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**Identifying conservation areas and habitat preferences of bottlenose dolphins *Tursiops truncatus* in the Central Coast of Ecuador**

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# Identifying conservation areas and habitat preferences of bottlenose dolphins *Tursiops truncatus* in the Central Coast of Ecuador

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## ABSTRACT

## INTRODUCTION

Bottlenose dolphins are widely distributed in tropical and temperate waters around the world. Several subspecies and local morphotypes have been described (Perrin 1984; Vermeulen and Cammareri 2009), including two main ecotypes known as coastal (or inshore) and offshore (or pelagic) forms. Both ecotypes have with different ecological requirements and their occurrence has been described along most of its distribution range (Perrin 1984; Van Waerebeek et al. 2017; Hoelzel et al. 1998).

Due to its distribution, the coastal bottlenose dolphin is one of the most vulnerable marine cetacean to human activities such as interactions with fishing gear, maritime traffic, and all forms of pollution (Van Waerebeek et al. 2007, Mangel et al. 2010, Félix et al. 2012, Félix et al. 2017, Castro et al. 2019). Coastal bottlenose dolphins are found in small groups, usually of a dozen animals or less, are generally resident, and genetically and morphologically differentiated of the offshore ecotype (Hoelzel et al. 1998, Sanino et al. 2005, Santillán et al. 2008; Rosel et al. 2009, Richards et al. 2013, Felix et al. 2018).

In Ecuador, both ecotypes have been recorded (Felix et al., 2018; Tirira et al. 2020). Resident communities of bottlenose dolphins have been studied in the Gulf of Guayaquil in southwestern Ecuador (Puna Island, El Morro, Posorja), where they show a decreased trend of more than 50% in 25 years (Félix 1994, 1997; Félix et al, 2017). Some bottlenose dolphin communities in southern Ecuador could disappear in few generations if the trend is not reversed (Félix & Burneo, 2020). Another bottlenose dolphin community with just nine individuals inhabits the MPA Puntilla de Santa Elena, north of the Gulf of Guayaquil (Félix et al., 2019), showing that the problem extends to other parts of the country. However, our knowledge on coastal bottlenose dolphins inhabiting the central and northern coasts of Ecuador is scarce, with only few sighting and strandings records (Castro and Waerebeek, 2019). The status of such dolphin communities is unknown, but most probably is like in the southern communities.

Since February 2021 we started surveys on the central coast of Ecuador aiming at 1) generate the knowledge baseline on the coastal bottlenose dolphins inhabiting this part of

Ecuador (southwestern Manabí and northwestern Santa Elena provinces); 2) identify priority areas for cetaceans conservation; 3) support marine rangers of the Machalilla National Park and other MPAs on cetaceans identification and ecology; and 4) strengthen collaboration between researchers, conservation groups, and other local stakeholders.

## MATERIALS AND METHODS

**Study area.** The study area is located in central Ecuador, southwest of Manabí province, and includes waters of several MPAs, the Machalilla National Park (PNM), Cantagallo Marine Reserve (RMC), Pachoche Wildlife Refuge (RMCP) and El Pelado Marine Reserve in the northwestern part of the Santa Elena Province (Figure 1). Puerto López was used as launching pier. The four MPAs are known for their importance for different species of marine megafauna threatened such as humpback whales, giant manta rays, whale sharks, dolphins, sea turtles, among others.

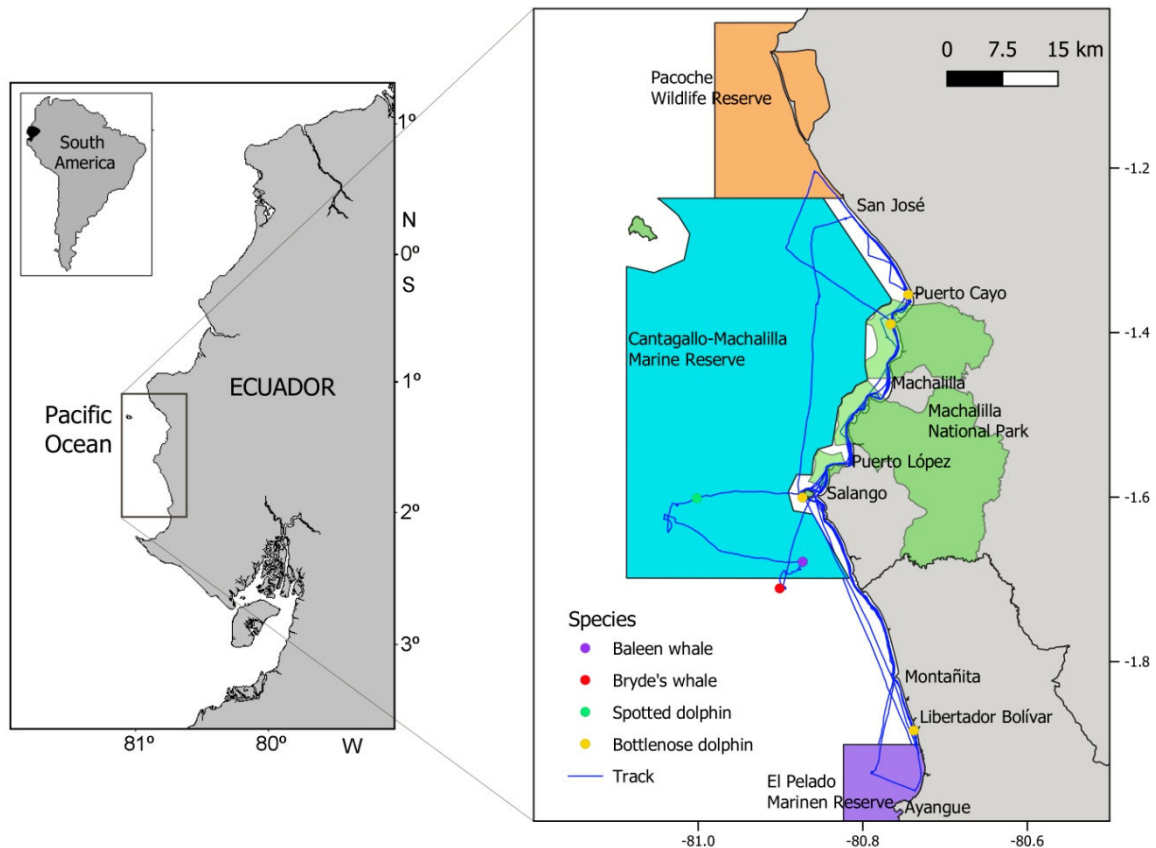


Figure 1. Study area in the central coastal zone of Ecuador. The map indicates the AMPs in this area (colored polygons), the survey tracks (blue lines) and the sighting sites (colored circles).

**Boat survey methods.** Boat surveys were carried out between February and March 2021 (Figure 1, Table 1). The surveyed area included Machalilla, Puerto Cayo, San José and part of Pacoche (RMCP) by north. Towards the south the surveyed area extended through Salango, Manglaralto, Montañita, Libertador Bolívar, Ayangue and the El Pelado islet. Trips lasted between 4 and 6 hours (depending on the number of groups observed) (Table 1). A 12 m length fiberglass boat with two 150 Hp outboard engines was used for the purpose. Most parts of the surveys included shallow areas between 200 and 400 m from the shore, where coastal bottlenose dolphins distribute. However, some surveys extended up to 6 miles offshore, particularly at Puerto Cayo, Salango and Ayangue (See Figure 1). Surveys were conducted at a speed of 10-12 knots, in Beaufort sea-state 2 or lower.

The crew included two researchers (CC and FF), a skipper and a sailor with experience in whale watching, and several volunteers. Sightings were spotted from the upper deck located 3 m above the water surface. A dolphin group was defined as all animals observed during the sighting, they in general moved with similar speed and behaved as a unit. The interaction with a dolphin group is termed an 'encounter'. Once a group was located, it was approached slowly to minimize disturbance, record data, and take photographs. A hand-held global positioning system (GPS Garmin 60) and a Navionics application for cell phone were used to record the entire route and to estimate the effort.

**Photographic identification of individuals.** Multiple photographs of the dorsal fins and body of the dolphins were taken using an 18–24-megapixel cameras (Canon EOS 80D) with 70-300 mm and 100-400 mm zoom lenses for individual identification, following procedures used in other similar studies (Würsig & Jefferson 1990; Félix et al., 2017). Photo-identification of bottlenose dolphins relies on marks and nicks on their dorsal fins (Würsig & Jefferson 1990). The trailing edge of the dorsal fin is easily damaged, resulting in a unique dorsal fin profile that can be used for individual identification and long-term monitoring. Photographs of other parts of the body will be used in the future to estimate the prevalence of scars resulting from human activities such as fishing gear and boat propellers (Félix et al., 2018), as well as unsuccessful attempts of predation.

A group was followed until attained a high level of confidence that all animals were photographed. The best photographs taken in each encounter were selected to create a catalogue, which was compared with other catalogues from the south of Ecuador (Museo de Ballenas catalogue) and available photographs taken opportunistically in the area. The database created included information on dolphins location, ID number, group size and composition, behavior and effort, among other data.

**Biological Samples.** A stick with sandpaper No. 30 at the tip was used to take epidermis from dolphins by rubbing (Bayas et al., 2018). This technique is safe for dolphins, it does not leave scars, and provide sufficient tissue for different molecular analyzes such as sex determination, genetic variability and phylogeny. Collected samples were maintained in alcohol 95% and refrigerated until laboratory analysis.

## RESULTS

**Effort.** Ten boat-surveys were conducted during the study period, five in February and five in March. Surveys length averaged 97 km (range 73.2-114 km). In total, 972.6 km were covered in 51 hours and 52 minutes of time at sea (Table 1).

Table 1. Research effort in the period February-March 2021.

Date	Distance (km)	Duration (hours)
2021-02-01	73.2	3:25
2021-02-02	102	5:54
2021-02-03	78.6	4:39
2021-02-04	97.7	5:09
2021-02-05	116	6:23
2021-03-01	101	4:20
2021-03-02	101	5:53
2021-03-03	114	5:21
2021-03-04	94.7	4:17
2021-03-05	94.4	6:10
<b>Total</b>	<b>972.6</b>	<b>51:52</b>

**Species recorded.** Two species of dolphins were recorded, the bottlenose dolphin and the spotted dolphin, a Bryde's whale and one species of whale that could not be identified.

Table 2. Records of the cetacean species identified with their date, position, number and behavior during the boat surveys.

Species	Scientific Name	Date	Geographic Position	Group size	Behavior	Comments
Bottlenose dolphin	<i>Tursiops truncatus</i>	2021-02-02	-1.35400° - 80.74472°	1	Feeding	Coastal ecotype
Bottlenose dolphin	<i>Tursiops truncatus</i>	2021-02-02	-1.38976° - 80.76588°	2	Milling	Coastal ecotype
Bottlenose dolphin	<i>Tursiops truncatus</i>	2021-02-04	-1.88373° - 80.73797°	2	Milling	Coastal ecotype
Bottlenose dolphin	<i>Tursiops truncatus</i>	2021-03-02	-1.60050° - 80.87329°	50-55	Resting	Oceanic ecotype
Spotted dolphin	<i>Stenella attenuata</i>	2021-03-05	-1.60157° - 81.00174°	15-20	Traveling	
Baleen Whale	<i>Balaenoptera</i> sp	2021-03-05	-1.67859° - 80.87295°	1	Traveling	Fin whale or Sei Whale
Bryde Whale	<i>Balaenoptera edeni</i>	2021-03-05	-1.71096° - 80.90099°	1	Traveling	

**Bottlenose Dolphin Sightings.** During the boat-surveys, four sightings were made, three of the coastal ecotype and one of the oceanic ecotype (Figure 2, 3).

### *Bottlenose dolphin coastal ecotype*

The coastal ecotype records were made off Puerto Cayo (n = 2) and off Simon Bolivar (n = 1), which resulted in an encounter rate of 0.0051 dolphins / km of survey. Additionally, in these three sightings only two individuals were recorded, that is, the same individuals recorded in Puerto Cayo on February 2 were recorded two days later in Simon Bolivar, 60 km to the south (Figure 1, Table 2).

The sex of one of the individuals was determined as male by a photograph of the genital part when breaching. The two were immature animals and exhibited typical inshore behavior, swimming slowly along the shoreline within the first 500 m. An ID number were assigned to both individuals as part of the first dorsal fin identification catalog for Central Ecuador.



Figure 2. Coastal bottlenose dolphin traveling close to the vessel in Libertador Bolivar. Note the triangular shape of the dorsal fin.

### *Bottlenose dolphin oceanic ecotype*

The group of oceanic bottlenose dolphins was found on the southern side of Salango Island, a small island located 1.2 km off a fishing village with the same name. Dolphins even approached on one occasion a few meters from the coast off the Salango village, according to an informant tourist boat.

The group contained 50-55 individuals, included all age/sex classes, adults, subadults and calves. The analysis of the sequence of photographs shows that the group consisted of several subunits in which the same individuals repeated over and over again. Ten adult females (mothers with calves) were identified in the group (Figure 4). A catalog of dorsal fins of 46 identified individuals was created.





Figure 3. Group of oceanic bottlenose dolphins (mothers with calves) resting around Salango Island. Note more falcate shape of dorsal fin.

**Behaviour.** Several behaviors were recorded during the sighting periods. Here the most remarkable.

*Playful or recreational activities.* On 2 February 2021, while observed a group of two coastal bottlenose dolphins, one of them kept away from the boat. Its mouth was always open apparently grabbing something like a plastic object (possibly a plastic bottle) with something whitish (maybe animal tissue or a type of clothing) and a rope. It could be a recreative activity with a bottle used by fishers as a buoy or to mark where fishing nets are set. This dolphin was observed again two days later off Simon Bolivar, without the plastic bottle and rope (Figure 4).



Figure 4. Coastal bottlenose dolphin observed with a small rope over its mouth and a plastic bottle. Possible recreational activity or interaction with fishing gear.

*Feeding.* On February 2 and 4, 2021, we observed two feeding periods in coastal bottlenose dolphins. A solitary dolphin and a group of two. During the first observation it was possible to photograph the prey chased by the dolphin leaping out of the water (Figure 6), a fish known locally as “corneta” *Fistularia sp.* (Figure 5). During the second case a dolphin chased fish on the waves close to the shore.



Figure 5. First photo. Photograph of the cornet fish leaping out of the water chased by a dolphin. Second and third photo. Male dolphin leaping close to shore, chasing prey.



*Resting.* A group of oceanic bottlenose dolphins found a few meters from the coast on Isla Salango was resting. They maintained in a relatively small area at least three hours swimming back and forth slowly within 2 km<sup>2</sup>. This is the first time that such behavior was seen in this area .

**Biological samples.** During the boat-surveys, a sample of epidermis from an oceanic bottlenose dolphin was collected by scraping with sandpaper (Figure 6).

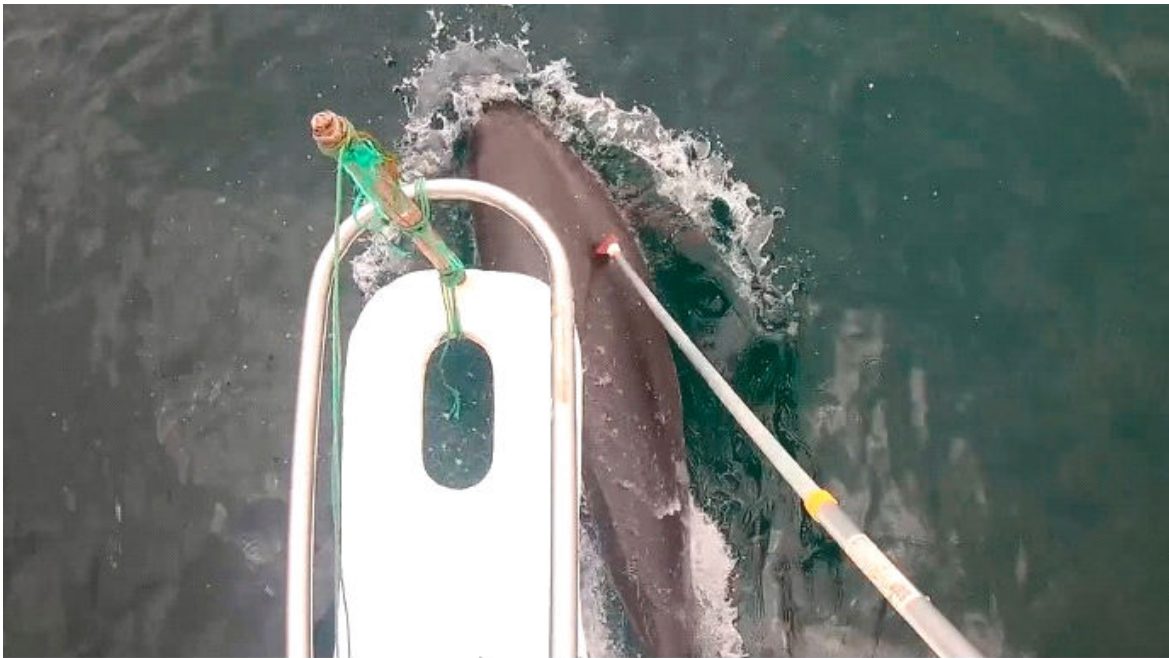


Figure 6. Scraping a sample of the epidermis of an oceanic bottlenose dolphin.

**Training for marine park rangers.** Twenty persons including marine rangers from the Machalilla National Park (PNM) and naturalist guides participated in the seminar on the identification of cetacean species, which was held on 4 February 2021 at the PNM offices (Figure 7). The objectives of this training included 1) To support the work of marine rangers of the PNM in their responsibility for monitoring and follow-up of threatened marine biodiversity; 2) share experiences in cetacean research in the PNM and in other parts of Ecuador; and 3) inform on the start of the new cetacean research in the PNM and surroundings waters.



Figure 7. Training on cetacean identification at Puerto López on 4 February 2021.

## DISCUSSION

This is the first dedicated research conducted on Central Ecuador aimed to study bottlenose dolphins. The study also attempts demonstrating the importance of MPAs in the area for several species of cetaceans.

Our results show that at least in the monitoring period (February-March) a reduced number of coastal bottlenose dolphins occur between Pacoche-Ayangue (around 100 km away). Only two different individuals were found along the coastal border of this extended area. The encounter rate (0.0051 dolphins/km) is approximately 29 times lower than reported southward at Puntilla de Santa Elena and in the inner estuary of the Gulf of Guayaquil (0.15 dolphins/km in both cases) (Félix et al., 2017; 2019). Notwithstanding, sightings from shore of coastal bottlenose dolphins were made by the authors in Ayangue in May 2015 and in Puerto López in July 2018. Moreover, residents of Puerto López, Puerto Cayo, Libertador

Bolívar and Valdivia informed the authors that dolphins are more abundant in this area during the dry season (April-November), so we do not rule out that dolphins were less abundant in the area at the time of monitoring due to seasonal movements.

The two individuals coastal bottlenose dolphins found were immature animals, one confirmed to be male. Adult individuals, particularly mothers with calves in the species have more restricted home ranges than males and constitute the social nucleus of the dolphin communities (Wells et al., 1987; Félix et al., 2017). Our findings suggests that there is not a year-round resident coastal bottlenose dolphin community inhabiting the surveyed area. Thus, larger groups of bottlenose dolphins reported previously could be either in transit of seasonally resident individuals that temporarily extend their distribution range towards Puerto López and Valdivia. If the case, most probably they come from the north because at Puntilla de Santa Elena, 30 km south of Ayangué, inhabits a resident bottlenose dolphin community that has been studied for many years with no seasonal patterns (Félix et al., 2019). It is also possible that the low number of coastal bottlenose dolphins found in the monitored area is an indication of a reduced or even extirpated population, which could be causing habitat fractionation and affect the flow of animals between the north and the south from the country.

The two recorded coastal bottlenose dolphins also show the existing connectivity among MPAs in this area, as they were found passing by through three MPAs, Machalilla National Park, the Cantagallo Reserve and the El Pelado Marine Reserve.

In the case of oceanic bottlenose dolphins, we highlight the long period they stayed around the southern side of Salango Island (at least 3 hours). Oceanic bottlenose dolphins are widely distributed, live in larger groups, and little is known about their social structure (Jefferson et al., 2008; Van Waerebeek et al., 2017). Information provided by tour operators in the area and by previous sightings of one of us (CC) in this area, suggests that oceanic bottlenose dolphins would use occasionally the Salango islet for resting. The catalog created of these animals will be key to understand their behavior, movements and distribution. There is no much information in the country on the bottlenose dolphin offshore ecotype, other than occasionally records during whale watching trips and strandings (Castro and Van Waerebeek, 2019; Félix et al., 2011) and bycaught animals in fishing gear (Castro and Rosero, 2010). The presence of the oceanic ecotype in Salango confirms that both ecotypes of the species distribute sympatrically in coastal waters of the Machalilla National Park, something also seen by one of the authors (FF) at Puntilla de Santa Elena.

## **RECOMMENDED ACTIONS**

- Continue the monitoring of coastal bottlenose dolphins in the summer (May-July) to determine whether the low encounter rate calculated is caused by a small population size or seasonal movements. Such information is needed to determine the status of this population.

- Future surveys should be extended offshore combining coastal surveys for bottlenose dolphins and offshore surveys for other species. Our results confirm that the diversity of other cetaceans is high in the area.
- Continue with training activities with emphasis on identification of cetaceans with focus on rangers and local natural guides. Citizen science could help to improve our knowledge of cetaceans in the area.
- Continue strengthening inter-institutional cooperation to support marine megafauna management in the country's AMCP. To this end, it is suggested to recommend that Ecuador support these research initiative.

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