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# Short Note

## Injury and Subsequent Healing of a Propeller Strike Injury to a Heaviside's Dolphin (*Cephalorhynchus heavisidii*)

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The wounds of dolphins and whales are known to heal rapidly and thoroughly in both natural and controlled situations (Bruce-Allen & Geraci, 1985; Corkeron et al., 1987a; Lockyer & Morris, 1990; Bloom & Jager, 1994). Healing rates vary with the severity of the injury but, in general, even the most severe wounds, exposing deep muscle tissue, heal almost completely within 5 to 8 mo (Corkeron et al., 1987a; Bloom & Jager, 1994; Visser, 1999). However, the scars resulting from deep wounds and mutilations along the edges of dorsal fins are known to last for years, and potentially throughout an individual's life (Würsig & Jefferson, 1990), and thus provide a useful set of marks which can be used to distinguish individuals in the field.

Photographic capture-recapture techniques are a powerful way to study wild populations of cetaceans but are reliant on the assumption that one is able to consistently identify individuals over long periods of time. Additionally, frequency, type, and size of body scars on cetaceans have also been used to infer age, sex, and social status in wild populations (Chu & Nieukirk, 1988; Gowans & Whitehead, 2001; Rowe & Dawson, 2008) as well as rates of interaction with other species, particularly predators (Corkeron et al., 1987b; Cockcroft et al., 1989; Gowans & Whitehead, 2001) and humans (Best & Schell, 1996; Best et al., 2001). It is thus important to have some understanding of the healing rate of these injuries. In this note, we report upon a series of observations of the healing of a propeller strike injury to a Heaviside's dolphin (*Cephalorhynchus heavisidii*) and discuss the implications relevant to mark recapture studies as well as conservation concerns.

Heaviside's dolphins are a poorly studied delphinid endemic to the coastal waters of the Benguela ecosystem along the southwestern coast of Africa. This species is known to be locally abundant (Elwen & Leeney, 2009; Elwen et al., 2009) and occurs continuously within its range (Findlay et al., 1992; Elwen et al., 2010). However, they show site fidelity to small home ranges (~50 km along shore) over at least 2 y (Elwen et al., 2006; Elwen, 2008), which may increase their susceptibility to localised threats. Heaviside's dolphins are exposed to a low degree of bycatch in fisheries throughout parts of their range (Best, 2007) and increasing pressure from marine tourism, especially along the central Namibian coast (Elwen & Leeney, 2008).

Walvis Bay, Namibia (22.9S 14.48E), is a north facing, sandy bottomed bay, roughly 10 × 10 km, protected from the open ocean on the western side by a low lying sand spit ending at Pelican Point. Within this bay, 26 tour boats (5 sailing catamarans and 21 catamaran ski boats, 6 to 9 m long) operate marine wildlife watching tours. Although Walvis Bay is a commercial and fishing harbour, these tour boats represent the vast majority of boat traffic that interacts with dolphins in the bay. Two of the principal target species of tour operators are a small population of approximately 77 bottlenose dolphins (*Tursiops truncatus*) and a larger population of approximately 505 Heaviside's dolphins (Elwen & Leeney, 2009). Both species are often observed riding the bow waves of boats and are actively pursued by tour boats to encourage bow or wake riding and maximise interaction with the vessel. All vessels operate under power when in the presence of dolphins, and no "swim with" operations exist in the area. Heaviside's dolphins are viewed on a daily basis at an area of known concentration, roughly 2 km$^2$ in size, directly north of Pelican Point at the northwestern extreme of the bay.

The injured animal (sex unknown, catalogue number C-021) was observed a total of 11 times and photographed on ten of these occasions between 13 June 2008 and 4 August 2010. The animal has been seen in both summer (February-

March) and winter (June-August) field seasons, suggesting site fidelity to the Walvis Bay area. All sightings except the last occurred within the concentration area around Pelican Point in Walvis Bay; the last occurred along the eastern coast of the bay approximately 27 km northeast. Prior to its injury, the animal had been identified from distinctive markings on its dorsal fin, including two small nicks, a larger square crenellation on the trailing edge of its dorsal fin, and a small white scar, similar in width to a tooth rake, on the top left side of the fin (Figure 1).

When initially observed with the propeller strike injury on 11 and 12 February 2010, the dolphin had nine roughly parallel cuts on its left flank between the front of the dorsal fin and the middle of the tail stock (the most anterior cut is only visible in a single photograph from 6 March). Other than the propeller wounds, the dolphin appeared to be in good health, with smooth skin and no obvious signs of emaciation. A dark lesion, flat to the skin and similar to the "Tattoo disease" described in several other species of cetacean (Van Bressem et al., 2003, 2007) lies on the light grey "cape" of the left fore-flank. This area of the body was not frequently exposed nor was it subsequently photographed, so following the development of this lesion was not possible. The lesion is visible in the very first photograph taken post injury and is thus presumably not related to, or a result of, any ill health associated with the observed propeller wound. Healing rate in dolphins as well as the presence of lesions may be associated with water temperature and salinity (Wilson et al., 1999), with healing occurring more quickly in warmer and more saline waters (S. Ridgway, pers. comm., 25 August 2010). The sea surface temperature (SST) was measured at the beginning of all dolphin encounters using an onboard Garmin 430 Fish Finder, and during those encounters with the injured animal, it ranged between 15.1 and 20.0º C. Salinity was not measured *in situ*, but a scientific cruise in the area during the same time of year in 2003 (Brüchert et al., 2003) reports salinity values of ~35.9 psu.

To simplify descriptions of the wounds, we assigned each cut a number from 1 through 9, starting at the anterior of the dolphin (Figure 1A) and counted all days subsequent to the 11 February 2010 as "days post injury." We calculated the distance between each pair of propeller cuts (except cut 1 which is only visible in a single very angled image) by measuring the distance in pixels (px) between the top insertion of each cut in Adobe *Photoshop CS3*. Pixels were converted to cm by assuming a mean vertical fin height for this species of 15.8 cm (Best & Abernethy, 1994). We calculated that 1 px in this image represented approximately 0.348 mm on the dolphin. Thus, the mean distance between cuts was 7.08 cm (1.28 SD) (cuts 2 and 3 = 8.51 cm, cuts 3 and 4 = 8.44 cm, cuts 4 and 5 = 7.46, cuts 5 and 6 = 7.64 cm, cuts 6 and 7 = 6.38 cm, cuts 7 and 8 = 5.13 cm, cuts 8 and 9 = 5.96 cm). All cuts were relatively short (only cuts 3 through 5 were entirely visible and measured 7.8, 6.8, and 7.6 cm, respectively). The cuts differed in width, with cuts 5 through 8 being the widest and deepest.

On the first 2 d of sighting post injury (11 and 12 February 2010), at least seven of the nine cuts were open (cut 1 not visible; cut 4 did not penetrate the skin), showing pale pink muscle and a clear differentiation between skin, blubber, and muscle tissues. No blood was seen, and differentiating between the shade of the muscle tissue on the 2 d is not possible due to different photo exposure. The cuts were clearly very fresh, however, and it is unlikely that they were made more than 2 or 3 d prior to the sighting. Bloom & Jager (1994) report similarly fresh, nonbleeding wounds on a bottlenose dolphin 24 to 48 h post injury. By the third, fourth, and fifth sightings of the animal on 2, 5, and 6 March (19 to 23 d post injury), skin had already covered cuts 1 through 3. Each of these scars showed a pale centre and dark outline. In cuts 5 through 8, the thick skin layer appeared to be beveled into the cut, with the skin closest to the wound showing a lighter grey colouration and a slightly darker outline at the very edge of the wounds. In cuts 6 through 8, the deepest and widest, the skin has not yet covered the wounds entirely. A layer of granulation tissue is obvious in the bed of the wound (Corkeron et al., 1987a). At the final sighting of the dolphin during the summer field season (22 March 2010, 39 d post injury), the anterior scars all show near-complete healing with the wounds only visible as discolouration on the skin (darker outline; paler centre), with no obvious indentation or swelling. The two deepest injuries (cuts 7 and 8) were the only ones still showing any of the white granular tissue, but they were reduced considerably in size compared to the previous sighting only 16 d prior. The most recent sighting of the injured animal (4 August 2010, 174 d post injury) showed all injuries to have healed and completely repigmented (no white scar tissue), but with the scars clearly visible and protruding slightly from the body (Figure 1H).

Given the size of the cuts, it is most likely they resulted from the propeller of an outboard engine such as those used on the research vessel and tour boats. Propellers for these types of engines range from ~30 to 40 cm rather than the much larger propellers used on the inboard engines of longline and trawler vessels (Beck et al., 1982; Wright et al., 1995). All cuts had the top edge anterior

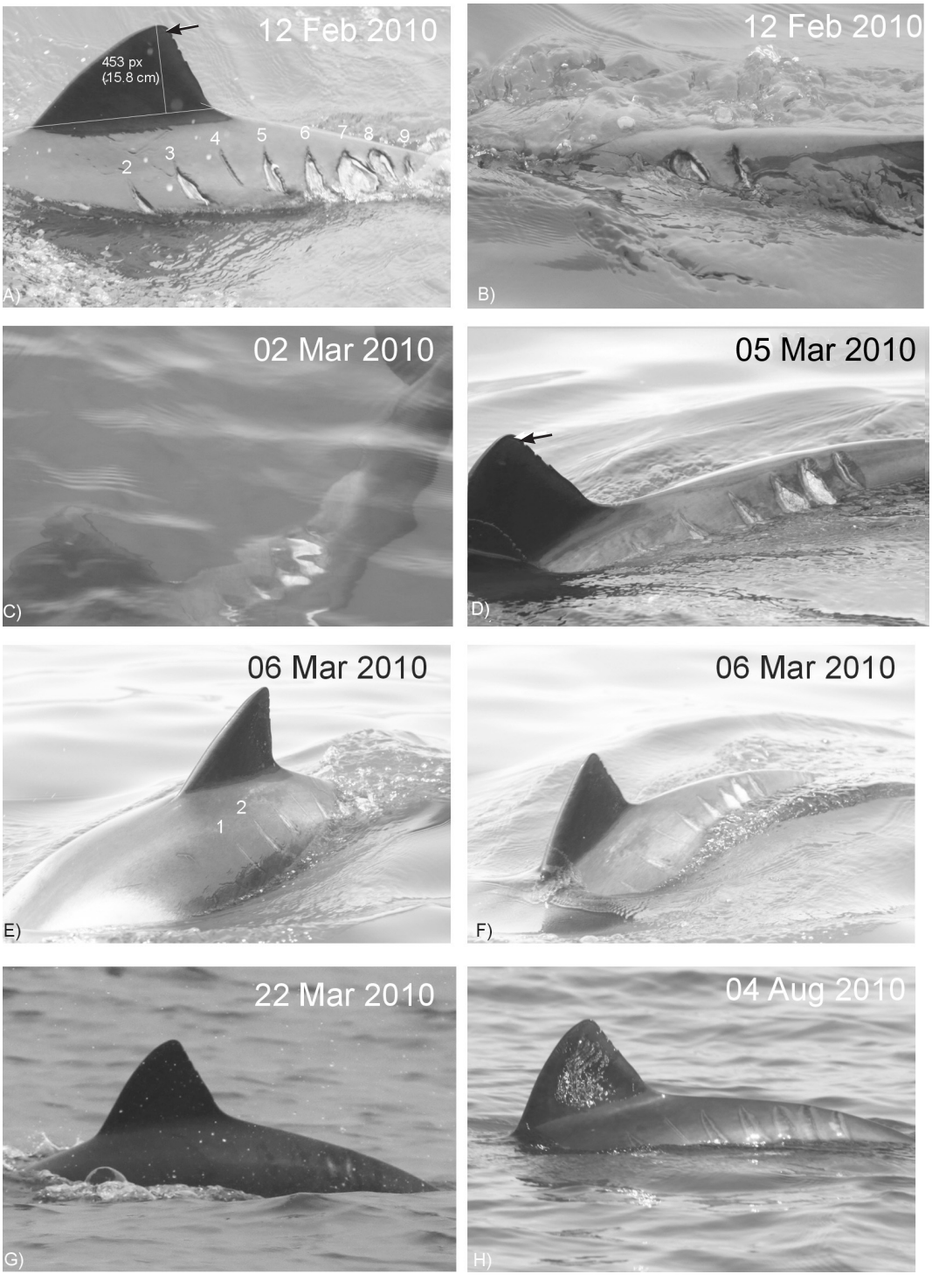


**Figure 1.** Progression of healing of propeller injury to a Heaviside's dolphin (*Cephalorhynchus heavisidii*) in Walvis Bay, Namibia; top left image used to measure spacing between cuts. Cuts 1 through 9 are labeled in images A and E. Arrows in images A and D indicate unhealed small white scar.

to the bottom edge (slanting forwards on the animal), suggesting that the animal was hit by a boat moving in the same direction as it. This is further supported by the posterior cuts being deeper; presumably the dolphin would move/flinch away from the propeller during the interaction.

The rate of healing of this wound occurred over a similar time frame to that observed in other dolphin species with similarly deep wounds. A shark bite wound at least 3 cm deep on the flank of a bottlenose dolphin in New Zealand closed completely within 30 d and healed to a scar within 45 d (Orams & Deakin, 1997). A severe wound to the top of the head of a bottlenose dolphin, which was caused by the skeg of an outboard engine, healed to a white scar within 3 mo (Lockyer & Morris, 1990). A propeller wound to a bottlenose dolphin in UK waters showed a slightly slower healing rate than that reported here, with some wounds still being open after 65 d, and complete healing to scars taking more than 100 d (Bloom & Jager, 1994). The slower rate of healing in this animal may have been related to a number of infections and abscesses observed in the wounds, the low water temperatures in winter (4 to 5º C), and high levels of bacteria associated with a sewer outfall in the region (Bloom & Jager, 1994).

Some instances of cetaceans learning to associate a boat with adverse conditions such as biopsy (Barrett-Lennard et al., 1996) or capture (Irvine et al., 1981) have been reported. However, the majority of studies have shown no long-term behavioural changes to short-term impacts or injuries (Weinrich et al., 1991; Weller et al., 1997; Krützen, 2002; Best et al., 2005). Despite such a recent and extensive injury, the dolphin reported on in this study readily approached the research boat and surfed the bow wave on several occasions, including when first seen post injury. Heaviside's dolphins actively interact with boats, readily surfing both the bow wave and wake. In the high density area north of Pelican Point, Heaviside's dolphins may be exposed to up to 12 vessels at a time, all actively seeking dolphin interactions (Elwen & Leeney, 2008). Although intense, the period of interaction is relatively brief over a 24-h period, with tour boat numbers peaking between 0900 and 1200 h, the duration of trips being curtailed by generally strong winds in the afternoon (Elwen & Leeney, 2008). That only one animal has been seen with propeller strike injuries despite a daily exposure to tour boats in this area suggests the risk of direct injury may be relatively low. The combination of a relatively large population, the high concentration of animals at Pelican Point, and the relatively short period of interaction time with boats likely reduces the encounter rate of individual animals with boats, despite the daily exposure.

Although dorsal edge injuries are usually regarded as effectively permanent (Würsig & Jefferson, 1990), superficial scarring, such as the small white scar on the tip of the left side of the dorsal fin (Figure 1) or those caused by tooth rakes, is generally thought to heal completely within several months (Lockyer & Morris, 1990). In contrast to the rapid healing of the propeller wounds, no discernible change in shape, size, or colouration of either the dorsal edge marks or the white dorsal scar was observed over the nearly 800 d of observation. The implications of these observations for long-term photo-identification studies are positive: (1) our data suggest that even small scars on the dorsal fins of Heaviside's dolphins may be useful for confirming identity in conjunction with dorsal edge marks over periods of several months to years, and (2) although the healing rate of deep wounds such as from a propeller is rapid, the scarring is still clearly visible for several months. This suggests a reasonable time frame within which assessments of the frequencies of various injuries such as those caused by shark bites or entanglements may be estimated accurately.

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