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Welfare of whales by-caught in fishing gear or struck by vessels

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Introduction

The goals of this paper are to: define terms relevant to industrially induced, but unintentional, trauma to whales; place the issue in a context of the prevalence of such mortalities in North American east coast waters; examine pertinent case studies; summarise the resultant pathobiology; and from this infer likely welfare concerns.

Cetacean by-catch has been defined as mortality or serious injury of animals that are 'captured' but discarded (Alverson *et al* 1994). By-catch can include drowning, or chronic injury from fishing gear entanglement. Serious injury is defined by the US Marine Mammal Protection Act (1972) as any injury that will likely result in mortality. A wound is any injury to living tissue, while a scar is a healed wound.

Vessels damage whales in two manners: incisions (sharp cuts) from rotating propellers, and blunt impacts from vessel bows, struts, skegs and rudders. Trauma can involve blubber, muscle, bone, viscera and neural tissues, with haemorrhage, oedema and haematomas.

In the period from 1970 through to 2009, a total of 323 whales were diagnosed as dead (222) or seriously injured (101) from fishing gear entanglement on the eastern seaboard of North America between Texas, USA and New Brunswick, Canada: species included minke (*Balaenoptera acutorostrata*), humpback (*Megaptera novaeangliae*), North Atlantic right (*Eubalaena glacialis*), fin (*Balaenoptera physalus*), sei (*Balaenoptera borealis*), Bryde (*Balaenoptera brydei*), sperm (*Physeter macrocephalus*) and unknown species. A total of 171 of these same species, and a blue whale (*Balaenoptera musculus*), were diagnosed as dead (163) or seriously injured (11) from vessel strike through the same time-period. See van der Hoop *et al* (2012) for these data.

Dead whales can be discovered in a variety of scenarios. By-caught whales can be found anchored in gear, drowned or alive, swimming entangled in gear or dead floating at sea or on the shore. Whales cut by propellers are found alive or dead at sea or beached dead. Whales with lethal blunt vessel trauma are dead on a ship's bulbous bow at sea, floating or beached. Blunt trauma is usually cryptic from an external viewpoint. Some whales are negatively buoyant on death, and sink. They refloat later if water depth and temperature enable sufficient decomposition gas to refloat them with the passage of time (Allison *et al* 1991). Much of the pertinent pathology observed in these scenarios has been described previously (Moore *et al* 2004; Campbell-Malone *et al* 2008; Cassoff *et al* 2011) but will be summarised here.

By-catch

Whale by-catch mainly involves gillnets, mobile trawls and fixed pot and trap fisheries (Johnson *et al* 2005). It can involve rope, net and other gear, such as surface float systems. Where a whale has insufficient power to break out of a system, it will either remain alive, if it can surface to breathe or it will drown. Where the whale has sufficient power to break out, as often seen with North Atlantic right whales and at times with humpback whales, the animal may carry the gear for months over thousands of miles. If there are two anchoring points on the animal with sufficient movement that the draw length of the gear exceeds the compliance of the epidermis and underlying tissues, the gear can saw into the blubber as recently modelled by Winn *et al* (2008).

Gillnets

Evidence of gillnet entanglement is often quite cryptic with subtle linear abrasions not penetrating the epidermis. At times, gear is found, but often the animal has been removed from the gear post mortem. A classic example of gradual gillnet invasion is North Atlantic right whale No 2030 (Moore *et al* 2004), where gillnet net stretched between both axillae slowly dissected off the intervening dorsal blubber sheet while the animal remained alive for six months (Figure 1).

Figure 1

Left aspect of blubber dissected off right whale No 2030 while still alive (Cape May, NJ 1999) by gillnet gear stretched over the back, fixed to both axillae (Moore *et al* 2004).

Figure 2

Cable abrasion on a humpback flipper (Georges Bank 2003). Animal assumed to have drowned in a trawl.

Figure 3

Chronic periosteal fibro-osseous proliferation over the elbow joint in right whale No 2301 (Virginia, USA 2004).

Trawls

Fish-eating whales, such as humpback, minke and fin, can be caught in bottom and mid-water trawl gear. They may show epithelial laceration from abrading trawl wires (Figure 2) and remnants of knotted trawl net twine can be found entangled in baleen and other body parts, where they have been cut out of the net at gear retrieval. They may also carry heavy rope with evidence of line parting under strain. Drowning is assumed to be a common end-point in these cases.

Fixed pot gear

Pot traps are set singly or in trawls of multiple pots connected by groundlines, with one or more vertical lines to a surface float system. Right and humpback whales that encounter this gear appear to frequently become entangled (Robbins & Mattila 2001). Most of them self-disentangle, others are disentangled by humans, but some remain persistently entangled. All appendages are at risk. Lethal events have involved simple wraps around the peduncle or rostrum, and complex involvement of one or both flippers, rostrum, lips and baleen. When ropes cut in around a flipper, the bone surfaces can undergo a massive proliferation of fibro-osseous new bone in an attempt to wall off the foreign body (Figure 3). In juveniles, flipper bones can grow around the constricting ropes, and vertebrae can be deformed by ropes wrapped around the body so that the animal grows a scoliosed spine (WA McLellan, personal communication 2011).

A series of 12 lethally entangled right whales averaged a duration from first seen with gear to observed dead of 5.3 months (RWC 2011). Seven others remained entangled for an average of 30 months.

The welfare implications of entanglement depend upon the scenario. Drowning presumably includes struggling, panic and gradual subsidence. Chronic entanglement includes laceration, constriction, scar formation, increased drag leading to emaciation, movement restriction, interference with feeding and scoliosis. Chronic sequelae to persistent entanglement include failure to feed though obstruction of the baleen by rope, and substantially increased drag from trailing gear (Figure 4), both of which can lead to emaciation. This could have significant energetic impacts reducing reproductive potential in sub-lethal cases.

Efforts to enhance the welfare of entangled whales include take reduction and disentanglement efforts (NOAA_2 2009; NOAA_1 2012; PCCS 2012), that have recently been aided in refractory cases by at-sea sedation (Moore *et al* 2010). However, the only lasting solution to this problem is take reduction.

Vessel strike

Vessels can collide with whales when they are alive or when they are already dead. Necropsies and histology as practical are undertaken to describe the pathology and establish if lesions are consistent with a functional circulation at the time of impact.

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Propeller incisions

These can affect any part of the body. They typically resemble an 'S' or 'Z' shape, depending on the rotation direction (Rommel *et al* 2007), with a series of repeated incisions along the direction of travel of the vessel relative to the whale. They tend to be more lethal if including the head and/or chest (Figure 5). Incisions not immediately lethal can debilitate appendages, such as a fluke blade, with resulting chronic weight loss. Sub-lethal incisions usually heal. In one case scars acquired as a juvenile broke down as a later pregnancy put new pressure on the wound sites with a consequent mortality (WA McLellan, personal communication 2011). Results have included pneumothorax, loss of a fluke blade or the entire fluke, and deep incisions into the abdomen.

Blunt trauma

This, especially in black-skinned animals, is often cryptic externally, and can only be diagnosed accurately with a full necropsy. Lesions include fractured mandibles, skull, ribs, and vertebrae (Figure 6). Where massive trauma to the vertebrae is observed, severance of the spinal cord has been suspected, although carcase condition at the time of necropsy often precludes such definitive determinations. Common lesions with pre-mortem collisions include haemorrhage, haematoma, oedema, and bone fracture.

Welfare aspects of vessel strikes are usually less drawn-out than gear entanglement. Animals appear to die from acute blood loss, or severe head or chest trauma. If they survive, there can be wound healing complications, with spread of cyamids, and loss of body condition.

Efforts to reduce vessel strike include areas to be avoided (Vanderlaan & Taggart 2009), vessel lane shifts (Vanderlaan *et al* 2008), seasonal speed restrictions and mariner education.

Conclusion

Acutely lethal entanglements involve death by drowning. Chronically lethal entanglements include laceration, constriction, immobilisation, and increased drag from trailing gear. The degree to which drag impacts non-lethal entanglements in terms of ability to reproduce, and other health parameters is poorly understood at this time. Vessel strikes, if lethal, usually involve rapid blood loss, or muscle, bone and neural trauma. Thus, the most severe animal welfare aspects of these cases involve the long drawn-out chronic entanglement cases (Moore & van der Hoop 2012). These have been previously compared unfavourably with the welfare aspects of intentional whaling mortalities using explosive harpoons (Moore *et al* 2006).

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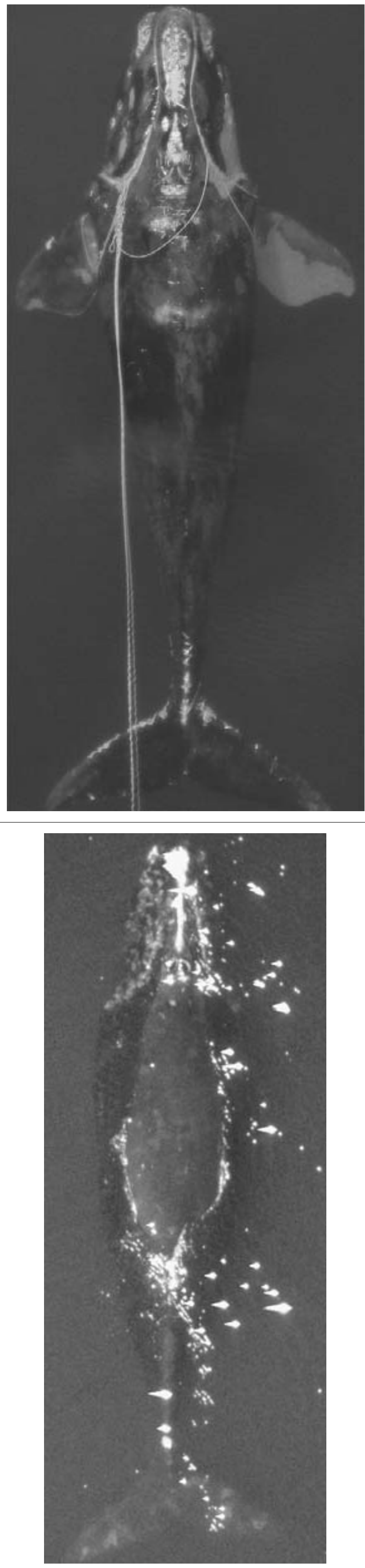
Figure 4



Showing (upper) entangled right whale No 3911 (Florida, USA 2011). Estimated to be 20% thinner than normal. Image by Jen Jakush, Florida Fish and Wildlife Conservation Commission, NOAA Fisheries Permit #932-1905-00/MA-009526 and (lower) a normal right whale. Note substantially greater width in chest and abdomen. Image by Wayne Perryman, NOAA Marine Mammal and Endangered Species Permit # 917.

Figure 5

Propeller incisions (with shark scavenging) along the head and chest of right whale GA 2006025 (Florida, USA 2006). Chest incisions penetrated the pleural cavity. Image by Katie Jackson, Florida Fish and Wildlife Conservation Commission, NOAA Fisheries Permit #932-1905-00/MA-009526.

Figure 6

Fractured transverse processes off twelve vertebrae from right whale mjm09406 (Nova Scotia, Canada 2006). Image by A Bogomolni, WHOI.

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