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Identifying threats for inshore bottlenose dolphins off central Ecuador

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ABSTRACT

The coastal ecotype of the bottlenose dolphin (Tursiops truncatus) is one of the cetaceans most vulnerable to human activities. It is thought to be distributed in small communities along the Ecuadorian coast, overlapping with areas of human settlement. Like other bottlenose dolphin communities in southern Ecuador, the communities on the central coast of Ecuador are thought to be experiencing a significant demographic decline, which is believed to be affecting all bottlenose dolphin communities along the Ecuadorian coast.

Over the past two years, research efforts have focused on field surveys in central Ecuador. The aim was to gather information about the bottlenose dolphins in the area, to improve our understanding of the potential threats they face and to develop conservation management measures. By analyzing the skin scars on their bodies, mainly on the dorsal fin, it has been possible to identify the main anthropogenic threats to these communities.

According to the scar analysis, the main threat identified was fishing interactions. A high proportion of the coastal dolphin population (n= 30, 85.7%) had scars on their bodies from fishing interactions. The other major threat found was marine pollution, highlighting the impact of plastic. On five occasions, interactions between coastal dolphins and marine debris (plastic) were documented.

INTRODUCTION

The bottlenose dolphin *(Tursiops truncatus)* is distributed worldwide in tropical and temperate zones. Several subspecies and local morphotypes have been described (Perrin, 1984, Vermeulen and Cammareri, 2009), including two main ecotypes known as coastal and oceanic. Both ecotypes are found throughout most of its range (Perrin, 1984, Hoelzel et al., 1998, Van Waerebeek et al., 2017), including the coasts of Ecuador (Félix et al., 2018b, Félix and Castro, In Press). Genetic and morphological differences occur between ecotypes, and each has different ecological requirements (Hoelzel et al., 1998, Sanino and Van Waerebeek, 2008, Santillán et al., 2008, Rosel et al., 2009, Félix et al., 2018b; Dromby et al., 2023). The coastal or inshore ecotype is mainly distributed in neritic waters and is characterized by small groups, usually no more than a dozen animals, with restricted movement patterns and high site fidelity (Kenney, 1990, Wells et al., 1999, Ingram and Rogan, 2002, Wells, 2013).

This ecotype lives in complex so-called fission-fusion societies, i.e. where individuals associate temporally based on reproductive status, sex and environmental aspects such as food availability and the need for protection from predators (Wells et al., 1987, Connor, 2000). In contrast, the oceanic ecotype inhabits deeper, offshore waters and occurs in larger groups with extensive movement patterns and low site fidelity (Wells et al., 1999, Bearzi, 2004, Silva et al., 2008). The offshore ecotype also shows higher gene flow with other populations and, therefore, higher genetic diversity than the coastal ecotype (Natoli et al., 2004, Tezanos-Pinto et al., 2008).

The coastal bottlenose dolphin is one of the most vulnerable cetaceans to human activities as its distribution overlaps with areas influenced by human settlements. Therefore, these populations are particularly vulnerable to disease, injury and mortality (Chan and Karczmarski, 2019), as a result of interaction with fisheries, vessel traffic and all forms of marine pollution (Read et al., 2006, Mangel et al., 2010, Félix et al., 2017, Van Waerebeek et al., 2017, Castro and Van Waerebeek, 2019). The coastal ecotype is believed to range along the entire coast of Ecuador where they are now scarce (Castro and Félix, 2021). In the last two years, research efforts have been concentrated on the southwestern coast of the country (Félix et al., 2022, Castro and Félix, 2021). Consequently, our knowledge of this ecotype inhabiting the central and northern zone is scarce, with only a few records of sightings and strandings (Castro and Van Waerebeek, 2019; Castro and Félix, 2021).

A better-studied population of estuarine bottlenose dolphins in the inner Gulf of Guayaquil (Southwestern Ecuador), shows a decreasing trend of more than 50% in 25 years (Félix et al., 2017). Similarly, another coastal bottlenose community inhabiting the Santa Elena tip (North of the Gulf of Guayaquil) had only nine individuals (Félix et al., 2019). Depressed demographic parameters are common to all bottlenose dolphin communities studied along the Ecuadorian coast, making the species highly vulnerable. If this trend is not reversed, some coastal communities could disappear within a few generations (Félix and Burneo, 2020). The coastal-estuarine ecotype is considered Critically Endangered in Ecuador (Tirira et al., 2021). The oceanic ecotype is present throughout the year and widely distributed on Ecuador's central coast, presenting some sympatric distribution with the coastal ecotype in some areas (Félix and Castro, In Press).

Scars lesions and trauma are often the first indicators of compromised health conditions that can be seen in free-ranging dolphins (Wilson et al., 1997, Van Bressem et al., 2009a, Van Bressem et al., 2009b, Maldini et al., 2010). Although skin scars may have been naturally caused by interaction with the environment and with conspecifics, in some cases skin lesions and traumas are related to anthropogenic factors such as vessel collisions and fishery interaction (Félix et al., 2018a, Félix et al., 2018c), and infectious pathogens as a consequence of changes in environmental conditions and pollution (Burdett Hart et al., 2012, Geraci et al., 1979, Van Bressem et al., 2007, Van Bressem et al., 2009c, Van Bressem and Aznar, 2003, Vilela et al., 2016, Ewing et al., 2017, Fury and Reif, 2012, Van Bressem et al., 2009b, Wilson et al., 2000, Castro et al., 2008, Van Bressem et al., 2008). Skin scars can be useful for detecting natural and anthropogenic stressors in the marine environment (Toms et al., 2020) and therefore inferences can be made about the level of impact on a specific population (Hupman et al., 2017; Félix et al., 2018a,). An analysis of lesions affecting bottlenose dolphins is valuable to identify natural and anthropogenic pressures the species faces along the coast of Ecuador.

This study aimed to gather information on bottlenose dolphins inhabiting the central coast of Ecuador, increasing our understanding of the potential threats they face and identifying management measures for their conservation.

METHODOLOGY

Study Area.

The study area is located in central Ecuador and includes areas that share the provinces of Manabí and Santa Elena, extending as far as Ayangue to the south and Río Puerto Cayo to the north, approximately 95km of the coast (Figure 1). The area also includes four coastal and marine protected areas: Pacoche, Cantagallo, Machalilla, El Pelado.

Surveys.

Research trips were conducted between 2021 and 2023 on board a 12-m-long fiberglass boat with twin 150 Hp engines. Trip days were chosen taking into account the lunar phase, to sail under favorable oceanographic conditions for the observation of dolphins (days with lower waves, Beaufort wind scale ≤ 2). Trips were made parallel to the coast at a constant speed of 12 knots and a distance of 200-300 m from the shore, as the coastal ecotype is generally distributed in the first 500m from the shore (Félix et al., 2017, Castro and Félix, 2021). Puerto López was used as a launching site.

Trips departed in the morning (8:00-10:00) and lasted between five and eight hours, depending on the number of groups approached and the time spent with each of them. Two routes were taken, north and south. The northern route extended from Puerto López to north Puerto Cayo and the southern south from Puerto López to Valdivia. Both routes had a similar extension, around 50 km. However, the back trip had a more direct and offshore route in search of the oceanic ecotype and other cetaceans. Data on bottlenose dolphins were also taken opportunistically from whale-watching vessels departing from Puerto López to la Plata Island, 40 km in a northwest direction, between 2001 and 2023.

During the trips, all persons onboard, made observation sweeps at a 90° angle permanently searching for dolphins by direct visual observation and covering both sides of the boat. The team included at least two researchers with expertise in cetaceans research, a skipper, a sailor, and a variable number of volunteers. Once the dolphins were found, the boat approached cautiously until a distance of 30-50 m, avoiding any sudden movements that may interfere with the dolphins' behavior. Information collected during the encounter included the position, number of animals, class composition, and behavior.

Photographs of the dorsal fin were taken for individual identification with 18-24 megapixel Canon cameras and 70-300 mm and 100-400 mm zoom lenses. Photographs of other parts of the body were used to evaluate human-made and ecological interactions. Photographs taken opportunistically onboard whale-watching vessels were also used complementarily to dedicated surveys. With the best photographs of dorsal fins, two independent catalogs for coastal and offshore ecotypes were created.

RESULTS AND CONCLUSIONS

Effort

During three years of dedicated research, a total of 50 trips were made accounting for 4,030.8 km. Detailed information on the effort and areas surveyed is found in Table 1 and Figure 1.

Table 1: Number of trips carried out by year between 2021 and 2023. The table specifies the extension of the trips along the coastal border (coastal) and the part of the trips that included areas over the shelf (offshore).

Year	Trips	Coastal (km)	Offshore (km)	Total Km
2021	12	972.3	-	972.3
2022	28	1,256.4	1,234.3	2,490.7
2023	10	194	373.8	567.8
TOTAL	50	2,422.7	1,608.1	4,030.8

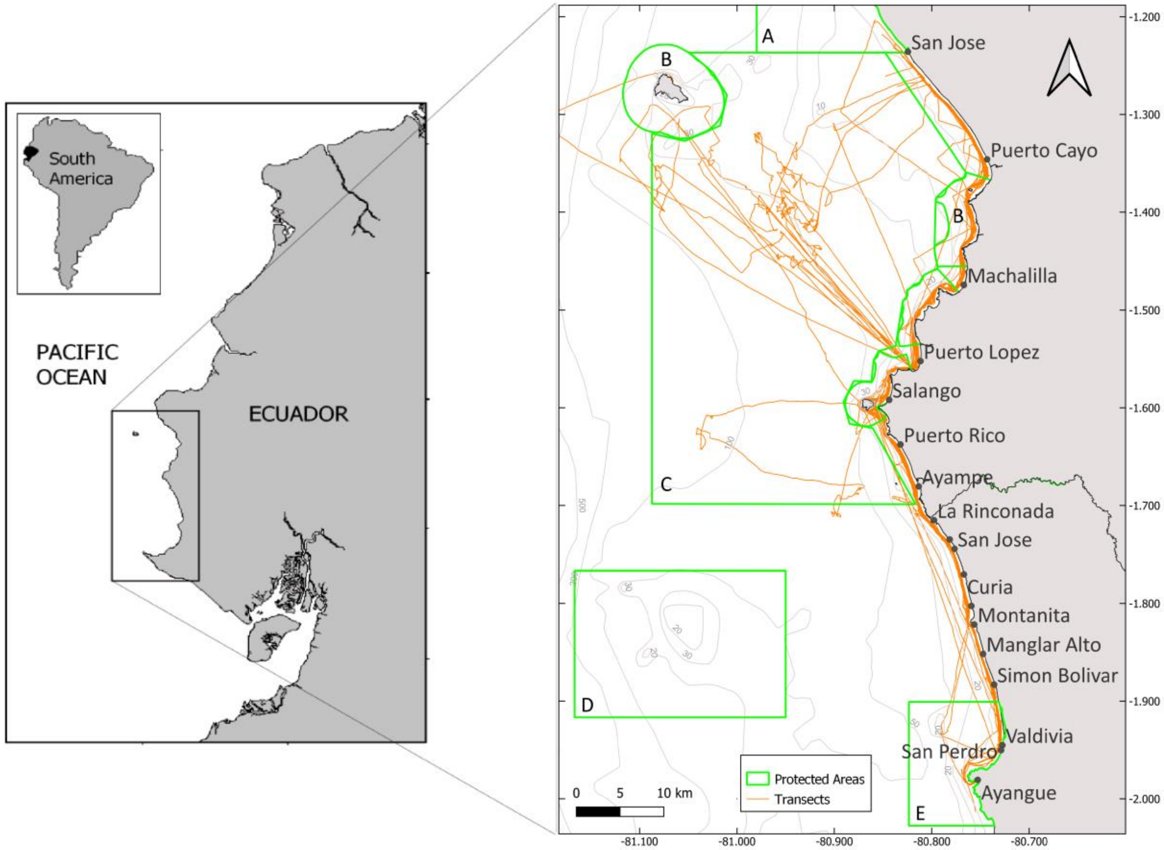

Figure 1: Area of study map in central Ecuador, showing the transects performed. Marine Protected Areas are indicated with letters: A) Pacoche, B) Cantagallo, C) Machalilla, D) Copei, and E) El Pelado.

Dolphin Encounters

During the study period, 14 groups (63.7%) were of coastal ecotype, seven (31.8%) with the oceanic ecotype, and one (4.1%) was mixed with individuals of both ecotypes. In total 50 coastal and 183 oceanic dolphins were identified by natural marks in their dorsal fin. As expected, group size changed markedly between both ecotypes. While oceanic dolphins were founded generally in big groups of 30 to 50 individuals (average 21, range 1-55), with rare occasions a single individual Most of the coastal dolphins sightings were of single individuals, the average group size was 2.4 (range 1-6). On a single occasion, a group of 20 dolphins composed of individuals of both ecotypes close to the coast was found (Figure 2).

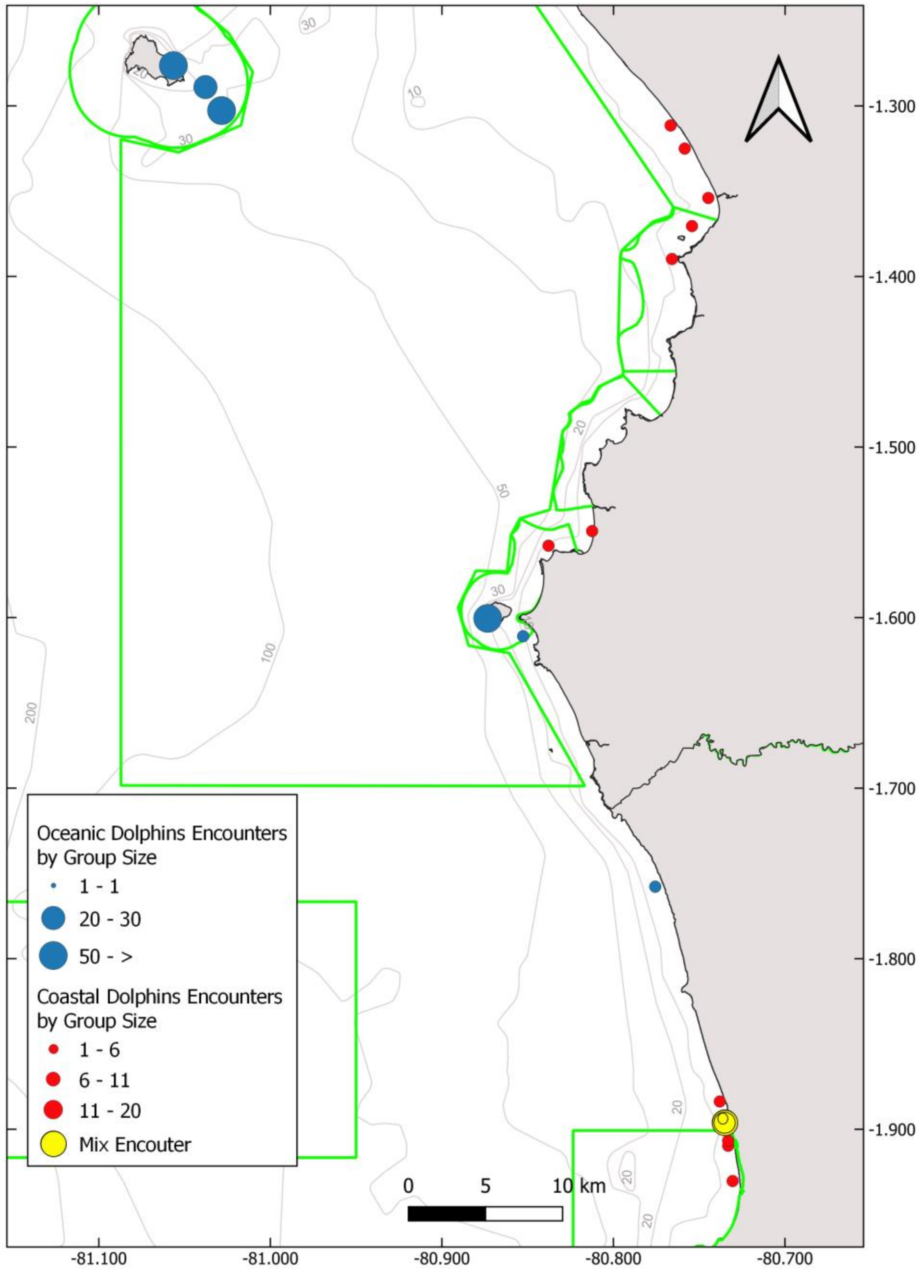

Figure 2: Map showing dolphin encounter location, discriminating by ecotype and group size. In blue is, the oceanic ecotype, in red coastal ecotype and in yellow is a group composed of individuals of both ecotypes.

Identified Threats

The main threats found were 1) fishery interaction, and 2) marine pollution (plastics).

Interaction with fisheries

Offshore ecotype. Information on fisheries interaction with the offshore ecotype was reviewed by Felix & Castro (in press), who reported that 43.6% of offshore dolphins had scars on the lower back related to fisheries interaction.

Inshore ecotype. mutilation of dorsal fin tips also suggests a high rate of interaction with fisheries. A high proportion of the coastal dolphin population (n= 30, 85.7%), showed marks on their bodies left by fishing interactions, and 10 individuals (28.5%) showed dorsal tip mutilations or deep cuts presumed by monofilament nets (Figure 3). Fifteen individuals (42%) showed whitish marks, usually on the tip of the dorsal fin, probably as the result of the healing process after the mutilation (Figure 4).

Figure 3: Photos of individuals inshore bottlenose dolphins with severe cuts and mutilations resulting from fishery interactions. Possibly monofilament nets that are clear plastic lines.

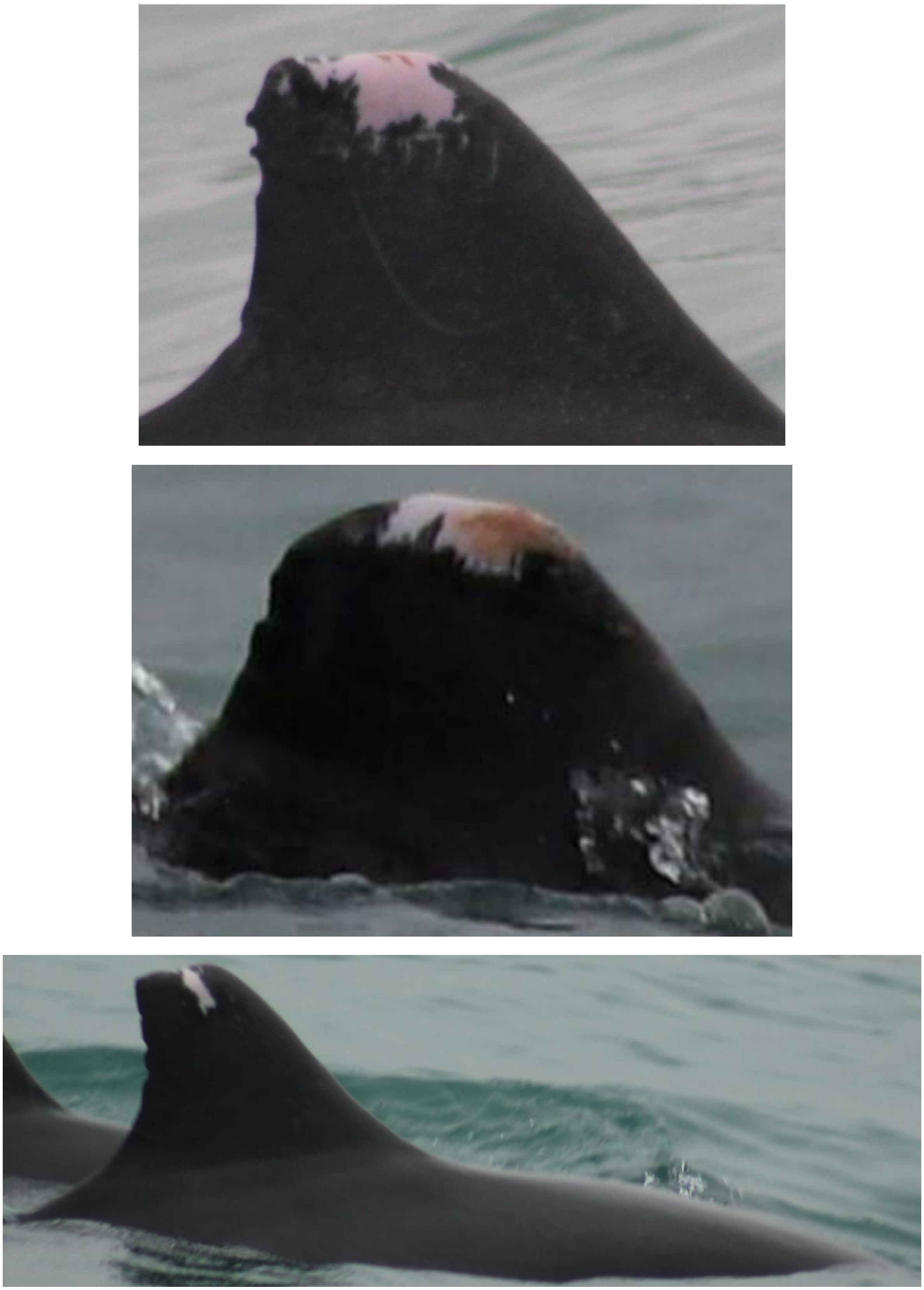

Figure 4: Photos of individuals inshore bottlenose dolphins with dorsal fin tip mutilation showing white scars from the healing process. This could be associated with some skin diseases.

Marine Pollution

Plastics

The increasing number of plastics on the water was noted with concern, especially in areas close to the coast. On five occasions, interactions between coastal dolphins and marine debris were documented (Figures 5 to 8). In one case, the interaction was with a plastic bottle, in another with plastic bags, one with a pack of chips made of up to seven layers, in which mainly aluminum and different types of plastic are interspersed, and in the other case with soft plastic.

On 2 February 2021, during a sighting of two coastal dolphins off Puerto Cayo, one of them, a young male identified in the Pacific Whale Foundation (PWF) catalog as M08, was recorded with a plastic bottle in its mouth. The bottle had a line attached to one end, suggesting that it was a bottle used by fishermen as a buoy or to mark the location of fishing gear. During the encounter, the dolphin was shy and kept its distance from the boat. The animal was resighted 2 months later on 2 April 2021, without a sign of the bottle (Figure 5).

Figure 5: Photo of a coastal dolphin interacting with a plastic bottle.

On 3 December 2021 at 08:50 am, 15 coastal bottlenose dolphins (including two females with calves) were observed off Puerto Lopez (-1.54932 S, -80.81244 W). It was noted that four individuals were found to have plastic bags on different parts of their bodies, a type of play behavior also recorded in other coastal dolphins within the inner Gulf of Guayaquil (Fernando Félix, unpublished data).

The first individual, identified as M35, had a snack packet on its dorsal fin (Figure 6). The second individual, identified as M16, had a transparent plastic bag on its dorsal fin and mouth (Figure 7). The third dolphin, identified as individual M28, had a plastic water bag on the side of its dorsal fin (Figure 8). The last individual had a plastic bag on its tail (no photo).

Figure 6: Photos of a coastal dolphin with a snack packet on its dorsal fin.

Figure 7: Photo of coastal dolphin (M16) with a transparent plastic bag on its dorsal fin.

Figure 8: Photo of a coastal dolphin (M28) with a plastic water bag on the side of its dorsal fin.

During the period December - May, there was an increase in rainfall along the Ecuadorian coast. The river's runoff and the heavy rainfall increased the amount of plastic and marine debris that ends up in the ocean. On several trips, large patches of marine debris were found and called to our attention. On 26 February 2023, we recovered from the sea some ghost fishing gear and a refrigerator used by fishermen to freeze their catch (Figure 9). On August 2022, we picked up from the water a 20 by 15 m^2 plastic tarpaulin floating used at social events and parties.

Figure 9: A refrigerator recovered from the sea

Skin disorders

In two (5.7%) coastal bottlenose dolphins, skin disorders such as nodules and blisters were observed. Only one case of dermal nodules was observed in oceanic dolphins (Félix and Castro, In Press), highlighting the highest vulnerability of the coastal ecotype.

Marine mammals are the primary sentinels of marine ecosystem change because they integrate and reflect ecological variation at large spatial and temporal scales (Moore, 2008). Thus, the decrement in dolphin populations in terms of health, welfare, and population size, reflects the quality of environmental conditions where anthropogenic activities are major threats. In this preliminary study, we can notice that both bottlenose dolphin ecotypes are exposed to several anthropogenic threats, reflecting the negative condition of an impacted ecosystem. The most relevant threats were found to be marine pollution and interaction with fisheries.

Interaction with fisheries

A large proportion of scars related to interaction with fisheries were found in both ecotypes (85.7% in the inshore form and 42% in the offshore form). However, in both cases the scars are of a different type, suggesting different fishing gear exposition. For decades, bottlenose dolphins have been affected by fishing activities off mainland Ecuador (Van Waerebeek et al., 1997, Castro and Rosero, 2010, Coello et al., 2010, Castro and Félix, 2021), but it is unknown to what extent the population has been impacted. In Ecuador, it is estimated that there are between 56,000 and 60,000 artisanal fishermen and that their livelihood depends mostly on fishing. In some cases, competition for the same resource between dolphins and fishermen makes the problem complex. Dolphins can be lethally entangled by nets and trawls. The high proportion of individuals with these marks indicates a severe and continuous interaction. Although a high rate of lethal bycatch is suspected, there is uncertainty about its extent and impact at the population level. Furthermore, quantifying the impact of fishery interactions, as well as the rate of lethal bycatch and its effects at the population level, is paramount to implementing successful mitigation and management measures.

Marine Pollution

Most coastal communities along the coast of Ecuador do not have sewers and discharge water directly into the ocean with little or no treatment. The proximity of dolphins to the coast makes them more susceptible to human-induced diseases such as lobomycosis, as seen in some coastal ecotype dolphins. Bioaccumulation tests for persistent organic pollutants or heavy metals have not yet been carried out on dolphin populations, with the exception in the inner Gulf of Guayaquil (Alava et al., 2020), which would help to understand the presence of chemicals in the dolphins' bodies. Although some of the scars, especially the white ones, are related to interaction with fishing, we do not rule out the possibility that they could be the result of healing from an infection contracted after the injury (caused by the nets).

On five occasions interactions between dolphins and marine debris were recorded, in all cases the interaction was with plastic, twice with soft plastic and once with hard plastic. Marine litter is considered one of this century's new evils. There is a volume of evidence pointing to its harmful effects on cetaceans, both in terms of entanglement and ingestion. This is something to take into consideration in future research as the severity of the problem may have been underestimated (Puskic et al., 2020). Many threats to dolphins can arise from interaction with marine debris, especially if ingested. But it can wrap tightly around their bodies cutting deep into their skin and increasing the risk of infections. Determining the cause of death of a dolphin is generally difficult and depends on many factors, however, there are several occasions where the ingestion of large quantities of marine debris, including plastic, is the most likely cause of death (Simmonds., 2012). The ingestion of microplastics by dolphin's prey is another aspect to keep in mind because of their potential toxicological and pathogenic effects. The consequences at the level of individuals have been documented, however, there is a total lack of understanding of the potential population consequences (Senko et al., 2020).

The ecological differences as well as the threats to each ecotype are exposed and demand specific management and conservation strategies, and environmental authorities and managers need to be aware of it. Coastal ecotype is characterized by its proximity to the coast, most of the time, we have found it where the waves break (Figure 10). Their habitat preference so close to the coast makes their populations in Ecuador highly threatened by anthropogenic impacts.

Figure 10: Bottlenose dolphins of coastal ecotype. Note its proximity to the beach in shallow areas

More information about distribution, habitat use, population trends, and health is urgently needed, especially for the coastal ecotype to propose mitigation measures. There are still many knowledge gaps about these ecotypes. More studies focused on contaminants and the characterization and quantification of skin disorders are needed to determine the population's health. Monitoring will continue to increase our knowledge of this species. As part of this monitoring, a drone is being used to better understand their social structure and behaviour. Underwater footage is also being taken with a Go Pro to better understand their vulnerability based on the markings on their body, not just the parts captured by traditional cameras. Skin samples are also taken by scraping with sandpaper for genetic studies.

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