Surveying and monitoring sea cucumber population densities in Bizerte Lagoon, Tunisia

Feriel Sellem[1]

Abstract

This work provides data on the abundance of sea cucumber species in a Mediterranean lagoon on Tunisia's northern coast. Assessments were conducted over a two year-year period in Bizerte Lagoon in an area divided into three stations and nine linear transects. Monitoring revealed that *Holothuria poli* and *Holothuria tubulosa* are the most common species. Data analysis showed that sea cucumber densities declined according to dates and stations, with some exceptions. A maximal density value of 96 individuals/100 m^2 was noted in October 2016, and a minimal of 13 individuals/100 m^2 was observed in October 2018. Analysis of variance revealed highly significant mean densities variation throughout the period of investigation. However, no significant mean density variation between stations is observed. In Bizerte Lagoon, the average density estimated for all species is 43.81 ± 23.72 individuals/100 m^2.

Keywords: sea cucumbers, density, Tunisia, lagoon, Mediterranean

Introduction

A sea cucumber fishery has appeared and developed in the northeast Atlantic Ocean and Mediterranean Sea. In the Mediterranean, the sea cucumber species particularly being targetted include *Holothuria poli, H. tubulosa, H. mammata, H. arguinensis and Parastichopus regalis* (Mohsen and Yang 2021).

Fishing for Mediterranean sea cucumber species has become attractive for international markets. Studies of the habitat, ecology and biology of these species are geographically limited, and concern mainly the northern basin (Dereli et al. 2016; González-Wangüemert et al. 2016). An illegal sea cucumber fishery exists, specifically in some parts of the southern Mediterranean. Most of the harvesting is carried out with no management plan in place, and exploitation seems to be uncontrolled. In the absence of measures, the stocks are threatened. This is the case for Tunisia, where sea cucumber harvesting has been carried out for years, without regulation (Sellem et al. 2017). Collections are mainly done by hand and or by snorkeling in shallow areas. In greater depths, gathering is done by scuba diving using small motorised boats. This illegal activity quickly developed along the coastline and the threat of loss of economically valuable species is real.

The objective of this study is to assess and compare the density and size distribution of sea cucumber populations in Bizerte Lagoon over a two-year period. Results will provide basic information on the ecology of species particularly those of commercial interest. This work provides also information on the state of the sea cucumber population in the lagoon, thus helping the authorities on the use of some data for management of this new fishery.

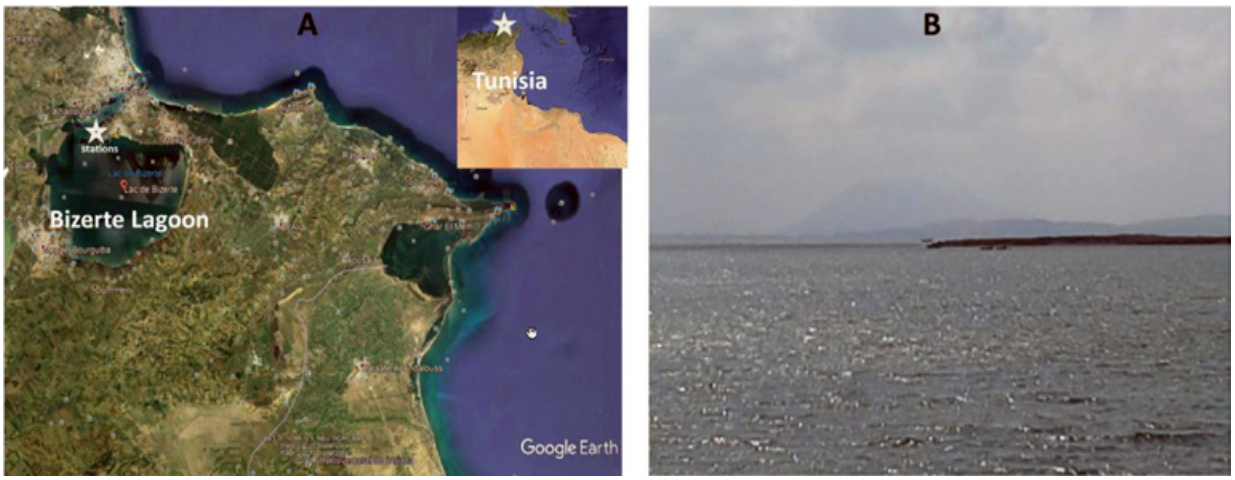

Figure 1. (A) Location of Bizerte lagoon, and sea cucumber survey area. (B) Study area. Photo by F. Sellem

[1] National Institute of Marine Science and Technology, Fisheries Science Laboratory. feriel.sellem@instm.rnrt.tn

Methodology

The study was carried out in the northwestern part of Bizerte Lagoon (Fig. 1), which is an important socioeconomic area for the country. Coastal fishing and mollusc farming (mussels and oysters) are the main activities carried out by the neighboring community.

The assessment area was divided into three stations (st1, st2 and st3) about 150 m apart, and defined by geographical coordinates. The stations and their depths were checked using a GPS and a depth gauge. Measurements were performed by scuba diving. Each station was evaluated at the level of three rectangular linear transects (4 m x 25 m). All sea cucumbers found in the 100 m^2 area were counted. Total length of randomly selected samples of sea cucumber species (10–20 individuals) were measured. Finally, a sample of sea cucumbers was collected haphazardly for species identification. Substrate, vegetation and macrofauna were recorded simultaneously. In total, 36 surveys were carried out in October 2016, April 2017, March 2018 and October 2018 in nine transects (T1, T2, T3, T4, T5, T6, T7, T8 and T9) at an average depth of 6 m.

Data analysis

Holothuroidea species were identified following the guidelines of Tortonese (1965). All sea cucumbers collected during the monitoring are used to calculate specific abundance. Mean densities were evaluated for 100 m^2. One-way analysis of variation (ANOVA) was used to compare means. Measurements of total length of individuals were recorded to the nearest 0.5 cm, and sea cucumber size distributions were represented with intervals of 1 cm.

Results

Specific abundance

Throughout the monitoring period, 359 sea cucumber individuals were collected and used for systematic identification. The area of investigation was uniform and the stations had the same benthic habitat profile, with the substrate composed of sandy muddy substrates with fragments of mollusc shells and some stones. The seagrass *Cymodocea nodosa* was the main phanerogam encountered in addition to macroalgae, particularly *Caulerpa prolifera* and *Enteromorpha* sp.

All samplings from surveys revealed a high relative abundance of *Holothuria poli* (73.81%), followed by *Holothuria tubulosa* (16.71%) (Fig. 2). *Holothuria forskali* was also present (6.12%), while *H. sanctori* and *H. mammata* were scarce (< 1%).

Densities

In total, 1847 sea cucumber individuals were counted at all three stations in Bizerte Lagoon. In October 2016, 457 sea cucumbers were found, while in October 2018 only 224 individuals were counted (Table 1). However, sea cucumbers were totally absent in October 2016 and October 2018 at the same transects T6 and the same station 2.

The population densities of sea cucumbers varied from 0 to 94 individuals/100 m^2 by transect. The average was 51 individuals (SD ± 18)/100 m^2 for station 1, 35 individuals/(SD ± 25)/100 m^2 for station 2 and 44 individuals (SD ± 25)/100 m^2 for station 3. Finally, the average density estimated for all stations throughout the study period was 43.80 individuals (± 23.75 SD)/100 m^2 (Fig. 3).

Table 1. Density value by station (individuals/300 m^2) of sea cucumber species in Bizerte Lagoon.

Period	station 1	station 2	station 3
October 2016	166	87	204
April 2017	202	148	136
March 2018	137	165	378
October 2018	114	24	86
Total	**619**	**424**	**804**

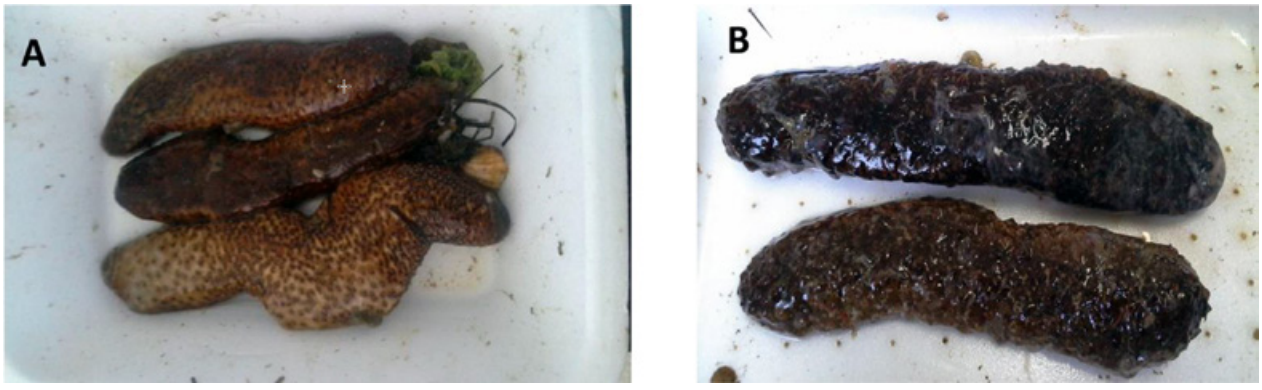

Figure 2. (A) *Holothuria poli* and (B) *Holothuria tubulosa* from Bizerte Lagoon. Photos by F. Sellem

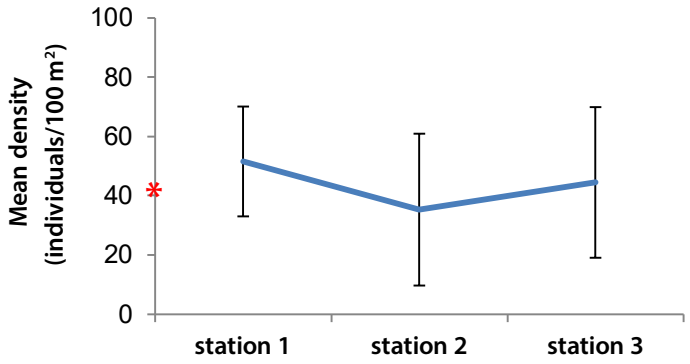

Figure 3. Mean density (individuals/100 m²) of sea cucumber species from Bizerte Lagoon. Vertical bars represent standard deviation (SD).

The highest mean density of sea cucumbers was observed in October 2016 at station 3 (68 individuals ±24 individuals /100 m²), while the lowest mean density was recorded in October 2018, also at station 3. No significant difference was observed between sea cucumbers densities at the level of the three stations (one-way ANOVA, p=0.249; p>0.05).

Average density regularly decreased with the time of the surveys (Fig. 4). Moreover, a significant difference was observed between the mean densities during the four periods (p = 0.034). Variations were observed between October 2016, April 2017, March 2018 and October 2018 (p = 0.023, 0.008, 0.026). On the other hand, a decrease in mean density is not regular according to the stations (Fig. 5).

Average size of sea cucumbers

During the study period, 309 individuals were measured *in situ* and are represented by 1 cm length size classes (Fig. 6). The total length of the sea cucumbers recorded varied between 8 cm and 32 cm and the sea cucumber average size was (17.35 ± 4.53 cm). Average sizes were 18.14 cm (± 4.621) for station1, 16.77 cm (± 4.58) for station 2, and 16.95 cm (± 4.29) for station 3.

Regardless of the period, distribution was multimodal. All size classes are present in October 2016, although in April 2017, March 2018 and October 2018 the smallest and largest size classes were scarce or sometimes absent.

Discussion

This survey was carried out in order to determine sea cucumber density from Bizerte Lagoon over two consecutive years. The lagoon is characterised by a biodiversity of sea cucumber species, and *Holothuria poli* is the most abundant species (Sellem et al. 2019). Over the two-year period, the results showed a decrease in the average density of sea cucumbers. Mean densities do not vary significantly between stations, but significant variations are observed seasonally. In October 2016 the average density was 51 individuals/100 m² while in October 2018 it was 25 individuals/100 m².

In a previous study in the lagoon, Ben Mustapha and Hattour (2017) estimated a mean density of sea cucumbers species at 0.29 individual /m² in November 2014. In Bizerte Lagoon, the average density of sea cucumbers, all species combined, was determined to be 0.43 individual/m² (present study). These results confirm that the values recorded in the lagoon are homogeneous. Nevertheless. it was noticed that the average density recorded in October 2018 was the lowest among all the data collected in the lagoon. In the literature, on a larger geographical scale, reported densities seem to vary, although some fluctuations could arise due to different survey methods. On the Turkish coasts of the Aegean Sea, for example, Aydin (2019) found the total number of sea cucumbers per square meter of three species (*Holothuria tubulosa, H. poli, H. mammata*) to be equal to 1.91 individuals/m². But later in the same region area, Lok et al. (2022) found lower densities for *H. poli* and *H. tubulosa*, varying between 0.02 individual/m2 and 0.002 individual/m². In Mediterranean lagoon environments, sea cucumber density data are scarce. Gonzalez-Wanguemert et al. (2018) reports a high density of *H. poli* (reaching 4.32 individuals/m² on Isla del Ciervo) in Spain for the Mar Menor.

In conclusion, this work reveals the impact of the harvesting of sea cucumbers on their density. The question of this anarchic fishing deserves to be discussed by fisheries departments and fishermen in order to adopt a management plan, the provisions of which would contribute to the preservation of this resource. As with all management plans, the main aspects to be regulated should include sea cucumber fishing quotas, limits of fishing areas, time closures to allow sea cucumber reproduction, limits on the number of licenses issued, restrictions on the type of fishing equipment that can be used to harvest sea cucumbers, and landing control.

Acknowledgements

Many thanks to the diving teams for the National Institute of Marine Science and Technology, especially Othman A. and Harki M. who participated in collecting the data. Also, thanks to the fishermen and shipping agents of Bizerte who helped us to conduct the fieldwork.

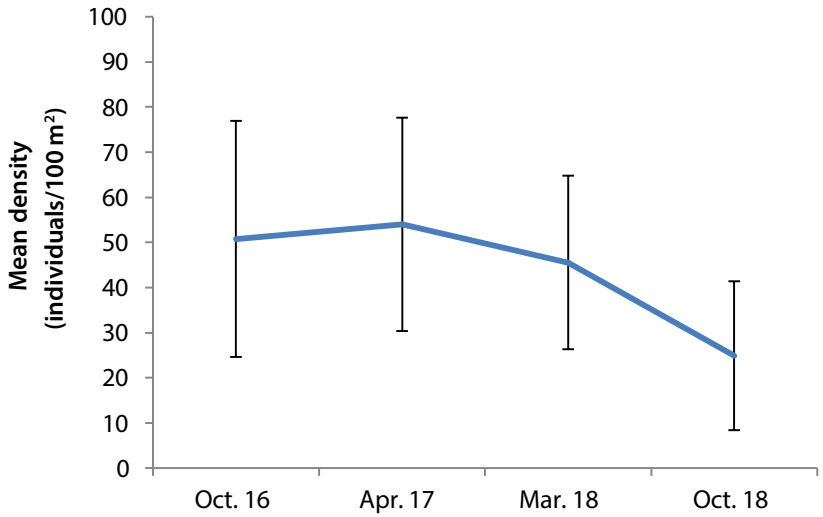

Figure 4. Mean density according to study period. Vertical bars represent standard deviation.

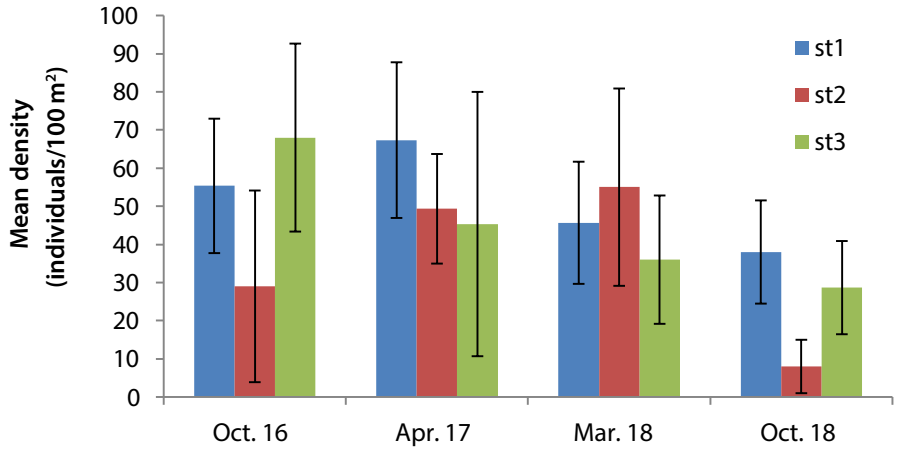

Figure 5. Mean density according to study station and period. Vertical bars represent standard deviation.

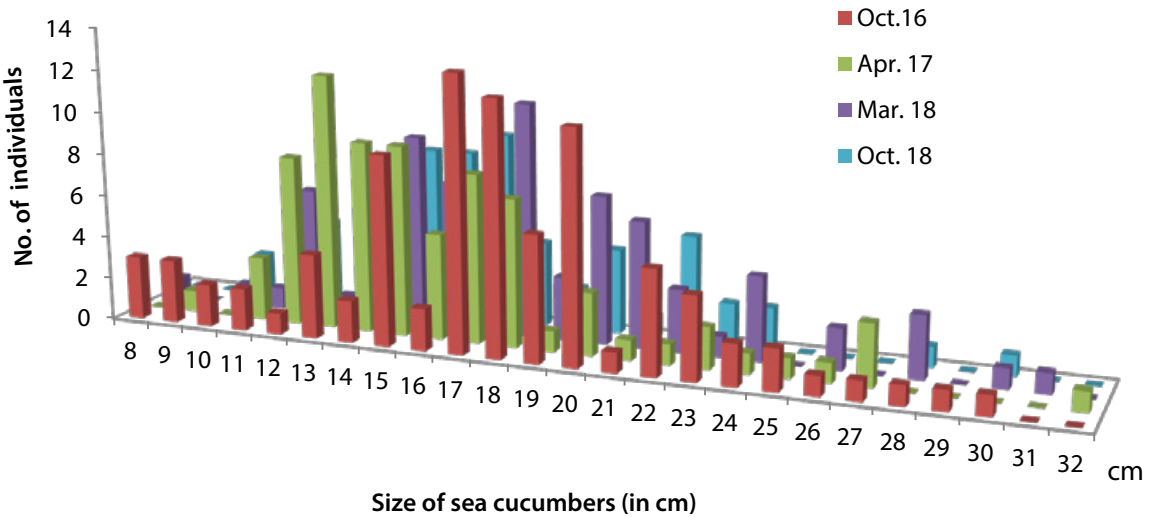

Figure 6. Size distribution of sea cucumbers from Bizerte Lagoon.

References

Aydin M. 2019. Density and biomass of commercial sea cucumber species relative to depth in the Northern Aegean Sea. Thalassas: An International Journal of Marine Sciences 35:541–550. https://doi.org/10.1007/s41208-019-00144-4

Ben Mustapha K. and Hattour A. 2017 Estimation de la population des holothuries des régions Jarzouna Metline El Hawar et de la lagune de Bizerte. Bulletin de l'Institut National des Sciences et Technologies de la Mer de Salammbô 44:147–163.

Dereli H., Culha S.T., Culha M., Ozalp B.H. and Tekinay A.A. 2016. Reproduction and population structure of the sea cucumber *Holothuria tubulosa* in the Dardanelles Strait, Turkey. Mediterranean Marine Science 17:47–55. doi: 10.12681/mms.1360

González-Wangüemert M., Valente S., Henriques F., Domınguez-Godino J. and Serrao E. 2016. Setting preliminary biometric baselines for new target sea cucumbers species of the NE Atlantic and Mediterranean fisheries. Fisheries Research 179:57–66.

González-Wangüemert M., Domînguez-Godino J. A. and Cánovas F. 2018. New records of sea cucumbers inhabiting Mar Menor coastal lagoon (SE Spain) Marine Biodiversity 48:2177–2182. DOI 10.1007/s12526-017-06600

Mohsen M. and Yang H. 2021. Sea cucumbers research in the Mediterranean and the red seas. p. 61–101. In: Mohsen M. and Yang H. (eds). Sea cucumbers aquaculture, biology and ecology. Oxford, England: Academic Press. doi: 10.1016/ B978-0-12-824377-0.00002-5

Sellem F., Graja S. and Brahmi Z. 2017. Données biologiques et valeur nutritive de la paroi *d'Holothuria poli* (Delle Chiaje, 1823) Holothuoidea, Aspidochirotida des îles Kerkennah (golfe de Gabès, Tunisie). Bulletin de l'Institut National des Sciences et Technologies de la Mer de Salammbô 44:1–18.

Sellem F., Guetat F., Enaceur W., Ghorbel-Ouannes A., Othman A., Harki M., Lakuireb A. and Rafrafi S. 2019. Sea cucumber species from Mediterranean lagoon environments (Tunisia western and eastern Mediterranean). SPC Beche-de-mer Information Bulletin 39:54–59. https://purl.org/spc/digilib/doc/zurdb

Tortonese E. 1965. Fauna d'Italia. Echinodermata. Bologna, Italy: Edizioni Calderini Bologna, Officine Grafiche Calderini. 422 p.