

Bottlenose dolphin seasonal occurrence in the Bizerte lagoon

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Résumé

La lagune de Bizerte est l'un des principaux écosystèmes lagunaires de Tunisie. Elle souffre de la pollution et des pressions anthropiques y compris les déchets agricoles, industriels et/ou urbains. Cependant, cet écosystème saumâtre de la côte nord de la Tunisie a un intérêt considérable en termes de développement socio-économique et de biodiversité. Outre son importance écologique, elle n'a jamais été sujet de suivi de cétacés. Dans cet article on discute la distribution spatio-temporelle et le comportement du grand dauphin au niveau de cette lagune. Des campagnes automnales (2008 et 2010) ont été effectuées indiquant une présence en petits groupes des grands dauphins au niveau des eaux peu-profondes (-10 mètres) et adoptant majoritairement un comportement de nutrition. Ce papier s'intéresse à la mise en évidence de la présence de "grands prédateurs" dans cet environnement qui souffre de conditions dégradées. Cette étude peut nous orienter à renforcer les actions visant à protéger et à restaurer cet écosystème. Ces résultats primordiaux peuvent être pris en considération pour orienter les autorités locales à adopter de nouvelles mesures de protection dans la lagune de Bizerte, décrite comme une zone exposée à des éléments potentiellement toxiques et caractérisée par une activité humaine intense.

Mots clés: grand dauphin, lagune de Bizerte, distribution, mesure de protection.

Abstract

The Bizerte lagoon is one of the three major lagoons indenting the shoreline of Tunisia. It suffers from pollution and anthropogenic pressures including urban agricultural and industrial waste. This brackish ecosystem of the northern Tunisian coast has a considerable interest in terms of socio-economic facilities and biodiversity. Besides its ecological significance, it has never been subject to cetacean studies. This paper investigates bottlenose dolphin distribution and their behaviour in the northern Tunisian coast. Seasonal campaigns occurred during fall seasons of 2008 and 2010 pointed out a dolphin presence most often in shallow water less than a depth of 10 meters. Social structure of the animal sighted is often composed by small groups. Feeding behaviour was the major activity of these marine mammals. This paper aims to highlight the occurrence of "top predators" in this environment suffering from degraded conditions. This study may help to reinforce actions aiming to protect and restore this ecosystem. These primordial results can be taken into account to support decision makers and local authorities to adopt a new protection measurement in this area described as an exposed zone to potentially toxic elements and characterised by an intensive human activities.

Keywords: bottlenose dolphin, Bizerte lagoon, seasonal occurrence, protection measurement.

1. Introduction

Human societies and cultures have long demonstrates that they are willing to accept degradation of some ecosystems in order to allow the expansion of other ones. Managing the environment on the basis of this theory implies gradual losses in the ecological organisation both in short term and in an evolutionary sense (Harte, 1995). For instance, natural productivity of coastal marine ecosystems is principally affected by human intervention and climate change. For these reasons the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organization (UNESCO) is encouraging coastal nations to establish national programs for assessing and monitoring coastal ecosystems (IOC, 1992). An essential component of an ecosystem management regime is the inclusion of a scientifically based strategy that monitors and assesses the changing states and health of the ecosystem by tracking key biological and environmental parameters (Costanza et al., 1992).

One of the important ecosystems in Tunisia is the Bizerte lagoon. It is one of the three major lagoons indenting the shoreline of Tunisia. It has a considerable interest in terms of socio-economic facilities and biodiversity. Indeed, this brackish ecosystem connected to the Mediterranean Sea by an outlet deepened dredging exchange water with "Lake Ichkeul" which is considered by UNESCO as a World Heritage Site (WHC, 2008). Nevertheless, the Bizerte lagoon is one of degraded coastal ecosystems in Tunisia due to the anthropogenic pressures including urban, agricultural and industrial waste, intense fisheries and aquaculture farms. It has been subject to long research studies focusing on the pollution effects on this biotope (Derouiche et al., 2004; Mzoughi et al., 2005; Trabelsi et al., 2005; Ben Saïd et al., 2007; Zrafi-Nouira et al., 2008; Lahbib et al., 2010). Pollution impacts affected both benthic and pelagic species which intend this site to be classified as biologically impoverished (Afli et al., 2008). Ecology of major food-web chain classes in the Bizerte lagoon have been subject of a continuous monitoring and research studies except marine

mammals like cetaceans. Despite their biological key role as top predators and their priority status according to the International Union for Conservation of Nature (IUCN) red list criteria, there are no data about coastal dolphin occurrence in the Bizerte lagoon.

Bottlenose dolphin *Tursiops truncatus* (Montagu, 1821) is the only Mediterranean species that is mainly coastal (Marini et al., 1996; López et al., 2002). Knowledge about this vulnerable species in Tunisian waters derives from data collected during opportunistic surveys aboard fishing boats (i.e Ayadi et al., 2009; Aïssi et al., 2009; 2010; Aïssi, 2010). Some other data have been collected from the stranding events (Bradai et al., 2008; Karaa et al., 2012) or from entangled animals in fishing gears (Ktari-Chakroun, 1980; Bradai, 1991; Bradai et al., 1998; Attia El Hili et al., 2010). The unique census dedicated to study cetaceans in Tunisian inshore waters was conducted exclusively along the eastern coast by Ben Naceur et al., (2004). However, results were very limited in space and time and did not cover Bizerte coasts. In consequence, the Agreement on the Conservation of Cetaceans of the Black Sea, Mediterranean Sea and contiguous Atlantic Area (ACCOBAMS) classed Tunisian water in the poorly studied area (Notabartolo di Sciara et al., 2007). Reviewing the available data about bottlenose dolphins in Tunisian waters, it will be clear that the distribution is poorly known and presents a large gap on the north coast.

This paper presents the results of the first survey dedicated to study bottlenose dolphin within the inshore waters of Bizerte, in the northern coast of Tunisia. The study detailed the dolphin seasonal and spatial distribution, analyzing sighting data collected in fall seasons of 2008 and 2010 in the Bizerte coasts. Pointing out the regular dolphin presence in this ecosystem, the study highlights the possible need to establish bottlenose dolphin conservation plans. At large scale, this monitoring can be taken into account as support for decision makers as well as local authorities to develop and implement effective remedial programs for improving the quality of degraded ecosystems and to adopt new protection measurements.

2. Materials and Methods

2.1. Description of the study area

The Bizerte lagoon is the second largest one located in the northern Tunisian coast (latitude: 37° 8'–37°14' N, longitude: 9° 46'–9° 56' E) extending for approximately 150Km². It is connected to the Mediterranean Sea and the Lake Ichkeul by straight channels (Figure 1). It reaches a maximum depth of 12 m and has a mean depth of 7 m. Sandy bottom covers the western and eastern sectors of the lagoon while silt deposits occur particularly in its centre (Harzallah, 2003).

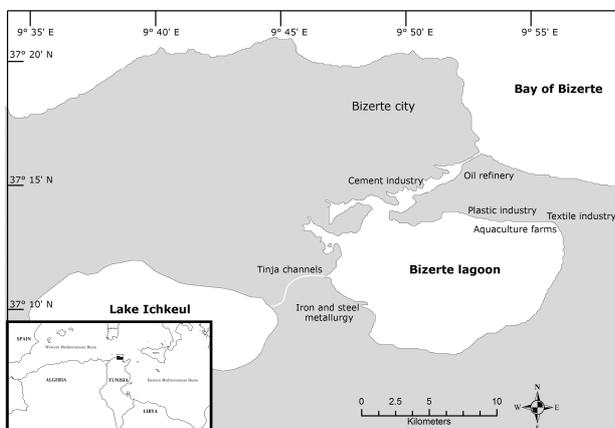


Fig.1. Geographical location of the Bizerte lagoon and its mainly connection channels with the Mediterranean Sea and the Lake Ichkeul

An overall presentation of the geographical situation of this ecosystem seems to be important to underline its ecological characters. According to Agostini et Bakun (2002), the prevailing westerly winds produce a coastal upwelling off the south coasts of Sardinia and a downwelling along the north-eastern coast of Tunisia.

The Ekman forces carry thus waters from the rich area towards the Tunisian coasts concentrating the nutrients.

The topography of the study area interacts with some hydrodynamic features, mainly caused by winds and inducing an accumulation of chlorophyll. In fact, the study area is a potential spawning ground and corresponds to a

significant reproductive ground for anchovy, mullet and round sardine (Gaamour et al., 2005; Zarrad et al., 2007). These small pelagic species represent the main diet components of delphinid (Blanco et al., 2001).

This retention area is characterized by a recent increasing of several important fisheries and industrial activities as oil refineries, metal, cement and plastic companies in its northern part. While, main activities in the eastern part are agriculture and aquaculture, both extensively using fertilizer and agro-chemicals. Indeed, based on recent analysis of physico-chemical water and sediment, the study area is extremely most exposed to toxic elements (Mzoughi et al., 2002; Trabelsi et Driss, 2005; Yoshida, 2006). Furthermore, imposex and other deformities have been assessed due to highest contamination level of pollutant on various species like gastropods (Lahbib et al., 2010).

2.2. Cetacean sightings

The cetacean survey in the Bizerte lagoon has not been subject of continual study. As the main objective of this monitoring was to maximize encounters with bottlenose dolphins, all campaigns have been oriented by indications supplied by volunteers, local authorities and fishing boats in the area. This preliminary 'oriented monitoring' started and covered fall seasons of 2008 and 2010. Various platforms have been used to accomplish this work.

The 'minimum' (maximum number of individuals seen in the surface at the same time), the 'best' (the best estimate of the group size) and the 'maximum' (the highest estimate of likely group size) have been estimated. In the proposed approach 'minimum' as absolute number has been used to estimate abundance.

Age class definitions used in this study followed those by Mann et Smuts (1998) and Mann et al. (2000). Individuals were classified as calves if they were one-half the size of an adult dolphin and often observed swimming alongside an adult animal in echelon or nursing positions. Juveniles were defined as individuals often observed in close association with an adult but never observed in the nursing position. Moreover, they can reach the two-thirds the size

of an adult. However adults were defined as large animals with 3 meters in length, marked or unmarked.

2.3. Dolphins' behaviour

Behaviour was characterized in function of the predominant activity of each group for the 5 first minutes of an encounter (Mann, 1999). Easiest behaviours identified were 'resting' and 'travelling' displaying respectively a stationary position immobile and moving steadily in one direction with synchronized dives (Shane et al., 1986). Nonetheless, 'feeding' is difficult to identify due to the animals spending majority of their time underwater. Indeed, this activity is strongly related to the pattern of distribution of prey. Dolphins can display in many ways, according to availability of food resources. So criteria defined by Acevedo-Gutiérrez et Parker (2006) were applied to recognize this activity. 'Bow riding' is excluded and not interpreted as natural behaviour; it is considered as an interaction between dolphins and our boat.

3. Results

This preliminary investigation about dolphin occurrence in the Bizerte lagoon covered fall seasons of 2008 and 2010. Cooperation with several local authorities oriented monitoring by supplying information about bottlenose dolphin occurrence in the study area. The navigation effort totalled 310 Km resulting of 18 bottlenose dolphin group sightings amounting to 72 individual (Table 1). Eight of them were classified as juveniles (11%) and no newborn or calves were sighted.

Sightings of groups with 3-7 individuals were predominantly encountered, and were estimated to be about 67% of all dolphin observations. Larger group of more than 10 individuals was infrequent (11%). However solely individual represent 22% of all sightings (Figure 2). The mean group size was 4 (SD=2.65, range=1-10). The density in this small area was estimated to be 0.23 individual/Km.

Dolphins left always this site after time of 'occupancy' and do not stay inside the lagoon long day. The most frequent recorded behaviour was feeding activity. Hunting techniques are different but commonly dolphins were seen

foraging collectively and were cooperating their movements on small areas not larger than 50 m². Based on fisherman information, dolphins were chasing up a great variety of fish including mainly mullets *Mugil* sp and sardine *Sardinella* sp. These prey species used the Bizerte lagoon as a spawning area during fall season.

Tab.1. Summary of all systematic and opportunistic encounters with bottlenose dolphins in the Bizerte lagoon.

Date	min	max	best	Longitude	Latitude
30-08-2008	10	15	10	9,832330	37,244260
02-09-2008	5	10	5	9,863000	37,195000
03-09-2008	1	1	1	9,808000	37,231156
10-09-2008	3	5	3	9,864000	37,259000
17-09-2008	1	1	1	9,832120	37,244240
21-09-2008	5	5	5	9,880000	37,189000
04-10-2008	3	4	3	9,808000	37,226124
20-09-2008	5	10	5	9,876000	37,190000
29-09-2008	3	5	3	9,832000	37,244160
02-10-2008	8	13	8	9,850000	37,251000
15-10-2008	5	10	5	9,808000	37,219333
19-10-2008	3	5	3	9,831000	37,237000
04-09-2010	2	2	2	9,816396	37,232536
05-09-2010	6	7	6	9,814018	37,211778
09-09-2010	5	10	5	9,885008	37,175099
17-09-2010	3	4	3	9,823357	37,172296
26-09-2010	1	1	1	9,865391	37,182105
16-10-2010	3	5	3	9,840171	37,184907

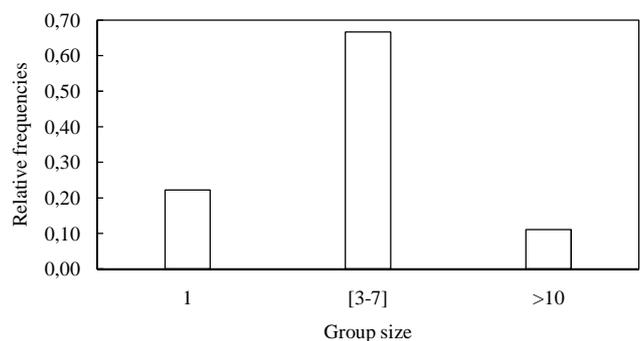


Fig.2. Group size of the encountered bottlenose dolphins off Bizerte during falls of 2008 and 2010.

4. Discussion and Conclusion

This study may be considered as the first attempt to investigate bottlenose dolphin occurrence in the Bizerte lagoon. During fall seasons 2008 and 2010 dolphins were sighted both solely and in small groups reaching a maximum of about 10 animals, and the mean group size was estimated at 4 ± 2 individuals. Ben Naceur et al., (2004) obtained a similar result; they observed that along the eastern Tunisian coasts, bottlenose dolphins were usually found in groups of 2-14 individuals, and mean group size was about 5 individuals. Compared to several studies in different coastal waters, inside or outside the Mediterranean Sea, results obtained are consistent and the mean group size of coastal bottlenose dolphin was always fewer than 10 individuals (Forcada et al., 2004; Bearzi, 2005; Cañadas et Hammond, 2006; Gómez de Segura et al., 2006; Bearzi et al., 2008a,b).

Some authors have suggested that the group size of bottlenose dolphin depend mainly on the patchy distribution and the abundance of prey (Dailey, 1993). Individuals of coastal populations would typically separate into smaller dynamic groups in order to occupy different areas to adapt their behaviour in function of prey hunting techniques (Shane et al., 1986). The presence of dolphins in Bizerte lagoon during fall seasons of 2008 and 2010 was most often related to feeding activities. This may put forward that within this brackish ecosystem bottlenose dolphin may have relatively food resources.

In the Bizerte lagoon, food resources are reportedly been linked to the spawning migration of some variety of fish as mullets and small pelagic bentho-nectonic species (according to local fishermen and unpublished information). Shane (1990) noted that the time that dolphins spend to feed increases during fall in response to the decreasing prey abundance due to fish emigration during that season. Obviously, observations are preliminary results and need therefore to be validated by further studies detailing prey abundance and distribution in the study area.

No newborn have been sighted during all the study period and the proportion of juveniles was 11%. This rate is quite low compared to prior results obtained off the eastern Tunisian coasts where the portion reached 43% of newborns, calves and juveniles (Ben Naceur et al., 2004). However, our study covered only fall therefore results give only a punctual view. No systematic data were collected in this area that would suggest a similar result.

The Bizerte lagoon is in the Mediterranean climatic setting. Seasonal occurrence of bottlenose dolphin in this shallow water ecosystem adopting mainly feeding behaviour could be related to the feeding habits of the species preying mostly on benthic and demersal fishes (Blanco et al., 2001; Santos et al., 2001).

Results obtained are however pioneer and may implicate that the Bizerte lagoon can be a probable seasonal feeding ground for bottlenose dolphin foraging. However further investigations are also required over a longer temporal scale in order to determine the trends of dolphin abundance and dolphin distribution. To verify this hypothesis effort should be expanded in time and space and photo ID technique should be used to identify the residency pattern.

The seasonal occurrence of vulnerable species in an ecosystem suffering from pollution and anthropogenic pressures may help to reinforce actions aiming to protect and restore this ecosystem. These primordially results can be taken into account to support decision makers and local authorities to adopt new protection measurements in this area.

Acknowledgements

The author thanks the Regional Activity Centre for Specially Protected Area (RACSPA) for funding partially this work, and local authorities for their cooperation and indications about dolphin occurrence. Special thanks also to the anonymous referees for their useful comments and their considerable help in improving the manuscript.

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