DEPARTMENT OF PLANNING, INDUSTRY & ENVIRONMENT

Guidelines for the initial treatment and care of rescued sea turtles

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Cover photo: Green turtle (Chelonia mydas), Arrawarra Headland, Coffs Coast Regional Park. Duane March/Dolphin Marine Rescue.

All other photos, unless specified, have been provided by Duane March, Dolphin Marine Rescue.

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1. Introduction

The purpose of this document is to provide licensed wildlife rehabilitators in New South Wales with guidelines for the initial treatment of sea turtles requiring rescue or rehabilitation, in line with the *Code of Practice for Injured and Sick Sea Turtles and Sea Snakes* (the Sea Turtle Code) (DPIE 2020).

The primary objective of wildlife rescue is to relieve suffering in sick or injured wildlife. The primary objective of rehabilitation is to successfully release and reintegrate the individual back into the wild population. These objectives determine decision-making during the assessment and rehabilitation process (Figure 1).

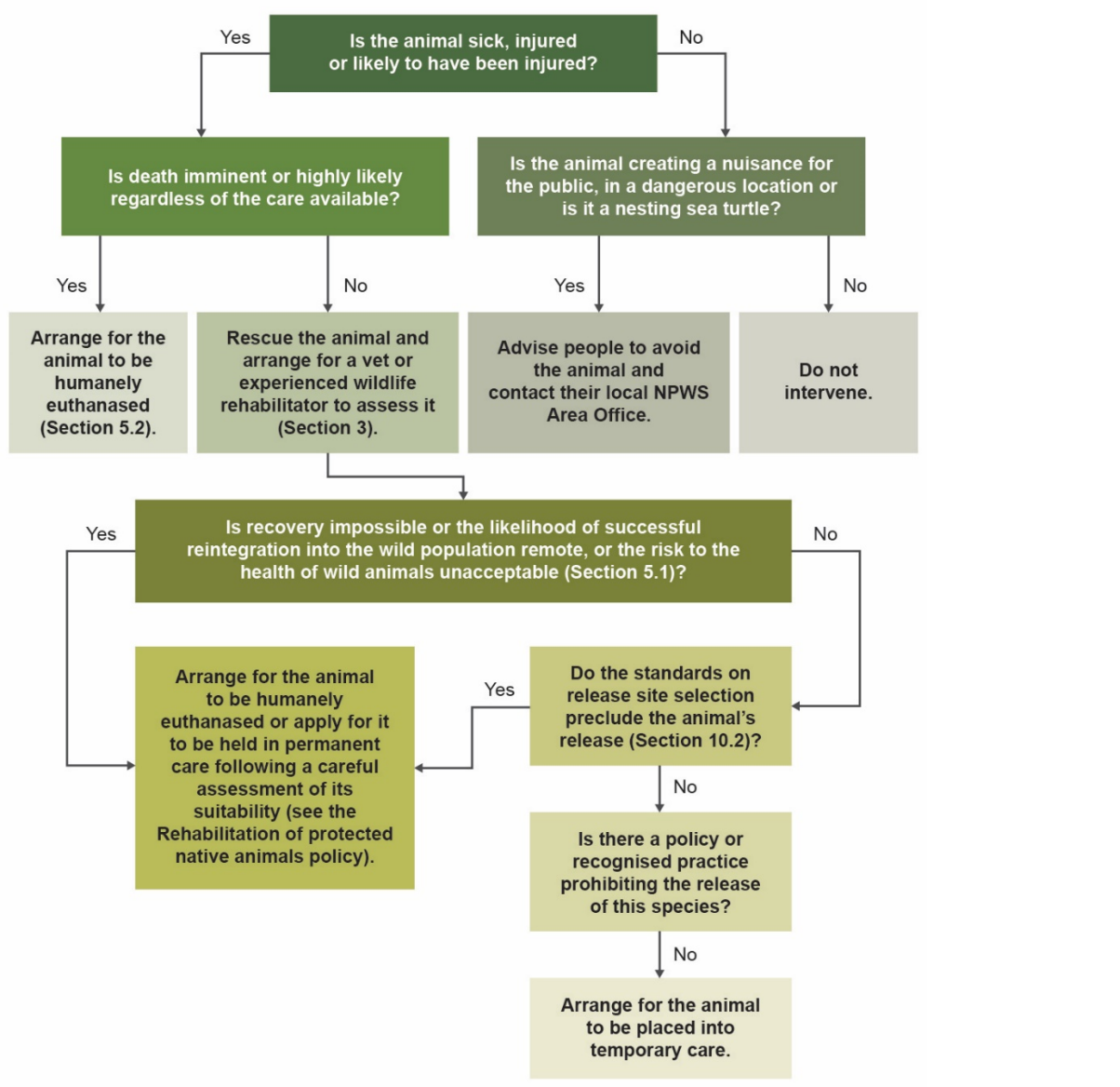

Figure 1 **Decision tree directing the course of action when a marine turtle is encountered**
(From the Sea Turtle Code)

These protocols refer to the six species of sea turtle encountered in New South Wales, including green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*Caretta caretta*), flatback turtle (*Natator depressus*), olive ridley (*Lepidochelys olivacea*) and the leatherback turtle (*Dermochelys coriacea*) (Figure 2). The external features of a sea turtle are shown in Figure 3.

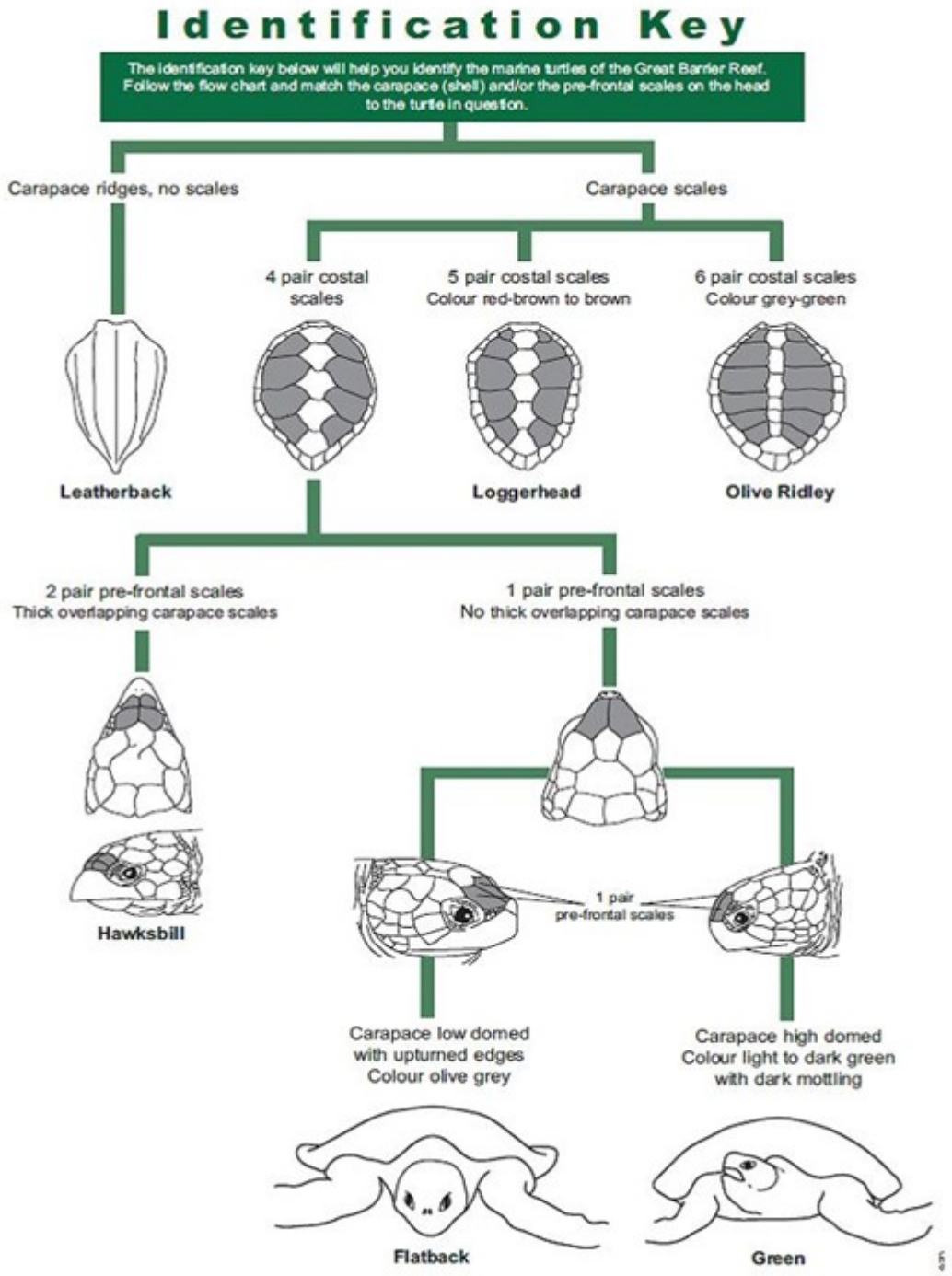

Figure 2 **Identification guide for sea turtles found in Australian waters**
(Courtesy of Queensland Government: Queensland Marine Turtle Field Guide)

2. Capture, restraint, and physical examination

As outlined in the Sea Turtle Code, rescuers must aim to have the turtle assessed by a veterinarian or experienced marine reptile rehabilitator within 24 hours of rescue to establish an appropriate course of treatment.

Clinical assessment aims to identify the severity of wounds, injuries or illness to determine the best course of action.

Distance examination

Clinical assessment begins before the rescue. Observations during this period will inform the rescuer of the required equipment and techniques to facilitate a safe capture for both the rescuer and the animal.

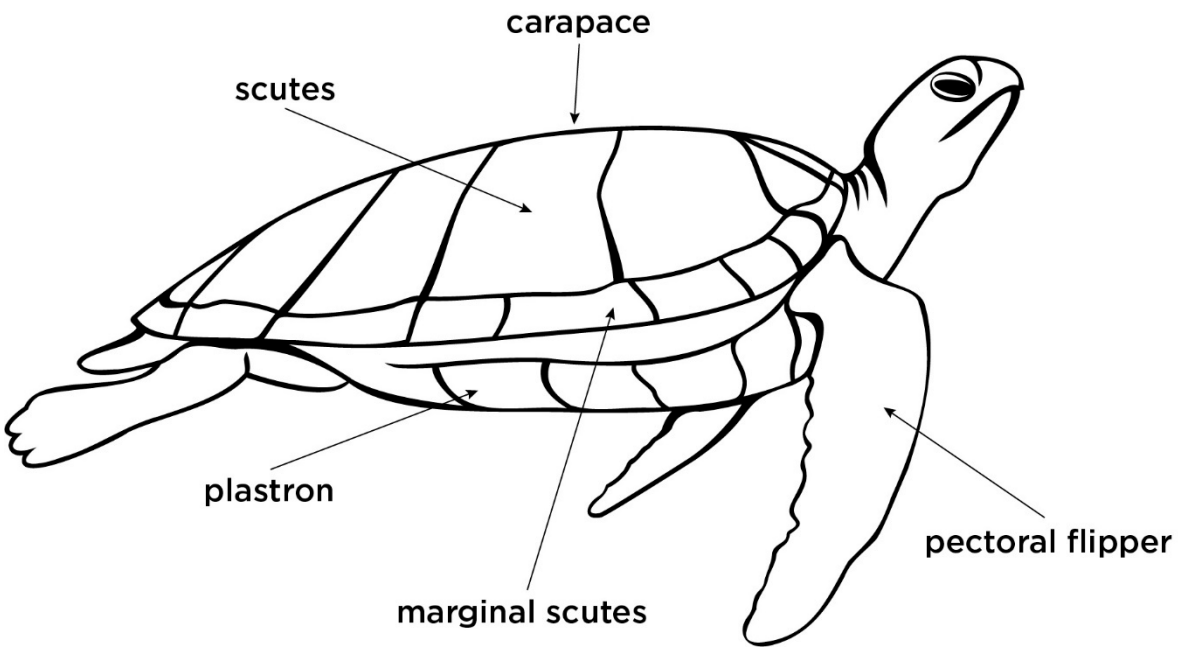

Figure 3 **Key external features of a sea turtle**

In-water assessment

Animals may require rescuing from aquatic environments. This can include surf zones and rock pools. There are a number of inherent dangers present to both the animal and the rescuer in these scenarios, including drowning, and at no time should the rescuer endanger themselves to rescue the animal (Manire et al. 2017).

Appropriate personal protective equipment, including wetsuits and rock shoes, should be worn in these scenarios, as stingrays and sea urchins are often present.

Where an animal is in the water, the rescuer should examine:

Ability to swim

Several factors should be assessed before rescue if the animal is swimming freely. These include:

- General activity – Note the animal's general level of activity and locomotion. The front (pectoral) flippers are the primary means of propulsion, so asymmetric or reduced use of front flippers may indicate injury or exhaustion.
- Abnormal swimming posture – Head trauma and parasitic infections (such as spirorchiidiasis and disseminated coccidiosis) can induce abnormal swimming patterns, including rapid circling and apparent disorientation and depressed mental activity.
- Respiration – Audible or excessive respiration may indicate the animal is having trouble breathing. This can occur if the animal has inhaled water or has a lung infection.
- Vision – Assess the animal's ability to visually navigate the aquatic environment. Consider the 'flight or fight' response when making this assessment as sometimes when sea turtles are faced with an adverse situation, they will flee with little regard for self-inflicted injuries.

Buoyancy

- Positive buoyancy occurs when injury or illness prevents the animal from being able to submerge for an extended period. It occurs when gas accumulates in the areas outside the lungs (pneumocoelomic floaters) or within the gastrointestinal tract (gastrointestinal floaters). The junction of the exposed carapace (hard upper shell) and the surface of the water is called the 'water line'. This junction becomes visible in animals with chronic positive buoyancy as the exposed carapace will be free of epibiotic growth (e.g. barnacles and molluscs). This is to be differentiated from 'behavioural buoyancy', which can be observed in sick turtles resting on the water's surface to conserve energy and avoid drowning. These animals will have a symmetrical water line and will be able to sink when faced with adverse surface conditions (Figure 13).

On-land assessment

Animals may require rescuing from the intertidal zone. Before handling the animal, rescuers should visually assess activity level, body condition, respiratory rate, external wounds, epibiotic load and the presence or absence of fibropapilloma (Figure 14) and determine if any fishing gear has been ingested or is entangling the animal.

This visual assessment will guide the rescue and transportation of the animal and inform diagnostics by the treating veterinarian or rehabilitator.

- Demeanour – A sea turtle can be classified as alert, depressed, or non-responsive. In a normal healthy turtle, the head is typically elevated when restrained or while breathing but may lay flat when placed on their plastron (underside of the shell). Signs of abnormal demeanour may include an inability to raise the head, head tilt, tremors and hyper-responsiveness to external stimuli.
- Carapace integrity – In chronically ill animals, the scutes (external plates on the shell) will not grow normally, and the keratin will appear to have receded from the margins. Increased pliability will be noted, particularly between the marginal scutes. Animals should also be checked for carapace trauma, including propeller injuries and fractures before transport.
- Body condition – Observation of the muscles of the head, neck and upper flippers will provide an indicator of body condition. In an emaciated animal, a protrusion from the back of the skull, called the supraoccipital process, can protrude through the overlying skin.

Capture, handling and transport

The rescuer should conduct a risk assessment before any rescue attempt, and where possible, protocols should be implemented to mitigate identified risks. A detailed approach to sea turtle rescue is outlined in the Sea Turtle Code.

When first encountered in the field, the animal should be visually assessed for any external injuries that need to be physically supported before moving the animal.

> Emaciated animals often have poor muscle tone and need to be handled with care to avoid fractures and internal injuries.

Transport can be stressful for animals (Knowles & Warriss 2007), and distances travelled should be minimised. Sea turtles tolerate transport relatively well (Hunt et al. 2016), however, handling should be minimised. General principles include using appropriately sized, padded containers (Figure 4). Padding is particularly important for emaciated animals as bones may be protruding from the plastron. In hot weather, a wet towel can be placed on the carapace to assist passive cooling. If this occurs, the animal should be supervised during transport to ensure the wet towel is not directly exposed to air conditioning, which could overly cool the animal, and to ensure the towel does not cover the animal's face, as it may obstruct breathing. Detailed transport methods are outlined in the Sea Turtle Code.

Figure 4 Transporting a large animal in a sling

There is a mattress under the sling to protect the plastron from pressure injuries, and the animal is restrained by grasping the front of the carapace. The front flippers are placed against the body to prevent the animal gaining purchase and propelling itself forward and are effectively restrained when the sling is folded. Transport on a mattress, with visual access to the turtle, is recommended for larger animals.

Restraint for physical examination

Most non-invasive procedures and physical examination can be performed using physical restraint alone. This can include holding the carapace using a firm hold at the front and back of the carapace, allowing the front flippers to flap freely or restraining the front flippers by grasping the edge of the carapace and the front flipper at the shoulder (Figure 5).

Figure 5 Restraint of a juvenile green turtle

The edge of the carapace can be held with the front flippers. The handler should wrap their fingers around the front flippers at the shoulder to provide cushioning when the animal flaps the flippers. The flippers should never be firmly restrained. Turtles will settle after an initial struggle.

Care should be taken when restraining the front flippers, as animals can fracture or dislocate bones if the front flippers are restrained too tightly (Norton 2014).

In smaller turtles, placement on an elevated, padded structure can prevent the animal gaining leverage with the front flippers and assist the operator with restraint. For larger animals, a similar outcome can be achieved by placing the animal on a tyre. This has the added advantage of relieving some of the pressure on the plastron.

The examiner should also be mindful that sea turtles can inflict a painful bite and cause serious injury.

Physical examination

An initial assessment of the sea turtle can provide a baseline health assessment and guide diagnostics and treatment protocols for the veterinarian or rehabilitator. While progressing through the physical examination, make notes and keep records of findings (Section 8).

Age and sexual maturity

The age at sexual maturity varies among species of sea turtle. In general, sexual maturity is reached when the curved carapace length (CCL) is approximately 75% of the adult CCL for that species (Snover 2002). The tail of a mature male will extend beyond the margin of the carapace (Wyneken 2003).

Body condition

Body weight and weight trends while the animal is undergoing rehabilitation can be a helpful indicator of hydration and nutritional status (Norton 2005). Turtles should be weighed on presentation and standardised measurements taken including CCL, curved carapace width (CCW), head width and tail length.

Subjective body condition scores (BCS) based on a scale of 1 – 5 can be used (Norton & Wyneken 2015), with 1 representing an emaciated turtle and 5 an obese turtle (Figure 6). Further information on BCS in turtles can be found online: Body condition scoring the sea turtle (LafeberVet).

Figure 6 Assessing body condition

Compare the concaved nature of the plastron top left (body score 1) with the convex nature of the plastron on the right (body score 4). Examination of the emaciated animal on the bottom left (body score 1) shows depressions in the carapace above the front flippers and reduced neck and shoulder musculature compared with the animal on the bottom right (body score 3).

Head

Assess the head, eyes and nostrils for signs of asymmetry, trauma and epibiotic coverage. Skull fractures are often associated with boat strike, and examination should include palpation of the skull to determine the presence or absence of instability that may indicate a fracture. Skull fractures carry a poor prognosis.

> In dehydrated animals the eyes will be sunken and skin tenting can be observed in the neck area.

Examining the eyes should include assessing the cornea (outermost surface of the eye) and surrounding membranes. Fibropapillomas may be present on eyelids and conjunctiva (tissue lining the eye) (Brooks et al. 1994). Cataracts have also been documented in sea turtles (Kelly et al. 2005). Vision can be confirmed by the presence of a menace response (evaluating behavioural or blink reflex in response to a visual threat), testing one eye at a time by covering the other eye, and waving a hand close to the animal's face and monitoring for a response. During this assessment minimal airflow should be created and contact with the eye avoided. Weak turtles often have a poor response despite no compromise to their vision.

Sea turtles do not have an external ear. The middle ear is covered by the tympanic scale that stretches across the auditory canal (Wyneken 2003). Swelling beneath the tympanic scale can be detected by asymmetry of the head and can be caused by infections or cranial fractures.

The nostrils are often blocked by excessive barnacle and algae growth, collectively called epibiota. When removing foreign material take care to avoid damaging the internal surfaces of the nostrils. Document any nasal discharge, including recording the colour and consistency.

To investigate the presence of abnormalities in the mouth, including plaques, ulcers or fishing hooks, applying constant pressure to the lower jaw will encourage the animal to open its mouth, facilitating an oral examination.

Skin and shell

Record the distribution and estimated age of observed skin and carapace lesions. Generalised skin fragility can be seen in debilitated animals suffering from advanced disease, and localised skin infections can be associated with barnacle attachment (Badillo et al. 2007). Pressure sores on the plastron can result from extended periods on land, and redness of the skin may indicate a generalised infection is present.

The plastron should be checked for protruding bones and general integrity. In emaciated animals, the plastron will be concave and there are often areas of translucent skin (Figure 7). This is best done after capture.

Growth of the shell is evident in rapidly growing juveniles by the presence of growth rings around the periphery of scutes. Epibiota on the skin and carapace can indicate poor health (Flint et al. 2010) and chronic disease. The burrowing barnacle, *Chelolepas chelonia,* can penetrate bone and can invade the abdominal cavity (Lauckner 1985).

Figure 7 Assessment of epibiotic load

The image on the left is upon admission and the image on the right is the same animal before release. In the left image, note the red tinge to the plastron that may indicate the animal has a severe infection. In the right image, note the lack of translucency and lack of concavity of the plastron.

Muscles and joints

Palpate the front and hind flippers, and assess the range of motion at each joint. Assess limbs and joints for any signs of swelling, asymmetry or instability.

Healthy animals should provide resistance when examined. Flaccid muscles with poor tone may indicate generalised weakness or a neurological disorder. Injuries to bones of the front flippers commonly result from entanglement in fishing gear and can cause strangulation with partial or complete amputation, fractures, significant blood loss and compromised tissue viability. Partial or total amputation of hind flippers is not uncommon, presumably the result of predator bites.

Cardiorespiratory system

Respiration consists of a forced exhale and respiratory rate can vary with activity and temperature. Animals rescued from the surf zone or from the beach may have aspirated water or sand, or both, and rescuers should confirm a clear airway is present (check the nostrils are clear of debris and sand). Respiratory disease can cause repeated mouth opening and rattles, crackles and gurgling noises during inspiration and expiration (Reckendorf et al. 2016).

Assessing heart rate and rhythm requires specialised equipment (ultrasound or doppler) and can be performed by a veterinarian. In emaciated juvenile animals an ultrasound can visualise the heart directly through the plastron (March et al. 2020).

Nervous system

Neurological examinations can be divided into central and peripheral components (Chrisman et al. 1997). See the Wider Caribbean Sea Turtle Conservation Network for a neurological examination checklist.

Examination of the central nervous system assesses brain function and spinal cord integrity. Abnormal findings can include head tilt, compulsive circling when swimming (which should only be evaluated once the animal has had time to acclimate to the environment), lack of jaw tone, head tremors, depressed demeanour and asymmetric, abnormal movements of the eyes.

The peripheral nervous system refers to all nervous tissues outside the central nervous system. The withdrawal reflex is a useful test to assess peripheral nervous system function. This is performed by pinching the tip of each aspect of the limb and monitoring for a response which can include an attempt to move the flipper or retraction of the head.

3. Clinical pathology

Haematology and biochemistry

A thorough veterinary assessment will include taking blood samples which can be collected with relative ease from top of the neck (the dorsal cervical sinus) (Owens & Ruiz 1980). This can be used to guide treatment protocols.

Haematogical assessment can be conducted relatively simply by an experienced veterinarian (Figure 8) and a basic assessment includes packed cell volume and a blood smear. Biochemical analysis often reveals compromised liver and kidney function (Flint et al. 2010; March et al. 2018).

Figure 8 **Blood collection from the top of the neck (dorsal cervical sinus) of a green turtle**

Note the circular yellow lesion to the left of the syringe is a result of the skin eroding over the skull.

Given the interaction between hydration status and disease processes, such as anaemia and low protein levels, results should be interpreted by considering the clinical appearance of the animal.

While haematological and biochemical reference intervals are broad for sea turtles in Australia (Flint et al. 2010), a general rule of thumb is that an animal with a packed cell volume of less than 20% is anaemic.

Faecal examination

All three standard methods of faecal examination (wet preparation, faecal float and faecal sediment exam) should be conducted on debilitated animals by a veterinarian. Faecal floatation is useful in detecting nematode ova and protozoal oocysts, and faecal sediment exam provides improved detection of trematode ova (Figure 9).

Coccidial infections with *Caryospora chelonia* have been documented in green turtles (Gordon et al. 1993; de Gouvea Pedroso et al. 2020). Husbandry conditions used to house debilitated green turtles can contribute to the spread of this disease. Clinicians and wildlife rehabilitators need to be mindful to practice appropriate quarantine protocols before housing animals together.

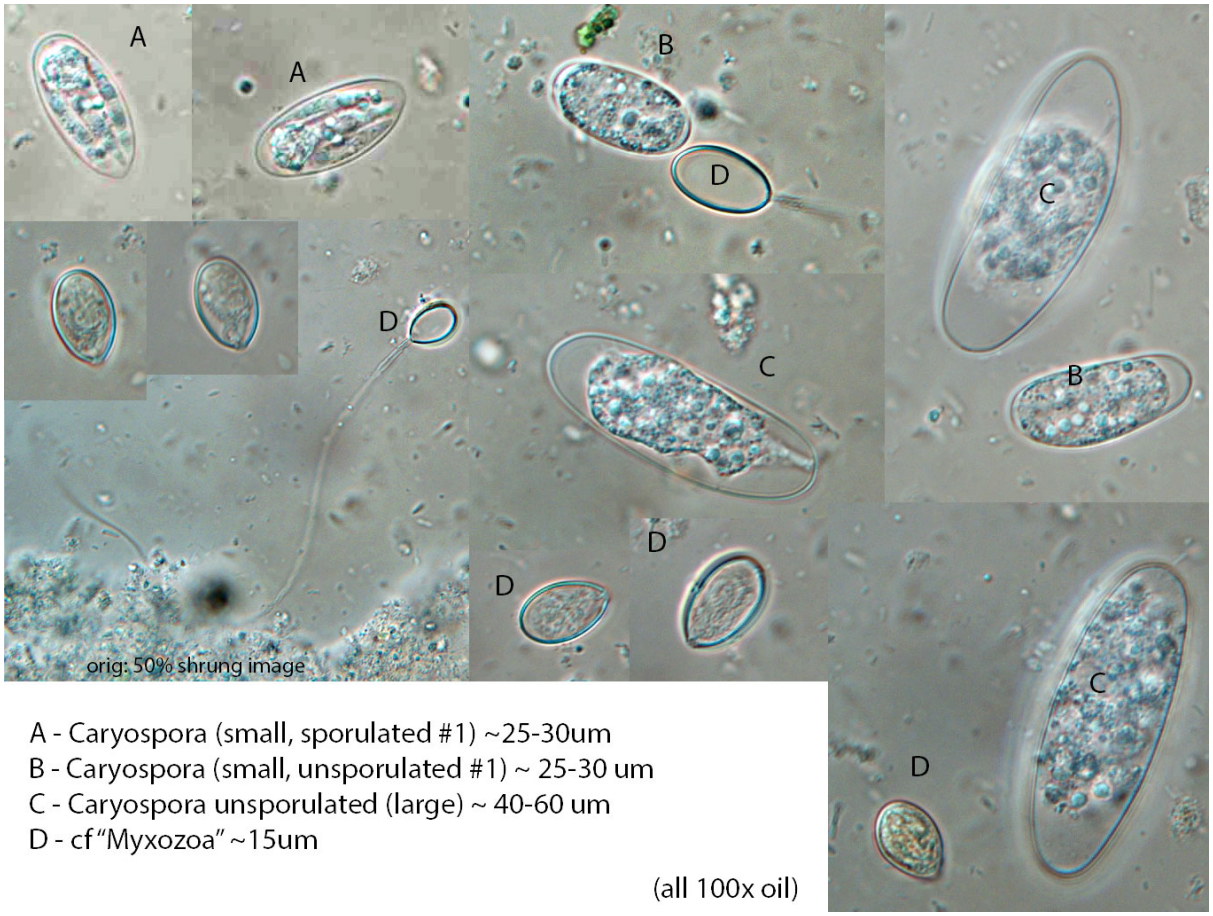

Figure 9 **Coccidian oocysts visible on faecal floatation**
Photo: Jan Slapeta.

4. Euthanasia

Indications for euthanasia are outlined in the Sea Turtle Code. They include:

- blindness in both eyes
- amputation of both front flippers
- loss of a front and hind flipper on the same side
- severely displaced carapace and plastron fractures where they are unlikely to reseal or heal
- skull fractures with associated neurological signs, including depression and paralysis.

Euthanasia should also be considered in severe neurological cases where animals are aggressively circling and do not respond to initial treatments.

Due to the endangered status of these animals and their ability to recover from serious injury, the decision to euthanise must only be enacted when conditions are clearly terminal and there is a direct need to end suffering. The decision should be made in consultation with a veterinarian with marine reptile experience or an experienced NSW National Parks and Wildlife Service (NPWS) officer, as outlined in the Sea Turtle Code.

Where possible euthanasia should be performed by a veterinarian. The method used must induce rapid loss of consciousness followed by cardiac arrest. If a veterinarian is not available to perform chemical euthanasia, alternative techniques for euthanasia are outlined in the Sea Turtle Code.

Several criteria should be used to confirm death, including lack of spontaneous movement, lack of deep pain response, absent cloacal tone, rigor mortis, no audible pulse when using doppler and no significant cardiac movement when using echocardiography. Sea turtle hearts can continue to contract for some time after death. Additional information on sea turtle euthanasia is present in the Sea Turtle Code.

5. Initial treatment

Fluid therapy

The various routes of rehydration for rescued sea turtles include immersion in fresh water, or intracoelomic (IC), subcutaneous (SC) or intravenous (IV) fluids. Fluids (IC, IV and SC) must be administered by a veterinarian or under the direct supervision of a veterinarian.

If the patient is stable enough to be placed in water, immersion in fresh water can enable rehydration through oral and cloacal intake. This has the added benefit of reducing the epibiotic load on the carapace and skin of the animal, as the marine organisms will be killed by immersion in fresh water and will slough off over time. However, care should be taken, as debilitated animals will drown in shallow water, and electrolyte imbalances, including low sodium balances, may occur within 48 hours (Ortiz et al. 2000).

Response to fluid therapy can be monitored via serial blood samples measuring packed cell volume, total plasma protein and plasma biochemistry, and should be conducted by a veterinarian.

IC fluid therapy involves injecting fluids into the abdominal cavity (coelom). It is less effective for initial treatments in severely compromised animals due to lower rates of absorption and the frequent presence of ascites (abnormal fluid build-up) in these animals. Therapeutic benefits (Innis et al. 2007; Camacho et al. 2015) have been documented with fluid delivery via this technique, however, inserting a needle into the coelomic cavity introduces the risk of injury or infection.

SC fluid therapy is administered in the pre-femoral space cranial to the hind flipper or in the area dorsal and medial to the shoulder. This is also a useful route for delivering medications where volumes exceed the preferred intramuscular dose (Mallo et al. 2002).

Wound care

Trauma is a common cause of sea turtle injury and mortality. The ability to effectively treat wounds depends on several variables including the cause, the tissues involved, and the time elapsed since the injury (Figure 10). All traumatic injuries are considered contaminated by the ocean environment, including debris such as sand.

The initial approach to wound management should include gentle flushing with sterile saline to remove debris. Where active infection is suspected, the wound should be thoroughly rinsed with a sterile solution or chlorhexidine antiseptic solution diluted to 0.05%, or for injuries around the eyes, povidone-iodine diluted to 1%.

In cases where the wound has or is suspected to have penetrated the coelomic cavity, flushing should be avoided and advice sought from an experienced wildlife veterinarian.

The skin of sea turtles is less elastic than that of mammals and is anchored at numerous attachment points, including the skull, carapace and plastron. This means surgical closure of large defects is not always possible.

Wounds to the carapace need to be assessed for depth and involvement of underlying tissue, including the spine. Wounds that puncture the top of the carapace can involve the lung, however, even with fracture of the bone, the internal membranes can provide an adequate layer of protection.

Rehabilitators should examine carapace fractures for audible gas release or release of bubbles when the animal is underwater. If these signs are noted, the animal must be taken to a veterinarian as soon as possible as this means that the lung is penetrated and carries a poor prognosis.

Deep wounds to the plastron can penetrate the liver and gastrointestinal tract. If this is suspected, assessment by a veterinarian is recommended, to investigate internal trauma before sealing the wound.

Active infections and recent wounds will have a red or pink appearance. As the wound heals, a yellow fibrous layer will form over the wound. This serves as a protective layer and should not be removed or disturbed.

Figure 10 Example of wound healing

Sea turtles can recover from large soft tissue deficits with minimal intervention and supportive treatment.

Managing bleeding

Bleeding can be stopped (haemostasis) as in other species via direct pressure. Tourniquets should be used with care, as they can cause significant and permanent tissue damage if left in place for too long. Severe, uncontrolled bleeding will need surgical intervention which should be conducted by a veterinarian.

Antimicrobial therapy

Treatment of confirmed or suspected bacterial infections is the primary reason for using antimicrobials. The choice of drug should be based on diagnostic testing (culture and susceptibility). Routine administration of antimicrobials to prevent disease is not recommended as it can result in increased prevalence of antimicrobial resistance (Kelly et al. 2006). Acquired antimicrobial resistance can complicate the treatment of future cases exposed to the same rehabilitation environment and can pose hazards for wildlife rehabilitators and clinicians. Antimicrobial drugs must only be prescribed by a veterinarian and used under their supervision.

Husbandry

Husbandry requirements for sea turtles in the initial period following rescue differ from requirements for sea turtles in longer term care. Husbandry should be adapted to each individual depending on the animal's behaviour and health status.

First 24 hours

Sick and injured sea turtles are often dry-docked on padded surfaces for initial emergency care (Norton & Wyneken 2015). These turtles can be kept moist by placing damp towels over the skin and carapace or regular misting.

Wet-docking can also be used for debilitated animals. In outdoor facilities it decreases the potential for flystrike. However, to prevent the animal from drowning the water level should be below the nostrils, as weak animals can lack the strength to lift their head to breath.

In both scenarios, the container used to house the animal should be large enough to allow the front flippers to be fully extended. Padding should be used in both wet-docked and dry-docked scenarios to avoid damaging the plastron. Padding should be uniform and completely fill the container, to prevent the animal becoming entangled or displaced if they move around.

After the first 24 hours

After the first 24 hours these animals can be transitioned into warm sea water. During this time animals should be supervised for short periods in shallow water to assess buoyancy, ability to swim, and strength. Periods of supervision can be extended based on the animal's response, before the animal is left in water overnight.

Where animals have been rescued from cold water, a gradual increase in temperature is needed to allow animals to acclimate. This is achieved by placing them in water no greater than 3°C above the sea temperature where they were found and gradually increasing the temperature by no more than 3°C each day until it reaches 23–26°C.

The water in the tanks should be maintained between 23 and 26°C and appropriately filtered. Food can be offered to the animal once the animal has defecated. To maintain hygiene, faecal material should be removed as soon as it is observed.

6. Common rescue encounters

Entanglement

Sea turtle skin is tough and relatively resistant to ligature injuries, such as entanglement in nets. Examining the skin of the neck and at the base of the flippers for redness, swelling and asymmetry can be used to detect subtle trauma (Figure 11). In addition to the soft tissue trauma that can result from entanglement, the animal has a high likelihood of drowning. Evidence of drowning in sea turtles is variable, however, if the rescuer detects foam bubbling from the mouth or nostrils, it is likely the animal has inhaled fluid while entangled.

Entanglement in monofilament fishing line leaves more detectable lesions and will cut through skin, fracture bone and compromise soft tissue (Figure 12).

Figure 11 Consequences of net entanglement

The entanglement has resulted in soft tissue damage, and some of the damaged skin has sloughed during healing. Photos: Larry Vogelnest.

Figure 12 Consequence of monofilament line entanglement

The entanglement has resulted in strangulation of the front flipper and fracture of the humerus, requiring amputation.

Foreign body ingestion

Fishing hooks and line

Ingestion of fishing line and hooks is not uncommon in stranded sea turtles. Over time, the trailing line will lead to ulceration and erosion of bone at the corners of the mouth. When an animal presents with hooks or fishing line attached, veterinary treatment is required.

Do not cut the line before veterinary assessment, as often the line can be used to locate the hook and aid removal.

The prognosis for animals in these situations depends on the location of the fishing hook and line within the gastrointestinal tract. If the length of line is short and the hook does not become lodged in the gastrointestinal tract, it is possible for the material to pass through the digestive tract and be expelled without incident (Valente et al. 2007). However, it is also possible the line may cause folds or pleats in the intestine and direct traumatic injury. In both scenarios, the resulting complications can be fatal.

Plastic and marine debris

Ingestion of plastics and other anthropogenic debris is commonly reported in sea turtles. This is likely to be the result of indiscriminate feeding behaviour in herbivores or post-hatchlings during the oceanic life phase (Schuyler et al. 2014), or the animal mistaking synthetic items for food (Mrosovsky et al. 2009). Complications from plastic ingestion can vary from malnutrition to obstruction of the gastrointestinal tract, which can be fatal, however, in some instances there may be no adverse impact on the animal.

If plastic is seen protruding from the cloaca, mouth or nostrils and the animal is not in immediate respiratory distress, where possible, removal should be conducted by a veterinarian or experienced sea turtle rehabilitator under veterinary supervision, as the process can cause further trauma or internal injury if not performed properly.

Float syndrome

Float syndrome is a general term used to describe animals with abnormal positive buoyancy and is commonly seen in stranded sea turtles. This generally results from an excess of gas, either within the gastrointestinal tract, or outside the gastrointestinal tract within the coelomic cavity. The location of the gas and the duration of the condition can be determined by assessing the animal's posture in the water and the pattern of growth of epibiota on the carapace.

Treatment depends on first identifying the location and cause of the excess gas. Gas can accumulate in the gastrointestinal tract due to intestinal abnormalities, including decreased motility (i.e. reduced ability of the muscles of the digestive tract to contract) or obstruction, or can accumulate as the animal swallows air. Gas outside the gastrointestinal tract is normally the result of small tears in the lung caused by blunt force trauma.

Float syndrome, or abnormal positive buoyancy (Figure 13), needs to be differentiated from animals that are voluntarily floating on the surface to conserve energy or to thermoregulate. Behavioural floaters will be capable of resting on the bottom when surface conditions are adverse.

Figure 13 Differentiating between abnormal positive buoyancy and voluntary floating

The animal on the left has a chronic positive buoyancy abnormality where the right-hand side of the carapace is predominantly above the waterline. This leads to an increased epibiotic load on the submerged side of the carapace and asymmetric placement of the front flippers as the animal needs to compensate for the tilted posture. The animal on the right is a 'behavioural floater', who is in poor body condition and chooses to remain at the surface. Note the waterline on the carapace and placement of the front flippers is symmetrical.

Disease

Debilitated turtle syndrome

Chronic debilitation is a common presentation in sea turtles entering rehabilitation clinics worldwide (Orós et al. 2005; Flint et al. 2009; Camacho et al. 2013; Stacy et al. 2018) and is usually the result of chronic malnutrition due to poor nutrient uptake. Often the cause cannot be identified, but can include inadequate food availability, gastrointestinal disease, foreign body obstructions, and prolonged physiological stress including exposure to cold water. Clinically animals appear emaciated, as identified by sunken eyes, have reduced muscle mass and a concaved plastron. Chronic nutrient deficits can result in weakened bones and sloughing skin and these animals should be handled with care.

Fibropapillomatosis

Fibropapillomatosis (FP) results in single or multiple lesions that can grow on the skin, carapace, plastron, and internal organs and have been reported in all marine turtle species. The lesions have a raised, irregular surface that can vary in colour (Figure 14). Lesions can obstruct vision, predispose animals to secondary infections, and result in fatal complications.

Chelonid herpesvirus 5 (ChHV5) has been identified as the likely cause of FP, however, the disease is more common in urbanised waterways, indicating water quality and environmental health may play a factor. FP is most common in juvenile green turtles, and marine leeches have been proposed as a potential pathway of transmission of the disease.

Where FP lesions are seen, the rehabilitator should implement strict quarantine procedures and contact a veterinarian to facilitate treatment and sample collection. The treating veterinarian should contact the Australian Registry of Wildlife Health on (02) 9978 4749 or (02) 9978 4788. Samples collected can be frozen at -80°C or stored in ethanol before transport.

Figure 14 Fibropapillomatous lesions on a juvenile green turtle
Note the surface of the lesions can be pink or grey in appearance. Photo: Karina Jones.

Infectious diseases

A range of infectious diseases can affect debilitated sea turtles including parasites, and bacterial and fungal agents.

Parasitic infections can include trematodes, such as spirorchiid flukes, which are a common cause of disease in debilitated sea turtles in Australia (Gordon et al. 1998; Flint et al. 2009). Adult spirorchiid flukes are found in the cardiovascular system, including the heart and major arteries as well as smaller vessels and other organs. Injury to the sea turtle results from both adult flukes and eggs and can include inflammation and obstruction of blood vessels (Stacy et al. 2010). Other species of trematode can cause disease also and can be found in the gastrointestinal and urinary tracts.

Bacterial and fungal infections are commonly encountered in stranded sea turtles and can cause respiratory disease, bone infections, dermatitis and ultimately terminal sepsis. However, these infections are normally secondary to other physiological stressors, including chronic malnutrition.

Boat strike

Vessel strikes are a relatively common cause of injury. The force of impact can result in significant soft tissue trauma even in cases where no external injury to the limbs or carapace is observed. This is particularly the case with jet ski collisions, where the impellor is incorporated into the shape of the jet ski hull. The force of the impact can lead to fatal internal bleeding.

Due to the nature of sea turtle surfacing behaviour, the head and carapace are the most affected areas. The appearance of the wound inflicted will vary based on the craft that struck the animal and can include a variety of blunt and sharp force injuries (Foley et al. 2019). Where the hull of the boat strikes the animal, a single, blunt force wound is often observed, with associated fractures, as opposed to injuries inflicted by a propeller, which will appear as a series of parallel sharp gashes (Figure 15).


Figure 15 Injuries caused by boat strike

The image on the left shows the multiple, sharp, parallel gashes from a propeller strike. Photo: David Blyde. The image on the right shows the single wound, often with secondary fractures, that results from being struck by the boat's hull.

Predator attack

Predation is another common injury in stranded sea turtles. Hatchlings and post-hatchlings are predated on by a variety of terrestrial and marine animals and sharks predate on juvenile and adult turtles. The sharp teeth of sharks will result in distinctive wounds, including deep rake marks and multiple incisions. In extreme cases, semicircular wounds will be seen where limbs are completely amputated or damage to the carapace or plastron is observed to the extent that internal organs are exposed.

The rescuer should examine the turtles and perform initial treatment principles described above and organise veterinary assessment as soon as possible.

Oil spills

Sea turtles can be exposed to oil following accidental anthropogenic spills. Exposure can result in direct contact, inhalation and direct ingestion. The immediate and long-term effects of exposure are unknown, but sea turtles are sensitive to chemicals and pollutants in general (Lutcavage et al. 1995) and hence exposure may result in significant injury and mortality.

External de-oiling of sea turtles is accomplished using the same principles as other oiled wildlife: using warm, diluted detergent and fresh water. Mayonnaise was used during the Deepwater Horizon oil spill to loosen areas of oil around the eyes and nostrils that were resistant to repeated saline flushing (Manire et al. 2017).

Diagnosis and treatment following inhalation or ingestion of oil should be performed by a veterinarian. If exposure to a chemical pollutant is suspected, the rehabilitator should contact the Australian Marine Safety Authority by ringing the Maritime Emergency 24-hour hotline on 1800 641 792 to report the event.

Hatchling management

Both hatchlings and post-hatchings can be found washed up on beaches and require rescue. An animal is considered a hatchling if it has a CCL of less than 5 centimetres and is free of epibiota. Post-hatchlings have a CCL of greater than 5 centimetres and may have some epibiota on the carapace following a period of drifting at sea before being washed back to shore.

Hatchling transport

Hatchlings and post-hatchlings can be transported in a container with moist sand (Figure 16). The container should be appropriately sized to allow the head and all appendages to extend without restriction. Transport temperatures should range between 23 and 27°C.

Multiple animals can be transported in a single container.

Hatchlings and post-hatchlings should not be transported in water.

Figure 16 Appropriate transport of hatchlings and post-hatchlings

Note the damp sand in the bottom of the bucket. During transport the container should be covered to reduce exposure to light and sound, and replicate a nest environment. Photo: Holly West.

Hatchling assessment

Hatchlings are considered ready for release when they have a reasonably straight carapace, no protruding yolk sac and are capable of righting themselves when placed on their back. Hatchlings from a failed nest site that have not been in the ocean, and hence have not undergone the ‘swim frenzy’, should be released from the beach on dusk, once deemed fit.

The ‘swim frenzy’ is a physiological state where hatchlings expend vast amounts of energy to traverse the near-shore environment to reach offshore currents where they begin the next phase of their life cycle, known as the ‘lost years’.

Post-hatchling assessment

Post-hatchlings can be found on the beach in need of rescue after intense weather events or following sustained onshore winds. Post-hatchlings will typically have a curved carapace length greater than 5 centimetres and may have some epibiotic growth on the carapace or skin. These animals have been drifting in sargassum beds before washing ashore and may

have consumed buoyant plastic that accumulates in these surface rafts. More serious injuries can be present, including trauma, foreign body ingestion and entanglement.

In some cases, post-hatchlings are relatively healthy and can be released after a short period of supportive care. Given these animals have completed the swim frenzy stage, they will benefit from an offshore release, having used the metabolic reserves required to traverse the near-shore environment.

Once the primary problem has been addressed, these animals can be housed on moist towels or supervised in warm shallow water, depending on energy levels. Water should be filtered to prevent secondary infections. Animals should be provided with access to appropriate UV exposure. Take care to predator-proof rehabilitation enclosures.

7. Quarantine and biosecurity

Quarantine practices are vital for controlling and preventing infectious disease transmission between patients undergoing rehabilitation.

> Treat all sea turtles as potentially infectious and take precautions to minimise disease transmission.

Quarantine practices include:

- Upon admission, examine all sea turtles for the presence of fibropapillomas and marine leeches.
- House sea turtles separately, including separate water for new individuals. If multiple animals are to be housed in one tank, a faecal exam should be conducted before combining to exclude the presence of infectious organisms such as protozoal oocysts.
- Disinfect towels between patients.
- Clean enclosures with an appropriate disinfectant, such as F10, between patients.
- Practice appropriate personal hygiene, including washing hands thoroughly between patients and using appropriate personal protective equipment.
- Inspect plumbing for the presence of marine biota, taking particular care to check for and remove vermetid worms (Figure 17). These gastropods can act as an intermediate host for spirorchiid flukes, amplifying the spread of these parasites in animals undergoing rehabilitation in the same facility.

Figure 17 Vermetid worm

Vermetid worms (*Thylaeodus* species) are an intermediate host for spirorchiid outbreaks in a rehabilitation clinic (Cribb et al. 2017). Photo: Richard Corner.

8. Record keeping

Maintain accurate records to track the progress and outcomes for sea turtles in care, and submit these records to NPWS.

Records to be maintained include:

- species and date of rescue
- encounter details
- individual identification: use a system that enables each animal in rehabilitation to be individually identified
- physical examinations: records of initial and subsequent physical examinations
- daily clinical and husbandry notes: feeding habits, faecal output, and the animal's ability to swim should be monitored and recorded daily during the initial period of rehabilitation
- fate: record the outcome of each case. Where the patient dies, a post-mortem examination should be conducted and results recorded.

9. References and further reading

Badillo F, Puig L, Montero F, Raga J & Aznar F 2007, Diet of Balaenophilus spp.(Copepoda: Harpacticoida): feeding on keratin at sea? *Marine Biology* 151(2): 751–758.

Brooks D, Ginn P, Miller T, Bramson L & Jacobson E 1994, Ocular fibropapillomas of green turtles (Chelonia mydas), *Veterinary Pathology* 31(3): 335–339.

Camacho M, Quintana M d. P, Calabuig P, Luzardo OP, Boada LD, Zumbado M & Orós J 2015, Acid-base and plasma biochemical changes using crystalloid fluids in stranded juvenile loggerhead sea turtles (Caretta caretta), *PLoS One* 10(7): e0132217.

Camacho M, Quintana MP, Luzardo OP, Estévez MD, Calabuig P & Orós J 2013, Metabolic and respiratory status of stranded juvenile loggerhead sea turtles (Caretta caretta): 66 cases (2008–2009), *Journal of the American Veterinary Medical Association* 242(3): 396–401.

Chrisman CL, Walsh M, Meeks JC, Zurawka H, LaRock R, Herbst L & Schumacher J 1997, Neurologic examination of sea turtles, *American Veterinary Medical Association* 211: 1043–1047.

Cribb TH, Crespo-Picazo JL, Cutmore SC, Stacy BA, Chapman PA & García-Párraga D 2017, Elucidation of the first definitively identified life cycle for a marine turtle blood fluke (Trematoda: Spirorchiidae) enables informed control, *International Journal for Parasitology* 47(1): 61–67.

de Gouvea Pedroso SB, Phalen DN, Terkildsen M, Blyde D, March DT, Gordon AN, Chapman PA, Mills PC, Owen H & Gillett A 2020, Coccidiosis in green turtles (Chelonia Mydas) in Australia: Pathogenesis, spatial and temporal distribution, and climate-related determinants of disease outbreaks, *The Journal of Wildlife Diseases* 56(2): 359–371.

Flint M, Morton JM, Limpus CJ, Patterson-Kane JC, Murray PJ & Mills PC 2010, Development and application of biochemical and haematological reference intervals to identify unhealthy green sea turtles (Chelonia mydas), *The Veterinary Journal* 185(3): 299–304.

Flint M, Patterson-Kane JC, Limpus CJ, Work TM, Blair D & Mills PC 2009, Postmortem diagnostic investigation of disease in free-ranging marine turtle populations: a review of common pathologic findings and protocols, *Journal of veterinary diagnostic investigation* 21(6): 733–759.

Foley AM, Stacy BA, Hardy RF, Shea CP, Minch KE & Schroeder BA 2019, Characterizing watercraft-related mortality of sea turtles in Florida, *The Journal of Wildlife Management* 83(5): 1057–1072.

Gordon A, Kelly W & Cribb T 1998, Lesions caused by cardiovascular flukes (Digenea: Spirorchidae) in stranded green turtles (Chelonia mydas), *Veterinary Pathology* 35(1): 21–30.

Gordon A, Kelly W & Lester R 1993, Epizootic mortality of free-living green turtles, Chelonia mydas, due to coccidiosis, *Journal of Wildlife Diseases* 29(3): 490–494.

Hunt KE, Innis CJ, Kennedy AE, McNally KL, Davis DG, Burgess EA & Merigo C 2016, Assessment of ground transportation stress in juvenile Kemp's ridley sea turtles (Lepidochelys kempii), *Conservation physiology* 4(1).

Innis C, Papich M & Young D 2007, Pharmacokinetics of metronidazole in the red-eared slider turtle (Trachemys scripta elegans) after single intracoelomic injection *Journal of veterinary pharmacology and therapeutics* 30(2): 168–171.

Kelly T, Walton W, Nadelstein B & Lewbart G 2005, Phacoemulsification of bilateral cataracts in a loggerhead sea turtle (Caretta caretta), *Veterinary record* 156(24): 774–777.

Kelly TR, Harms CA, Lemons C, McLellan C & Hohn AA 2006, Influence of preoperative oxytetracycline administration on community composition and antimicrobial susceptibility of cloacal bacterial flora of loggerhead sea turtle, Caretta caretta, post-hatchlings, *Journal of Herpetological Medicine and Surgery* 16(1): 9–14.

Knowles T & Warriss P 2007, Stress Physiology of Animals During Transport, *Livestock handling and transport,* T Grandin, CAB International, Wallingford, UK**:** 312–328.

Lauckner G 1985, *Diseases of reptilia*, Hamburg.

Lutcavage M, Lutz P, Bossart G & Hudson D 1995, Physiologic and clinicopathologic effects of crude oil on loggerhead sea turtles, *Archives of Environmental Contamination and Toxicology* 28(4): 417–422.

Mallo KM, Harms CA, Lewbart GA & Papich MG 2002, Pharmacokinetics of fluconazole in loggerhead sea turtles (Caretta caretta) after single intravenous and subcutaneous injections, and multiple subcutaneous injections, *Journal of Zoo and Wildlife Medicine* 33(1): 29–35.

Manire CA, Norton TM & Stacy BA 2017, *Sea Turtle Health & Rehabilitation*, J Ross Publishing Incorporated.

March D, Marshall K, Swan G, Gerlach TJ, Smith H, Blyde D, Ariel E, Christidis L & Kelaher B 2020, The use of echocardiography as a health assessment tool in green sea turtles (Chelonia mydas), *The Australian Veterinary Journal,* in press.

March D T, Kinette-Herrin K, Peters A, Ariel E, Blyde D, Hayward D, Christidis L & Kelaher BP 2018, Hematologic and biochemical characteristics of stranded green sea turtles, *Journal of Veterinary Diagnostic Investigation* 30(3): 423–429.

Mrosovsky N, Ryan GD & James MC 2009, Leatherback turtles: the menace of plastic, *Marine pollution bulletin* 58(2): 287–289.

Norton T & Wyneken J 2015, *Body Condition Scoring the Sea Turtle*, http://lafeber.com/vet/bodycondition-scoring-the-sea-turtle.

Norton TM 2005, Chelonian emergency and critical care, *Seminars in avian and exotic pet medicine*, Elsevier.

Norton TM 2014, Sea Turtle Restraint, http://lafeber.com/vet/sea-turtle-restraint.

Orós J, Torrent A, Calabuig P & Déniz S 2005, Diseases and causes of mortality among sea turtles stranded in the Canary Islands, Spain (1998–2001), *Diseases of aquatic organisms,* 63(1): 13–24.

Ortiz RM, Patterson RM, Wade CE & Byers FM 2000, Effects of acute fresh water exposure on water flux rates and osmotic responses in Kemp's ridley sea turtles (Lepidochelys kempi), *Comparative Biochemistry and Physiology Part A: Molecular & Integrative Physiology* 127(1): 81–87.

Owens DW & Ruiz GJ 1980, New methods of obtaining blood and cerebrospinal fluid from marine turtles, *Herpetologica* 17–20.

Reckendorf A, Tuxbury K, Cavin J, Silver G, Brisson J, McManus C, Stacy B, Merigo C & Innis C 2016, Laryngeal Paralysis in a Loggerhead Sea Turtle (Caretta caretta), *Journal of Herpetological Medicine and Surgery* 26(1–2): 20–25.

Schuyler Q, Hardesty BD, Wilcox C & Townsend K 2014, Global analysis of anthropogenic debris ingestion by sea turtles, *Conservation biology* 28(1): 129–139.

Snover ML 2002, *Growth and ontogeny of sea turtles using skeletochronology: methods, validation and application to conservation,* Duke University Durham, North Carolina, USA.

Stacy BA, Foley AM, Greiner E, Herbst LH, Bolten A, Klein P, Manire CA & Jacobson ER 2010, Spirorchiidiasis in stranded loggerhead Caretta caretta and green turtles Chelonia mydas in Florida (USA): host pathology and significance, *Diseases of aquatic organisms* 89(3): 237–259.

Stacy NI, Lynch JM, Arendt MD, Avens L, Braun McNeill J, Cray C, Day RD, Harms CA, Lee AM & Peden-Adams MM 2018, Chronic debilitation in stranded loggerhead sea turtles (Caretta caretta) in the southeastern United States: morphometrics and clinicopathological findings, *PloS One* 13(7): e0200355.

Valente ALS, Parga ML, Velarde R, Marco I, Lavin S, Alegre F & Cuenca R 2007, Fishhook lesions in loggerhead sea turtles, *Journal of wildlife diseases* 43(4): 737–741.

Wyneken J 2003, The external morphology, musculoskeletal system, and neuro-anatomy of sea turtles, *The biology of sea turtles* 2: 39–77.