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NOTE

Severe mutilation of a Critically Endangered Taiwanese humpback dolphin *Sousa chinensis taiwanensis* by fishing gear

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ABSTRACT: Direct observations of the causes of injuries to cetaceans are rare events. For very small and declining populations, such events may be even less likely to be observed because of the few individuals that remain. A long-term monitoring program using photographic identification of individuals resulted in the documentation of an individual Taiwanese humpback dolphin *Sousa chinensis taiwanensis* that survived a harmful interaction with fishing gear. An adult female that was accompanied by a young calf sustained massive damage to several tissue types on her dorsal surface. From the injuries, it is clear that the animal had suffered intense trauma that likely caused pain for several months as the fishing gear sliced through its dorsal hump and fin. Given the incredible mutilation, the animal is likely compromised at some level and probably continues to experience ongoing pain. This case, along with observations of other individuals in this population bearing serious injuries or being entangled in fishing gear, is direct evidence that the impacts of local fisheries on this subspecies are almost certainly unsustainable.

KEY WORDS: Taiwan · Humpback dolphin · Injuries · Fisheries impact · Conservation · Critically Endangered · Entanglement

INTRODUCTION

The Taiwanese humpback dolphin subspecies *Sousa chinensis taiwanensis* is endemic to the waters off western Taiwan (Wang et al. 2015) and is listed as Critically Endangered by the IUCN Red List of Threatened Species (Reeves et al. 2008). The population numbers about 75 individuals (Wang et al. 2012) and is suspected to be declining (Slooten et al. 2013, Araújo et al. 2014) due to 5 major threats, including habitat loss due to terraforming (often called 'reclamation'), pollution (both air and water), noise, reduction of freshwater input into the estuaries upon which these dolphins depend and fisheries (specifically entanglement in gillnets), which was identified as the most direct and immediate threat to this subspecies (see Ross et al. 2010, Dungan et al. 2011, Slooten et al. 2013, Wang et al. 2017). Thousands of gillnets (mainly various forms of trammel nets) are used within the highly restricted distribution of the Taiwanese humpback dolphins (see Slooten et al. 2013). Population viability analyses showed that the impact of fisheries alone can drive the population towards extinction well before the longer-term impacts of the

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other major threats are realized, especially if any additional mature female dolphins are removed from the population (Araújo et al. 2014).

Entanglements of smaller cetaceans often result in death fairly rapidly, and the probability of recovering these carcasses is low for various reasons: (1) The killing (intentionally or otherwise) of cetaceans in Taiwan is prohibited, so to avoid possible punitive consequences, bycatch is usually discarded at sea either intact or in pieces (especially if fishermen desire some meat for personal consumption). (2) Humpback dolphins are generally negatively buoyant (at least initially), so discarded carcasses would sink and (3) with large tidal fluctuations and strong currents occurring within most of the Taiwanese humpback dolphins' known distribution, carcasses are unlikely to strand on beaches. Even though Taiwanese humpback dolphins are seen during almost every survey trip conducted in decent marine conditions, only 4 Taiwanese humpback dolphin carcasses have been reported (see Wang et al. 2015) since the establishment of cetacean stranding networks in Taiwan about 20 yr ago. In contrast, there have been many more stranding records of species that are uncommonly observed in the waters off western Taiwan. For example, there are many stranding records of Risso's dolphins *Grampus griseus* along western Taiwan, but this species has never been observed in the inshore waters off western Taiwan (J. Y. Wang unpubl. data), and few have been reported from waters farther offshore (Huang 1996). Thus, the few carcasses of Taiwanese humpback dolphins that are available for examination can only provide minimal information on the impacts of threats.

Observations of injuries on living dolphins can provide a window into understanding the impacts of some human activities. A large proportion (31.2%) of Taiwanese humpback dolphins bear serious injuries that have been attributed to fishing gear, and a few have also been observed entangled in fishing lines (see Ross et al. 2010, Slooten et al. 2013, Wang et al. 2017). However, determining the cause(s) of most injuries is difficult because it is rare to observe the cause(s) directly. In this note, we describe an extreme case of a fisheries-induced mutilation of a member of this Critically Endangered subspecies of dolphin.

MATERIALS AND METHODS

Data from a long-term (since 2002) photographic identification monitoring program of the subspecies (see Wang et al. 2012 for details) were examined to document the severe injuries of an adult female Taiwanese humpback dolphin, TW-88. In 2016, the structures of the injuries of TW-88 were measured to the nearest 0.5 cm using laser photogrammetry equipment (double GreenBeam 1000 lasers separated by 10 cm) attached to the tripod collar mount of a Nikkor 70–200 mm f2.8 VRII lens. The spacing of the lasers at multiple lens-to-target distances (between 5 and 25 m) was checked daily, and the spacing of the lasers never deviated from 10 cm separation during the field work periods.

RESULTS AND DISCUSSION

Photographic history of TW-88

The individual TW-88 (later named 'Cupcake' as a result of her disfigurement) was first observed and identified on 5 August 2008 as a member of a group of 12 dolphins. Since then, she has been photographed in all subsequent years, except 2009 and 2014. In 2008, TW-88 already possessed a wide, healed semi-circular scar on the upper torso area and another thin, healed semi-circular scar below the base of the dorsal fin on her left side; a small piece of the tip of her dorsal fin was also cleanly sliced off (Fig. 1a). The cause(s) of these injuries are unknown. On 26 August 2010, 10 July 2011 and 23 July 2011, TW-88 was observed with 11, 15 and 3 other dolphins, respectively. In 2010 and 2011, she appeared more or less as in 2008, but she was accompanied by a young calf in 2011. On 5 July 2012, TW-88 (accompanied only by her calf) was observed with 2 strands of monofilament fishing lines (with no additional gear), one embedded deep into the base of her dorsal fin and the other slicing into the base of her slight dorsal hump (the ends of both lines hung freely on the sides of the dolphin). It was clear that both lines had entered TW-88 through the anterior (leading) edge of her dorsal fin and hump (Fig. 1a). The exposed trailing filaments of the lines were encrusted with considerable biotic growth, which indicated TW-88 had been carrying these lines for some time. The lines were in the process of slicing through TW-88's body with the lines exerting increasingly more hydrodynamic drag with the accumulation of biotic growth. As the lines sawed slowly through the dolphin, the lacerations anterior of the lines healed/fused together so the dorsal chunks of tissue above the cuts were not amputated. On the animal's left side, the exposed portion of the upper line was

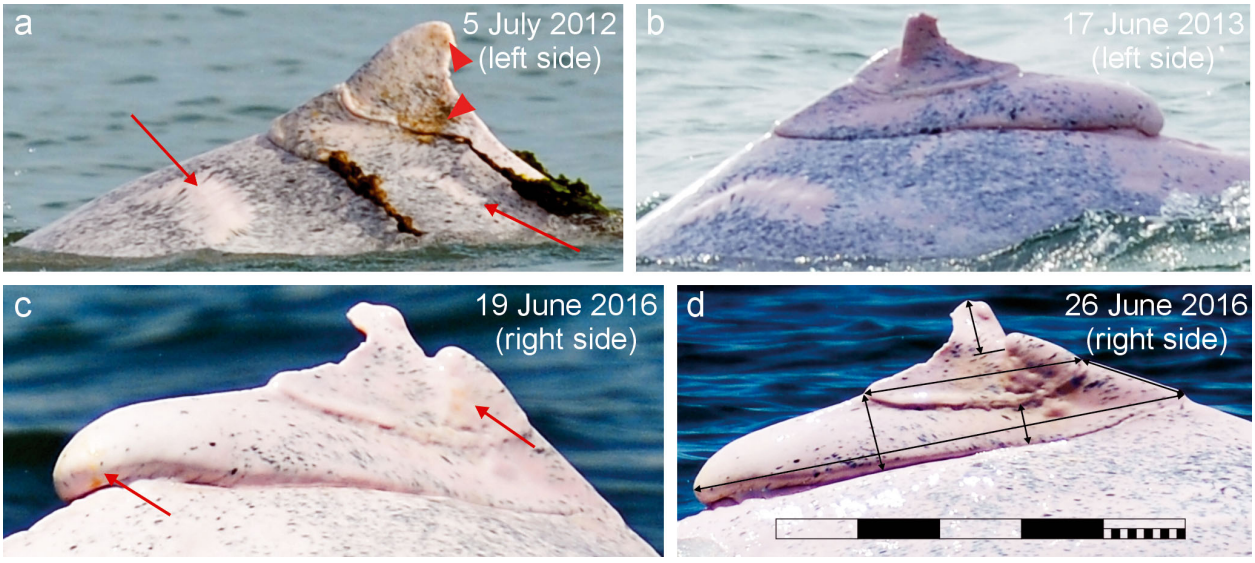

Fig. 1. Adult female (TW-88) Taiwanese humpback dolphin *Sousa chinensis taiwanensis* showing (a) 2 fishing lines slicing through its dorsal fin and hump at the base of the dorsal fin (the old healed injuries [arrows] were incurred prior to 2008 when this individual was first identified) and orange (like diatomaceous) film patches on the dorsal fin (arrowheads), (b) the healed injuries resulting from the fishing lines slicing through the dolphin completely and a new injury to the dorsal fin, splitting it vertically, (c) orange film on the dorsal fin and at the posterior end of the stump of healed tissue (arrows) and (d) the measurements taken of the structures of the injury using laser photogrammetry; scale bars = 10 cm (large) and 1 cm (small). All photographs were taken by J. Y. Wang / CetAsia Research Group

at least 25 cm long while that of the lower line was at least 12 cm long (note: the total length of an adult Taiwanese humpback dolphin can reach about 250 cm; see Wang et al. 2015). Because this individual was clearly injured, showed signs of avoidance towards our vessel (although not energetically fleeing) and was accompanied by a calf, we did not want to overly disturb or stress the animal or its calf so we did not attempt to approach it too closely or to prolong our presence after decent photographs had been obtained of the lines and the injured area, and for photo-identification purposes. As a result, the right side of the dolphin was not photographed. In total, we spent 44 min following TW-88 and her calf.

On 17 June 2013, TW-88 was photographed again with just her calf. She had lost the lines, which appeared to have sliced completely through and exited the trailing edge of her dorsal fin and upper caudal peduncle resulting in a severely disfigured dorsum (Fig. 1b). The lines penetrated and damaged multiple layers of tissue including the skin, blubber, epaxial muscles, connective tissues and possibly bone (the neural spine[s] of vertebra[e]). In addition, her dorsal fin was split cleanly and nearly down the middle with the anterior part curving to the right while the back portion slanted to the left. This new injury may be unrelated to the initial lines that sliced through her but was probably the result of another interaction with human activities. Given its clean cut, this new dorsal fin injury was again most likely fisheries-induced. It is unknown if there are any injuries to the ventral surface of TW-88 because we have never photographed or observed this part of the dolphin.

On 20 June 2015, TW-88 was observed with 9 dolphins, but the group did not include her previous calf so the calf was likely weaned by this time. In 2016, TW-88 was observed on 3 days (7, 19 and 26 June) in groups of 29 (it was in a subgroup of 4 dolphins that was heading rapidly towards a larger group of 25 dolphins), 28 and 34 individuals, respectively. In all 3 sightings in 2016, she was accompanied by a new, young calf and an individual that was almost certainly her previous calf. Her healed dorsal surface, as observed in 2015 and 2016, showed no noticeable changes compared with 2013. Surprisingly, the swimming movements of TW-88 did not appear to be obviously laboured or unusual (at least at the surface), even though she was greatly mutilated.

In 2012, orange film patches (likely diatomaceous in nature) were observed on the dorsal fin (left side) just anterior to the point where the upper line was

cutting into the base of the dorsal fin. In 2016, we observed 2 clear but small patches of orange film on the dorsal fin (right side) and posterior end of the dorsal stump (Fig. 1c). In 2016, we were also able to measure TW-88's injuries using laser photogrammetry (Fig. 1d). The main upper and lower cuts were separated by 13.0 cm (anterior edge), 5.0 cm (at the narrowest point) and 9.5 cm (at the posterior end of the cut at the base of the dorsal fin). The injured mass of tissue caused by the lower cut was 61.5 cm long, and the cut through the base of the dorsal fin was 27.0 cm long. The length of the vertical split of the dorsal fin was 7.0 cm.

Impact on the individual (welfare and suffering)

Given the massive lacerations through multiple tissues, it is likely that TW-88 suffered (and possibly continues to suffer) the similar chronic pain and stress which have been described for large baleen whales that are not killed immediately by entanglement in fishing gear but sustain severe injuries (e.g. Cassoff et al. 2011). Such long-term injuries were described as one of the cruelest forms of human-caused impacts because the victims experience long-term intense suffering that results from the gear cutting slowly into various body parts over several months before they are killed or eventually freed (Moore et al. 2006, Moore & van der Hoop 2012, Moore 2014). Thus, death of large whales due to entanglement can be more protracted and torturous than the direct killing of whales by commercial hunting (see Moore et al. 2006). Although many small cetaceans (especially small young individuals) are killed quickly by entanglement, some like TW-88 can survive entanglement for some time and thus experience the same intense suffering as described for large whales and concessions to their health, life span and reproductive potential (e.g. Wells et al. 2008, Barco et al. 2010). The orange film found on TW-88 appears to be a sign of compromised health and is consistent with that observed on several other individuals of this subspecies (J. Y. Wang unpubl. data; also see Yang et al. 2013) and other species (e.g. Wilson et al. 1999). However, we also concur with the other studies that the orange film does not appear to be debilitating or infectious.

Even though this was an example of the remarkable resilience of a humpback dolphin to not only recover from such a major trauma but also to continue to survive and reproduce, the potential longer-term impacts of such events on the fitness of this dolphin are unknown. Furthermore, the welfare, health, future survivorship and reproductive potential of her offspring may also be affected because TW-88 may have been compromised during the calf's dependent years. However, the impacts of injured mothers on their calves are even more difficult to understand and will require long-term monitoring to compare calves of compromised mothers with calves of uninjured mothers.

Impact on the population (risk of extinction)

Given the few remaining Taiwanese humpback dolphins and the modelled consequences of the removal of any additional individuals from this population (especially females; see Araújo et al. 2014), TW-88 and the other injured and gear-entangled individuals provide strong evidence that fisheries off western Taiwan are unsustainably impacting this population (Slooten et al. 2013, Araújo et al. 2014, Wang et al. 2017). Moreover, the impact of fisheries is under-represented because not every individual can be photographed each year, and only a subset of the few dolphins that do experience fisheries interactions will be photo-documented. Therefore, it is impossible to determine if individuals that were not photographed in any given year were killed by fishing gear. Photo-identification data are also generally limited to the dorsal surfaces of dolphins, so fisheries-related injuries to other parts of the dolphin will not be observed. The reasons for the underestimation of the impact of fisheries on baleen whales (Cole et al. 2006) may be exacerbated for small cetaceans such as the Taiwanese humpback dolphin. Small cetaceans (especially some species such as members of the Phocoenidae family and younger, smaller or older and weaker and health-compromised individuals) are more likely to die from acute drowning or complications resulting from injuries suffered during fisheries entanglement than large cetaceans, because size and power of the entangled individual is a major determinant of the victim's ability to break free of fishing gear and escape drowning (see Angliss & DeMaster 1998). Furthermore, such mortalities for Taiwanese humpback dolphin are unlikely to be reported by fishermen because the subspecies has the highest level of legal protection in Taiwan so any killing is considered illegal. Also, discarded carcasses of Taiwanese humpback dolphins are unlikely to strand on beaches (see above) and even less likely to do so in a sufficiently fresh state for the cause of death to be determined confidently. Of the small

number of stranded Taiwanese humpback dolphins (n = 4), only 2 were fresh and both were found emaciated and exhibited classic signs of gillnet entanglement (Wang et al. 2015, J. Y. Wang unpubl. data). Both were also individuals that had been monitored for more than a decade, but their causes of death would not have been known if not for the improbable recovery of their carcasses in a fresh state. However, it was not possible to determine if emaciation contributed to the animals' entanglements or emaciation resulted from being entangled for a protracted period prior to death.

Incorrect determinations of the causes of injuries from photographs can also underestimate or overestimate the impacts of fisheries. If not for the observation of the lines that were slicing through TW-88, the resultant deformities observed on TW-88 may have been erroneously attributed to a cause other than fisheries. For example, Jutapruet et al. (2015) claimed that an injured Gulf of Thailand humpback dolphin (see their Fig. 5c) was caused by a boat propeller. However, the photograph showed the individual with a deeply embedded line (apparently undetected by the authors) that had sliced through a large part of the dorsum just anterior to its dorsal hump. The exposed part of the line was covered with biotic growth (appearing very dark in the photograph so likely the reason for being overlooked) but still visible and the cut, anterior to the line, was already healing (in a manner similar to TW-88). In the case described by Jutapruet et al. (2015), the impact of fisheries was underestimated while the impact of vessel collision was inflated.

Compared to the threats from pollution, habitat degradation and noise, the impacts of fisheries on the Taiwanese humpback dolphins are the most direct and immediate. Fisheries impacts are also the easiest to understand and mitigate, and action to eliminate the impacts on this unique subspecies is urgently needed to circumvent the concerning downward trajectory of these dolphins towards extinction.

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