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ABSTRACT

We document 8 cases (30 animals) of incidentally captured cetaceans and pinnipeds used as bait with improvised Fish Aggregation Devices (iFAD) by fishermen in coastal Ecuador. At least *Stenella attenuata, Delphinus delphis* and *Globicephala macrorhynchus* are affected, as well as *Otaria byronia*, the latter reportedly killed on purpose. Dead sperm whales may be opportunistically exploited as FADs. This is the first report of baited FADs in Ecuador and its extent is unknown. This practice has not been reported from neighbouring countries. Without regulation it could rapidly expand and lead to directed kills and conservation problems for affected marine mammal populations.

Key words: FAD, marine mammals, bycatch, bait

INTRODUCTION

Ecuador's coastline extends over 2859 km, including open coasts facing the Eastern Pacific Ocean and coasts associated with inland waters of estuaries formed by different rivers.
The small-scale fisheries on the Ecuadorian continental coast are represented by the Artisanal Coastal Fishery that uses small boats to fish in coastal areas, and the Artisanal Oceanic Fishery, which operates in the open sea with the support of a larger ship. Both of them capture demersal and pelagic fish (FAO, 2003). According to the Secretariat of Fisheries Resources (Subsecretaría de Recursos Pesqueros, SRP), there are 234 fishing communities, with a total of 19,770 artisanal boats and between 63,970 - 87,280 small-scale fishers registered as members of the current fishing population in Ecuador (Alava *et al.*, 2017). The main fishing gear presently used include: trammel or surface gillnets (*trasmallo*) of 800 m long by 3 m high, the 3200 m long cachema longline (*espinel corvinero*) with 800 hooks, the longline (*palangre*) of 36-72 m, and the purse-seine net (*red de cerco*) up to 1300 m long and 30 m deep. In Ecuador, the small-scale fishing fleet uses mainly longlines and surface gillnets (mesh sizes: 7.5-13 cm) to catch pelagic fin fish species including dorado (dolphin-fish), several tuna and billfish species and sharks (Subsecretaría de Recursos Pesqueros, 2009; Alava *et al.*, 2017).

The lethal interaction of small cetaceans with fisheries is widely recognized as one of the biggest global conservation problems of recent decades (Northridge, 1985; Reeves *et al.*, 2003; Hucke-Gaete *et al*., 2004). In Ecuador, human activities cause severe direct and indirect anthropogenic impacts on marine mammals, including fisheries interactions (Félix and Samaniego, 1994; Van Waerebeek *et al.*, 1997; Félix *et al*., 2007; Castro and Rosero, 2009; Alava *et al*., 2017), vessel collisions with cetaceans (Van Waerebeek *et al.*, 2007; Félix and Van Waerebeek, 2005; Félix *et al*., 2007) and short-term impacts generated by whale-watching tourism (Scheidat *et al.*, 2004). Skin diseases have been indirectly linked to contaminants (Castro *et al.*, 2008; Van Bressem *et al.*, 2015).
In Ecuador three types of fishing gear have been associated with incidental captures of marine mammals:
(i) surface gillnets set mainly for pelagic fishes, swordfish (*Xiphias gladius*), billfishes (Istiophoridae); (ii) longlines of different lengths also targeting pelagic fish; and (iii) purse-seines targeting different tuna species such as yellowfin (*Thunnus albacares*), bigeye (*Thunnus obesus)*, skipjack or barrilete (*Katsuwonus pelamis*), but also dorado (*Coryphaena hippurus*), croaker, among others.

Prior studies have reported incidental capture rates of dolphins by Ecuadorian fishermen in coastal waters. Two catch rates with drift gillnets were estimated in the early 1990s, namely 0.13 dolphins /trip and 0.034 dolphins /trip (Félix and Samaniego, 1994). In the Gulf of Guayaquil, a daily catch rate for *T. truncatus* was estimated at 0.0064 bottlenose dolphins /day, or 0.019 bottlenose dolphins / trip but the CI were very wide (Van Waerebeek *et al.*, 1997). The highest incidental catch rate was obtained in August 2009 when 0.18 dolphins /day/ equivalent trip was estimated (Castro and Rosero, 2010).

However, there is virtually no information about the use of marine mammals for fishing purposes in coastal Ecuador. At Puerto Bolívar (southern Ecuador) one fisherman admitted harpooning a bottlenose dolphin near Puná Island, for bait in the longline fishery. Other fishermen operating in the Gulf of Guayaquil indicated they either discarded bycaught dead dolphins at sea or, when possible, sold them for bait to Peruvian fishermen (Van Waerebeek *et al.*, 1997).

This paper presents the first well-documented records on the take and use of cetaceans and pinnipeds as fishing bait in continental Ecuador. The purpose is to document and raise awareness about the occurrence of these illicit practices, propose to regulate them, and generally to promote the adoption of management measures to better protect populations of marine mammals in Ecuador.

MATERIAL AND METHODS

The information presented here was obtained by the Pacific Whale Foundation (PWF) and compiled as a database of stranding and bycatch records, observations through fish market monitoring as well as interviews with crew members of commercial fishing vessels and local fishermen. Information was collected opportunistically during irregular visits to fishing ports, surrounding beaches and other coastal locations of continental Ecuador in the period 2009-2017. Only stranding records where we observed fishing gear, indications of baiting, cutting, or other evidence of human manipulation, were taken into account. One case (# 1) is based on information received from the Municipality of Pedernales and examination of photos. Condition codes of carcasses (C.C.) were determined according Geraci and Lounsbury (2005).

A fish aggregating (or aggregation) device, or FAD, is defined as a man-made object used to attract ocean going pelagic fish such as tuna, billfishes and dorado (mahi-mahi). They usually consist of buoys or floats tethered to the ocean floor with concrete blocks. Industrial fisheries utilize large, commercially produced FADs made of metal and plastic floats, so they can be utilized for long periods (Morgan, 2011), however there is a recent tendency to replace these with biodegradable materials. Once deployed at sea they are rarely lifted out of the water. We here discuss smaller, *improvised FADs* (iFADs) fabricated and used by artisanal fishermen (Fig. 1).

RESULTS

Marine mammals as bait

Eight incidents of marine mammal strandings that had been used as bait (one suspected) were registered at three different locations: Cojimíes, Puerto López and Salango (Manabí) from 2009 to 2016 (Table 1). When found washed ashore or floating nearshore, carcasses were either directly attached to a FAD, or wrapped in some assemblage of netting, lines and buoys, with clear indications that they had been handled by people and were not simply the result of accidental entanglement in fishing gear.

In total 30 individuals of five different marine mammal species were determined as used for bait associated with a FAD. Most frequently encountered were South American sea lions (*Otaria byronia*) (Fig. 2) but also three species of Delphinidae were found: one pantropical spotted dolphin (*Stenella attenuata)* (Fig. 3), one short-beaked common dolphin *(Delphinus delphis)* (Fig. 4), and two short-finned pilot whales (*Globicephala macrorhynchus*). Finally, a dead sperm whale *Physeter macrocephalus* is thought to have been utilised opportunistically as a FAD by itself, which may be a common practice considering that accidental entanglements of sperm whales occur frequently in Ecuador (PWF, unpublished data). On two occasions more than one large marine vertebrate (cetacean, sea lion or sea turtle) were found associated on the same beach in Cojimíes, Manabi Ecuador, coinciding time – space (Table 1). The animals had washed ashore, or were found floating nearshore, with remains of ropes, floats, weights, or were attached to a still intact improvised FAD (Fig.7).

The carcasses were found mainly in an advanced state of decomposition (mode, C.C.= 4), as most had apparently remained some time stranded, their skin was sunburnt and many showed holes typically made by scavenging

ghost crabs (Ocypodidae) which are common on Ecuador's beaches. Also, some bare bones (C.C. 5) were found wrapped in small-mesh netting tied to large floats (Fig. 7) where all soft tissues had already been scavenged by fishes or other marine organisms.

Some cases deserve some further comments:

Case 1. The newsletter 'Diario Manabita' of 9 November 2009 had first published an article on the stranding of 17 sea lions, a sperm whale and one sea turtle (unidentified species) on the beach between Cojimíes and Pedernales. Unfortunately the animals were quickly buried without the respective scientific analysis. This seems to be the earliest reported stranding related to the use of marine mammals as bait in Ecuador. The Municipality of Pedernales first raised the suspicion that the cause of those strandings was associated to the use of FADs by fishermen [1].

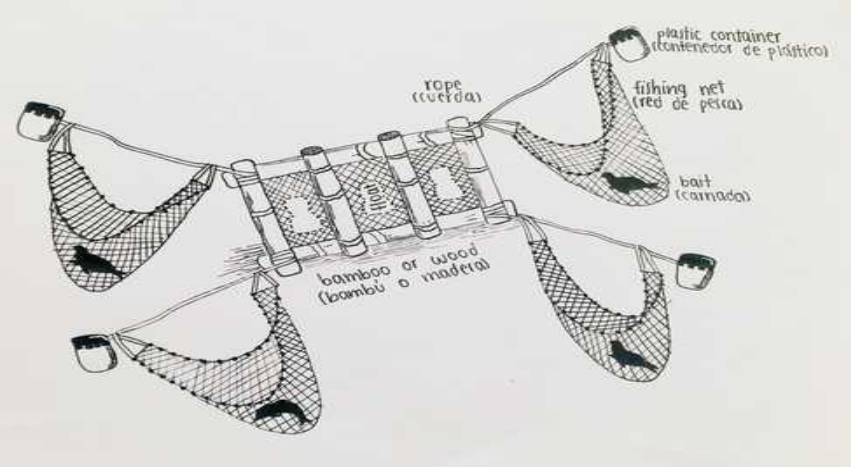

Fig. 1. Diagram of the improvised FAD found on Cojimíes Beach, Ecuador, on 09 November 2009. Illustration by Alejandra Loaiza C.

Case # 7, # 8. Another multiple-species FAD stranding was registered consisting of a short-finned pilot whale, 7 South American sea lions and 3 unidentified sea turtles in Cojimíes in September 2016. Some sea lions were wrapped in netting tied to a wooden structure with floats and a tank. Five sea lions were tied with thin ropes to the same structure, with weights and floats or were found detached along the beach. The pilot whale had cuts in the dorsal fin and tail, possibly where it was tied to the structure or some floating tank. Several components used in FADs were found (Figs. 6, 7). The origin of the FAD is unknown but due to its size perhaps an industrial fishing boat had lost it or the FAD broke loose from its moorings and it washed ashore. The FAD was found on the beach attached to green plastic flotation tanks. Black netting holding the complete carcasses of sea lions were found attached at both sides (Fig.7). In one, only bare bones were found, suggesting that perhaps this bait was in place for an extended time.

Improvised Fish Aggregating Devices

Artisanal fishermen do not seem to invest in the large, commercially available FADs. Instead they seem to make their own: far simpler and smaller versions (Fig. 7) which we refer to as improvised Fish Aggregating Devices (iFADs). We suggest that most of the latter are baited with the remains of marine mammals or sea turtles, often several specimens simultaneously (Fig. 1). Three types of iFADs have been found washed ashore, the difference being the presence or absence of floats and the type of construction and materials used.

- *Type 1*. Marine mammal carcasses moored with thin ropes by their pectoral fins, body or tail. They are possibly moored close to certain fishing gear and they remain floating by themselves, attracting fish. No

1 http://www.eldiario.ec/noticias-manabi-ecuador/135848-animales-marinos-fueron-encontrados-muertos-en-cojimies/

float is present. Are used by artisanal fishermen (Fig. 2). We suspect that floating dead whales may be used in this way.

- *Type 2.* Marine mammals wrapped in netting and tied to floats. The nets are heavier and have weights and floats with mooring lines. Possibly used by artisanal fishermen, chinchorreros and others (Fig. 6).
- *Type 3.* Marine mammals wrapped in fishing nets but at the same time tied to floats supporting larger, mostly rectangular wooden and bamboo structures, which can hold several bait-carcasses simultaneously (Fig. 7).

Case	Date	Location	# Ind.	Species	CC	Observations
1	09/11/2009	Between Cojimies-Pedernales	17	*Otaria byronia*	3-4	Associated ropes and buoys
2	09/11/2009	Between Cojimies-Pedernales	1	*Physeter macrocephalus*	3-4	Associated ropes and buoys. 1 seaturtle near-by.
3	23/11/2012	Puerto López	1	*Stenella attenuata*	4	Rope tied around tailstock
4	11/08/2014	Salango	1	*Otaria byronia*	3-4	Thin black rope tied to the body
5	15/06/2016	Puerto López	1	*Delphinus delphis*	4	
6	17/09/2016	Puerto López	1	*Globicephala macrorhynchus*	4	Head, partially severed; cut-marks present
7	30/09/2016	Cojimies	7	*Otaria byronia*	3-4	Tied to improvised FAD. Rope, weights, buoys, float tanks present.
8	30/09/2016	Cojimies	1	*Globicephala macrorhynchus*	3-4	Associated rope, weights, buoys. Cuts in dorsal fin and tail. 3 dead sea turtles found at same location.

Table 1. Documented cases of marine mammals utilized as bait with iFADs on the Ecuadorian coast from 2009 to 2016. Carcass condition codes (CC) follow Geraci and Lounsbury (2005). Case # 2 is a suspected case.

Although no observations have been made of operating baited FADs at sea, they are thought to function by attracting smaller marine organisms including small fish to feed on the bait, which then in turn may attract and concentrate larger fish species (tuna, billfishes, sharks). The latter are then easily encircled by purse-seines or taken by other means (e.g. long-lines), as is done with commercial FADs.

Interviews with artisanal fishermen revealed that small cetaceans are obtained from incidental captures in fishing nets, while sea lions were beaten to death. According to artisanal fishermen, the use of marine mammals as bait is carried out only by industrial tuna fisheries and chinchorreros (purse-seine) who take advantage of the night to opportunistically fish for other species such as dorado using FADs. The name in Spanish for this activity is *plantado*. However, some interviews revealed that artisanal fishermen were also using small cetaceans and sea lions obtained opportunistically. The term in spanish for this type of bait is *siembra*. Thus the words *plantado* and *siembra* are synonyms, applied when referring to industrial or artisanal fishing, respectively.

The use of dead marine mammals as bait in FADs is very effective, due to their strong smell, high amount of fat and long permanence in the water. A fisherman from Puerto López stated: "*The best thing to catch dorado fish, is the fat of sea lions and dolphins, with which [the FAD] is baited as these remains stay intact for several days*". The FADs used by commercial fisheries in Ecuador have begun to be regulated. Artisanal fishermen have requested regulation from the Ecuadorian Government[2]. However, there are indications that also industrial fishermen may have started to bait FADs to increase effectiveness, but this has not been substantiated.

2 http://www.eldiario.ec/noticias-manabi-ecuador/47913-plantados-afectan-la-pesca-artesanal/

Fig.2. South American sea lion (Case #4) found floating near Isla Salango on 11 August 2014.
A nylon rope was tied (not entangled) around the forebody and around the base of the pectoral fins. Photo PWF.

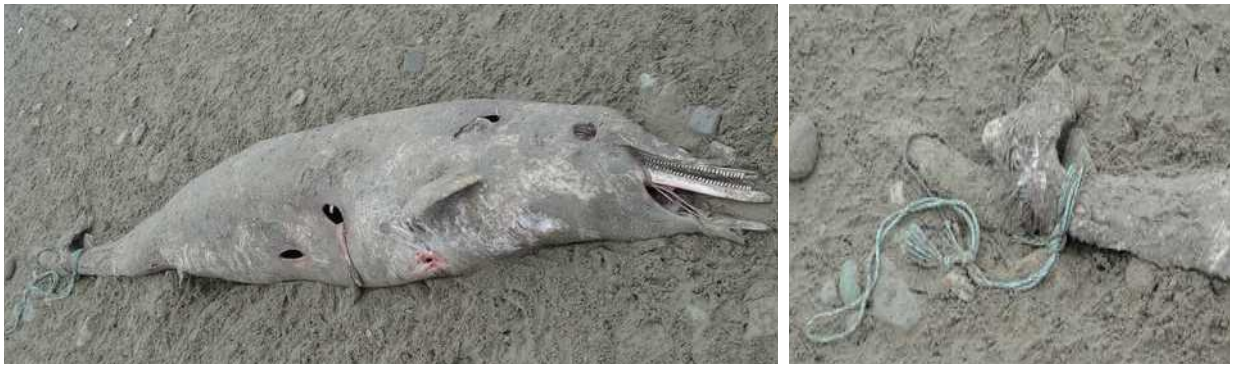

Fig. 3. Pantropical spotted dolphin (Case #3) as found on a Puerto López beach, 23 November 2012. The dolphin had green nylon rope firmly tied to its tailstock. Floats (not shown here) were found associated. Photos PWF.

Fig. 4. A young short-beaked common dolphin (case # 5) as found stranded at Puerto López on 15 June 2016. The body showed cut marks, while its skin was sun-burnt.

Fig. 5. Head of short-finned pilot whale (case # 6) found at the fishing port of Puerto López. Cut-marks indicated utilisation, almost certainly for baiting FADs. The animal is thought to be a bycatch victim. Photos PWF.

Fig. 6. Two of seven sea lions (case #7) found in association on Cojimíes beach on 30 September 2016. Note white nylon rope doubly wrapped and knotted around the flippers (not accidentally entangled) and black rope wrapped around the body. Floats were attached to the lines. Lead weights were also present. At least four differently coloured lines were used.

Fig. 7. Improvised FAD found on the beach of Cojimíes in September 2016 (case #7) with the attached remains of two pinnipeds, probably South American sea lions (pinniped scapula, humerus and ribs are recognizable), wrapped in small-mesh netting. Photos MAE.

DISCUSSION

On 4 May 2017, the Tuna Conservation Group made recommendations for the use and design of FADs for industrial fishing, especially tuna fishing in Ecuador[3]. They discussed experiments with certain biodegradable materials and designs already done in the country by tuna processing companies. However, the issue of baited FADs has not been addressed.

Several questions were raised by our findings. The main question ofcourse concerns to what extent improvised FADs are used by Ecuadorean artisanal fishermen and since when. Also, what is the incidence of baiting FADs, is it standard practice (we suspect) or is it something occasional. It is unclear also whether the observed mixed-species arrangements may have not been coincidence but arranged by design. Conceivably each bait species may have different characteristics, e.g. decompose at a different pace, preferentially attract different marine organisms, or other.

It is reasonable to believe that the lack of relevant legislation, regulation and control regarding the use of FADs, may have allowed artisanal fishermen in Ecuador to start using improvised FADs baited with marine mammals as to improve their fishing operations. It will be difficult to study the extent of use and evaluate the impact of this activity considering that the improvised FADs are hard to visibly trace when deployed at sea. Indeed the few FADs that were documented had reached the shore and were encountered by chance.

Little is known of the potential use of baited FADs in waters of neighbouring countries, indeed where did this practice first arise. There is no evidence, for instance, that baited FADs are or have been deployed off Peru, Chile or Colombia. However the use of small cetaceans as bait in longline fisheries, especially for sharks, has long been widespread in Peru (e.g. Van Waerebeek and Reyes, 1994; Van Waerebeek *et al*., 2002; Mangel et al., 2010). More recently, Peruvian gillnet fishermen have also resorted to attaching butchered parts of small cetaceans directly to wide-mesh multifilament gillnets to attract sharks, rays and other large fishes, which in some way could be considered a Type 1 improvised FAD, but structured FAD devices with floats (Type 2 and 3) as described above have so far not been documented (K. Van Waerebeek, pers. observations). In the northern Peruvian port of Salaverry 38% of gillnet fishermen indicated they baited their nets with small cetaceans in 2005-2007. This proportion increased to 79% for gillnet fishermen targeting sharks (Mangel *et al*., 2010).

3 https://www.tunacons.org/responsive/pdf/InformePlantadosFAD%E2%80%99sTUNACONS.pdf

We here reported the first cases of cetaceans and sea lions used as bait in FADs in Ecuador. The overall scarcity of information begs for more thorough fact-finding investigations that could then serve as guidance to propose legislation that would control or prohibit the use of marine mammals as bait, search for alternatives, and establish exemplary sanctions. If left unaddressed, within a short period of time, illicit directed takes of both cetaceans and pinnipeds could increase dramatically and lead to severe conservation problems for Ecuador's marine mammal populations involved.

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