Common Diseases and Traumatic Injuries of Stranded Cetaceans

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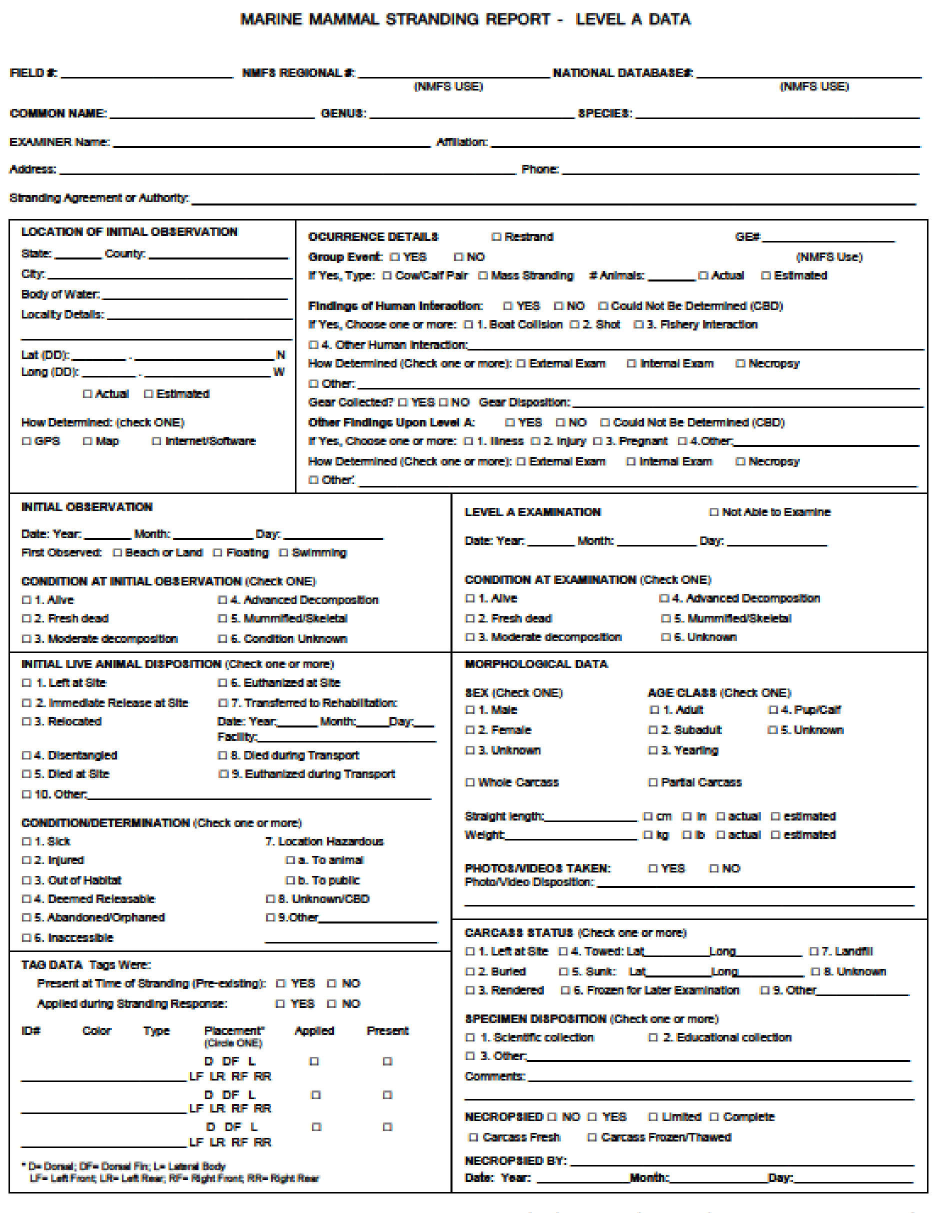
Introduction

Marine mammal populations are declining, with many classified as endangered.[1] Growing public concern and federal regulations have led to further public and federal interest and forensic investigations into cetacean strandings with a desire to expand care and diagnostic testing for these species.[2] According to the National Oceanic and Atmospheric Administration (NOAA), a stranding event is when a marine mammal or sea turtle is found dead or alive on the beach. Stranding events can also occur when a marine mammal or sea turtle is alive but out of its natural habitat and unable to return. Dolphin and whale strandings occur for various reasons such as disease, predation, environmental conditions, lack of an adequate food source, and anthropogenic involvement such as commercial or recreational fishing by-catch, vessel strike, deliberate illegal trauma and environmental toxins.[3] Like other wild animals, marine mammals do not portray signs of disease until their condition has severely declined.[4] Therefore, an animal is severely diseased, injured, or deceased when a stranding occurs. Examination of stranded cetaceans offers valuable information for bio-monitoring and determining cause of death and subsequently better management protocols for wild and captive cetaceans.[2] Cetaceans act as a sentinel species providing insight into environmental conditions, such as ecosystem health and toxins in the water.[5] Stranded cetaceans can reportedly suffer from maladies such as by-catch, pneumonia, and parasitic infection.[1]

History and Presentation

History (predominantly from public observers) is a valuable and essential puzzle piece for assessing stranded cetacean individuals. Individuals may be live or dead stranded on the beach or may be found near shore in shallow water or off shore in estuaries or other water channels. Thus, location of stranding, age of stranded individual, sex, body condition, any clinically relevant signs and external and internal lesions are recorded on the Level A marine mammal stranding report form (Figure 1).[6] In all stranding cases, multiple physiologic samples are collected for and submitted to NOAA.

Figure 1. Marine Mammal Stranding Report-Level A Data.[6]



MARINE MAMMAL STRANDING REPORT - LEVEL A DATA

FIELD #: ____ NMFS REGIONAL #: ____ (NMFS USE) NATIONAL DATABASE#: ____ (NMFS USE)

COMMON NAME: ____ GENUS: ____ SPECIES: ____

EXAMINER Name: ____ Affiliation: ____

Address: ____ Phone: ____

Stranding Agreement or Authority: ____

LOCATION OF INITIAL OBSERVATION
State: ____ County: ____
City: ____
Body of Water: ____
Locality Details: ____
Lat (DD): ____ - ____ N
Long (DD): ____ - ____ W
☐ Actual ☐ Estimated
How Determined: (check ONE)
☐ GPS ☐ Map ☐ Internet/Software

OCURRENCE DETAILS ☐ Restrand GE# ____ (NMFS Use)
Group Event: ☐ YES ☐ NO
If Yes, Type: ☐ Cow/Calf Pair ☐ Mass Stranding # Animals: ____ ☐ Actual ☐ Estimated
Findings of Human Interaction: ☐ YES ☐ NO ☐ Could Not Be Determined (CBD)
If Yes, Choose one or more: ☐ 1. Boat Collision ☐ 2. Shot ☐ 3. Fishery Interaction
☐ 4. Other Human Interaction: ____
How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy
☐ Other: ____
Gear Collected? ☐ YES ☐ NO Gear Disposition: ____
Other Findings Upon Level A: ☐ YES ☐ NO ☐ Could Not Be Determined (CBD)
If Yes, Choose one or more: ☐ 1. Illness ☐ 2. Injury ☐ 3. Pregnant ☐ 4.Other: ____
How Determined (Check one or more): ☐ External Exam ☐ Internal Exam ☐ Necropsy
☐ Other: ____

INITIAL OBSERVATION
Date: Year: ____ Month: ____ Day: ____
First Observed: ☐ Beach or Land ☐ Floating ☐ Swimming

CONDITION AT INITIAL OBSERVATION (Check ONE)
☐ 1. Alive ☐ 4. Advanced Decomposition
☐ 2. Fresh dead ☐ 5. Mummified/Skeletal
☐ 3. Moderate decomposition ☐ 6. Condition Unknown

LEVEL A EXAMINATION ☐ Not Able to Examine
Date: Year: ____ Month: ____ Day: ____

CONDITION AT EXAMINATION (Check ONE)
☐ 1. Alive ☐ 4. Advanced Decomposition
☐ 2. Fresh dead ☐ 5. Mummified/Skeletal
☐ 3. Moderate decomposition ☐ 6. Unknown

INITIAL LIVE ANIMAL DISPOSITION (Check one or more)
☐ 1. Left at Site ☐ 6. Euthanized at Site
☐ 2. Immediate Release at Site ☐ 7. Transferred to Rehabilitation:
☐ 3. Relocated Date: Year: ____ Month: ____ Day: ____ Facility: ____
☐ 4. Disentangled ☐ 8. Died during Transport
☐ 5. Died at Site ☐ 9. Euthanized during Transport
☐ 10. Other: ____

CONDITION/DETERMINATION (Check one or more)
☐ 1. Sick 7. Location Hazardous
☐ 2. Injured ☐ a. To animal
☐ 3. Out of Habitat ☐ b. To public
☐ 4. Deemed Releasable ☐ 8. Unknown/CBD
☐ 5. Abandoned/Orphaned ☐ 9.Other ____
☐ 6. Inaccessible

MORPHOLOGICAL DATA
SEX (Check ONE) AGE CLASS (Check ONE)
☐ 1. Male ☐ 1. Adult ☐ 4. Pup/Calf
☐ 2. Female ☐ 2. Subadult ☐ 5. Unknown
☐ 3. Unknown ☐ 3. Yearling
☐ Whole Carcass ☐ Partial Carcass
Straight length: ____ ☐ cm ☐ in ☐ actual ☐ estimated
Weight: ____ ☐ kg ☐ lb ☐ actual ☐ estimated

PHOTOS/VIDEOS TAKEN: ☐ YES ☐ NO
Photo/Video Disposition: ____

TAG DATA Tags Were:
Present at Time of Stranding (Pre-existing): ☐ YES ☐ NO
Applied during Stranding Response: ☐ YES ☐ NO

ID#	Color	Type	Placement* (Circle ONE)	Applied	Present
____			D DF L LF LR RF RR	☐	☐
____			D DF L LF LR RF RR	☐	☐
____			D DF L LF LR RF RR	☐	☐

* D= Dorsal; DF= Dorsal Fin; L= Lateral Body
LF= Left Front; LR= Left Rear; RF= Right Front; RR= Right Rear

CARCASS STATUS (Check one or more)
☐ 1. Left at Site ☐ 4. Towed: Lat ____ Long ____ ☐ 7. Landfill
☐ 2. Buried ☐ 5. Sunk: Lat ____ Long ____ ☐ 8. Unknown
☐ 3. Rendered ☐ 6. Frozen for Later Examination ☐ 9. Other ____

SPECIMEN DISPOSITION (Check one or more)
☐ 1. Scientific collection ☐ 2. Educational collection
☐ 3. Other: ____
Comments: ____

NECROPSIED ☐ NO ☐ YES ☐ Limited ☐ Complete
☐ Carcass Fresh ☐ Carcass Frozen/Thawed
NECROPSIED BY: ____
Date: Year: ____ Month: ____ Day: ____

NOAA Form 89-864; OMB Control No.0648-0178; Expiration Date 01/31/2017 PLEASE USE THE BACK SIDE OF THIS FORM FOR ADDITIONAL REMARKS

*Derived from NOAA, National Marine Fisheries Service.[6]

Often, marine mammal strandings are typically reported by the public to law enforcement or local stranding networks. In response to strandings, standing networks gather evidence from the environment, stranded carcass, or information from people who have been observing a live, in water, stranded individual which is typically then captured for physical examination and released, rehabilitated, or necropsied depending on the examination. Location and body of water in which the animal is found in or near, weather at the of capture and/or carcass discovery, state of the animal (alive or dead, and if dead, degree of decomposition), any recent history or evidence of human interaction, and morphological data (such as body weight, length, and condition scoring).[3] In addition to viral and bacterial epidemic or infection, adverse factors that potentially impact and lead to cetacean strandings include fungal infection, parasitism, biotoxins, anthropogenic contaminants, secondary septicemia, and shortage of prey or alteration of the food chain.[7] Strandings may also result from anthropogenic trauma such as boat strike, by-catch (or entanglement in fishing gear), or intentional abuse.[8] Evidence of trauma may not be readily apparent when evaluating a stranded carcass and traumatic lesions may be limited to internal organs or osseous structures. In addition, predation, scavenging, and advanced decomposition can mask or alter lesions.[7] Traumatic events such as boat strikes are especially a concern with the growth of the shipping industry.[7] Lesions that may indicate a possible boat strike include multifocal superficial lacerations with or without musculoskeletal layer involvement, evisceration, osseous fracture, hematoma, and/or hemorrhage.[7]

In stranding cases where by-catch is suspected there may be signs of aspiration or asphyxiation and lesions associated with net entanglement.[9] Asphyxiation may be a cause of death when laryngeal displacement or obstruction occurs.[10] Signs of aspiration include dyspnea, froth, water, or blood in the trachea or blowhole. A dolphin’s large lungs and extended breath hold times increases their susceptibility of inhaling anthropogenic contaminants and may result in lung injury or bacterial pneumonia.[11] Common anatomical locations that can demonstrate lesions from fishing gear entanglement are the mouth, head, flippers, and the tail.[12] Signs of drowning or aspiration are not pathognomonic for entanglement with fishing gear, but rope or netting marks may also be seen encircling and/or constricting the body.[9] During subacute entanglement marine mammals may be weak, vocalizing, unresponsive to humans, or have difficulty exhaling.[12] Pulmonary parenchymal changes related to severe respiratory distress caused by trauma are more readily detectable in small animals due to wider availability of diagnostic tools such as thoracic radiographs and pulse oximetry. Such signs would generally include evidence of external trauma, coughing, hemoptysis, vomiting, regurgitation, tachypnea, increased respiratory effort and lethargy. Respiratory distress may be noticeable in live cetacean strandings, with by-catch or entanglement cases. Respiratory distress or pulmonary disease in general, is a more occult entity in cetaceans and can be seen in individuals entrapped in fishing or dredging equipment. Outward signs include lethargy, increased respiratory effort and rate with the blowhole remaining permanently open.[13,14] Frothy pulmonary fluid and/or pulmonary edema may also signal pneumonia caused by bacteria or parasitic infection or cardiac failure.[1] Animals may additionally have subclinical primary pulmonary disease and may not have any outward clinical signs, however, some animals have been reported with decreased respiratory capacity and diving ability (especially true of *Halocercus* parasitism).[1]

Boat strike or propeller impacts can result in blunt force or sharp trauma. Marine mammals having suffered a traumatic event may have impaired locomotion, diving, respiratory compromise or may be listless and at the water's surface.[12] Swelling, external discoloration or exposed muscle, impaired respiration, and/or hemorrhage from the rostrum or blowhole are additional signs a traumatic event has occured.[15,16] Non-anthropogenic trauma can occur with intra and inter-species aggression. With regard to neonatal bottlenose dolphins, external lesions are not typically seen with aggression in this age group.[16] As social animals, bottlenose dolphins engage in aggressive behavior during pod cooperation, sexual interactions, and male alliances.[17]

Pathophysiology Including Anatomical Considerations

The pathophysiology of trauma is somewhat similar in marine mammals to trauma in other species, in that trauma can occur from any number of scenarios. In marine mammals, however consideration should be given to unique environmental exposures and anatomical variances that can contribute to trauma associated morbidity and mortality. The blowhole in marine mammals also produces sound and is the equivalent of nostrils in other species.[4] Unlike other mammals where it has a connection with the esophagus and serves the purpose of protecting the lower airway and producing sound, the trachea of marine mammals only connects to the blowhole.[18] However, regurgitation and/or aspiration may still occur as a secondary complication with regard to neurologic or other polytrauma.[15] Head, intracranial and pulmonary trauma may result in aspiration of blood suggesting ante-mortem blunt force trauma.[15]

Exposure to biotoxins could impair marine mammals perception or mental awareness, predisposing them to anthropogenic trauma such as by-catch.[12] Biotoxins, such as domoic acid and brevetoxin have been associated with unusual mortality events.[3] Brevetoxins are neurotoxins produces by the dinoflagellate, *Karenia brevis,* which is responsible for red tides.[19] Red tides are a public health risk and cause animal mortalities.[19] Brevetoxins bind to sodium channels resulting in activation of neurons, skeletal muscle cells and cardiac cells.[19] Biotoxins, such as domoic acid, alter neurological function of marine mammals and have been suggested to precipitate the interaction with anthropogenic materials leading to trauma.[12] Biotoxins have been linked to unusual mortality events.[3] Unusual mortality events are mass die-offs or an increase in frequency of strandings of a specific species.[3]

By-catch can produce lesions similar to those seen in terrestrial mammal asphyxiation or aspiration.[9] Trauma associated with by-catch is often associated with necroscopic evidence of drowning rather than gross evidence of physical injury.[9] Pulmonary lesions that can occur secondary to by-catch include pulmonary interstitial or alveolar disease due to edema congestion, or excessive froth within the lower and upper airways, emphysema, parenchymal or pleural hemorrhage or petechiation and hemorrhagic pericardial effusion. [9] Pulmonary edema and froth within the airways are seen with asphyxiation due to the hypoxic damage of the alveolar membrane leading to erythrocyte and protein leakage (or increased oncotic pressure) within/into the alveoli.[9] Drowning or pulmonary edema can occur by two mechanisms: the fluid or seawater is inhaled into the alveoli causing alveolar damage or water and proteinaceous fluid fills the alveoli due to a change in the osmotic gradient due to laryngospasms or vasculitis.[20] Traumatic asphyxiation or drowning should be on the differential list if by-catch and net entanglement is suspected. However, within the first 5-10 minutes post mortem, the atrio-ventricular and sinoatrial nodes contract leading to pulmonary edema. Increased hydrostatic pressure within pulmonary vasculature, leads to the release of fibrin and interstitial fluid into the alveoli.[9] Histological indications for by-catch, but not specific to underwater entrapment, are pulmonary edema, intra-alveolar hemorrhage, and emphysema.[9] Congestion is also normally seen grossly and histologically in the liver, kidney and thoracic *rete mirabile* with underwater entrapment. [9] The thoracic *rete mirabile* is arteries and veins between the thoracic vertebral bodies responsible for temperature countercurrent exchange.[14] An indication of ante-mortem trauma to the respiratory tract is ingestion of blood which can be observed in the stomach chambers on necropsy.[2] As with any pulmonary parenchymal infiltrate or hemorrhage, additional differentials should include non-traumatic causes of pulmonary lesions such as bacterial, viral, fungal or parasitic pneumonia; until proven otherwise.[9] Often, unknown trauma is a diagnosis of exclusion when obvious evidence of such is lacking. Bronchointerstitial pneumonia caused by infestation of *Halocercus brasiliensis* and dolphin morbillivirus have been reported in strandings.[1] Nematodes, *Anisakis and Braunina cordiformis,* can cause bronchoalveolar occlusion and moderate to severe bronchial, interstitial or granulomatous pneumonia.[1] Infrequently, (0.02%) pneumonia can be caused by gram-negative bacteria and signs of septicemia can be apparent and subsequent multifocal bacterial pulmonary thromboembolic shower and severe inflammatory pulmonary disease (similar to acute respiratory distress syndrome or sudden respiratory distress syndrome of other mammals).[1] The sequela to this cascade was inevitable parenchymal necrosis.[1] Endotoxemia develops rapidly in cetaceans and gram-negative bacterial infection increases the risk for endotoxemia. The presence of open wounds provides opportunity for such microbial colonization and proliferation and could lead to deep tissue invasion.[15,4] Unlike people, in which sepsis is often associated with multiple organ failure, cetaceans affected by endotoxic shock have petechial and ecchymotic hemorrhages and diffuse intravascular coagulation (more like horses).[4] Such ecchymosis could be confused for polytrauma and differentiation between the two would require further work up.

Bruising may be seen in non-lethal injuries as the hemorrhage resolves and progresses in color. As hemoglobin, hematoidin, and hemosiderin is metabolized, bruising may change in color from red to blue in 2-4 days then to green in a week, then to yellow by 2 weeks.[16] However, in some species of cetaceans, color changes may not be evident due to the dark pigmentation of the animal's skin or epidermis.[16] Similar to other mammals, inflammatory cells are recruited to injured areas with neovascularization and the formation of granulation tissue.[16] Water disturbances can also interfere with distinguishing ante- and post-mortem wounds. Blood may be absent in an open wound due to hemolysis and leaching of blood from water exposure.[15]

Diagnostic Approach and Considerations

As with companion animals, the physical assessment of the animals is an important first step in evaluating the cause of stranding. Initially, a visual health assessment should be performed.[14] External examination includes body measurements, body condition, weight, documentation of any injuries, skin color, and cyamid load (or crustacean species parasite, also known as whale louse). In live strandings, behavior, buoyancy, and alertness are important to note.[14] Complete evaluation the health status of a stranded cetacean includes obtaining blood samples for hematology, chemistry, and toxicology analysis, blowhole and anal slit culture swabs for bacterial and fungal analysis, and a urine sample for toxicology.[3] Auscultation can be performed on live animals to determine if there are any lung abnormalities.[13] Fluid in the airways is collected to distinguish between bodily fluid and seawater using specific gravity.[2] In the field, additional minimally invasive methods of assessing the stranded individual include portable radiography if available or sonography. Pulmonary sonography is reportedly easy to perform and valuable for point of care/critical care assessment. In this author's experience, the study can aid in evaluating for pleural hemorrhage/fluid, parenchymal disease, pleuritis and lymphadenopathy. Sonography is highly operator dependent. Additional limitations include depth limitations inherent to the machine and glare if performed on the beach, boat side or docked on the boat. Stranding assessments can occur in different settings, such as live in water or beach strandings (alive or dead). State departments and private stranding networks may respond to strandings, but all information is reported at a federal level to NOAA[3]. Live captures in open water or on the beach has the potential for three outcomes, relocation, rehabilitation or euthanasia. For disoriented animals that cannot return to their natural habitat, relocation is the ideal option.[3] Stranded animals may require medical attention. When this is the case, rehabilitation with the intention of release is recommended.[3] Humane euthanasia can be performed by a trained veterinarian if the health of the animal is in critical condition.[3] When approaching a stranded animal, the degree of decomposition is assessed. Live strandings are Code 1.[2] Dead strandings in good condition are code 2.[2] Moderate decomposition with bloating is Code 3. Severe decomposition with severe scavenger damage, soft blubber, and liquefied muscles are Code 4 and code 5 is skeletal remains.[2] Beach necropsies are performed if the degree of decomposition is Code 3 or greater. Fresh strandings may be taken to the stranding network for a more thorough necropsy. To conclusively determine a cause of death, a thorough necropsy, following stringent recommended protocols and examination, is indicated.[16] Pathological information, history, gross lesions, radiology, toxicology and hematology are all diagnostic modalities indicated for evaluation of a stranded animal.

Routine testing should be followed for wellness and treatment of captive cetaceans. Hematology, complete blood count, serum biochemistry, urine collection, gastric fluid assessment, blubber biopsies for toxicology and histology, and blowhole swabs for cytology and culture.[14] Like companion animal medicine, leukocytosis may be seen with inflammation or eosinophilia with parasitic disease or biotoxins.[18] Serum biochemistry will evaluate creatine phosphokinase, lactate dehydrogenase, and aspartate transaminase (AST) for muscle damage.[2] AST can also indicate liver damage. A more specific enzyme in bottlenose dolphins, is alanine aminotransferase (ALT).[4] Serum biochemistry also assesses kidney function by analyzing levels of blood urea nitrogen (BUN) and creatinine.[4] Although, BUN is normally higher in marine mammals compared to terrestrial mammals due to the consumption of high dietary protein.[4] Possible differentials for muscle damage include capture myopathy and acute rhabdomyolysis.[2] Urine should be collected to test for urinalysis and evaluation for the presence of myoglobin, hemoglobin, and toxins. Histopathology and microbiology are also useful diagnostic modalities. Nematode infection has been observed as a concurrent condition with by-caught species.[1] Bronchoalveolar lavage and/or bronchoscopy are useful in getting samples from stranded cetaceans in rehabilitation. [13]

In addition to skin biopsy, if any cutaneous or dermal lesions are present upon examination, tissue samples are submitted for histological review and all lesions are photographed. Photographs are taken in situ with an identifier and scale.[2] In both live and deceased evaluations, wounds are thoroughly described with regard to texture, shape, and margins of the wound or lacerations can discern if the trauma occurred ante-mortem and led to the stranding or occurred as a result of exposure artifacts such as predation or water disturbances.[2] If possible, stranded individuals should be should be assessed for fractures or other obvious osseous defects. Radiographs can be a valuable diagnostic modality in either live or dead stranding cases for the evaluation of bone injuries. Long bones with traumatic injuries exposing marrow or fat tissue are diagnosed with special histological stains, Oil Red O or osmium tetroxide.[2]

As discussed, location of stranding is an important element to consider. For example, if most lesions are on the ventral aspect of the animal and do not appear to be a result of scavenging, the animal was most likely struck by a vessel post-mortem.[2] Lacerations are consistent with propeller marks. When located along the ventral aspect of animal, lacerations imply that a boat strike post-mortem has occurred. Visceral herniation or evidence of rupture is documented even though these can represent post-mortem changes.

Ante-mortem injuries may also be noticed with evidence of blood drainage from organs, including liver, kidneys, and lymph nodes.[2] Histological evidence of external trauma may include organ hemorrhage, edema or muscle fiber degeneration.[12] In many cases, lesions cannot be differentiated as ante- or post-mortem boat strikes or predation due to the level of decomposition or autolysis.[5] Degenerative changes seen in muscle fibers may indicate traumatic injury or stress induced with live stranding and handling.[5] The *longissimus dorsi* muscle, the main muscle used for locomotion, can be assessed histologically for severe acute diffuse or multifocal degenerative change as an indication for traumatic injury.[7] These histological changes can be seen even if the muscle was not directly injured.[7] Characteristics of myofibril injury include lack of cross-striations, size variation, and swollen with flocculent, granular or hyalinised eosinophilic sarcoplasm.[7] The majority of lesions seen in ship-strike cases involved type II fibers rather than type I fibers, which is more often associated with stress or capture myopathy.[7] However, tissue injury associated with a stress response was seen more often in cetacean calves that had traumatic lesions.[5] Boat strike injuries typically involve skin, soft tissue, and occasionally bones. However, autolysis, scavenging or water disturbances may mask injuries and the cause of death. Histopathology is a useful diagnostic tool in determining if lesions are stress-related or if lesions are secondary to direct injury. Histologic staining should include the traditional hematoxylin and eosin (H&E) as well as special stains when indicated.[2] Myofiber fragmentation and hyalinization or deterioration into a translucent material can be seen despite a lack of gross evidence.[5] Boat strikes can occur pre- or post-mortem and histopathology is an important tool in determining whether or not a boat strike occurred ante- or post-mortem.

Diagnosing underwater entrapment, which includes by-catch and net entanglement cases fall into a category of confirmed, probable, and suspected based on the criteria developed by Paul D. Jepson, Table 1.[9]

Table 1: Criteria for diagnosing underwater entrapment

Confirmed	Probable	Suspected
Reported by fisheries observer	Froth in lungs	Based on observer experience and lack of other cause of death evidence
Entangled in gear	Whole or partially digested prey	
Whole or partially digested prey in stomach	Bruising of appendages or neck or rostral, mandibular fractures	
Net marks	Rope marks	

*Adapted with minimal revision from *Peracute underwater entrapment of Pinnipeds and Cetaceans*, Jepson PD.

Limited necropsies, such as beach necropsies, or necropsy without histopathology submission or results, are termed “suspected cases” of underwater entrapment, and cannot be confirmed. [16]

Diagnosis of by-catch or entanglement as cause of death or stranding is made by evaluation of lacerations, encircling lesions, lesions along the rostrum (beak or snout) or mandibular lesions.[9] Lesions may erroneously be misconstrued as being due to fishing gear or boat trauma when in reality they were caused by post-mortem scavenging, post-mortem human involvement, or rake marks (linear lacerations caused by teeth marks of other cetaceans).[9] Consideration should also be given to nutritional or other disease processes.[9] To confirm a diagnosis of underwater entrapment, the cetacean would have been reported by a fisheries observer, entangled in fishing gear, and have net marks. Probable diagnosis can be made with rope marks, froth in the lungs, prey in the stomach, and bruising around fin and neck.[9] Single lesions are not conclusive for diagnosing entanglement, however, when wounds are multiple or many in nature, by-catch should be suspected.[12] An important note when diagnosing a by-catch is make sure the animal is in good nutritional status to rule out other underlying causes.[9] The diagnosis of chronic entanglement is made using characterizations of lacerations such as remodeling, epidermal proliferation, and exposed granulation tissue on histopathology.[12] Indications of blunt force trauma include frank and/or subcutaneous hemorrhage, edema hematoma, lacerations, skeletal muscle hemorrhage or laceration, fractures, and visceral herniation or rupture.[16] While, sharp trauma is often seen by the presence of one or more parallel wounds that are shaped linear to sigmoid.[15] Sharp trauma can be a result of the propeller, skeg, or rudder on a boat.[15] Sharp incising wounds are often a result of propeller trauma, while blunt force trauma may be due to a boat strike or intra and inter-specific aggression.[16] Subcutaneous hemorrhage of the ventral neck, thoracic and abdominal regions, as well as lung and liver ruptures have been documented in cases of neonatal aggression.[16] Exposed muscle result from blunt or sharp trauma. Thorough examination of the skeleton is important in necropsy of suspected sharp injury cases to look for evidence of trauma such as bone nicks, shearing, fractures, and displacements.[15] Radiographs are useful in diagnosing traumatic injuries. Thoracic radiographs may reveal pneumothorax along with the cause such as rib fractures.[12] Ultrasound is useful for diagnosing soft tissue pathology, however, lung ultrasonography cannot penetrate past the lung surface.[13]

Investigating a cause of death in cetacean strandings can be challenging, strandings should be designated live open water, live beached, dead open water, dead beached and the cause of death should be labeled as suspected or confirmed. If confirmation is available, due to various factors that inhibits concrete evidence found on necropsy. Unlike small or domesticated animals, traumatic events are rarely witnessed with cetaceans. Ability to effectively reach the necropsy site in a timely manner, loss of tissue through scavenging, boat strikes, anthropogenic materials, past lesions, and decomposition are all factors that potentially mask the cause of death.[2] Histology is an important aspect of confirming a diagnosis, however, in peracute deaths microscopic lesion may be minimal.[15]

Treatment and Management Options

Efficient response to a live cetacean stranding is crucial to survival for these species. Stranded cetacean individuals frequently have disease (some of which have zoonotic potential). Thus, diseased individuals should be protected from other threats. Temperature, the surf in the immediate time surrounding the stranding event, and sea water aspiration are threats to a stranded animal. [13] Lung auscultation will determine if an animal needs immediate attention. Gravity out of the water, shock, and lung pathology can adversely impact respiration and should be monitored during transportation. [13] If less than 50% of air is moving through the lung fields, furosemide (1mg/kg) intramuscular injection is recommended if the animal appears hydrated. [13] Dehydration can be corrected with oral fluids and proper diet. [13] Monitoring water quality and salinity is important to managing these species once in captivity.[14] Capture myopathy can lead to death or severe spinal curvatures for stranded cetaceans and those in captivity. [13] An injection of vitamin E and selenium (1mL/100lb) and vitamin E daily can prevent development of spinal curvatures. [13] Due to the risk of endotoxemia, antibiotics that do not promote the release of endotoxin such as quinolones, aminoglycosides, and later-generation cephalosporins are recommended.[4]

Expected Outcome and Prognosis

Anthropogenic involvement is the leading cause of death in stranded cetaceans as commercial fishing gear poses a significant threat to cetaceans.[9] However, non-anthropogenic trauma is a continued threat. Age-related injuries or infanticide is recognized in neonatal bottlenose dolphins.[16]

Dolphins and whales are typically critically ill at the time of stranding and will deteriorate without medical attention.[13] Causes of death early in rehabilitation are often due to electrolyte imbalances, dehydration, and water aspiration. Weak animals are at risk of water and sand aspiration or drowning if they cannot support themselves to keep their entire blowhole out of the water. [13,14] Unlike small animals, where cage rest is recommended for respiratory distress, it is crucial for marine mammals to start swimming in the first week of rehabilitation due to the risk of pulmonary embolism. [13,12] Prognosis can be assessed with the use of hematology such as inflammatory leukograms, electrolyte imbalances, anemia, and elevated serum amyloid A and creatinine kinase.[15] If septicemia is evident, prognosis is poor. Mortalities associated with bacterial sepsis are approximately 50%.[4] Husbandry behaviors may be used to allow veterinary intervention.[4] Rehabilitation success may be lower severely diseased patients due to their uncooperative nature and state of disease.

Conclusion

In conclusion, cetaceans are most commonly stranded due to anthropogenic trauma and pneumonia associated with lungworm infestation (*H. brasiliensis).*[1] Trauma is typically caused by ship strikes, by-catch, or net entanglement. Public awareness and reporting is crucial to rapid response, providing care to live stranded individuals, and gaining information from dead stranded cases to assess for causes of death and potential for wider environmental implications given that these are sentinel species.

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