2019 IMEKO TC-19 International Workshop on
Metrology for the Sea
Genoa, Italy, October 3-5, 2019

Long-term residency of *Tursiops truncatus* in the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea)

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***Abstract* – Photo-identification data of *Tursiops truncatus* in the Gulf of Taranto were collected from 2013 to 2018, providing information on its residency pattern and spatial distribution in the study area. On a total of 1117 dolphins observed through the study period, 92 individuals were distinctly identified. Among them, 57 were re-sighted up to fourteen times and the occurrence of 36 individuals re-sighted in different years provides the evidence of multi-year resident, occasional visitor and transient individuals. These results suggest an important inter-annual variability in the habitat use of the study area and emphasize the importance of the Gulf of Taranto as suitable habitat for *T. truncatus*. Although the majority of the identified dolphins seem to prefer shallower waters within 200 m, 26 individuals have been re-sighted on upper slope grounds, suggesting the occurrence of an offshore ecotype in the study area. Further studies are necessary to investigate driving forces influencing seasonal residency and site fidelity patterns of this dolphin species.**

I. INTRODUCTION

The common bottlenose dolphin *T. truncatus* (Montagu, 1821) is a cosmopolitan species distributed in both tropical and temperate waters [1], [2], [3]. The species exhibits inshore and offshore ecotypes with different morphological, behavioural and ecological evidence, including different preys and habitat preferences [2]. In the Mediterranean Sea, the *T. truncatus* is considered more related to the inshore ecotype because it is mainly distributed in coastal waters within the limits of the continental shelf (< 200 m) [4], [5]. However, it has been found above the shelf-break in the western Mediterranean Sea suggesting a closer link with the offshore ecotype [6], [7].

The common bottlenose dolphin in the Mediterranean basin was affected by different anthropogenic threats [8] [9]. In particular, the historical intentional killing, bycatch, habitat loss and degradation, prey depletion as well as marine traffic and marine pollution have caused a reduction of its Mediterranean sub-population by at least 30% over the last 60 years [10]. Thus, the species was assessed by IUCN as Vulnerable with evidence of a declining trend in its population [11].

In the Gulf of Taranto, an effort to identify the main physiographic and anthropogenic features influencing the distribution and the abundance of *T. truncatus* was made [12] [13]. However to provide effective indications on the management and mitigation of human impacts on this species, it is necessary improve information on its critical habitat, temporal distribution and abundance. For this purpose, the photo-identification as non-invasive and relatively inexpensive method allows to answer different question [14]. This study provides preliminary results on the residency pattern of *T. truncatus* in the Gulf of Taranto based on photo-identification data, updating information on its distribution in the study area.

II. MATERIALS AND METHODS

A. Study area

The Gulf of Taranto is sited in the Northern Ionian Sea (Central-eastern Mediterranean Sea) and covers an area approximately of 14,000 km^2 from Santa Maria di Leuca to Punta Alice (Fig. 1). The geomorphology of basin is characterized by a wide continental shelf with descending terraces in the eastern sector and by a narrow continental shelf with a steep slope cut by several channels in the western one. This severe reduction of continental shelf from east to west is due to the presence of the Taranto

Valley, a NE-SE submarine canyon with no clear bathymetric connection to a major river system [15], [16], [17]. This singular topography implies a complex distribution of water masses producing a high seasonal variability in upwelling currents [18].

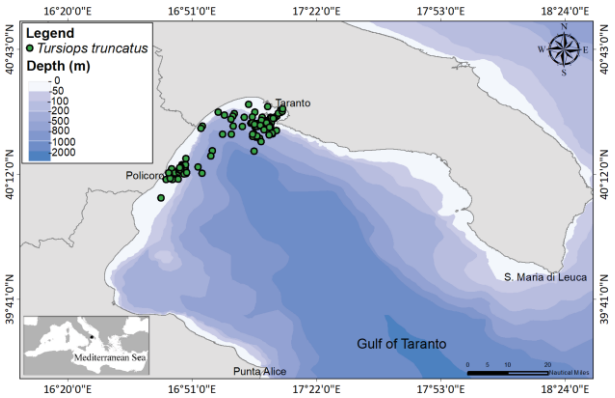

Fig.1. Map of the Gulf of Taranto (Northern Ionian Sea, Central-eastern Mediterranean Sea) with indication of sightings of T. truncatus *occurred from 2013 to 2018.*

B. Data Collection

Photo-identification data were collected from July 2013 to November 2018 during standardized vessel-based surveys carried out on board of a 12 m catamaran. Daily surveys were carried out only in favorable weather conditions (Douglas scale ≤ 3 and Beaufort scale ≤ 4) and with a sampling effort settled at about 5 h/day along 35 nautical miles. A line transect sampling was adopted according to [19], investigating a survey area of about 640 km^2 until 2017 and an area of about 960 km^2 in the 2018. Observations were made with the naked eye or 7×50 binoculars. When a dolphin or a group had been sighted, date, sea weather condition, geographic coordinates, depth (m), time of first contact, group size (number of individuals) were recorded. In addition, images useful for the photo-identification were collected by a minimum of two photographers positioned on the bow of the research vessel, using a digital camera Nikon D3300 with Nikon AF-P 70-300 mm, f 4,5-6,3G ED lens. In particular, several images of individuals within the group were taken trying to collect images of both sides of dorsal fin of each individual in the sighted group.

C. Photo-identification process

The common bottlenose dolphins were identified based on photos of long-lasting marks such as notches, cuts and deformities in the edges of their dorsal fin as well as depigmentation areas [20], [21]. To minimize misidentification, all images were processed and stored based on their quality rate ranged from 1 to 4 according to the sharpness and focus of the photo and the position of the dorsal fin relative to the frame (Table 1) [22]. Only images with a quality rate of 1 or 2 were used to create the digital catalogue of photo-identified individuals. Moreover, to fast-track the match process of photo-identified dolphins, each individuals were classified into one of four categories of distinctiveness according to the presence/absence of recognizable features (Table 2, Fig.2) [22]. Calves and individuals classified in "Low" distinctiveness category were not included in analysis of residency pattern. Finally, each photograph was compared and matched with existing images in the catalogue. The whole photo-identification process was carried out by two observers to reduce the bias and the chance of false positives (different individuals identified as the same) or false negatives (the same individual classified as two different).

Table 1. Quality rate criteria.

Quality rate	Criteria
1	Good quality: dorsal fin is focused, perpendicular to the camera and the entire fin is in the frame
2	Medium quality: dorsal fin is focused with a satisfactory angle and the entire fin is in the frame
3	Bad quality: dorsal fin is out of focus and/or the entire fin is not in the frame
4	No info: doesn't hold any photo-identification value

Table 2. Categories of distinctiveness of dolphins.

Distinctiveness	Description
Distinguished	Individuals had at least one permanent, clear and easily identifiable notch
Good	Individuals had several nicks
Medium	Individuals had small nick or scar that were difficult to re-identify
Low	Individuals had no identifiable features/marks

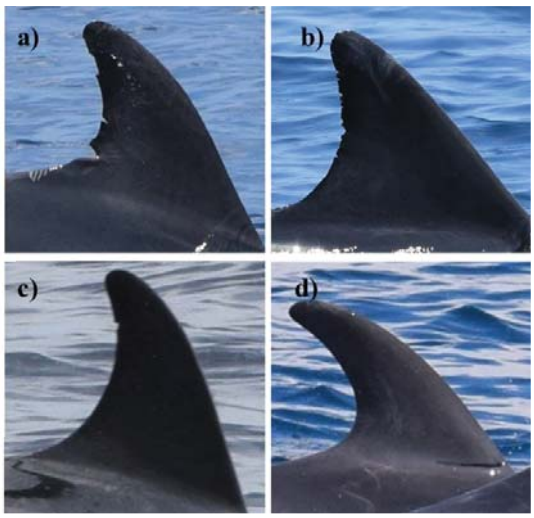

Fig.2 Fins belonging to four categories of distinctiveness: a) Distinguished; b) Good; c) Medium; d) Low.

D. Residency pattern

In order to identify the temporal variation in the use of habitat in the study area, the residency pattern of photo-identified common bottlenose dolphins was determined based on their sighting rate and their presence across seasons [23]. Individuals were classified in three categories (Table 3) according to their sighting rate, calculated as the proportion of number of surveys in which a dolphin was identified on the total of photo-identification surveys. Dolphins with a MSR or a HSR and occurring in multiple seasons were defined 'Resident'; those with a LSR but occurring in multiple seasons were classified as 'Occasional Visitors'. Finally, individuals with a LSR and occurring only in one season were defined 'Transient'.

Table 3. Criteria of classification of dolphins photo-identified according to their sighting rate.

Sighting rate	Criteria
Low sighting rate (LSR)	Individuals sighted < 10% of the surveys with photograph taken
Moderate sighting rate (MSR)	Individuals sighted between 10 and 30% of the surveys with photograph taken
High sighting rate (HSR)	Individuals sighted > 30% of the surveys with photograph taken

III. RESULTS

From July 2013 to November 2018, 131 daily surveys were carried out for a total of 655 hours of observations and 8491 km covered, obtaining 139 sightings of *T. truncatus*. Sightings occurred in a depth range from 2 to 900 m with a mean depth value of 132±159 m. The group size ranged between 1 and 25 individuals, with a mean value of 8±5 dolphins. Photo-identification data were collected in 68 daily surveys mainly during summer and spring months (79.4 % of daily surveys). A total of 1117 *T. truncatus* were observed, of which 59 individuals were photo-identified from both side, 15 individuals were identified from left side and 18 from right side, resulting in a total of 92 individuals photo-identified.

Among the photo-identified individuals, 35 common bottlenose dolphins (38%) were sighted only once, and 57 individuals (62%) were re-sighted up to fourteen times through the study period. Of re-sighted individuals, 21 dolphins were re-sighted only in one year, 19 in two years, 13 in three years, 3 in four years and only 1 in five non-consecutive years.

According to the sighting rate of each individual and their occurrence in single or multiple seasons, 52 dolphins were classified as 'Transient', 30 as 'Occasional visitors' and 10 as 'Resident'.

Concerning the spatial distribution of photo-identified dolphins during the study period, 26 individuals of *T. truncatus* resulted distributed in a range depth between 375 and 700 m with a mean value of 479±96 m. Moreover, these individuals have never been sighted in association with other 66 photo-identified dolphins, distributed in a range depth from 9 to 277 m, with a mean value of 91±65 m.

IV. DISCUSSION

The implementation of a photo-identification study of *T. truncatus* from 2013 to 2018 provided useful information on the spatial distribution of the species in the Gulf of Taranto and on its residency pattern.

The photo-identification of 92 distinct common bottlenose dolphins in the study area resulted in line with the previous estimate of abundance provided for the same study area [12], [13]. Concerning its distribution, the species seems to prefer shallower waters within 200 m as reported in the Western Mediterranean Sea [6], [24], [5], [25]. However, the re-sighting of 26 individuals on upper slope grounds during the study period, could suggest the occurrence in the study area of offshore ecotype as reported in Balearic Islands [7]. Obviously, this hypothesis needs to be examined in the light of genetic and morphometric studies as well as feeding habits, resulting aspects that should be considered in a compared analysis between ecotypes [26], [27].

The re-sighting of 57 common bottlenose dolphins up to 14 times during the investigated period and the occurrence of 36 individuals re-sighted in different year provides the evidence that this species returns in the study area repeatedly. In addition, the presence of resident, occasional visitor and transient individuals indicated a remarkable degree of inter-annual variability in the habitat use. These results emphasize the importance of the Gulf of Taranto as suitable habitat for the *T. truncatus*

requiring the enforcement of measures of conservation for the species as well as the striped dolphin, the Risso's dolphin and the sperm whale occurring in the basin [12], [13], [28], [29], [30], [31], [32].
However, further studies on the species are necessary to investigate driving forces influencing the residency pattern during seasons and to provide information on its site fidelity. In addition, findings suggest the need to implement the photo-identification method as well as the photo-identification catalogue of *T. truncatus,* developing an Artificial Intelligence (AI) able to identify automatically individuals, as already implemented for *Grampus griseus* in the Gulf of Taranto [33], [34], [35], [36].

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