out-of-water assessment (OWA) should also be conducted. Neurologic abnormalities exhibited during an IWA are often similarly expressed on land; however, displays of seizure activity, head pressing, torticolis, ataxia, and an open-mouth gape are generally only evident during an OWA (Gillett, pers. obs.).

Irregularities in the skin of sea snakes indicate previous trauma. Much of the trauma is likely attained through interaction with prey itself or from the strata sea snakes may encounter in search of prey, such as coral reef. Some trauma (such as penetrating wounds or spinal fractures), however, may be the result of predation on sea snakes by species such as sea eagles (Fig. 3a), which can inflict serious injury, or suspected anthropogenic causes as a result of boat strike or trawler net injury (Fig. 3b) (Gillett, pers. obs.).

**External examination and epibiota**

Sea snakes all possess highly contractile circular pupils and have large sinuses in the choroid that likely function to equalize pressure in the eye during diving. They possess ocular spectacles, as is the case in terrestrial snakes, and normal healthy eyes should be clear and bilaterally equal in size. Although the eyes are not the sole sensory method for prey detection in sea snakes, they are important for identifying movement of prey and predators. Damage to the eye or spectacle can have significant survivorship implications for these predatory species. The examiner should assess the pupillary response to light as well and should also look for direct damage and irregularities in the shape of the eye, iris, and spectacle. If the spectacle is damaged the eye can be stained with fluorescence dye to assess for subsequent corneal damage. The presence of edema or spectacle discoloration (Fig. 2a), bulging of the eye, or proptosis indicates significant trauma and can significantly affect vision. Damage or lesions within the mouth may similarly affect vision, as the flow of lachrymal secretions may become obstructed, leading to distension of the subspectacular space or bullous spectaculopathy (Fig. 2b) (Gillett, pers. obs.).

Epibiota, including barnacles, algae, and decapods, are encountered in the marine environment, and high numbers can colonize the skin of many marine animals, including sea snakes (Fig. 4a, b), leading to problems performing ecdysis and resulting in secondary skin conditions. To combat this accumulation, marine species may frequently rub against firm substrates or have symbiotic relationships with ‘cleaning’ fish species, such as *Labroides*, *Gobiosoma*, and *Elacatinus*, that assist in reducing ectoparasitic load. Sea snakes can also utilize their frequent and natural skin shedding behaviors to reduce epibiotic burdens, which may involve tying

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**Figure 2.** (a) Marked opacity of the spectacle in a sea snake (*Disteria major*) due to injury or dysecdysis. (b) Bullous spectaculopathy in the eye of a sea snake (*Acalyptophis peronii*) due to blockage of the nasolacrimal duct as a result of oral trauma.

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themselves in knots or contacting a solid substrate.\textsuperscript{21}

The presence of large numbers of epibiota on any stranded sea snake should alert the examiner to potential illness or injury. Inability to remove barnacles and other organisms may be due to a functional constraint, such as spinal or soft tissue injury, or to underlying disease factors resulting in altered nervous system function or general debilitation. Retained shed may also build up around persistent organisms, predisposing the animal to further dysecdysis as well as localized skin infections at the site of attachment.

**Body condition**

Body weight and body condition are often used as indicators of health status in a variety of species and can be used similarly for stranded sea snakes. Although useful as a baseline parameter, body weight may vary significantly in the short term if an animal has recently fed or if it is significantly dehydrated, which has been demonstrated for sea snakes.\textsuperscript{12} For this reason, body weight and body condition indices based upon weight may be unreliable indicators of health status. The authors propose that muscle mass provides a relatively consistent and useful assessment of body condition in intermittently feeding species such as sea snakes.

Muscle mass is generally unaffected by mild dehydration, feeding status, or acute injury. However, chronic illness, severe dehydration, and chronic injury can reduce muscle mass significantly, and, therefore, body condition assessments based on muscle mass can assist with accurate determinations of health status. Although body condition assessments can be somewhat subjective, this can be overcome through the formulation of explicit standard guidelines to clarify the assessment pro-

![Figure 3](image1.png)

**Figure 3.** (a) Penetration wound to the body of a sea snake (*Pelamis platurus*) from sea eagle predation. (b) Linear wound to the head of a sea snake (*Hydrophis elegans*) from presumed boat strike.

![Figure 4](image2.png)

**Figure 4.** (a) Algal growth on the head of a sea snake (*Disteria major*). (b) Severe epibiosis of a sea snake (*Hydrophis elegans*) by goose-necked barnacles.
cess and ensure consistency. Accordingly, the authors propose that sea snake body condition be assessed by examining four parameters: 1) dorsal longitudinal muscle mass (via physical palpation of the muscles on either side of the spine), 2) degree of muscle coverage over the ribs (via physical palpation of ribs and muscles along the length of the body), 3) muscle coverage over the tail vertebrae transverse processes (via palpation of either side of the tail from vent to tail tip), and 4) presence of fat bodies in the abdominal cavity (via palpation ventrally along the length of the body from the upper one-third of the body to the tail). After assessing these four parameters a body condition score can be determined using the following categories: 1 = emaciated; 2 = poor; 3 = fair; 4 = good; or 5 = excellent. Descriptions of these categories are as follows:

**Ejaciated:** The snake is obviously underweight, with individual bones and ribs clearly evident under the skin. No muscle is palpable along the spine, tail, or over the ribs. The body has a distinct ‘V’-shaped appearance. The abdominal cavity is sunken, as is evident on the ventral surface, with no fat bodies detectable and all organs clearly distinguishable on palpation.

**Poor:** The snake is obviously underweight, with spine and ribs clearly visible. Muscle is barely palpable along the length of the spine and the tail, and is not palpable over the ribs and individual ribs can be clearly identified. The bones of the spine are obvious under the skin. The body has a ‘V’-shaped appearance. No fat bodies are detectable in the abdomen, and all organs are clearly distinguishable on palpation.

**Fair:** A moderate amount of muscle is palpable along the length of the spine, tail, and over the ribs. Although still identifiable, individual ribs are not easily isolated. The top of the spine is visible but is not sharp. The body has a rounded ‘V’-shaped appearance. Fat bodies may or may not be detectable in the abdominal cavity, and most organs are clearly palpable.

**Good:** The snake appears moderately well muscled. Muscles are clearly palpable over the spine, tail, and ribs. Individual ribs cannot be detected. The top of the spine is only just visible, and the body has a ‘U’-shaped appearance. Some fat bodies are detectable in the abdominal cavity, and only some organs can be palpated (as a result of the presence of fat in the abdomen).

**Excellent:** The snake obviously well muscled. All muscles are clearly palpable over the entire spine, tail, and ribs. No ribs are detectable. The body is distinctly rounded, with an ‘O’-shaped appearance. Large amounts of fat bodies are detectable in the abdominal cavity, and most of the organs cannot be palpated (as a result of the large amount of fat present).

**Morphometric measurements and sex determination**

Standard morphometric measurements exist for reptiles, including sea snakes. These routinely include SVL and TL. Although growth rates in sea snakes are poorly known, the collection of morphometrics can assist the examiner with determining a size range (i.e., adult or juvenile) in most species. For facilities and authorities in which regular numbers of the same species of snake are encountered, the collation of this data may prove valuable over time as a reference for size variations among commonly encountered species.

Midbody circumference measurements are not widely published but may provide some benefit when assessing body condition in sea snakes. For example, a sea snake in excellent body condition will have a midbody circumference greater than that of an emaciated snake of the same species with a similar length (Gillett, pers. obs.). It is important to note that the location of a midbody circumference is somewhat subjective. To maintain as much consistency as possible the circumference should be taken from below the level of the stomach, at a point approximately two-third along the total length of the snake to avoid including a recently ingested prey item in the circumference measurement. This measure should be interpreted with caution in females as a result of the possibility of them being gravid.

Age and sex can be difficult to assess in sea snakes. Growth rates have been described for only a small number of species, in which length is proportionate with age and maturity. Sex can be determined in a similar manner to that used in terrestrial snakes, either by cloacal probing or cloacal ‘popping’ through manual extrusion of the hemipenes. Cloacal probing is the authors’ preferred method, as it is a widely practiced and accepted technique used in reptiles and is relatively atraumatic to the snake when performed correctly.

**Physical palpation**

As in many animals, abdominal palpation in sea snakes can be useful for identifying irregularities within the abdominal cavity, such as neoplastic masses and gastrointestinal obstructions, or for determining a heart rate by direct palpation of the heart (Gillett, pers. obs.).
Ventrally, the ribs of sea snakes are not joined, leaving a detectable ‘gap’ that allows for palpation of the sea snake’s abdomen. This ‘gap’ is not unique to sea snakes and is a feature of virtually all serpents; however, the ability to palpate most major organs in most sea snakes appears relatively consistent. In sea snakes of body condition 4 or below it is possible to feel for masses in organs such as the liver, splenopancreas, kidney, stomach, or reproductive tract (Gillett, pers. obs).

To perform an abdominal examination sea snakes need to be restrained by one of the previously described methods. The examiner should palpate ventrally along the length of the body from the upper one-third of the body to the tail. Palpation should be performed by placing the thumb along the dorsal spinal surface while gently pushing the first, second, and third fingers up between the tips of the ribs toward the spine. This should be repeated in a smooth and gradual fashion, moving from neck to vent.

Spinal trauma may be evident during the IWA and OWA, indicated by weakness or lack of body movement caudal to a spinal injury. On occasion wounds or distinct ridges and lumps may be seen along a portion of spine. These irregularities should alert the examiner to the potential spinal injury or fracture. Sometimes, however, there may not be clear visible evidence of spinal fractures, and instead gentle palpation and manipulation of the spine may be required, with diagnosis confirmed using imaging. The thumb should be placed along the ventral scales while the fingers are ‘walked’ along the dorsal aspect of the spine, from as far cranial as possible (without compromising examiner or handler safety) to the tip of the tail, feeling for ‘steps,’ protrusions, or injuries in the spine itself.

**DIAGNOSTIC TECHNIQUES**

**Blood collection**

Blood collection and interpretation are essential components of a thorough clinical assessment in any species. Biochemical and hematologic reference ranges have recently been established for three species of sea snake (*Hydrophis elegans*, *Lapemis curtus*, and *Acalyptophis peronii*) and provide some indicators to assess for organ or hematologic dysfunction (Gillett, unpubl. data).

Collecting blood from sea snakes can be done in the same manner as that used for terrestrial snakes via venipuncture of the ventral coccygeal vein. When collecting from the coccygeal vein varying degrees of lymph contamination can occur. To overcome this, a needle can be inserted into the vein without the syringe attached, with blood allowed to fill the hub of the needle. A microhematocrit tube can then be placed into the hub of the needle for blood collection and subsequent packed cell volume and total protein readings. A blood smear can be made from the rest of the blood in the needle, or a syringe can be attached and gentle aspiration employed to collect larger volumes of blood.

Cardiac puncture is an accepted method of blood collection in snakes but is often only recommended in anesthetized animals. It is not recommended as a primary method of blood collection in sea snakes, particularly those for immediate release. If access to the coccygeal vein is not available, cardiac puncture should only be employed if the snake is anesthetized to reduce the risk of trauma to the heart muscle, and the snake should be monitored for at least 24 hr postanesthesia.

**Fecal examination**

Examination of fresh fecal material can indicate the presence of internal parasites and in some cases can allude to the diet preference. Internal parasitism is a common finding in wild sea snakes; however, the abundance and species of parasite may vary with illness. Fresh fecal material can easily be collected from the live snake and in some cases may be expelled voluntarily. If not voluntarily expelled, feces can be collected by gently massaging the lower abdomen toward the vent. Fecal flotation or fresh preparation can be performed on feces to ascertain parasite load and species.

**Imaging**

Imaging can denote radiography, computed tomography (CT), magnetic resonance imaging (MRI), or ultrasonography. Often, not all of these imaging techniques are available to the examiner, and these studies should only be conducted by trained veterinarians or technicians. Radiography is often most accessible and provides valuable information during a clinical examination, especially in cases of spinal trauma or bony fractures. MRI, CT, and ultrasonography can be utilized for assessing soft tissue and internal organs and provide detailed information about the organ in question. For any of these procedures the animal needs to be restrained, as previously described, and in some cases anesthetized. At all times applicable precautionary measures such as head restraint by an experienced handler should be implemented to avoid risk of envenomation. If a
lesion is located during abdominal or spinal palpation this region should be imaged.

Where radiography is employed, it is ideal to image the entire snake, even if lesions are not palpated during a physical examination. Foreign bodies such as hooks or sinkers can be missed by palpation and may only be detected by radiography. Similarly, calcification of organs or regions of the spine may not be palpable but can sometimes be evident on a radiograph.

Radiography provides visualization of the skeleton as well as an outline of some internal organs (Fig. 5a). The lung is particularly visible as a translucent gas-filled structure extending almost the full length of the body. The tracheal and bronchial lung in the cranial third of the body is clearly evident before the rest of the respiratory tract narrows at the heart and extends as a narrow translucent ‘tube,’ known as the saccular lung, almost to the vent. The saccular lung can often be obscured by gas in the intestines or colon. It is possible to identify parasitic flukes within the lumen of the lung in a lateral-view radiograph (Gillett, pers. obs.), but this should not be used as a definitive indicator for the presence of lung flukes, as other soft tissue structures overlying the lung can appear similar. The outline of the heart is obvious as a soft tissue mass obscuring a small portion of the bronchial lung. The liver, kidneys, and splenopancreas are often difficult to identify as individual structures unless their densities are abnormal as a result of disease.

Factors that may obscure the field of view on sea snake radiographs include barnacles, as a result of their high calcium content (Fig. 5b). It is important not to confuse the external location of barnacles with potential foreign bodies, as their locations may overlie the lung and abdominal fields. Fresh prey items may be seen in the stomach, and there is potential to see developing young using radiography (Fig. 5c).

Lesions that have been identified by radiography in sea snakes include mineralized neoplastic lesions of the kidney (Fig. 6), liver, and splenopancreas; osteomyelitis; spondylosis; bony fractures; and foreign bodies.
CONCLUSION

Thorough ante-mortem examination of sea snakes that strand in coastal regions is an important strategy for the veterinarian charged with diagnosing and treating these animals and for management authorities responsible for understanding and reducing the reasons sea snakes strand. This guide provides a systematic, standardized approach to examination, diagnosis, and management of stranded sea snakes.

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LITERATURE CITED

### Appendix A

**Sea Snake Health Assessment Form**

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<td></td>
</tr>
<tr>
<td>Paralysis</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Ectoparasite and fouling organism load:

<table>
<thead>
<tr>
<th>Ectoparasite/organism type</th>
<th>Total load</th>
<th>Primary location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algae coverage</td>
<td>0-25%</td>
<td>Head Body Tail</td>
</tr>
<tr>
<td>Bivalve mollusc number</td>
<td>1-5</td>
<td>Head Body Tail</td>
</tr>
<tr>
<td>Barnacle number</td>
<td>1.5</td>
<td>Head Body Tail</td>
</tr>
<tr>
<td>Other ectoparasite number</td>
<td>1-5</td>
<td>Head Body Tail</td>
</tr>
</tbody>
</table>

#### Physical examination:

<table>
<thead>
<tr>
<th>Body</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Head</th>
<th>Eyes</th>
<th>NAD</th>
<th>Clear</th>
<th>Opaque</th>
<th>Injuries</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mouth</td>
<td>Mucosa: NAD</td>
<td>Hyperaemic</td>
<td>Pale</td>
<td>Petechia</td>
</tr>
<tr>
<td></td>
<td>Nostrils</td>
<td>NAD</td>
<td>Exudates</td>
<td>Injuries</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Skin</td>
<td>NAD</td>
<td>Retained shed</td>
<td>Wounds</td>
<td>Indentifying features (brands etc)</td>
</tr>
<tr>
<td></td>
<td>Spine</td>
<td>NAD</td>
<td>Fracture</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Body</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdominal Palpation</td>
</tr>
<tr>
<td>---------------------</td>
</tr>
<tr>
<td>Heart</td>
</tr>
<tr>
<td>Stomach</td>
</tr>
<tr>
<td>Repro tract</td>
</tr>
<tr>
<td>Liver</td>
</tr>
<tr>
<td>Spleno-pancreas</td>
</tr>
<tr>
<td>Colon</td>
</tr>
</tbody>
</table>

**Vent**

- NAD
- Hyperaemic mucosa
- Exudates
- Prolapsed hemipenes
- Injuries

**Tail**

- NAD
- Injuries

**Diagnostic samples and results:**

<table>
<thead>
<tr>
<th>Blood</th>
<th>Collected</th>
<th>Result/Details of sample</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithium heparin</td>
<td>ml</td>
<td></td>
</tr>
<tr>
<td>Serum</td>
<td>ml</td>
<td></td>
</tr>
</tbody>
</table>

**In house analysis**

- Tail
- Heart

- PCV:
- TP:
- Smear:

**Biochemistry**

**Haematology**

**Faeces**

- Completed

**Wet preparation**

**Faecal floatation**

**Diff Quick stain**

**Gram stain**

**Other**

- Completed

**Radiographs**

**Wound swab**

**Blood culture**

**Formalin fixed tissues**

**Frozen tissues**

**RNA later**

**Other notes**