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ARTICLE

Characterizing common bottlenose dolphin (*Tursiops truncatus*) ecology aspects in the central coast of Peru: Distribution, group dynamics, skin lesions and behavior patterns

Caracterización de aspectos ecológicos del delfín mular (*Tursiops truncatus*) en la costa central de Perú: Distribución, dinámica de grupo, lesiones de la piel y patrones de comportamiento

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Resumen.- A pesar de ser una especie conspicua en la costa central de Perú (~12°S), existe poca información sobre el estado de la población del delfín mular (*Tursiops truncatus*) en esta región. Para contribuir con nuevo conocimiento, se realizaron observaciones desde navegación durante el otoño y la primavera austral de 2021. Cincuenta y dos individuos fueron foto-identificados y caracterizados como ecotipo costero. Veinte individuos fueron avistados nuevamente entre ambas estaciones, lo que sugiere una presencia continua de estos individuos recapturados a lo largo del periodo de estudio. Además, mediante un análisis de fotografías, se describen las lesiones cutáneas en los delfines mulares. Los grupos de delfines tuvieron un tamaño promedio de 12,7 individuos (DE= 7,7) y se encontraron a una distancia promedio de 391 m (DE= 229,5) de la costa y a una profundidad promedio de 6,7 m (DE= 0,39). Los grupos estuvieron conformados principalmente por adultos y juveniles, y el comportamiento predominante fue el nado multidireccional. La descripción de los aspectos ecológicos y de comportamiento, así como la ocurrencia de delfines mulares confirma la importancia de este hábitat para la especie.

Palabras clave: Ecotipo costero, foto-identificación, aleta dorsal, delfínidos

Abstract.- Despite being a conspicuous species on the Peruvian central coast (~12°S), limited information exists about the population status of common bottlenose dolphins (*Tursiops truncatus*) in this region. Observations were made from navigation surveys during the austral autumn and spring of 2021 to contribute new knowledge. Fifty-two individuals were photo-identified and characterized as coastal ecotypes. Twenty individuals were re-sighted between the two seasons, suggesting a continuous presence of these recaptured individuals throughout the study period. Also, skin lesions on the bottlenose dolphins are described from the photo analysis. Dolphin groups had a mean size of 12.7 individuals (SD= 7.7) and were found at a mean distance of 391 m (SD= 229.5) from shore and a mean depth of 6.7 m (SD= 0.39). Groups were formed mainly by adults and juveniles, and their predominant behavior was milling. The description of the ecological and behavioral aspects, as well as the occurrence of common bottlenose dolphins confirms the importance of this habitat for the species.

Key words: Coastal ecotype, photo-identification, dorsal fin, delphinids

INTRODUCTION

Common bottlenose dolphin *Tursiops truncatus* Montagu, 1821 (Cetacea, Delphinidae) is arguably the best-studied cetacean species (Wells & Scott 2018). The plasticity of the species to adapt to different environments has resulted in two ecotypes: oceanic and coastal (Bearzi *et al*. 2009, Perrin *et al*. 2011, Zaeschmar *et al*. 2020). Differences between these ecotypes have been demonstrated through physical characterization (*i.e.*, cranial morphology, tooth diameter), ecological patterns, and genetic analysis (*e.g.*, Segura *et al*. 2006, Perrin *et al*. 2011, Costa *et al*. 2016, Félix *et al*. 2018, Oxford-Smith *et al*. 2024). The Society of Marine Mammalogy (Committee on Taxonomy 2023)[1] currently recognizes four subspecies: the Black Sea bottlenose dolphin (*T. t. ponticus*), the Lahille's dolphin (*T. t. gephyreus*) in the southwestern Atlantic Ocean off South America, the Eastern

[1]Committee on Taxonomy. 2023. List of marine mammal species and subspecies. Society for Marine Mammalogy. <www.marinemammalscience.org>.

Tropical Pacific dolphin (*T. t. nuuanu*), and the globally distributed common dolphin (*T. t. truncatus*). While the latter two subspecies are associated with the oceanic ecotype (Tardin *et al.* 2020, Costa *et al.* 2023), Lahille's and Black Sea bottlenose dolphins are characterized as coastal ecotype (Costa *et al.* 2016, Logominova & Agafonov 2019).

Around the world, some populations of the coastal ecotype have been diligently monitored for decades (*e.g.*, Shark Bay, Connor *et al.* 2000; Golfo de Guayaquil, Félix 1994) due to its very shallow neritic distribution (Milmann *et al.* 2017) and long-term residence pattern (Jiménez & Alava 2014, Dinis *et al.* 2016, Félix *et al.* 2017, Pérez-Alvarez *et al.* 2018). These assessments have yielded broad knowledge of bottlenose dolphin biology and ecology, particularly about the factors affecting population dynamics (Barratclough *et al.* 2019). This includes monitoring their interaction with anthropogenic activities such as fishing and tourism, including bycatch, hunting, or collisions with vessels (*e.g.*, Dwyer *et al*. 2014, Félix *et al.* 2017, Barnhill *et al.* 2022), as well as evaluating their health well-being. Bottlenose dolphins are sentinels of marine environmental health (Wells *et al.* 2004), and the presence of skin diseases or malformations is indicative of the presence of environmental and/or anthropogenic stressors (Barraclough *et al.* 2019).

Despite the vast knowledge about this species, in some regions, there is limited ecological information that precludes local assessment of its conservation status (Pleslić *et al.* 2021). This is the case of the bottlenose dolphin on the central coast of Peru. Despite being often recognized by citizens (Guidino *et al*. 2023), available information about the ecology, health, and population status of free-living populations is limited to a few studies (*e.g.*, Van Waerebeek *et al.* 1990, Reyes *et al.* 2002, Llapapasca *et al.* 2018, 2022; Pacheco *et al.* 2019). Descriptions of the diet and structure of the population in relation to its coastal habitat have been made from landed and/or stranded specimens (*e.g.*, Van Waerebeek *et al.* 1990, 2017; García-Godos *et al.* 2007).

Monitoring in different ports throughout the coast identified the central region of Peru as a site of frequent interaction between artisanal (*i.e.*, small-scale) fisheries and small cetaceans (Read *et al.* 1988, Van Waerebeek & Reyes 1990, Van Waerebeek *et al.* 1990). This artisanal fishery is characterized by using vessels with a storage capacity of up to 32.6 m^3 and an overall length of 15 m (Peruvian Law Nº 25977)[2]. Fishing is carried out predominantly by manual labor and using several fishing gears, including gillnets, longlines, and purse-seine nets (Guevara-Carrasco & Bertrand 2017). Species records from 1985-1987 and 1990 in Pucusana port have shown that between 20 and 30 individuals of the total small cetaceans captured annually were bottlenose dolphins, both oceanic and coastal ecotypes (Read *et al.* 1988, Van Waerebeek & Reyes 1990, 1994). Although legal protection for delphinids was established in 1996 (Peruvian Law N° 26585)[3], prohibiting the capture, use, and commercialization of small cetaceans, this species is still affected by bycatch and direct hunting (Van Waerebeek *et al.* 1997, 2017; Mangel *et al.* 2010, Campbell *et al.* 2020, Peña-Cutimbo *et al*. 2024). Unlike other populations distributed along the southeast Pacific coast, where ecological aspects and negative impacts of human activities on different populations have been documented (Jiménez & Alava 2014, Félix *et al.* 2017, Pérez-Alvarez *et al.* 2018, Alava *et al.* 2020), on the Peruvian central coast, their conservation status remains unknown, and the consequences of these interactions cannot be determined with certainty (Guidino *et al.* 2023).

Improving the management of this species requires understanding distribution patterns, population dynamics, behavior patterns, and health status through *in situ* studies. Also, baseline data are crucial for assessing changes in population parameters over time and evaluating whether conservation efforts are effective. Such information can help set the compliance of the current mitigation actions and strengthen protection measures to reduce anthropogenic impacts (Sutherland 1998, Defran & Weller 1999). This study aimed to characterize groups of bottlenose dolphins on the Peruvian central coast (~12°S), describing their occurrence, spatial distribution, group size and age categories composition, behavior, and potential skin lesions.

Materials and methods

Eight navigation surveys were conducted: four in the austral autumn (19 April 2021-1 May 2021) and four in spring (26 November 2021-1 December 2021), in waters between Pucusana (12°28'47.3"S; 76°47'50.5"W) and Arica beach (12°18'6"S; 76°15'14"W) in the Peruvian central coast (Fig. 1). Seven surveys departed from Pucusana, navigating parallel to the coast and heading northwards to Arica beach, using a fiberglass boat of 7.3 m length with twin 100 HP outboard engines (Fig. 1a). The last survey departed from El Silencio beach northwards to Arica beach, using a Venator inflatable boat of 3.8 m length with a 60 HP outboard engine. Navigation was conducted when sea conditions were favorable according

[2]Ley Nº 25977 - Ley General de Pesca. Publicado en el Diario Oficial El Peruano el 22 de diciembre de 1992. <https://faolex.fao.org/docs/pdf/per1377.pdf

[3]Ley Nº 26585 - Ley que declara a delfines y otros mamíferos marinos como especies legalmente protegidas. Publicado en el Diario Oficial El Peruano el 15 de junio de 1996. <https://docs.peru.justia.com/federales/leyes/26585-apr-2-1996.pdf>

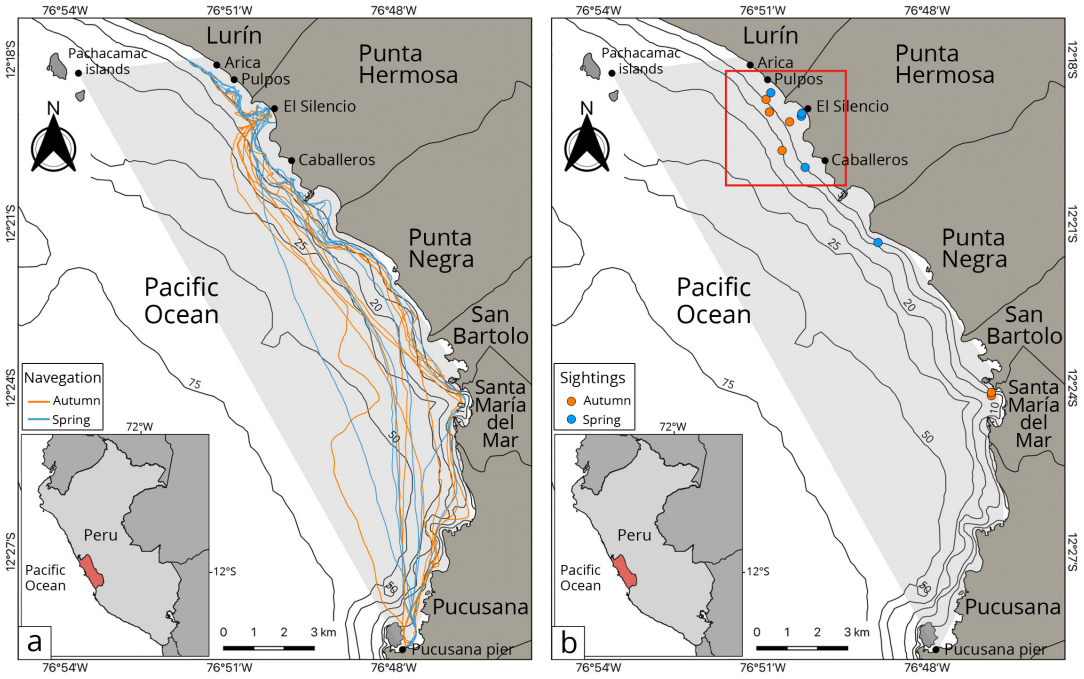

Figure 1. The study area between Pucusana to Arica along Lima region, Peruvian central coast, with a) navigation tracks in colored lines (348.5 km) and b) sighting positions of common bottlenose dolphin groups. The gray polygon represents the study area (~108.4 km²). The red rectangle marks the area where frequent sightings were recorded / Mapas del área de estudio entre Pucusana y Arica a lo largo de la región de Lima, costa central peruana, con a) las rutas de navegación en líneas de color (348,5 km) y b) las posiciones de avistamiento de los grupos delfines mulares. El polígono gris representa el área de estudio (~108,4 km²). El rectángulo rojo marca la zona donde se tuvieron avistamientos frecuentemente

to the Beaufort scale, usually between 0 and 3 (Defran & Weller 1999). The boat departed at 9:30 h and finished at 12:30 h. Survey routes were recorded using the GPS "track" option (Garmin eTrex® GPS version 10x with WGS 84 system).

A group of bottlenose dolphins were considered to be all individuals within an approximately 100 m radius displaying a similar activity (Smolker *et al*. 1992). Best estimates of group size were made by direct counts and consensus of three experienced observers on board. Group composition was registered considering adults, juveniles, and calves by direct observations. A juvenile was distinguished as an individual approximately two-thirds the size of an adult with light gray coloration. Calves were defined as smaller than juveniles, with very light coloration, usually swimming close to an adult, assumed to be the mother (Culloch 2004, Berrow *et al.* 2012).

During surveys, photographs of both sides of the dorsal fin were taken using a digital camera (Canon® EOS20D) SLR with a 70-300 mm zoom lens of 8.2 MP (Canon Inc.; Tokyo). Lens aperture varied between F/1.4 and F/5.6, and the time exposure was 1/1,600. Photographs intended to capture the shape of the dorsal fin from the base and perpendicular to the body axis (Félix *et al.* 2018). This allowed distinguishing marks (*e.g.*, linear or circular scars), spots, and color patterns to identify individual dolphins. Only good-quality photographs (*i.e.*, clear focus, sharpness, size, and detailed profile of the dorsal fin) were used for individual identification. Photographs of other body parts were used to evaluate the presence of skin lesions or injuries using the method proposed by Thompson & Hammond (1992). This method involves the analysis of photographs to distinguish visible clinical signs that may help characterize diseases that could be associated with human activities or ecological interactions in the bottlenose dolphin population (Leone *et al.* 2019, Taylor *et al.* 2020).

An occurrence was determined as the presence/absence of individuals during surveys in the study area. To describe the identity of this population (coastal or oceanic ecotype), three indexes based on dorsal fin measurements were used: height/length base (h/b), width at half height/length base (a/b), and the overhang of the dorsal fin tip/length base (*i.e.*, falcateness) (s/b) (Félix *et al.* 2018), using ImageJ 1.52p software (Schneider *et al.* 2012). Dorsal fin indices (Felix *et al.* 2018) were used referentially to establish the ecotype of the dolphins under study. Dorsal fins of oceanic bottlenose dolphins are relatively thinner and falcate (high s/b) than those of the coastal ecotype (Félix *et al.* 2018).

Geographical positions were recorded at the beginning and end of each sighting. The QGIS 3.16 software (QGIS.org 2021)[4] was used for spatial analysis. The first GPS position was used to analyze group distribution in function to the coast and depth. The QGIS tool "Measure line" was used to estimate the distance from the sighting location to the closest perpendicular point at the shore. The software Surfer 12.4 version (Golden Software 2014)[5] was used to obtain the depth of dolphins' positions from the shoreline to the 25 m isobath by interpolation, using the Kriging method.

During sightings, the behavioral states of the bottlenose dolphins were recorded via scan sampling (Altmann 1974). Observations were conducted at five-minute intervals during a 30-minute period throughout the entire observational time. Behavioral states were classified into five categories: feeding; traveling; socializing involving playing, agonist interaction, and courtship and copula events; resting; and milling (Table 1) (Bearzi 2005, Baker *et al*. 2017, Miočić-Stošić *et al*. 2020). Photographs were taken during these events to identify potential prey. Group sizes, distance from shore and depths, and frequencies of behavioral categories were compared between seasons using the non-parametric Mann-Whitney U-test in the SPSS Statistics program version 21.0 (IBM Corp. 2012)[6].

Results

A total of 348.5 km was covered with a navigation effort of 23.1 h (Fig. 1), compassing a total of 8.2 effective hours observing bottlenose dolphins. Most dolphin groups were sighted in the northern part of the study area between Caballeros (12°19'50.8"S; 76°49'52.0"W) and Pulpos Beach (12°18'22.1"S; 76°50'54.9"W) (Fig. 1b). Bottlenose dolphins were present at a mean distance of 391 m (SD= 229.5) to the closest point to the coast, ranging from 121.4 to 806.8 m. Sightings occurred over waters at a mean depth of 6.7 m (SD= 0.39, range= 2.8-12.3 m). Some individuals were observed swimming in shallow waters of < 2 m, but no GPS locations were taken for dolphins in these areas. The mean distance to the coast was greater during autumn (mean= 489.2 m, SD= 262.1; range= 128.6-806.8 m) than in spring (mean= 273.2 m, SD= 118.3; range= 121.4-430.1). However, no significant differences were detected (U= 7, $P > 0.05$). Mean depth was significantly greater (U= 0, $P < 0.05$) during the fall (mean= 8.8 m, SD= 2.1; range= 7.0-12.3 m) than during the spring (mean= 4.3 m, SD= 1.3; range= 2.8-5.5 m).

Table 1. Categories of behavioral states of common bottlenose dolphins analyzed in the central coast of Peru (Elaborated based on Baker *et al.* 2017) / Categorías de los estados de comportamiento de delfines mulares analizadas en la costa central de Perú (Elaborado en base a Baker *et al.* 2017)

Behavioral state	Definition
Feeding	Search, capture, and consumption of prey or feeding behaviors. Sometimes prey is observed in the dolphins' mouths, and birds can be seen above the individuals or groups.
Traveling	Rapid movement in the same direction, maintaining a close spacing and surfacing almost synchronously. Short and relatively constant breathing intervals. Group formation can vary, and breaching is observed when swimming speed increases.
Socializing	Variable direction of movement, individuals in close proximity or touching often interact; including playing, agonists interaction, courtship, and copula events.
Resting	Slow and stable activity, during which no other identifiable activities are performed. Synchronized, short, and relatively constant diving intervals. Individuals grouped closely.
Milling	A zigzagging movement within the same place without heading towards a particular direction. Variable diving intervals, but mostly short. Group formation varies.

[4]QGIS.org, 2021. QGIS Geographic Information System. QGIS Association. QGIS project <http://www.qgis.org>

[5]Golden Software. 2014. Surfer® (12.4.784 version). Golden, Colorado <www.goldensofware.com>

[6]IBM Corp. 2012. IBM SPSS Statistics (21.0). IBM Corp. <www.ibm.com>

Eleven groups were observed during surveys, without exceeding two groups per survey. The mean group size was 12.7 (SD= 7.7, range= 2-25) and was similar in autumn (mean= 13.3, SD= 8.6; range= 2-25) and spring (mean= 12, SD= 7.4; range= 5-20) (U= 11, $P > 0.05$). Groups were composed mainly of adults (Fig. 2). During autumn (April), four adult-calf pairs were sighted, while in spring (December), only two adult-calf pairs were observed. Fifty-two bottlenose dolphins were photo-identified. Of the total individuals, 63.5% (*n*= 33) were identified in autumn and 36.5% (*n*= 19) in spring. The values of dorsal fin indexes (*n*= 48; h/b= 0.70, SD= 0.06; a/b= 0.51, SD= 0.03, s/b= 0.08, SD= 0.03) indicate the presence of the coastal ecotype in all individuals registered in this study.

The cumulative curve of identified individuals increased continuously and did not reach the plateau (Fig. 3). Of the 52 identified individuals, 44.2% (*n*= 23) were re-sighted on a single occasion, 26.9% (*n*= 14) were observed twice, 19.2% (*n*= 10) in three surveys, and only 9.6% (*n*= 5) on four occasions. Twenty (38.5%) of the identified individuals were sighted during both sampling seasons. Also, two individuals identified during this study (44PA2021, 47PA2021) were recognized in photographs from 2012 taken by Sebastian Silva.

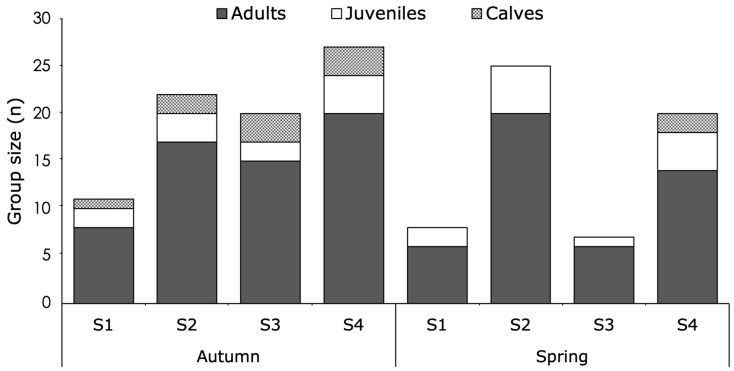

Figure 2. Composition of bottlenose dolphin groups by age/class in surveys conducted during the fall and spring of 2021. S= sampling survey. The total number of individuals by age/class was pooled for surveys 3 and 4 in the autumn, and survey 2 in the spring / Composición de los grupos de delfines mulares por edad/clase en los muestreos realizados durante el otoño y la primavera de 2021. S= salida de muestreo. El número total de individuos por edad/clase se agrupó para las salidas 3 y 4 en otoño, y la salida 2 en primavera

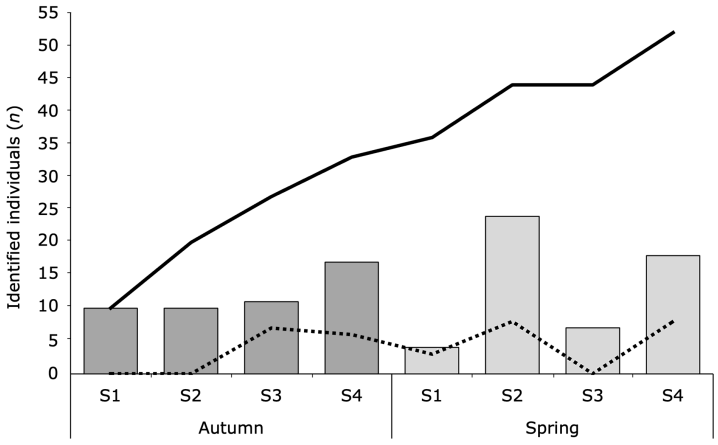

Figure 3. Occurrence of photo-identified common bottlenose dolphins on Lima region, Peruvian central coast, during autumn and spring 2021. Bars represent the total number of identified individuals in each survey (S). The black line represents the cumulative number of identified individuals. The dotted line represents the number of re-captured individuals / Ocurrencia de delfines mulares foto-identificados en la región de Lima, costa central peruana, durante el otoño y la primavera de 2021. Las barras representan el número total de individuos identificados en cada salida (S). La línea negra representa el número acumulado de individuos identificados. La línea de puntos representa el número de individuos recapturados

Different skin lesions were identified. One individual (55PA2021) presented ulcerated pale dermatitis-like lesions at both sides of its dorsal fin and the edges of the caudal fin (Fig. 4a). Irregular gray, non-uniformly rounded spots were observed on the dorsal area of another individual (unidentified) (Fig. 4b). Two dolphins (49PA2021, 14PA2020) showed circular spots with white borders and wounds near the rake marks on the dorsal fin and the absence of the dorsal fin tip (Fig. 4b, red arrow). Two individuals (26PA2020, 41PA202) swimming closely presented an orange hue coloration in the dorsal area with diffuse borders (Fig. 4c). Two other individuals (10PA2020, 33PA2020) showed cutaneous nodules along the dorsum and at the dorsal fins base (Fig. 4d). Finally, one individual (45PA2021) had a marked body deformity with a scar on the right dorsal side (Fig. 4e). The dorsal fin was bent and slightly tilted to the right side, where the deep and straight scar was located.

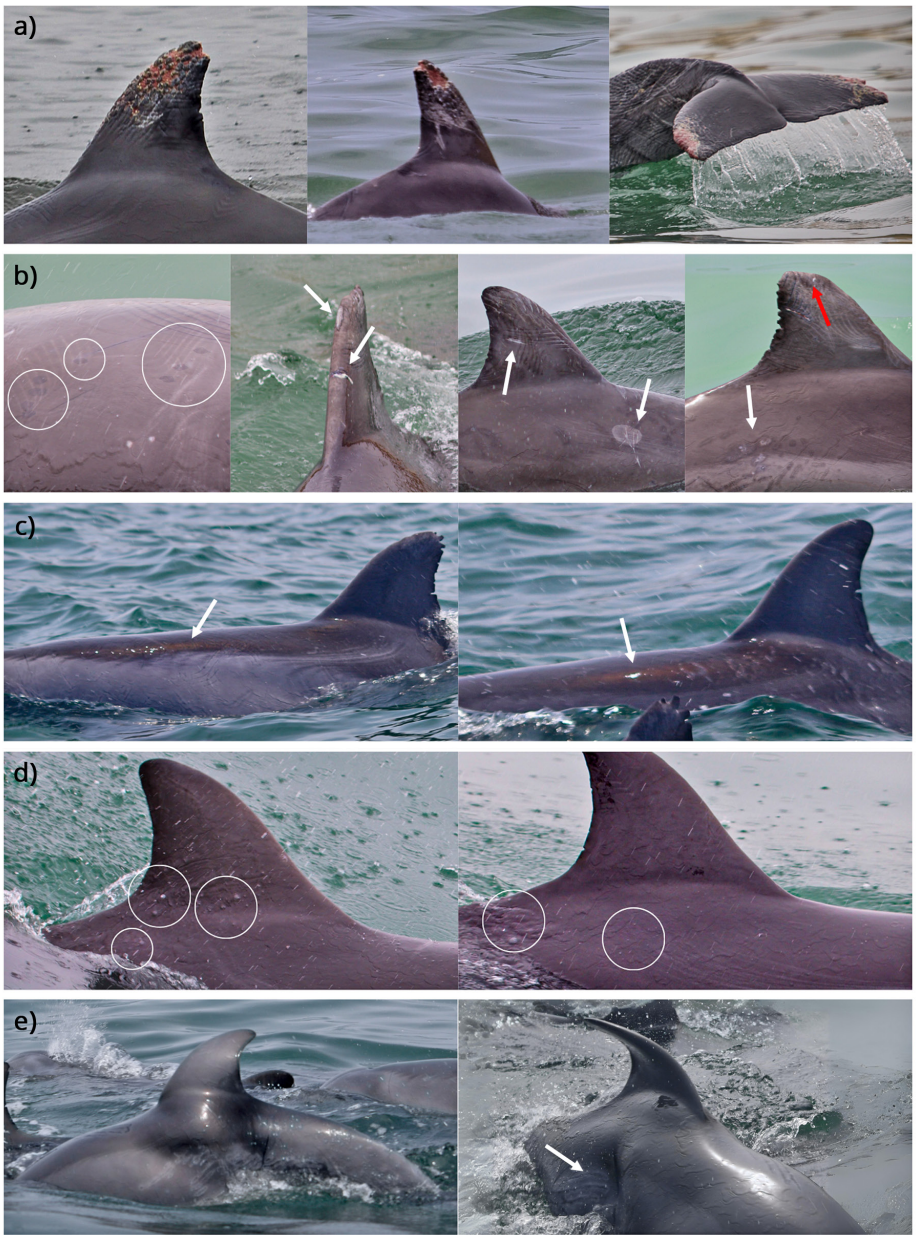

Figure 4. Body and skin lesions recognized during the study (highlighted with white arrows and circles): a) wounds probably related to ulcerative dermatitis, b) irregular gray spots and wounds near the rake marks and missing dorsal fin tip (red arrow), c) orange coloration on the surface of the dorsal region, d) skin nodulations, e) body deformity / Lesiones corporales y cutáneas reconocidas durante el estudio (resaltadas con flechas y círculos blancos): a) heridas probablemente relacionadas a una dermatitis ulcerada, b) manchas grises irregulares y heridas cerca de las marcas de rastrillo y falta de la punta de la aleta dorsal (flecha roja), c) coloración anaranjada en la superficie de la región dorsal, d) nodulaciones cutáneas, e) deformidad corporal

Four of the five behavioral categories were recorded: milling, feeding, traveling and socializing. Bottlenose dolphins were observed mainly milling (total= 41%) and traveling (34.7%) (Fig. 5), often following south and in a north-easterly direction. During feeding (16.4%), dolphins swam belly-up below the prey and suddenly turned to the surface to catch small pelagic Jack mackerel (*Trachurus murphyi*) fish, identified by photographs. Occasionally, the adults tossed their prey up or/and flipped out of the water to recapture it later. Seabirds such as the Inca tern (*Larosterna inca*), Belcher's Gull (*Larus belcheri*), and Peruvian pelican (*Pelecanus thagus*) approached during feeding. The least common behavior was socializing (7.8%), which involved calves approaching adults by breaching and tail slapping and individuals swimming tightly, uniting the ventral area of their bodies sideways close to the surface. Milling behavior was the only category that showed a significant difference between both sampled periods (U= 1000, $P < 0.05$), being higher in spring (58.1%) than autumn (23.8%).

During feeding, groups were dispersed (> 5 dolphin body lengths from each other), and on two occasions, the joining of two groups was observed. Although the study area is an artisanal fishing zone, no fishing or tourist boats were observed near the dolphins during surveys. No evidence of interaction with fishing nets was detected. Also, bottlenose dolphins did not show any drastic behavior change (*e.g.*, evasive movements, stopping surface activity) with the boat's presence during surveys. They even approached the boat closely and surface activities, including bow-riding, spy-hopping, and breaching, were observed.

Discussion

Our results confirm the presence of a small group of bottlenose dolphins of the coastal ecotype similar to those reported elsewhere along the southeast Pacific coast (*e.g.*, Félix 1994, Reyes *et al.* 2002, Félix *et al.* 2017). The values of dorsal fin indexes from this bottlenose dolphin groups (*n*= 48; h/b= 0.70, SD= 0.06; a/b= 0.51, SD= 0.03, s/b= 0.08, SD= 0.03) are similar to those presented in Felix *et al.* (2018) for coastal bottlenose dolphins in Peru (h/b= 0.68, SD= 0.08, *n*= 9; a/b= 0.52, SD= 0.04, *n*= 7; s/b= 0.07, SD= 0.03, *n*= 7). Coastal bottlenose dolphins are characterized by high habitat fidelity and prolonged residence times (Maze & Würsig 1999, Dinis *et al.* 2016). This is a pattern also observed in other populations off Ecuador (Jiménez & Alava 2014, Félix *et al.* 2017, 2019) and Chile (González *et al.* 1989, Sanino & Yañez 2001, Sanino *et al.* 2005, Sanino & Van Waerebeek 2008, Pérez-Alvarez *et al.* 2018), where the same individuals have been continuously re-sighted for over ten years. The preliminary results of this study suggest that bottlenose dolphin groups frequently use the study area, as twenty (38.5%) of the identified individuals were sighted during both sampling seasons, despite the temporal difference of nearly six months. Since this population on the central coast of Peru belongs to the coastal ecotype, it is also expected to have high fidelity and long-term residence patterns. However, further long-term surveys are necessary to confirm this trend. As shown in other studies, the cumulative curve of photo-identified individuals reaches a plateau with more temporal sampling effort (Zolman 2002, Chilvers & Corkeron 2003).

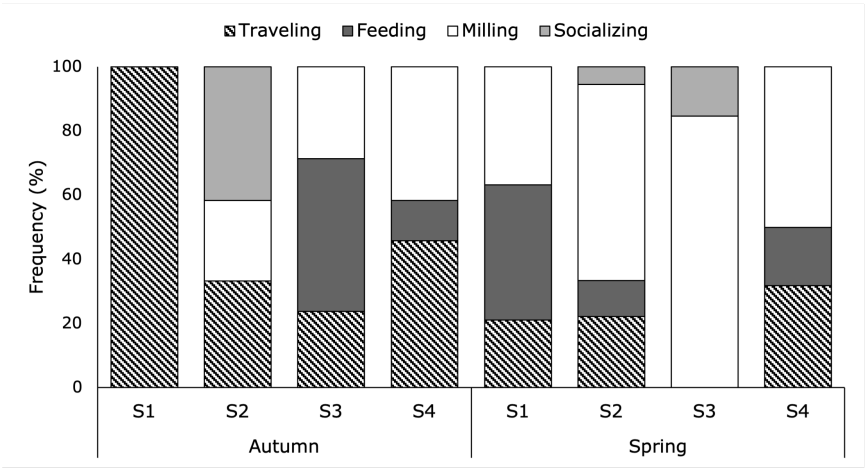

Figure 5. Frequency (%) of common bottlenose dolphin behavioral states during autumn and spring surveys (S) in 2021 / Frecuencia (%) de las categorías de comportamiento del delfín mular durante los muestreos (S) de otoño y primavera en 2021

The photographic analysis allowed the identification of different lesions described previously by Van Bressem *et al.* (2007, 2015a, b), Félix *et al.* (2017), Leone *et al.* (2019), and Toms *et al.* (2020). Although not detected in this study, this population could be affected by anthropogenic activities present in the area (*e.g.*, vessel traffic, water pollution, fisheries-induced mortality) (Mangel *et al*. 2010, Van Waerebeek *et al.* 2017, Campbell *et al.* 2020). However, no biopsies or other sampling were performed to determine the etiology of the identified lesions; thus, the natural origin cannot be ruled out. Future research should be able to identify the etiology and monitor the prevalence and incidence of these identified lesions.

The group size is consistent with previous descriptions from the south-central coast of Peru (Van Waerebeek *et al.* 1990, Reyes *et al.* 2002) and elsewhere along the southeast Pacific coast (*e.g.*, Jiménez & Alava 2014, Félix *et al.* 2017). Groups of the bottlenose dolphin coastal ecotype usually tend to aggregate in shallow and near-shore waters, where prey may aggregate (Silva 2007). Habitat type influences the encounter rates of bottlenose dolphins, being higher in sheltered areas (*e.g.*, bays and estuaries) (Dinis *et al.* 2016). In the study area, the coastline where groups were recorded is characterized by relatively small sandy beaches with rocky cliffs in between (Tejada 2018), providing sheltered locations that may facilitate dolphins capturing their prey. Changes in spatial distribution, such as the difference in depth during autumn, could be related to the behavioral flexibility of this species, performing exploratory movements around their home range in search of prey and potential mates (Morteo *et al*. 2019).

Bottlenose dolphin behavior varies according to social, environmental, and ecological conditions such as prey availability, movements, and/or oceanographic processes (Hawkins & Gartside 2008). In the seasonal analysis, significant differences were only observed in milling behavior, which occurred more often in the spring. Since milling is associated with foraging, the difference between seasons could be due to increased foraging effort during colder seasons to meet energy and fat storage needs at lower temperatures (Bräger 1993, Moller & Harcourt 1998, Ribaric & Clarkson 2021). However, this would have to be verified by conducting long-term analysis of these behaviors and characterizing the availability and movements of their prey in the area. During foraging, groups were kept small and dispersed, which appears to optimize coordination and prey location (Würsig & Würsig 1979, Torres & Read 2009). Socialization behaviors were also observed to maintain the bottlenose dolphin group's cohesion and social structure (Gowans *et al.* 2007, Kuczaj & Eskelinen 2014). Despite this, further studies to characterize their behavior in this area are still required to identify any changes that may occur in the future.

Our results highlight the importance of the study area as a suitable habitat for coastal bottlenose dolphins, as evidenced by their continuous presence, where calving and feeding behavior occur. However, to enhance our understanding of the ecology and behavior of this dolphin population, it is necessary to increase research efforts by implementing systematic surveys and consider the different anthropogenic stressors occurring in the area. The information generated in this study will contribute to raising awareness about protecting the species and its habitat.

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