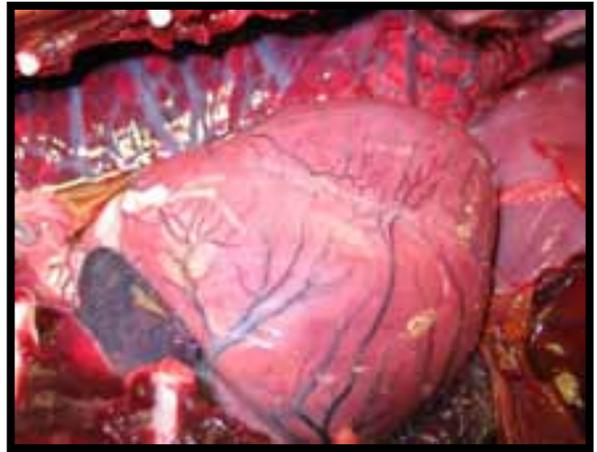




A pictorial guide to sea otter anatomy and necropsy findings



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Introduction

The purpose of this guide is to provide a collection of photographs of normal anatomy and lesions previously seen during necropsies of Northern sea otters (*Enhydra lutris kenyoni*). Organ systems that are minimally represented indicate areas where additional focus and photos are needed in future necropsies.

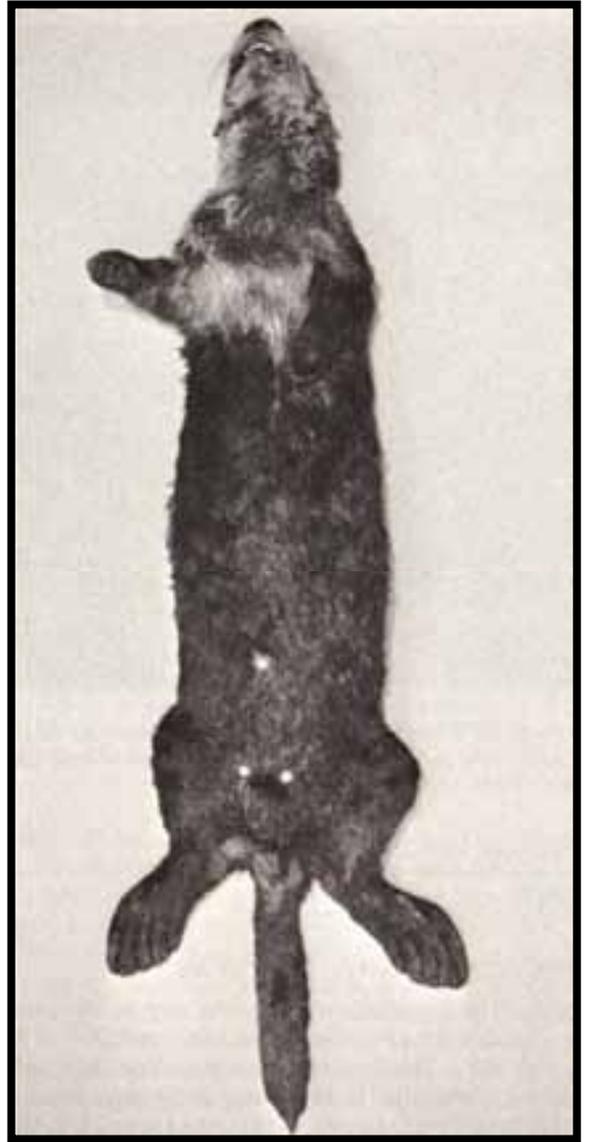
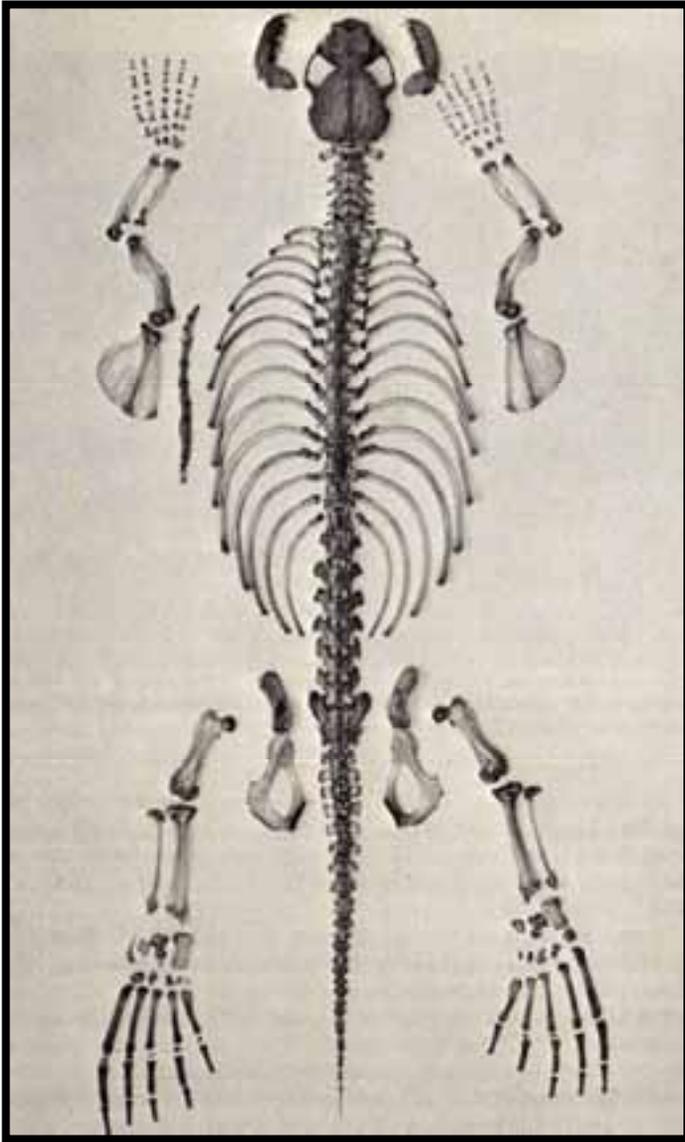
This guide will take you through the systems, in an order similar to that you might follow doing a necropsy. The first step is an external examination with collection of morphometric data (mass, length, maximum girth, right forepaw width, right canine width) followed by examination of the integument, palpation of the bones, joints and muscles (musculoskeletal system) and examination of the oral cavity, eyes, ears, nose, genital and rectal orifices.

Sea otters are divided into three subspecies related to morphologic features of the skulls and genetic studies:

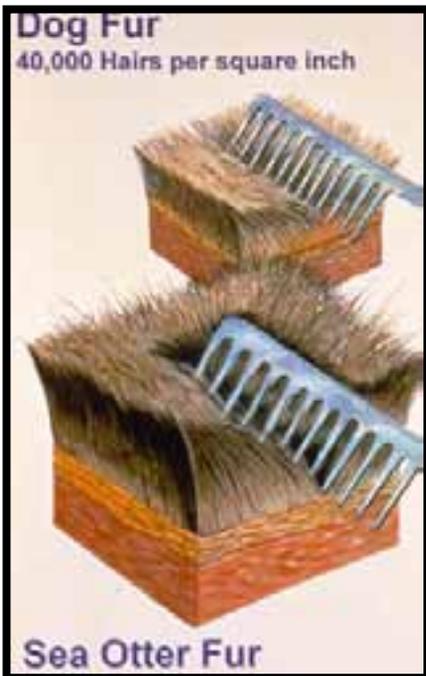
Enhydra lutris lutris (Russia)

Enhydra lutris kenyoni (Alaska)

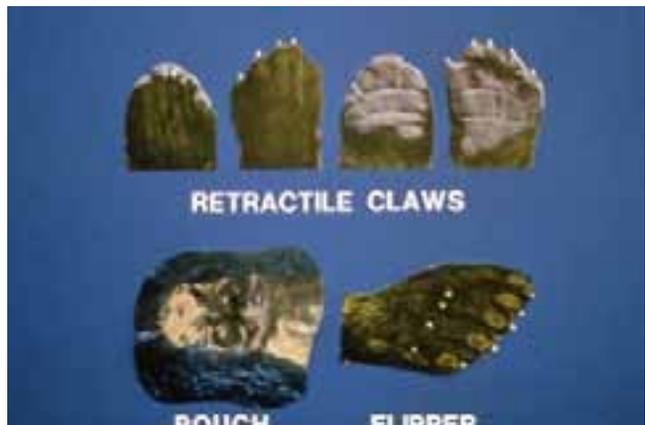
Enhydra lutris nereis (California)



Sea otter have loose skin, very little body fat, and no scent glands. They are moderately sexually dimorphic. Males can exceed 45 kg (99 lb) and 148 cm (57 in.) in length and females can be 32.5 kg (71.5 lb) and 140 cm (54.6 cm) in length. They have 7 cervical, 14 thoracic, 6 lumbar, 3 sacral and 20-21 caudal vertebrae. Absence of a clavicle may allow for greater flexibility of the pectoral girdle.



Sea otters have a certain amount of “grizzle” or blondness of the fur on the muzzle and extending down the neck, the degree of which depends on age and genetics.



Instead of a blubber layer, sea otters depend on their dense fur for warmth, and a very active metabolism. Sea otter fur is the densest of any mammal with 26,413 to 164,662 hairs/cm². Sea otters spend a significant part of their day grooming and conditioning their fur. Their fore feet are small paws that have retractable claws and are assets for foraging and grooming. Their rear feet are modified for swimming, however the shortened femurs and longer 5th digit make walking on land awkward.

Integument (skin)



Possible papillomas on the lip margin



Overgrooming



Oiled otter

Teeth

Relative to river otters, sea otters have flattened molars for crushing prey rather than tearing. Sea otters are aged by looking at the rings in the first pre-molar tooth which are counted – similar to rings in a tree core.

The dental formula is I 3/2, C 1/1, P 3/3, M 1 / 2; total 32. Note the two pairs of lower incisors. The lower incisors protrude and are chisel-shaped to scrape meat from the shells.



Levels of tooth wear



Light wear



Teeth stained purple from eating urchins.



Broken, decayed teeth



Fractured tooth.



Heavy wear

Fat stores

Body fat stores in sea otters are evaluated at four levels:

- 1.) None – no visible fat on tissue
- 2.) Little – some fat visually detected on tissue
- 3.) Average – fat is easily detected on tissue
- 4.) Abundant – fat is ample and covers much of the surface of the tissue

Fat is evaluated at four distinct sites on the animals:

- 1.) Subcutaneous – fat that is located between the skin and muscle layers that is readily visible after the animal has been skinned
- 2.) Groin – Fat in the area on the inside of the thigh where the leg meets the body. This is measured by slicing the fat layer with the scalpel and inserting a plastic ruler, measuring to the nearest 0.1 cm
- 3.) Kidneys – fat located on the top of the kidney and the fat occurring between the reniculi of the kidney itself. Whole right kidneys are being collected to attempt to develop a quantitative measure for this fat store
- 4.) Mesenteric - fat associated with the supportive membranes which supply the intestines with blood

Fat stores (subcutaneous)



Fat, subcutaneous, None



Fat, Subcutaneous, average



Fat, subcutaneous, abundant

Fat store (groin)



Groin fat, None

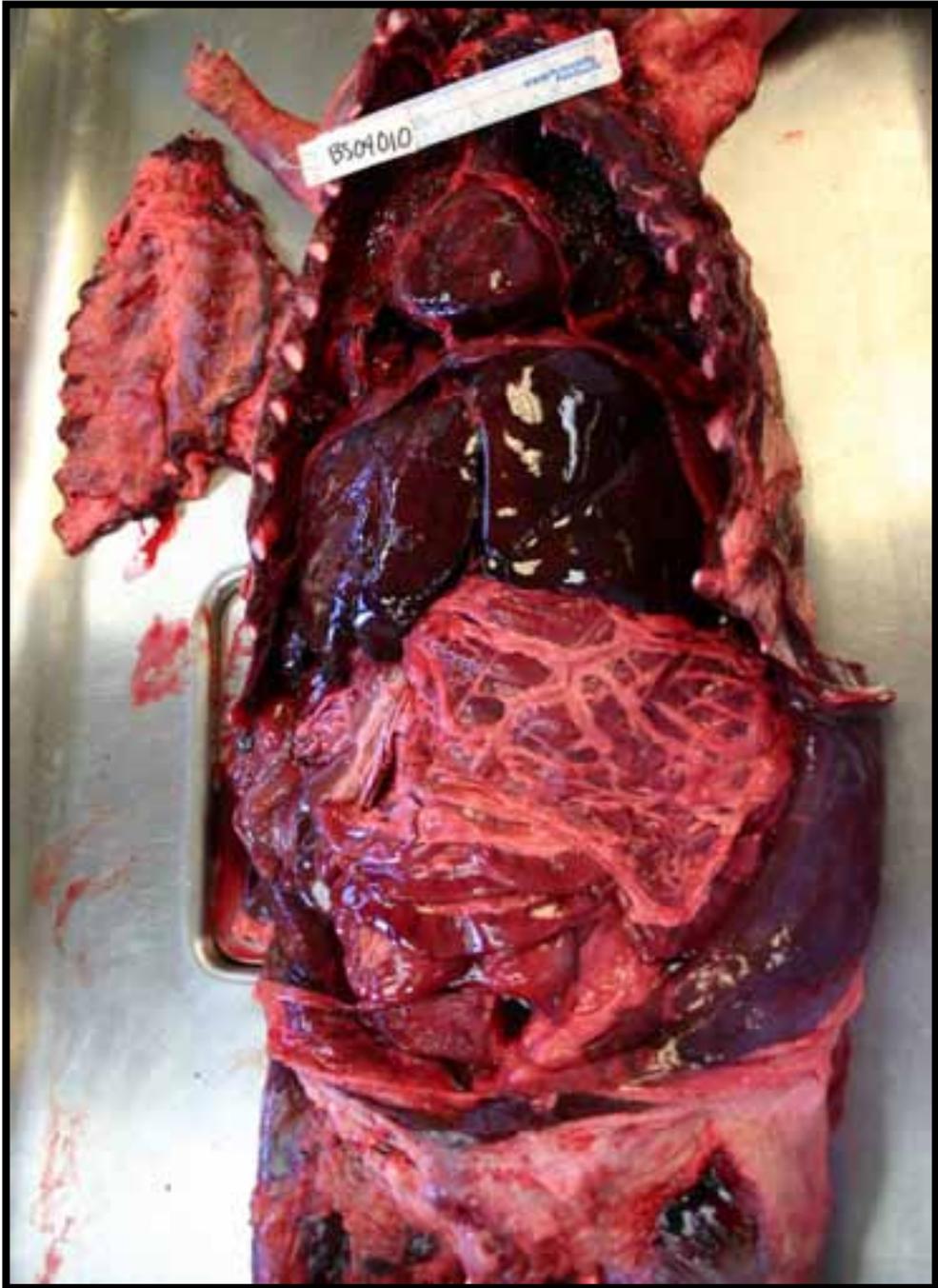


Groin fat, average



Groin fat, Abundant

Initial incision



Musculoskeletal



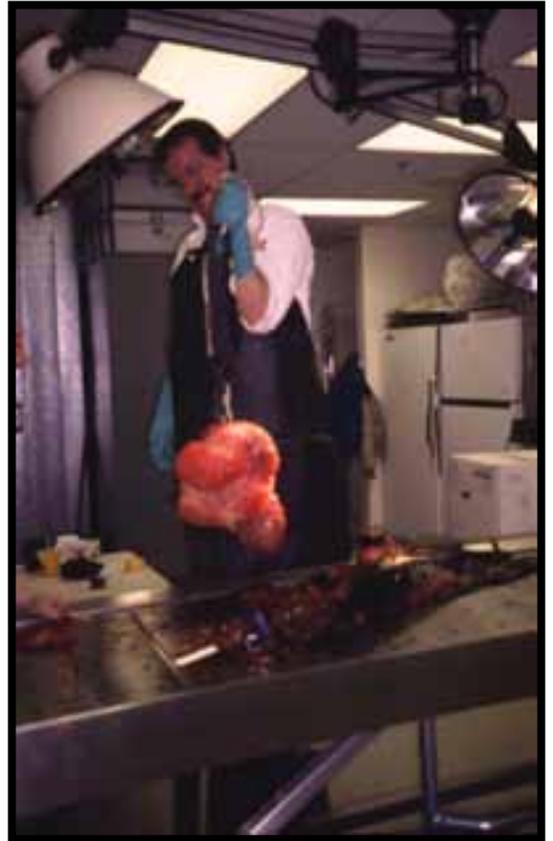
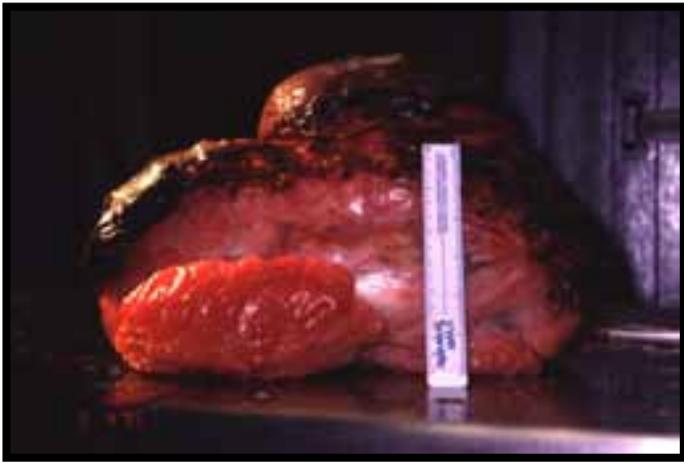
Boat strike injuries. Propeller cuts and a fractured mandible.



Arthritis with marked ulceration of the articular cartilage (arrows).



Nodular proliferation at the costochondral junction (cause unknown)



Several mesenchymal tumors have been seen including a chondrosarcoma (above and to the right) and a low-grade fibrosarcoma (below), both originating from ribs.



Endocrine system

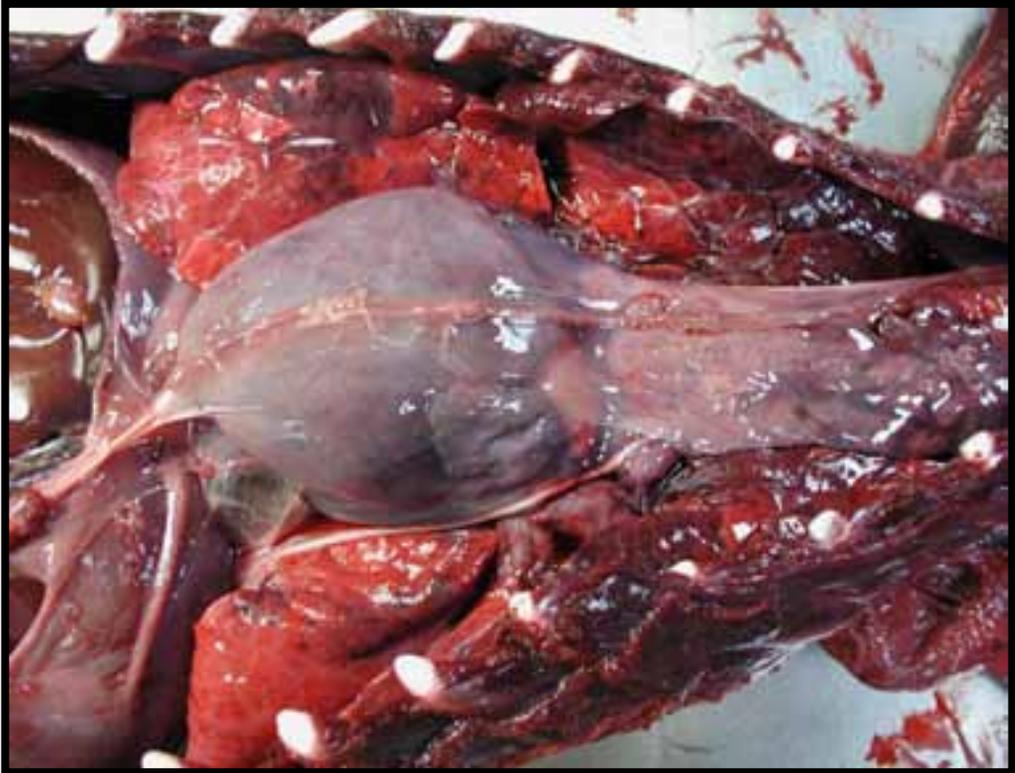


The adrenal glands are located just cranial and medial to the kidneys. Nodular adrenocortical hyperplasia is a common finding.



The thyroid and parathyroids are located just caudal to the larynx, bilaterally, just adjacent to the trachea. This thyroid is more prominent (larger) than commonly seen. Parathyroids (not visible in this photo) are small, pale, round nodules sometimes seen at either pole of the thyroid.

Cardiovascular system



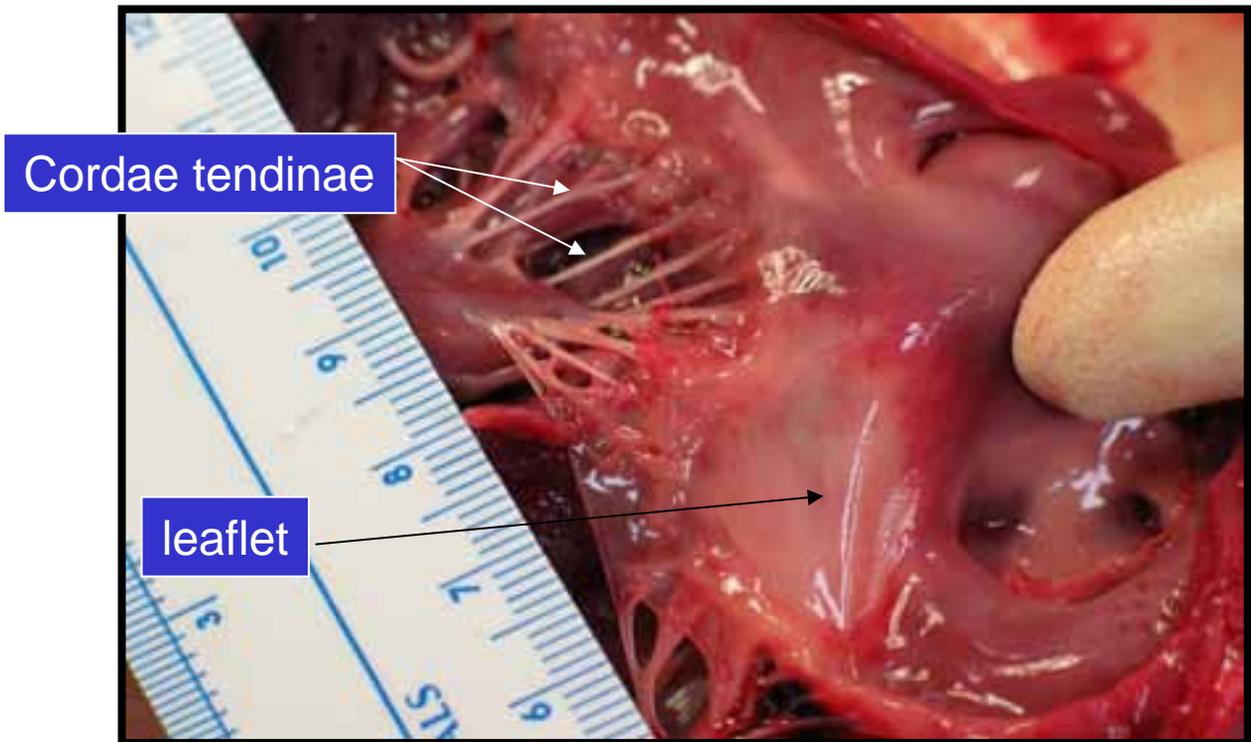
CV system includes the heart (surrounded by the pericardium), and blood vessels



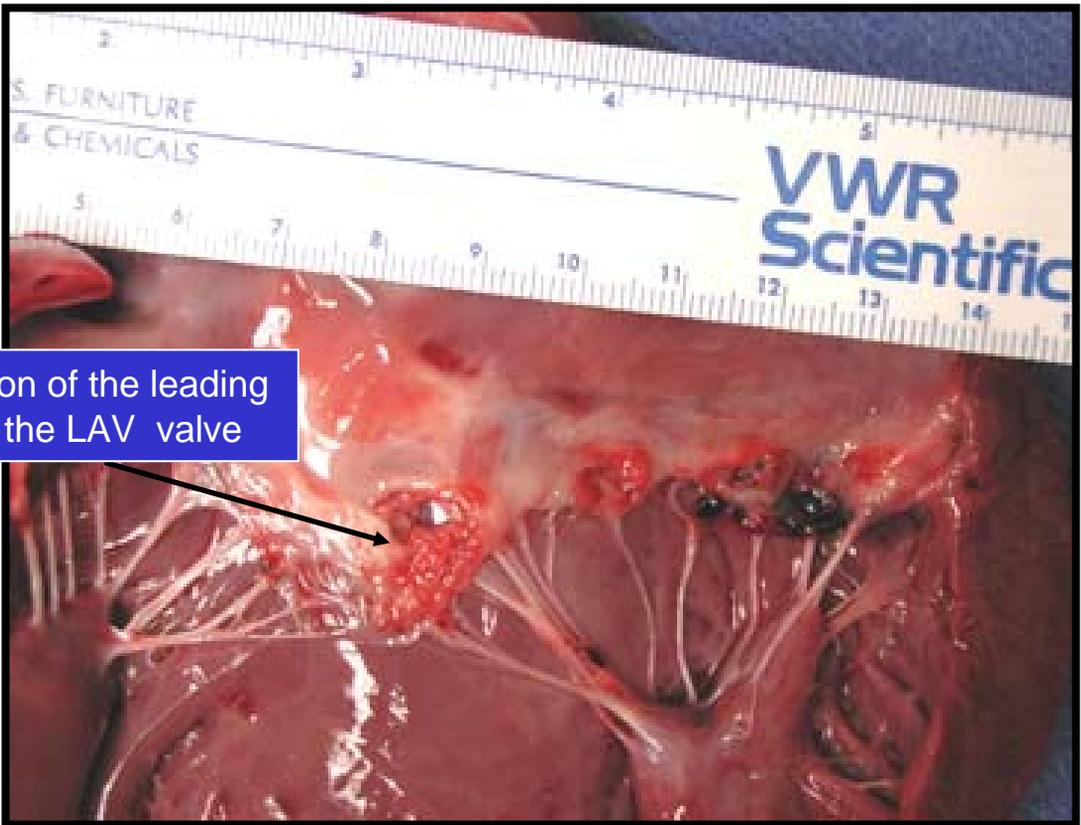
This animal has an enlarged heart (cardiomegaly), pulmonary edema and emphysema characterized by widening of the interlobular septa.



To examine all of the chambers, valves and myocardium the heart is opened following the flow of the blood. The pulmonary artery and aortic valves are semilunar, with 3, crescent shaped, thin delicate leaflets .



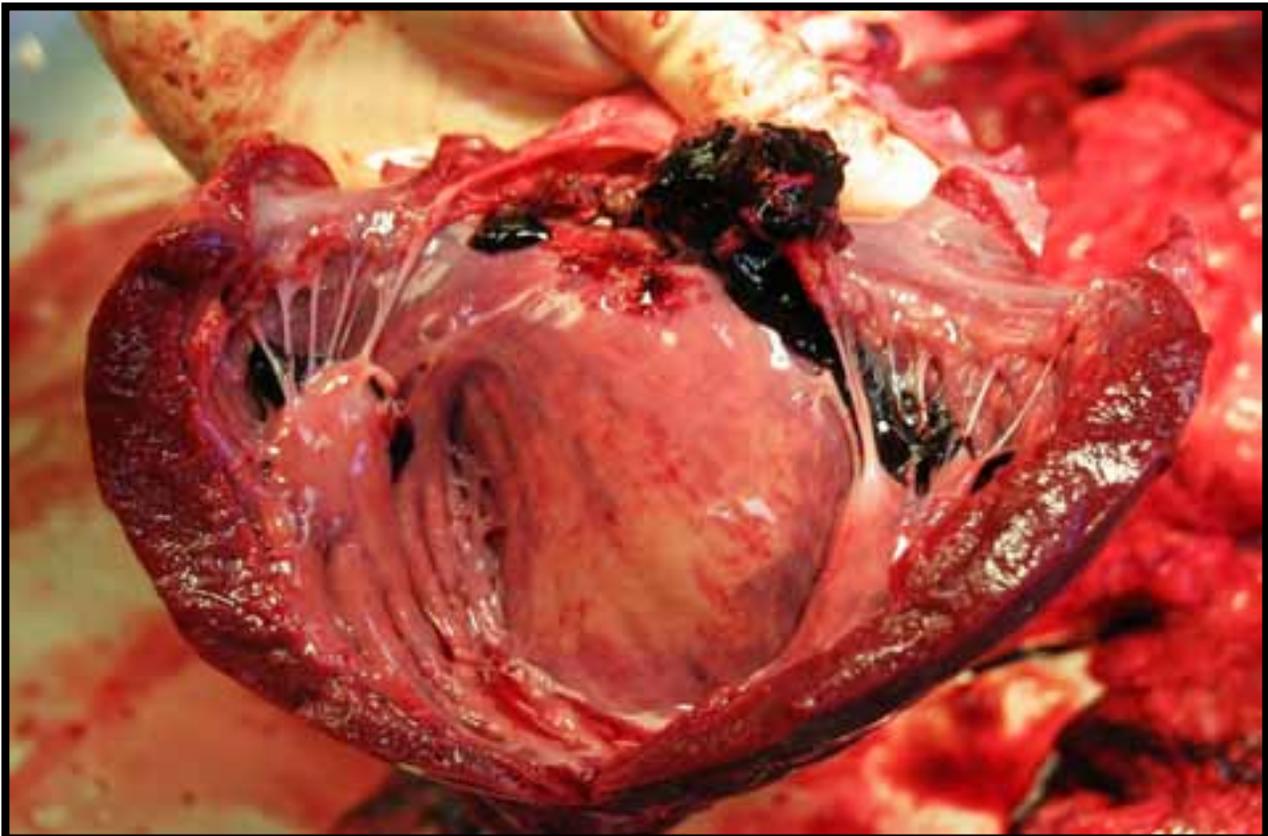
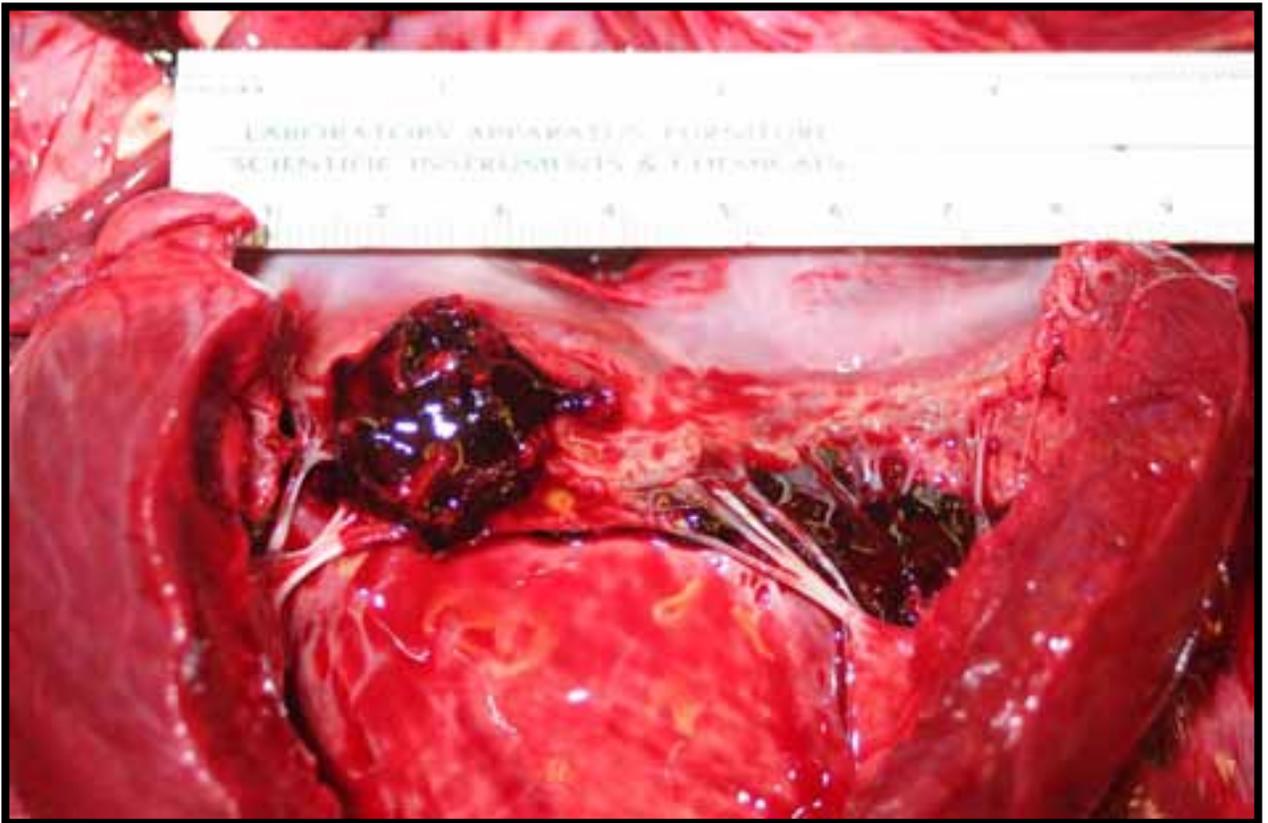
Normal right and left atrioventricular (RAV and LAV) valves have thin delicate leaflets attached to the myocardium by cordae tendinae. 18



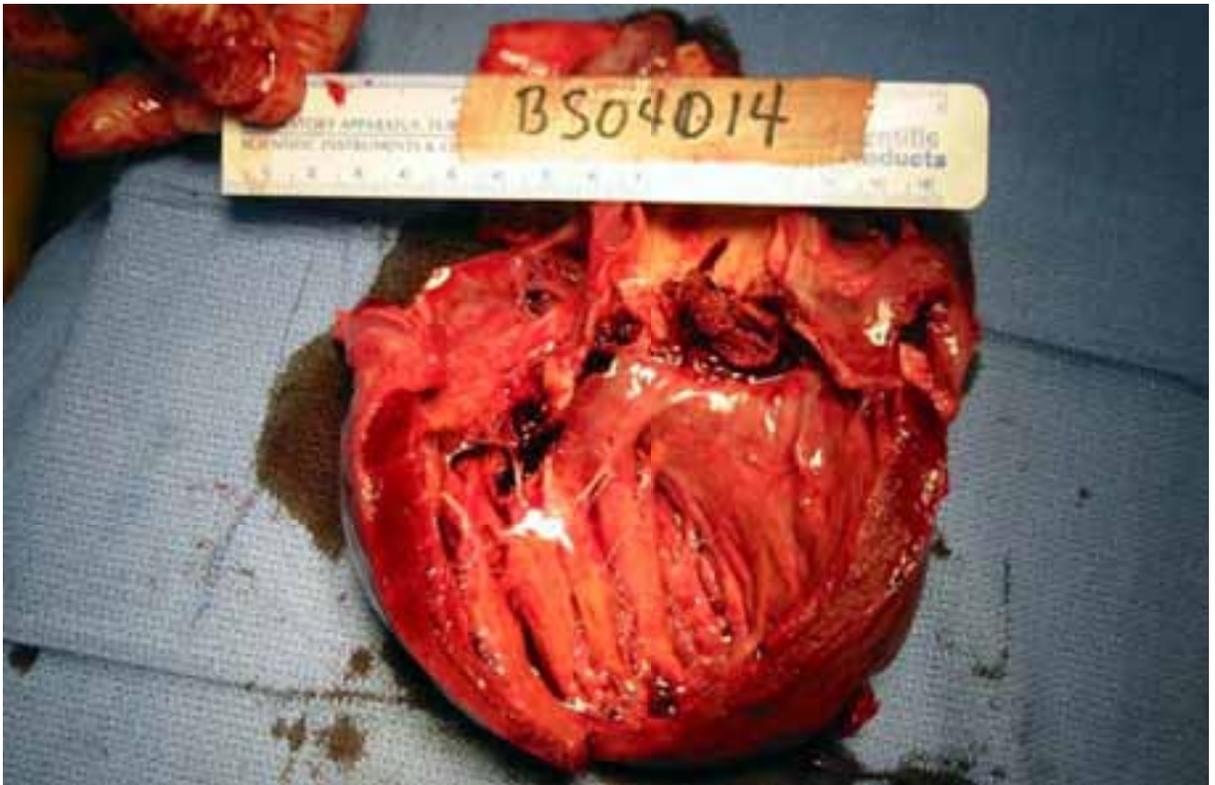
Vegetative valvular endocarditis is a relatively common lesion to see in the sea otters in Alaska. All cases have involved the left side of the heart. This is a mild case, with ulceration of the left AV valve.



One case involved only the aortic valve, but had a large, destructive lesion



The majority of cases involved both the left atrioventricular (top photo) and aortic valves (bottom photo)

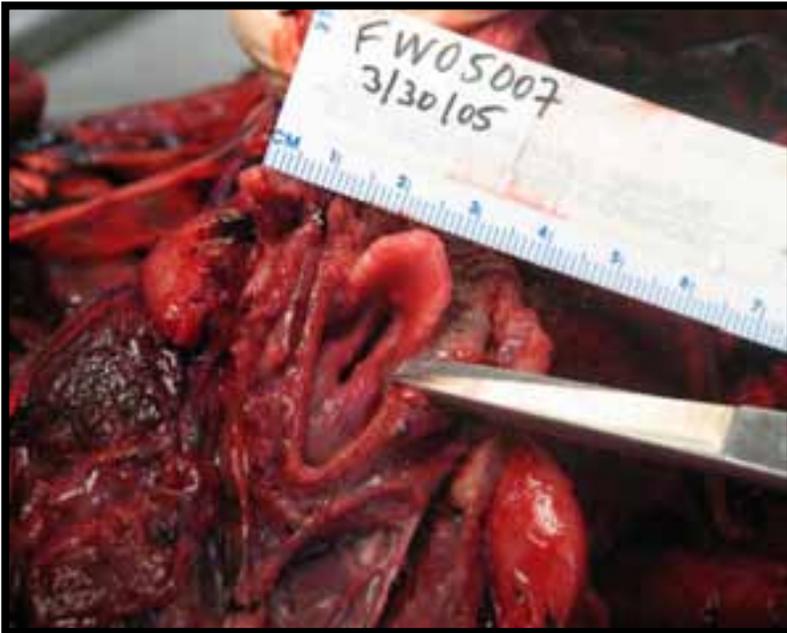


In endocarditis cases, there is typically extensive thromboembolic disease; fragmentation of the vegetative lesions with release of septic fibrin clots into the bloodstream. This results in infarction of the myocardium (areas of pallor in the wall of the heart), kidneys, spleen, liver, brain and less frequently other sites including the skeletal muscle and adrenal glands.

Saddle thrombus



Respiratory system



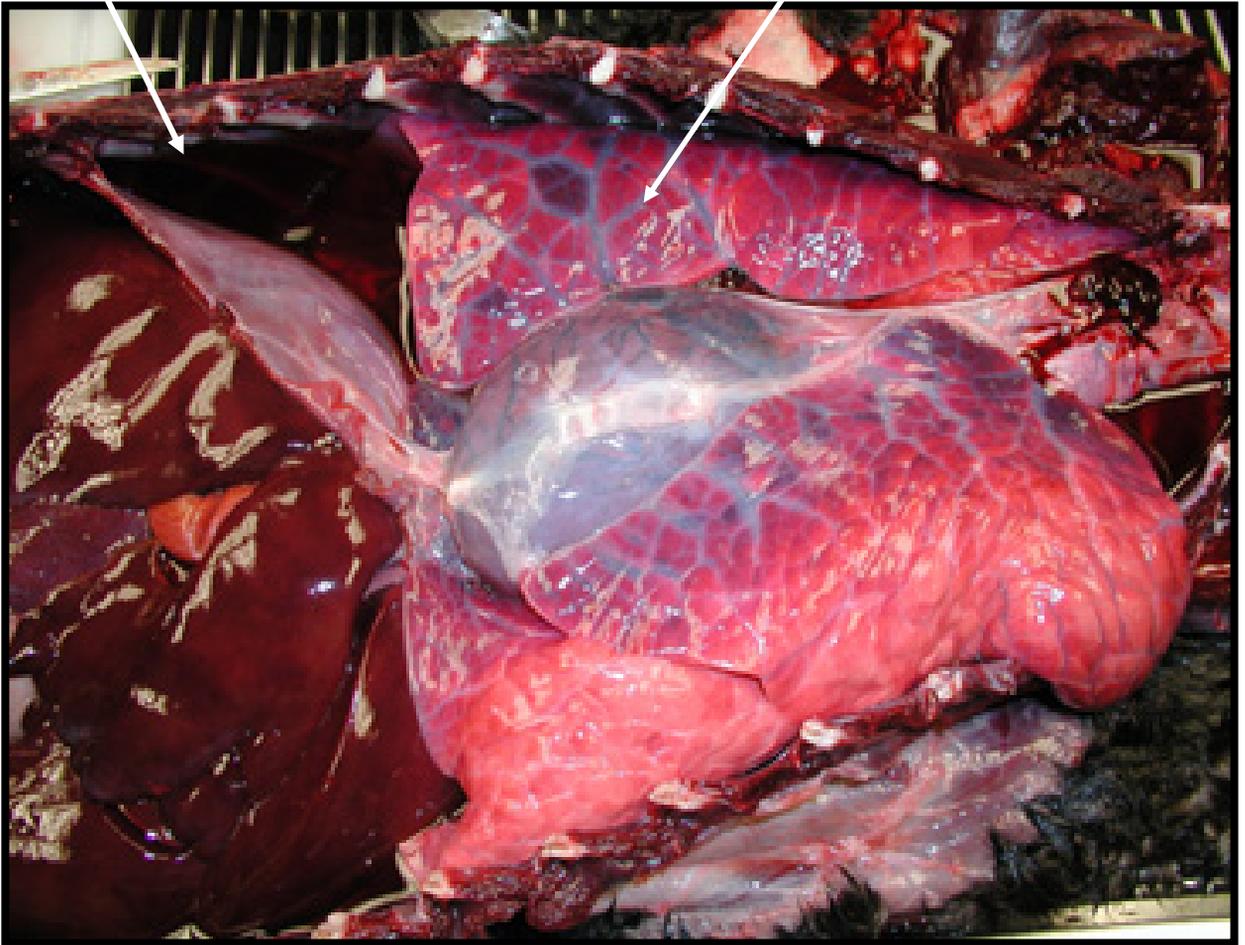
Larynx (scissors pointing to) – In this case the larynx is very reddened (laryngitis)



In relation to body weight, the sea otter lung capacity is 2-4 x greater than pinnipeds. The right lung has four lobes and the left has two. Some cartilage supported airways extend into the alveoli, to compensate for compression during diving while others branch into nonsupported airways.

Pleural effusion

Widened interlobular septa



In this case, there is widening of the interlobular septa due to air (emphysema) and fluid (pulmonary edema). There is also a large amount of fluid in the chest cavity (pleura effusion). This animal was in left heart failure due to severe valvular endocarditis. Pulmonary emphysema is also commonly seen in sea otters with respiratory distress for a wide variety of lesions. Pulmonary edema is seen commonly with cardiovascular failure such as occurs with valvular endocarditis and myocarditis. Very severe pulmonary edema is seen in drowning cases. Stable foam in the trachea and bronchi is diagnostic for pulmonary edema.

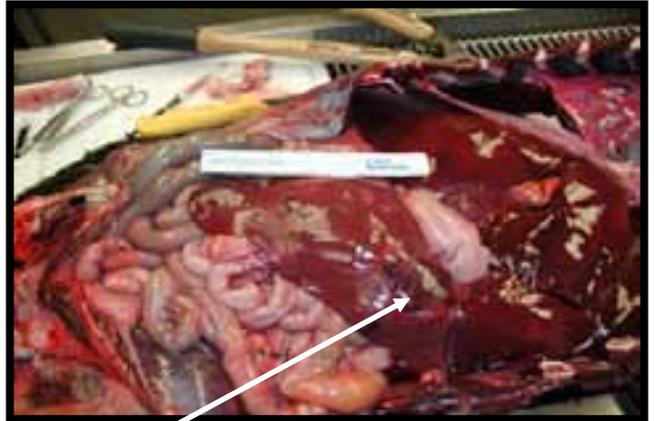


Foam in the trachea

Lymphoid system



Normal spleen



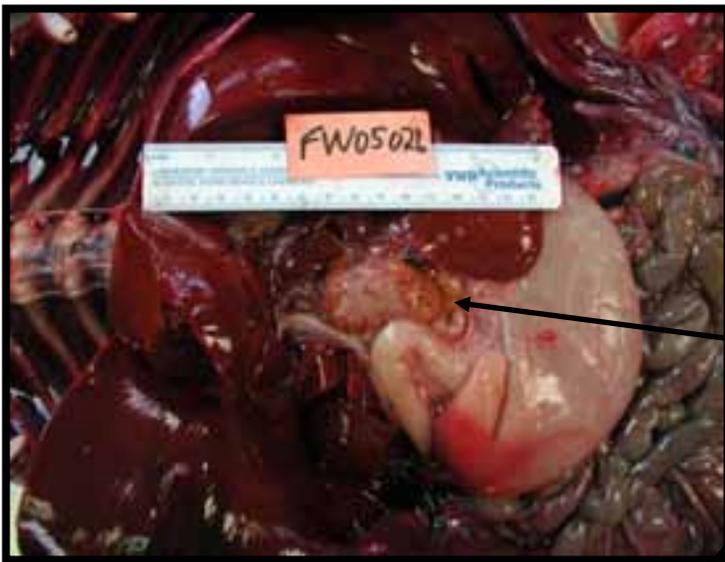
Splenic infarct in an animal with valvular endocarditis



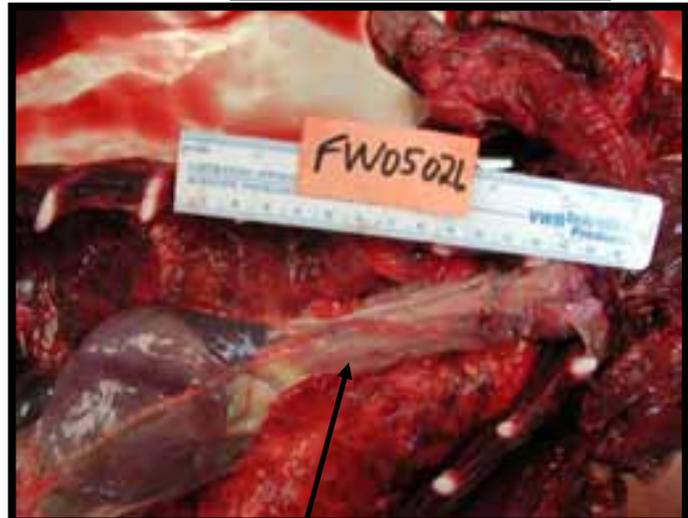
Diffuse splenomegaly, most likely due to immune stimulation (lymphoid hyperplasia).



Splenic metastases in an animal with disseminated carcinoma



These tissues are from an animal with a disseminated infectious disease. There is massive enlargement of the hepatic hilar lymph node, cervical lymph nodes and spleen. This was a young pup and the thymus is also severely atrophied.



Massive splenomegaly (enlarged spleen)

Atrophied thymus

Digestive system

The digestive system is composed of the liver and gall bladder, pancreas and the gastrointestinal tract. The GI tract includes the stomach, small intestine, large intestine, and rectum. Sea otters do not have a cecum. Ulcers in the stomach and melena (digested blood in the GI tract) are relatively common findings and are most likely a stress response. Parasites are common in the GI tract and include acanthocephalans (thorny headed worms), tapeworms and nematodes. *Corynosoma* sp. are the most common acanthocephalan seen in AK sea otters. Intestinal perforations due to *Profilicollis altmani* type acanthocephalans commonly seen in CA sea otters have not been documented in AK sea otters. Tapeworm infestation *Diplogonoporus tetraapterus* are associated with eating fish and occurs in moderate prevalence in sea otters in Prince William Sound.

In the latter half of the 1990s increased sea otter mortalities were found in the Cordova area with emaciation / colonic impactions / heavy tapeworm loads and perforations of the GI tract due to the presence of a nematode *Pseudoterranova decipiens*. Fish are an intermediate host for this (and other) nematode. An investigation found a local fish processing plant that was grinding up its waste product into larger than normal sizes. The GI tract problems were most likely due to the otters feeding on this fish waste as the problem was resolved when the plant agreed to have its waste barged offshore.

Liver and gall bladder



Liver and gall bladder (arrow) within normal limits. Trematodes / flukes *Orthosplanchnus fraterculus* are not uncommon in the gall bladder. Though they can cause quite a bit of peribiliary fibrosis, obstruction of the biliary system does not appear to commonly occur.



HUGE liver in case of heart failure (passive congestion)

Pancreas



Pancreas -- The pancreas is located in the mesenteries adjacent to the duodenum, extending over to the area of the spleen. It is very diffuse, light pink and sometimes difficult to discern from the mesenteric fat.

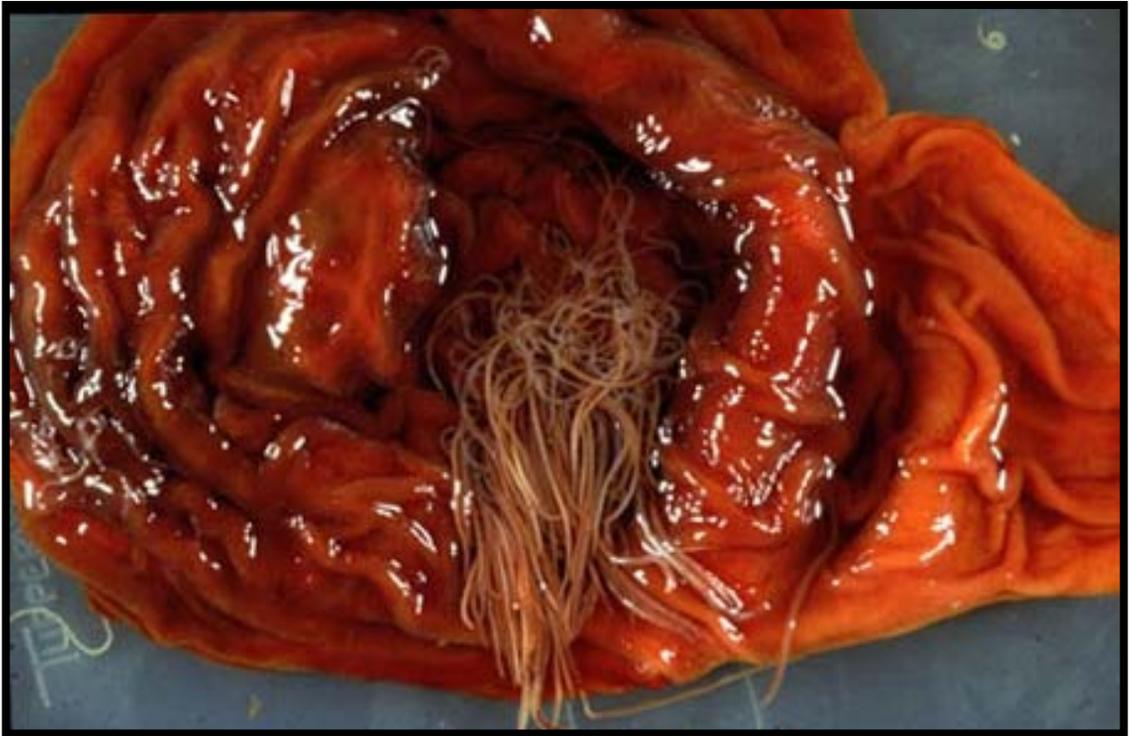
Stomach



Ulcer scar on surface of the stomach

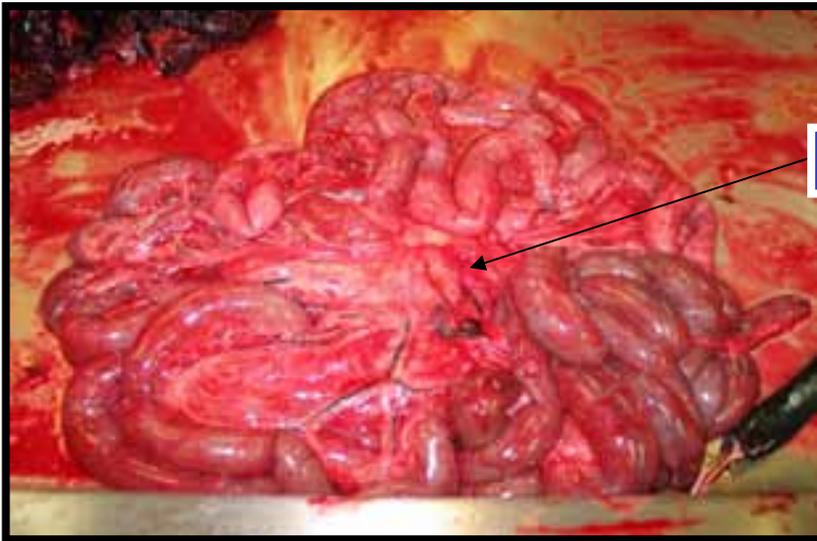


Stomach ulcers



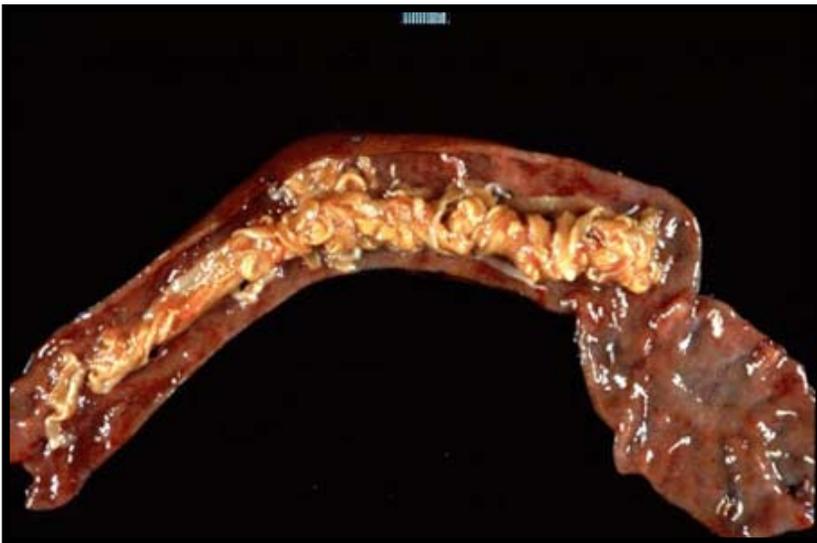
Nematodes in stomach

Intestine

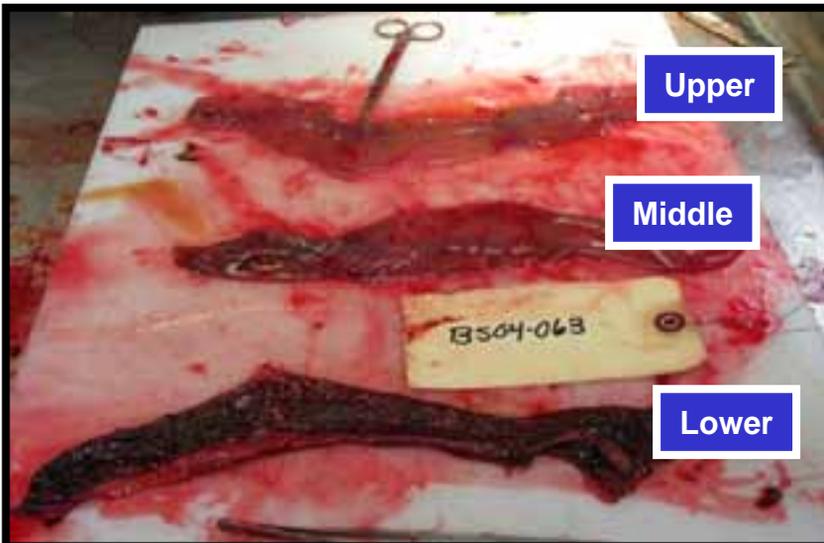


Small intestine within normal limits.

Mesenteric lymph node



Tapeworms in small intestine

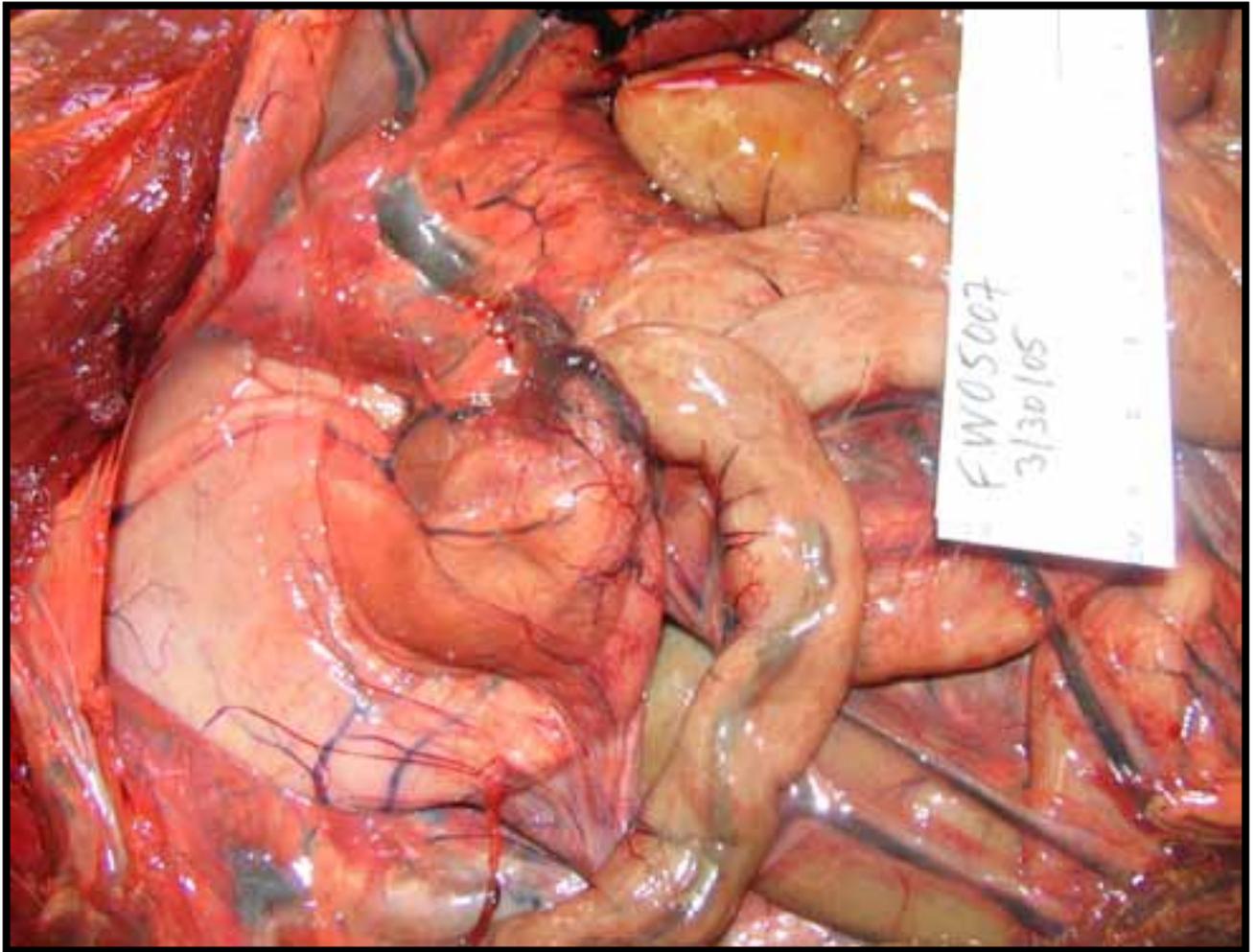


Samples of upper, middle, lower normal GI tract

Upper

Middle

Lower



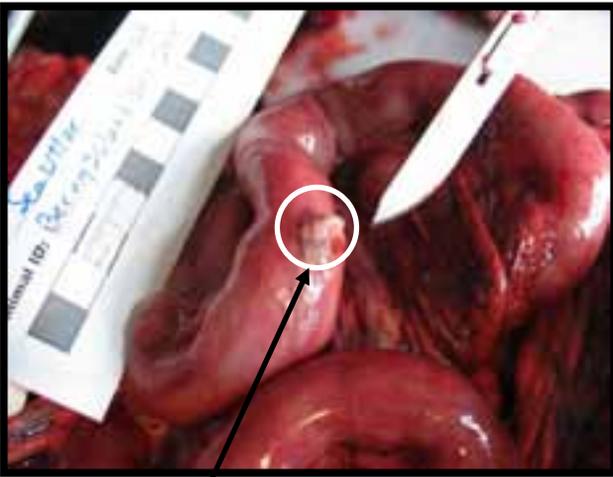
There are “paint-brush” hemorrhages on the surface of the intestine and stomach (suggestive of septicemia) and a cloudy, red-tinged fluid in the peritoneal cavity (peritonitis).



Intestinal intussusception



Intestinal torsion

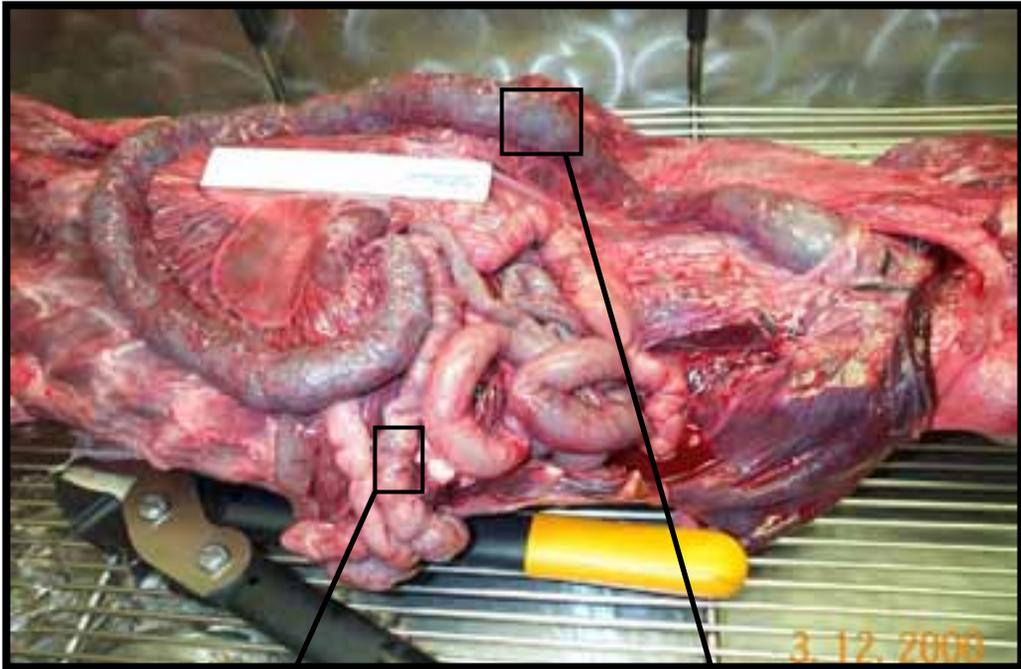


Intestinal perforation due to a unidentified nematode.



Colon

Colon impaction



Cestodes in plicated section of small intestine above the impaction



Colon impaction with mussel shell

Mesentery



(Abundant fat for a sea otter)

Omentum



Urinary system



No to little fat



Average fat



Abundant fat

Kidneys

The kidneys are reniculate, or multilobed where each lobe or renule has all the components of a metanephric kidney. These reniculi can act, and be affected by pathologic processes independent of one another, therefore sampling multiple reniculi for culture or histopathology is important.



Renal infarction (or cut off of the blood supply) and necrosis (cell death) of the kidney tissue in an animal with valvular endocarditis. On the capsular surface, this is manifested as a very discrete, sharply delineated area of pallor. On cut section, the area of discoloration is classically wedge shaped with the base of the wedge along the capsular surface.

Urinary bladder

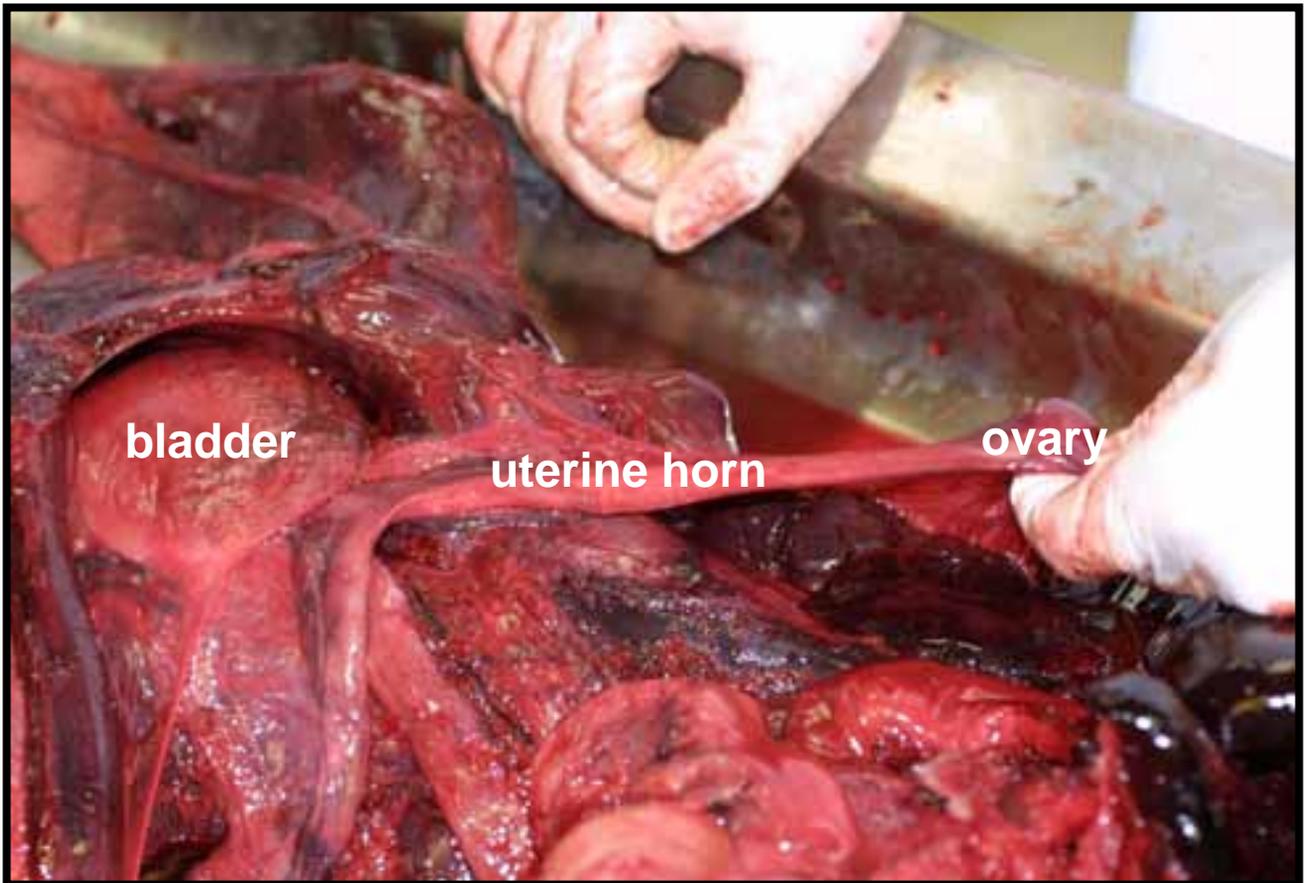


Urinary bladder with inflammation (cystitis) characterized by reddening and roughing of the mucosa.



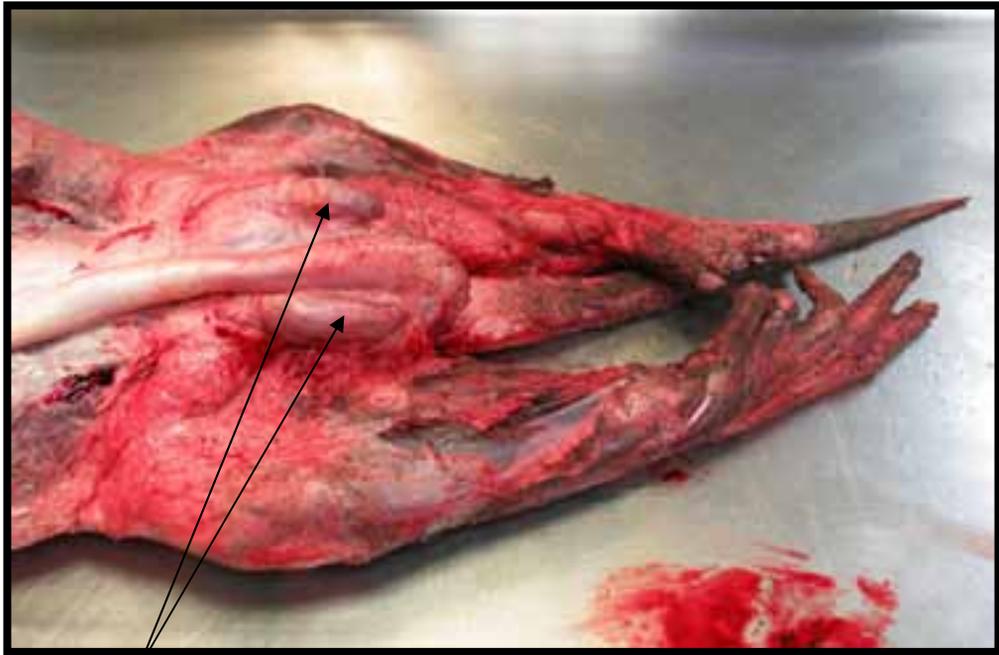
Obstruction and massive distention of the urinary bladder due to a prolapsed penis

Female reproductive tract



Sea otters have a bicornuate uterus.

Male reproductive tract



The testes are inguinal in the sea otter.

The penis contains a bone, or baculum. Fractures of this bone are commonly seen due to intraspecific fighting (no photo).



Prolapsed penis

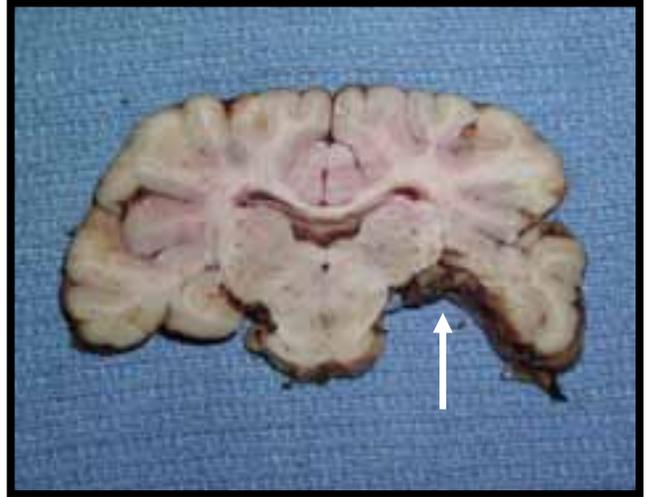


Prolapsed penis (in a live captured animal!)

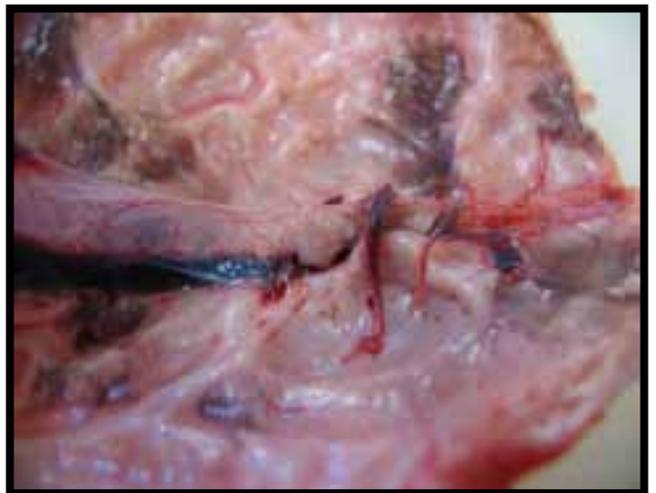
Nervous system



Congenital cyst in the brain parenchyma (porencephaly) in a rehab animal that had persistent seizuring



Infarct in the brain (arrow) in an animal with valvular endocarditis



Firm mass on the meninges (probable meningioma)

Acknowledgements

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For more copies of this guide please contact Verena Gill at Marine Mammals Management, U.S. Fish and Wildlife Service, MS 341, 1011 East Tudor Road, Anchorage, AK 99503 or e-mail verena_gill@fws.gov

