SUMMARIZED NECROPSY OF THE FLORIDA MANATEE

- Martine de Wit, 2007

External examination of the carcass

Before starting the internal examination, information on general body condition, weight, wounds, scars, discharge from body orifices, and other abnormalities is recorded. Detailed measurements of fresh propeller wounds can aid determination of the vessel type that was related to the trauma (Rommel *et al*., 2007). Wound measurements may include chord length, maximal width, chord depth, cut span, and fitting of propeller circle templates. The manatee is scanned for PIT tag microchips. Photographs are taken of the dorsal, ventral, and lateral aspects of the carcass, including scars. In addition to photographs, wounds and scars are sketched in a standardized form (see Appendix I). Body measurements are performed with the manatee positioned on its back (see Appendix II). A biopsy from the fluke and/or nail is collected for genetic analysis.

Figure 1. Watercraft-induced wounds. Watercraft can inflict both sharp- and blunt-force trauma. Sharp force trauma (1a) involves injuries from sharp skegs, fins, and propeller blades. Blunt-force trauma (1b) involves injuries from hulls, keels, blunt propellers and skegs, etc. Because the manatee dermis is so tough, external abnormalities may appear minor in blunt-force trauma. However, internal tissue damage (including bone fractures) can be extensive under superficial skeg wounds as presented in 1b.

Figure 2. Bloody discharge from eyes and nares. Bloody discharge from eyes and nares is a nonspecific finding that can be seen in manatees that died due to brevetoxicosis. The hemorrhage may be related to congestion and inflammation of the respiratory tract, and/or consumptive coagulopathy.

Figure 3. Cutaneous lesions with ulceration on nose and lips. Epidermal hyperplasia, pustular dermatitis, and ulcers are commonly seen in manatees with "Cold Stress Syndrome". The lesions may be due to ischemic necrosis and thus often located at temperature sensitive body extremities, including face, flippers, and fluke margins.

Internal examination of the carcass

Initial incisions

Longitudinal cuts (through dermis, superficial muscles, and blubber) are made parallel to the long axis of the body along the midline and at the lateral margins of the carcass. Transverse cuts are placed at the cranial margin of the flippers and at the umbilicus. At this stage, if the carcass is fresh enough to have representative fat stores, blubber and skin thickness measurements are taken at the level of the umbilicus (see Appendix II). While removing the skin, blubber and muscle layers, attention should be paid to serous atrophy of fats and subcutaneous abscesses. The ventral aspect of viscera (mostly intestine) will be exposed at this point.

All organs are examined on serosal and cut surfaces; texture, color, lesions, bloodiness, etc. are described.

Abdominal cavity

The abdominal, mesenteric, and omental fat stores are assessed. To remove the gastrointestinal tract, the mesenteries are cut, starting with the large intestine. The stomach, duodenum, and cecum are removed with the intestines attached.

Gastrointestinal tract. The manatee GI tract can account for up to 23% of the total body weight and measure ~40 meters in an adult manatee (Reynolds & Rommel, 1996). Manatees are considered hindgut fermenters, and passage of digesta is relatively slow, ~2 weeks. The complete GI tract is opened and evaluated. The stomach, duodenum, proximal and distal small intestine, cecum, and proximal and distal large intestine are described individually. The contents are described, which includes moisture, texture, degree of mastication, and color. Attention should be paid to foreign or unusual objects, such as monofilament or tunicates, and blood staining of ingesta. The mucosa is examined and the presence, amount, and type of parasites is noted. The nematode *Heterocheilus tunicatus* is commonly found in the stomach and duodenum, and the trematode *Chiorchis fabaceus* is often found in the cecum and colon.

Pancreas and spleen. The small spleen is located within the gastrolienal ligament and closely related to the greater curvature. The pancreas can be found at the C-shape loop of the duodenum.

Liver and gallbladder. The organ description of the liver includes assessment of the margins. In a fresh carcass, the margins should be sharp; roundness may reflect decomposition. The gallbladder normally contains ~10-30 ml of bile.

Kidneys. The kidneys are located on the ventrocaudal aspect of the hemidiaphragms near the midline. Because of their position, the kidneys are prone to impact injuries, which results in lacerations or fractures on their surfaces. These fractures commonly originate from the ancillary vessels that are found on the kidney surface. In some cases, this trauma can lead to death due to exsanguination.

Urogenital system. The gonads are located lateral and slightly caudal to the kidneys. When opening the uterine horns in female manatees, attention should be paid to the presence of placental scars in the mucosa. Mammaries are found in the axillae.

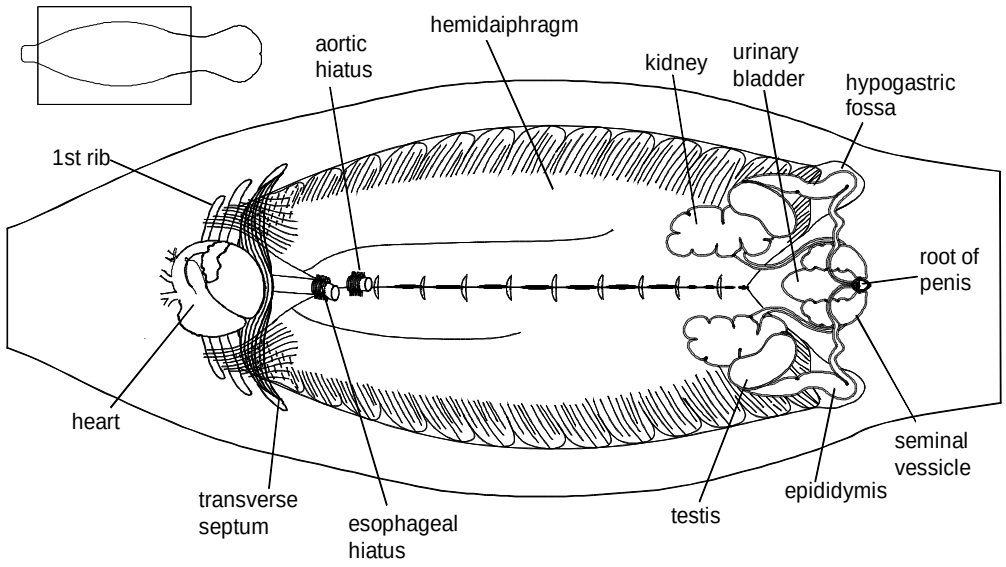

Figure 4. Schematic illustration of the ventral aspect of the hemidiaphragms, the heart, and male urogenital system. (after *Rommel and Reynolds*, 2000)

Vascular system

Heart. The heart is visualized after removal of the sternum. As the sternum is being removed, care should be taken to examine the thymus. The thymus is located on the cranial and ventrocranial aspects of the pericardium, between the sternum and pericardial sac, and wraps around the great vessels of the heart. In adult manatees, the caudolateral margins of the thymus are often fatty and involuted. The heart is separated from the liver and the rest of the abdominal cavity by a unique structure, called the transverse septum. Epicardial fat, valves, and chambers are assessed.

Thoracic cavity

Hemidiaphragms. In manatees, the diaphragm is subdivided into distinct hemidiaphragms, which run horizontally and are attached to the ribs laterally and to the vertebral column medially (Rommel and Reynolds, 2000). This configuration forms two separate pleural cavities in the manatee. Normally, the hemidiaphragms are intact and tightly stretched between the midline and lateral aspects of the abdomen. Trauma can lead to lacerations, with rib fractures perforating the hemidiaphragm. When hemo- or pyothorax is present, the hemidiaphragm often distends into the abdominal cavity.

Lungs. The lungs are relatively flattened and elongated, and extend caudally in the pleural cavities. Impact or propeller trauma can induce severe abnormalities in the lungs and thoracic cavity. Lung perforations by fractured ribs, hemothorax, pneumothorax, and chronic changes such as pleuritis, abscesses, fibrosis, and pyothorax are common findings in manatee trauma cases. However, due to the organization into two isolated pleural cavities, one respiratory half may be functional. Bloody lung parenchyma and airways can indicate brevetoxicosis. The trematode *Cochleotrema cochleotrema* is a common finding in the airways, lung, and upper respiratory tract.

Figure 5. Caseous consolidated lung and the other functioning lung in a manatee with chronic boat injury.

Figure 6. Manatee with fresh propeller wounds. Propeller cuts can penetrate into the pleural cavity, leading to protrusion of the lung with each inhalation.

Head and neck

Prior to separating the head, the thyroid should be examined and its appearance and texture noted (i.e. fluid-filled follicles). The thyroid is typically U- or H-shaped, and rests on the ventral and lateral aspects of the trachea, cranial to the bronchial bifurcation and just dorsal to the sternohyoid muscles. In young animals with a large thymus, the caudal most margins of the thyroid can be juxtaposed to the cranial most margins of the thymus. When dissecting the head away, attention should be paid to lymph nodes, abscesses, edema, and signs of trauma such as epidural blood clots. Prior to sectioning the skull, the head is skinned and subdermal tissues examined for signs of trauma.

A mid-sagital section of the head is made using a band saw, and the nasopharyngeal and oropharyngeal mucosae are examined for parasites, congestion, and lesions. The brain is removed and the meninges are examined for congestion, blood clots, or other pathologies. Prior to collecting an earbone, the peribullar sinuses are examined for blood clots. An earbone is then collected from each manatee >150cm in body length. Histological preparation of the earbone allows determination of age using growth-layer-group counts.

Skeleton

Manatees and other sirenians have only 6 cervical vertebrae, but the normal number of cranial nerves. The massive amedullary ribs dominate the skeleton and range between 16-19 rib pairs. Bones are checked for fractures, (sub)luxations, and remodeling. If lesions are present, surrounding soft tissue might be affected with blood clots, laceration, fibrosis, hemorrhage, etc.

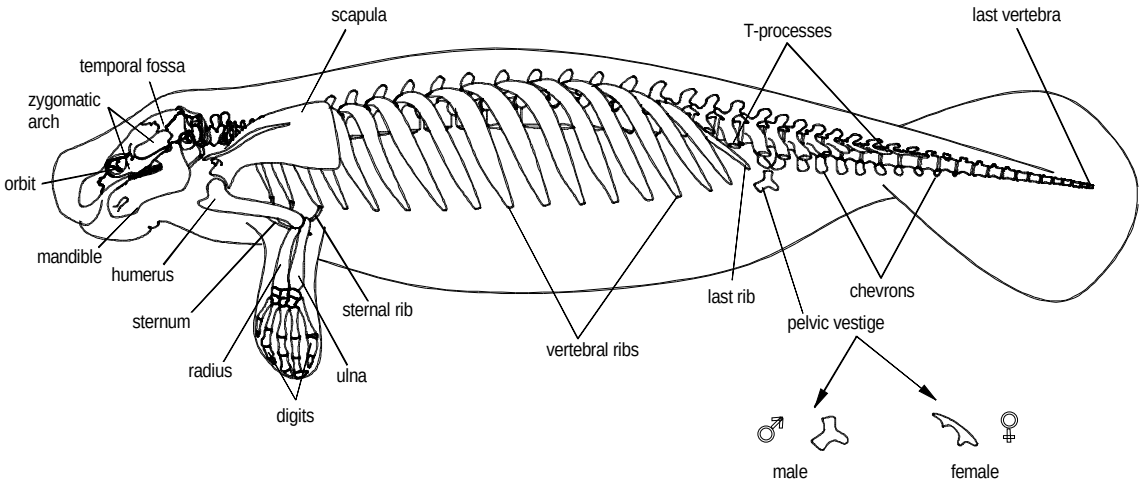

Figure 7. Articulated skeleton of the manatee with body outline. Note that the pelvic vestiges exhibit sexual dimorphism. (S.A. Rommel, illustration after *Fagone et al.* 2000).

Common causes for manatee mortality

Watercraft-related mortality
(Rommel *et al*., 2007; Lightsey *et al*., 2006)

Historically, watercraft mortality represents ~25% of manatee deaths. Watercraft can inflect both sharp- and blunt-force trauma. Sharp-force trauma involves injuries from sharp kegs, fins, and propeller blades. Blunt-force trauma involves injuries from hulls, keels, blunt skegs and propellers, boat strakes, anti-ventilation plates, trim tabs, propeller shafts, struts, rudders, propulsion system torpedoes, or speedometer pickups. Slightly more than half of the lethal trauma inflicted on manatees by watercraft is blunt-force trauma.
Trauma often affects the pleural cavities. Lacerations of the lung associated with fractured or luxated ribs, and vertebral separations are common. Because of the unique structural and physical isolation of the two hemidiaphragms, a laceration to the right or left side alone can still allow the manatee to survive by relying on a single viable lung for respiration. Hemothorax, pneumothorax, pyothorax or fibrin adhesions can be found. In the abdominal cavity, blood clots, frank blood, and loose GI contents are abnormal and can be indicative of trauma. Organs, particularly the kidney, may be surrounded by hemorrhage and may display pallor due to exsanguination. In cases of trauma to the head or respiratory system, the manatee will often swallow blood, thus staining the stomach contents around the cardia. The presence of well-formed blood clots can be used as a forensic tool to demonstrate ante-mortem trauma, even in badly decomposed carcasses. However, location and shape of blood clots should be interpreted cautiously. Knowledge of normal manatee vasculature is mandatory so that clots related to veins and plexuses are not used as evidence of ante-mortem trauma.
Manatees have a remarkable ability to repair damage to their bones. This is most often seen in the remodeling of the ribs and vertebrae in chronic watercraft injuries. Proliferative bone formation can occur as a sequel to fracture and luxation. In some animals, dramatic exostoses form.

Figure 7. Remodeled ribs and vertebrae due to chronic watercraft injury.

Brevetoxicosis (red tide)
(Bossart *et al*., 1998, 2002)

The red tide dinoflagellate *Karenia brevis* is indigenous to Florida and a constant threat to manatee survival. *K. brevis* produces brevetoxin which is neurotoxic. Characteristic clinical signs in affected manatees include tremors, paresis/paralysis, and lethargy. Exposure to red tide and consequently to brevetoxins can occur via several routes. Manatees eat seagrasses and other vegetation which may contain epiphytes. Many associated epiphytes filter feed *K. brevis* cells and concentrate brevetoxins internally. Also, brevetoxins can be associated with the seagrass itself. Mortality through ingestion of brevetoxin infected seagrass can occur even after a bloom is over. Manatees can also be exposed to the red tide aerosol via inhalation.
Pathological findings are non-specific and may include bloody discharge from eyes and nares; congestion in nasopharyngeal mucosa, respiratory tract, and meninges; bloody cut surfaces of kidney, lung, and liver; and distinct dark red corticomedullary junctions in the kidney. Similarly, histopathology may demonstrate congestion, hemorrhage, edema, inflammation, and hemosiderosis. Brevetoxicosis is confirmed by measurement of brevetoxin concentrations in stomach contents, urine, and tissues such as lung, liver, and kidney with ELISA. Immunohistochemistry for red tide diagnosis has also been developed but is not widely available.

Cold stress
(Bossart *et al*., 2002)

Manatees are tropical to subtropical in distribution, and migrate to warm water refuges during the winter. Water temperatures below 20ºC for extended time initiate a chronic disease complex known as the “cold stress syndrome”. The manatee’s relatively low metabolic rate and poor insulation compromise its ability to cope with cold conditions. Morbidity and mortality are correlated with animal size, experience, and migratory abilities. Thus, adult manatees may handle the effects of cold better than subadults or calves.
Clinically, the most common signs are lesions, varying from whitening of the skin at the extremities to ulceration, and emaciation. These manatees often demonstrate dehydration, hypoglycemia, leucocytosis, and metabolic acidosis. Complications that are commonly observed during rehabilitation include enteritis, abscessation, and pneumonia. Pathological features of cold stress include serous atrophy of fats, lymphoid depletion, enterocolitis, epidermal hyperplasia, pustular dermatitis, and myocardial degeneration.

Suggested references

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