

Mediterranean Marine Science

Vol 22, No 1 (2021)

Vol 22, No 1 (2021)



Evidence of a second nursery area of the sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827) in the Eastern Mediterranean Sea

NURI BASUSTA, ASIYE BAŞUSTA, CANER E. OZYURT

doi: [10.12681/mms.24490](https://doi.org/10.12681/mms.24490)

To cite this article:

BASUSTA, N., BAŞUSTA, A., & OZYURT, C. E. (2021). Evidence of a second nursery area of the sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827) in the Eastern Mediterranean Sea. *Mediterranean Marine Science*, 22(1), 20–26. <https://doi.org/10.12681/mms.24490>

Evidence of a second nursery area of the sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827) in the Eastern Mediterranean Sea

Nuri BAŞUSTA¹, Asiye BAŞUSTA¹ and Caner E. OZYURT²

¹ Firat University, Fisheries Faculty, Elazığ, Turkey

² Faculty of Fisheries, Cukurova University, Adana, Turkey

Corresponding author: nbasusta@hotmail.com

Contributing Editor: Fabrizio SERENA

Received: 7 August 2020; Accepted: 12 November 2020; Published online: 8 January 2021

Abstract

The sandbar shark (*Carcharhinus plumbeus*) is a large coastal shark species with a cosmopolitan distribution; it has been listed as Endangered in the Mediterranean Sea and Vulnerable for the rest of the world on the IUCN Red List of threatened species. The Gökova's Boncuk Cove in south-western Turkey and the Gulf of Gabès in southern Tunisia are the only known nursery area for the Mediterranean population. On the 24 – 27 July 2017, eight specimens of sandbar sharks, four males, and four females, were accidentally caught at a depth of 7 to 9 m by a pelagic bluefish longline off the coast of Yumurtalik Bight in the Gulf of Iskenderun. The total lengths and weights of males and females were 54.5 – 61.0 cm, 930 – 1,484 g, and 49.6 – 62.4 cm, 918 – 1,568 g, respectively. They all had unhealed umbilical scars that were still open as a narrow slit, measuring 4.35 and 5.39 mm in length. This study provides a record of the neonate sandbar sharks from the Yumurtalik Bight. Consequently, this occurrence represents that this area of the north-eastern Mediterranean Sea may be a second breeding and nursery grounds for this species after the Boncuk Cove in Gökova Bay in Turkey.

Keywords: Boncuk cove; bycatch; Carcharhinidae; nursery area; neonates; Yumurtalik Bight.

Introduction

The sandbar shark (*Carcharhinus plumbeus* [Nardo, 1827]) in the family Carcharhinidae (requiem sharks), is a large coastal shark species that has a cosmopolitan distribution (Heist *et al.*, 1995; Golani *et al.*, 2006). Numerous allopatric populations represent it throughout tropical and temperate coastal areas of the world, mainly found in the Mediterranean Sea, the Atlantic, western Pacific, and Indian oceans (Pinet, 2012; Davenport, 2016). They are highly migratory shark species with an annual migration dependent on sea surface temperature (Pinet, 2012; Davenport, 2016). They often migrate in large schools typically along coastlines and not trans-oceanic, segregating by age and then by sex when adult and can travel up to 600 miles (1,000 km) in one year (Merson & Pratt, 2001; McAuley *et al.*, 2005; Davenport, 2016). The sandbar sharks in the Mediterranean Sea generally reach maturity at a total length varying between 154 to 160 cm for males and 166 to 172 cm for females (Saïdi *et al.*, 2005). The female has a mean of eight to ten pups every other year or every third year, with a 12 month gestation period (Springer, 1960). It is an important commercial species playing a significant role in the commercial shark fishery

of the Eastern North Atlantic, the Western North Atlantic, the South China Sea, and Western Australia (Vannuccini, 1999; Lesinski, 2011). In the Mediterranean Sea, Tunisia has the highest production of elasmobranchs with an annual catch of 2000 tonnes, and >70% of this comes from the Gulf of Gabès (cited in Saïdi *et al.*, 2019).

The population of sandbar sharks has been plummeted dramatically across the world due to fishing pressure. Consequently, it is listed as a Vulnerable species globally based on the IUCN Red List of Threatened Species criteria (Musick *et al.*, 2009; Nieto *et al.* 2015; Saïdi *et al.*, 2019). Furthermore, it has been categorized as Endangered in the Mediterranean Sea (Dulvy *et al.*, 2016). Generally, sharks are characterized by a K-selected life-history characterized by slow growth rates and long-lived, taking so long to reach sexual maturity with low fecundity resulting in lower possible population increase rates (Holden, 1974; Casey *et al.*, 1985; Romine *et al.*, 2006). Therefore, with such fragile life histories, they are extremely vulnerable to habitat degradation and overexploitation that has triggered a dramatic decline in their population tendency to a higher risk of extinction (Frisk *et al.*, 2002; Ferretti *et al.*, 2008; Bradley & Gaines, 2014). Hence, a modest level of fishing mortality and anthropogenic exploitation



Fig. 1: Map of the Yumurtalik Bight in the Iskenderun Bay, the north-eastern Mediterranean Sea with an inset depicting the location where the sandbar sharks *Carcharhinus plumbeus* were caught accidentally by a pelagic bluefish longline on 24–27 July 2017. The location of the first nursery (Boncuk bay) is also shown on the left that is based on the coordinate obtained from Google Map.

rapidly resulted in population depletion since the early 2000s in a large-scale Mediterranean case study (Frisk *et al.*, 2002; Ferretti *et al.*, 2008). The depleted population's recovery is prolonged, which may take several decades or longer to approach pre-exploitation levels (Camhi *et al.*, 1998; Peschak, 2014; Kabasakal *et al.*, 2017). Therefore, identifying shark nursery areas is a prerequisite for the conservation and documentation of appropriate management measures for advancing sustainable management of shark populations (Heithaus, 2007; Onate-González *et al.*, 2017).

The Gökova's Boncuk Cove in south-western Turkey is the only well-known nursery area of sandbar sharks in the Mediterranean Sea (UNDP, 2016). Fishing activities across Gökova Bay have been banned to protect the population of sandbar sharks in the Mediterranean Sea (Kızılkaya, 2019). Together with those of Başusta (2016), the results of this study should confirm the existence of one more nursery ground for this endangered species in Yumurtalik Bight in the Eastern Mediterranean Sea.

Materials and Methods

Study area

The Yumurtalik Bight is located on the Gulf of Iskenderun's west coast in Turkey (Fig. 1). The Bay is roughly rectangular, 65 km in length, 35 km wide, and 2,275 km², located in the Levantine Basin, covering a relatively large area of the continental shelf (Yilmaz *et al.*, 1992; Yilmaz & Sönmez, 2018). The Gulf of Iskenderun seems to be heavily polluted due to the intensive environmental disturbances, including shipping traffic, industrial enterprises, fishing cages, river discharges, and residential units (Yilmaz & Sönmez, 2018).

Accidentally caught Sandbar sharks

Sandbar sharks were entangled in a pelagic bluefish longline at a depth of 7 to 9 m during an experimental fishing operation. The pelagic bluefish longline was composed of 100 hooks of a number 9 fishing hook (Fig. 2). Leaping mullet (*Chelon saliens* [Risso 1810]), cut into

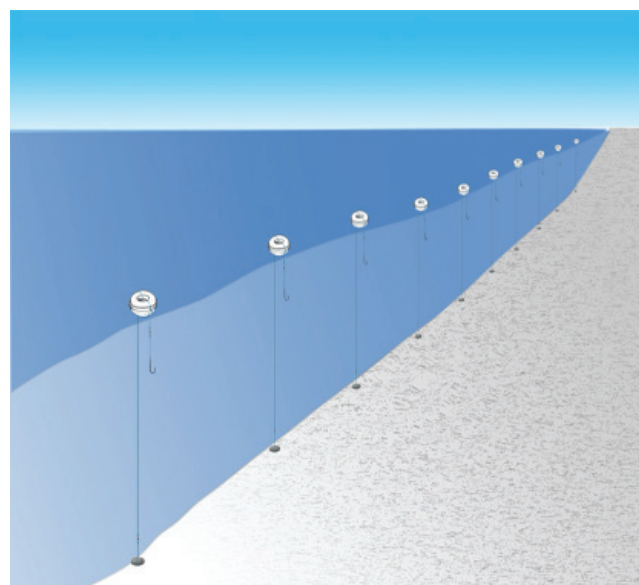


Fig. 2: The sandbar sharks *Carcharhinus plumbeus* with a lateral view caught accidentally on 24–27 July 2017, off the coast of Yumurtalik Bight, Gulf of Iskenderun, north-eastern Mediterranean Sea.

two pieces, were used as bait and hooked on a longline fishing rod. The sandbar sharks specimens were transported on ice to the Faculty of Fisheries, University of Firat - Elazig for detailed examination where they were identified, weighed, measured, and their sex determined (Compagno, 1984). The species identification was based on sandbar sharks typical diagnostic features, as described by Compagno (1984). Furthermore, the umbilical scar status was used to determine the sandbar shark's relative age (Norris & Lopez, 2010). All specimens were finally deposited in the Museum of Fisheries Faculty, Firat University (FFM-FISH/2017-01 to FFM-FISH/2017-08).

Results

Seven sandbar sharks on 24 July 2017 and a single sandbar shark on 27 July 2017 were unintentionally caught off the coast of Yumurtalik Bight: N 36°44'44.39", E 35°42'22.77" (Fig. 3). The data on morphometric measurements of the individual sandbar sharks is provided in Table 1. There were four male and four female sandbar

Table 1. Morphometric measurements of the sandbar sharks *Carcharhinus plumbeus* caught accidentally on 24 – 27 July 2017, off the coast of Yumurtalik Bight, Gulf of Iskenderun, north-eastern Mediterranean Sea.

FISH No.	MALE				FEMALE			
	1	2	3	4	5	6	7	8
Umbilical scar Length (mm)	4.40	5.11	5.14	5.48	4.35	4.74	5.39	5.03
Total weight (g)	930.0	1,368.0	1,222.0	1,484.0	918.0	1,194.0	1,568.0	1,520.0
Total length (TOT)	54.5	57.9	58.6	61.0	49.6	57.2	62.4	63.0
Fork length (FOR)	43.3	46.5	46.6	48.5	40.9	45.7	50.8	50.8
Precaudal length (PRC)	39.5	41.7	42.7	44.2	37.6	41.6	45.6	46.0
Pre-second dorsal length (PD2)	33.6	35.7	35.7	38.2	31.4	35.3	38.3	39.2
Pre-first dorsal length (PD1)	15.6	17.8	15.7	17.8	14.6	17.0	17.4	18.2
Head length (HDL)	13.0	13.7	13.4	13.4	13.0	13.5	14.8	14.9
Prebranchial length (PGI)	10.7	11.5	10.8	11.8	10.7	11.2	11.7	12.2
Preorbital length (POB)	3.2	3.2	3.2	3.8	3.0	3.0	4.0	4.1
Prepectoral length (PP1)	12.4	14.2	13.0	14.6	13.1	13.8	14.0	14.5
Prepelvic length (PP2)	26.7	29.1	28.2	30.9	26.6	27.3	35.0	30.6
Preanal length (PAL)	33.3	35.8	35.4	37.9	32.5	34.4	38.4	38.1
HEAD								
Eye length (EYL)	9.0	9.0	9.0	9.0	9.0	9.0	9.0	9.0
Eye height (EYH)	9.0	9.0	9.0	10.0	9.0	9.0	9.0	9.0
Preoral length (POR)	45.0	47.0	47.0	46.0	46.0	43.0	47.0	48.0
Prenarial length (PRN)	30.0	31.0	32.0	34.0	35.0	31.0	31.0	33.0
Intergill length (ING)	26.0	32.0	30.0	30.0	27.0	27.0	35.0	30.0
PECTORAL FIN								
Pectoral anterior margin (PIA)	94.0	92.0	99.0	107.0	89.0	89.0	105.0	113.0
Pectoral length (PIL)	52.0	57.0	60.0	60.0	54.0	53.0	60.0	59.0
Pectoral posterior margin (P1P)	79.0	81.0	90.0	84.0	72.0	69.0	82.0	85.0
Pectoral height (P1H)	86.0	87.0	95.0	96.0	78.0	84.0	102.0	101.0
Pectoral base (PIB)	37.0	36.0	45.0	47.0	35.0	39.0	44.0	43.0
Pectoral inner margin (PII)	30.0	35.0	35.0	34.0	28.0	31.0	38.0	35.0
DORSAL FIN								
First dorsal anterior margin (DIA)	78.0	80.0	86.0	87.0	76.0	77.0	96.0	97.0
First dorsal base (DIB)	69.0	73.0	78.0	80.0	68.0	74.0	81.0	76.0
First dorsal length (DIL)	95.0	98.0	100.0	105.0	88.0	96.0	107.0	103.0
First dorsal inner margin (DII)	23.0	29.0	20.0	26.0	21.0	23.0	27.0	28.0
First dorsal posterior margin (DIP)	55.0	57.0	76.0	68.0	52.0	51.0	67.0	65.0
First dorsal height (DIH)	60.0	53.0	65.0	65.0	47.0	50.0	62.0	62.0
CAUDAL FIN								
Dorsal caudal margin (CDM)	147.0	160.0	168.0	165.0	112.0	160.0	170.0	171.0
Terminal caudal margin (CTR)	26.0	35.0	38.0	33.0	14.0	28.0	30.0	35.0
Subterminal caudal margin (CST)	15.0	16.0	16.0	14.0	10.0	16.0	17.0	18.0
Upper postventral caudal margin (CPU)	85.0	88.0	107.0	95.0	73.0	95.0	100.0	100.0
Lower postventral caudal margin (CPL)	29.0	32.0	37.0	32.0	24.0	27.0	40.0	38.0
Preventral caudal margin (CPV)	59.0	56.0	53.0	59.0	52.0	56.0	59.0	65.0
CLASPER								
Clasper inner length (CLI)	30.0	29.0	34.0	33.0				
Clasper outer length (CLO)	14.0	15.0	15.0	17.0				



Fig. 3: A sketch of pelagic bluefish longline in which sandbar sharks *Carcharhinus plumbeus* were caught accidentally on 24–27 July 2017, off the coast of Yumurtalik Bight, Gulf of Iskenderun, north-eastern Mediterranean Sea.

sharks, and their total lengths and weights ranged between 54.5 – 61.0 cm, 930 – 1,484 g, for male and 49.6 – 62.4 cm, 918 – 1,568 g for female. They were all neonates who were confirmed from their unhealed umbilical scars (Fig. 4). The open umbilical scar lengths were between 4.35 and 5.39 mm.

Discussion

This study provides additional information on neonate occurrence in the Yumurtalik Bight located in the Gulf of Iskenderun, confirmed by accidentally caught sharks' unhealed umbilical scars. This finding supports the finding by Baştusta & Erdem (2000) and Baştusta (2016), and in combination, they suggest the Yumurtalik Bight in the Gulf of Iskenderun as a second breeding area of sandbar sharks in the Mediterranean Sea after Gökova's Boncuk Cove. Baştusta (2016) reported a total of 55 specimens (28 males and 27 females) of sandbar sharks caught accidentally from the same area of the Mediterranean (Fig. 5). Also, Baştusta & Erdem (2000) reported a single neonate sandbar shark, measuring 57 cm total length, obtained from a depth of 15–20 m off the Yumurtalik coast. In addition, at least two other researchers also reported the existence of sandbar sharks from the same study area (e.g., M. Bilecenoglu, unpub. data, 1996; Kabasakal, 2002); however, their findings were published within gray literature and were not accessible to make a comparison with the present study.

Sandbar shark size at birth has been reported between 53 cm total length to 66 cm total length for Northern Australia (Stevens & McLoughlin, 1991), 60 cm total length to 75 cm total length for the China Sea (Taniuchi, 1971), 40 cm total length to 75 cm total length for South Africa (Bass *et al.*, 1973; Cliff *et al.*, 1988), 51 cm total length to 65 cm total length for the Atlantic Ocean (Springer, 1960; Cadenat & Blache 1981; Amorim *et al.*, 1998; Diatta *et al.*, 2008), and 46 cm total length to 65 cm total length for the Mediterranean Sea (Saïdi *et al.*, 2005; Lipej *et al.*, 2008). In this study, the sandbar sharks total lengths 50 to 63 cm seems to be in line with the findings of Saïdi *et al.* (2005) for the Mediterranean Sea. However, variations in the size of young sandbar shark at birth are mainly geographic as suggested by Garrick (1982).

Sandbar sharks typically mate in the spring or early summer: specifically May and June in the northern hemisphere (Ward, 2017). They are aplacental viviparous spe-

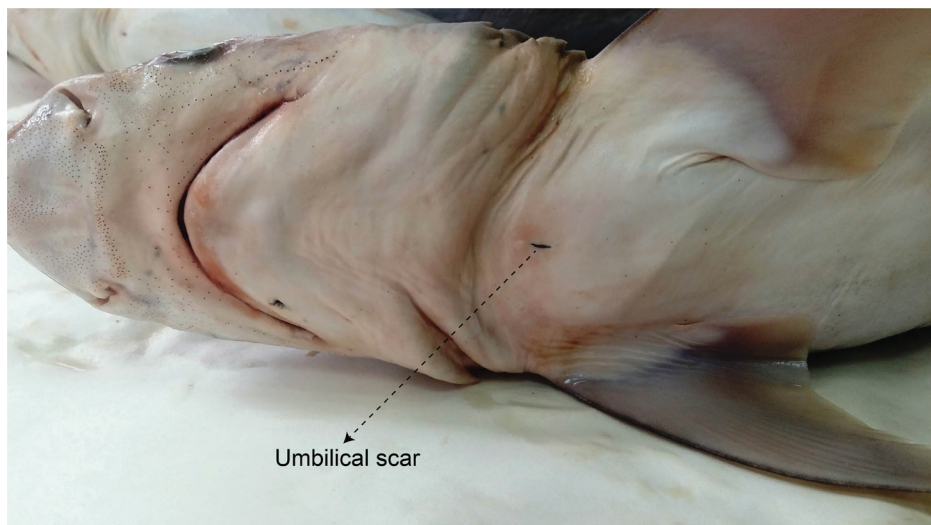


Fig. 4: The view of an unhealed umbilical scar of sandbar sharks *Carcharhinus plumbeus* were caught accidentally on 24–27 July 2017, off the coast of Yumurtalik Bight, Gulf of Iskenderun, north-eastern Mediterranean Sea.

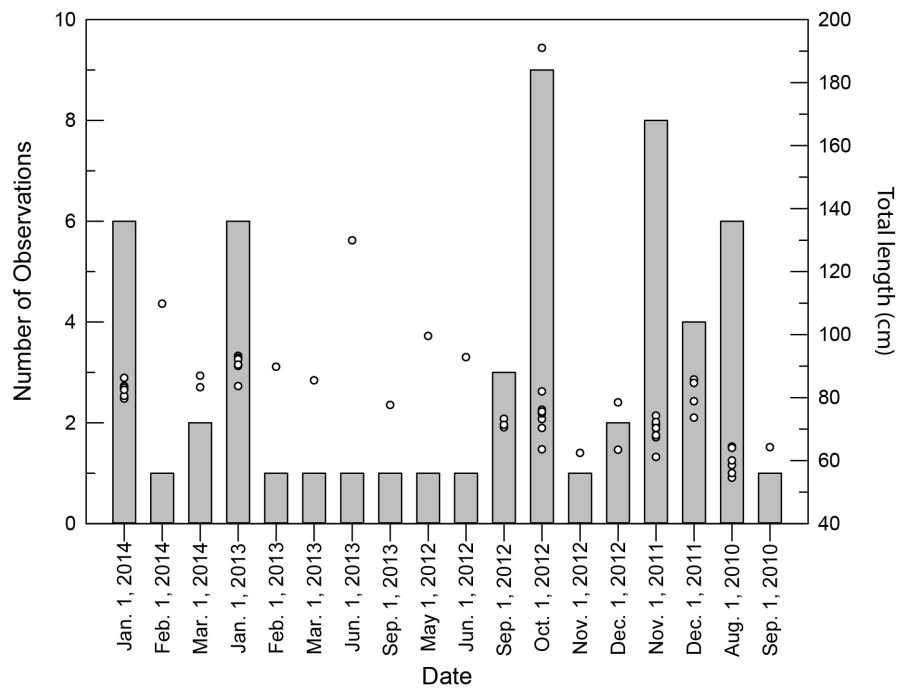


Fig. 5: Frequency of sandbar sharks *Carcharhinus plumbeus* observations caught as accidentally by pelagic longlines and commercial trawling from depths of 25 and 125 m of Mersin Bay and Iskenderun Bay, eastern Mediterranean Turkish coasts between August 2010 and March 2014 (Başusta, 2016). The bars represent the number of observations and dots (o) represent the size of sandbar sharks.

cies who give birth to their pups (range from 55 to 70 cm) in shallow inshore nursery grounds (Carrier, 2017; Ward, 2017). The northwestern Atlantic and Eastern Mediterranean are the two well-known nursery grounds for sandbar sharks (Springer, 1960; Musick & Colvocoresses, 1986). The largest nursery area for this species in the northwestern Atlantic is most likely to be in the Chesapeake Bay (Springer, 1960; Musick & Colvocoresses, 1986). Several smaller nursery areas of the sandbar sharks in the northwestern Atlantic are also reported along the Atlantic coast in New York, Delaware, Virginia, South Carolina, and mid-Florida (Springer, 1960; Castro, 1993; Merson, 1998; Merson & Pratt, 2001; Grubbs *et al.*, 2007). The Gökova's Boncuk Cove in south-western Turkey is the only well-known nursery area of the sandbar sharks in the Mediterranean Sea (UNDP, 2016). Consequently, fishing activities across the Gökova Bay are banned to protect the population of sandbar sharks in the Mediterranean Sea (Kızılkaya, 2019). The Gulf of Gabès in the central Mediterranean Sea (southern Tunisia) is also confirmed as a nursery area for sandbar sharks' Mediterranean population (Bradaï *et al.*, 2005; Saïdi *et al.*, 2005; Enajjar *et al.*, 2015). Furthermore, the northern Adriatic Sea may also serve as a nursery area for the Mediterranean population of sandbar sharks (Costantini & Affronte, 2003).

Conclusions

The presence of neonates, small juveniles, and pregnant females is necessary to declare an area as a nursery (Castro, 1993; Heupel *et al.*, 2007). Heupel *et al.* (2007) suggested that an area requires three criteria to be identified as a nursery: (1) species are more commonly en-

countered in the area than other areas, (2) species have a tendency to remain or return for extended periods, and (3) the area or habitat is repeatedly used across years. Başusta (2016) reported a total of 55 sandbar sharks caught between August 2010 to March 2014, over 65% of which had a total length of 72.2 cm to 191.0 cm, and 29.1% were 60.0 cm to 71.4 cm; the rest of them were 55.0 cm to 58.5 cm in total length (Figure 5). Thus, this study, together with the results from Başusta & Erdem, (2000) and Başusta (2016) suggest that the Yumurtalık Bight in the Gulf of Iskenderun meets the criteria proposed by Castro (1993) and Heupel *et al.* (2007). This potentially new nursery area of sandbar sharks requires developing specific management and conservation strategies to protect critical sandbar shark habitat for their sustainability in the Mediterranean Sea. Since the Yumurtalık Bight (Gulf of Iskenderun) experiences various anthropogenic pressures, including shipping traffic, industrial enterprises, fishing cages, river discharges, and residential units (Yılmaz & Sönmez, 2018), these might put the sandbar shark population at a high risk of becoming depleted.

Funding: Çukurova University Research Foundation supported this work. Project Number: FBA-2017-7834 and presented on the 23. Annual Conference of European Elasmobranch Association in Rende-Italy. EEA Conference 2019 funding was provided by the Scientific and Technological Research Council of Turkey (TUBITAK) No:1919B021902085. The data presented in this article were produced within the projects above; however, only the authors of this article are responsible for the results and discussions herein.

Conflict of Interest: The authors declare that they have no conflict of interest.

Ethical approval: The authors followed all applica-

ble international, national, and institutional guidelines for the care and use of animals.

Sampling and field studies: The authors from the competent authorities have obtained all necessary permits for sampling and observational field studies.

Data availability: All data generated and analyzed during this study are included in this published article.

Author Contributions Statement: N.B. did species identification, and wrote the manuscript. A.B. participated in species identification. C.O. provided the samples, and both A.B. & C.O. contributed significantly in the revision of the manuscript. All authors read and approved the manuscript.

References

- Amorim, A.F., Arfelli, C.A., Fagundes, L., 1998. Pelagic elasmobranchs caught by longliners off southern Brazil during 1974-97: an overview. *Marine and Freshwater Research*, 49 (7), 621-632.
- Bass, A., D'Aubrey, J. D., Kistnasamy, N., 1973. *Sharks of the east coast of southern Africa. I. The genus Carcharhinus (Carcharhinidae). Vol. 33.* Oceanographic Research Institute, Durban, 168 pp.
- Başusta, N., 2016. Length-weight relationship of sandbar shark *Carcharhinus plumbeus* (Nardo, 1827) in Iskenderun Bay (North-Eastern Mediterranean Sea). p. 41. In: *41st CIESM Congress, 12-16 September 2016*. Kiel, Germany.
- Başusta, N., Erdem, Ü., 2000. İskenderun Körfezi balıkları üzerine bir araştırma [A study on the pelagic and demersal fishes of Iskenderun Bay]. *Turkish Journal of Zoology*, 24, 1-20.
- Bradaï, M.N., Saïdi, B., Bouaïn, A., Guelorget, O., Capapé, C., 2005. The gulf of Gabès (central Mediterranean): Nursery area for the sandbar shark, *Carcharhinus plumbeus* (Nardo, 1827) (Chondrichthyes: Carcharhinidae). *Annales: Series Historia Naturalis*, 15 (2), 187-194.
- Bradley, D., Gaines, S.D., 2014. Counting the cost of overfishing on sharks and rays over half of all shark and ray species are at risk of extinction or at least heading that way. *Elife*, 3, e02199.
- Cadenat, J., Blache, J., 1981. *Requins de Méditerranée et d'Atlantique (plus particulièrement de la Côte Occidentale d'Afrique)*. Editions de L'office de la Recherche Scientifique et Technique Outre-Mer, Collection Faune Tropicale, No:XXI, Paris, 330pp.
- Camhi, M., Fowler, S., Musick, J., Bräutigam A., Fordham S., 1998. *Sharks and their relatives: ecology and conservation: Occasional paper 20.* Species Survival Commission, World Conservation Union, Gland, Switzerland, 63 pp.
- Carrier, J.C., 2017. *Sharks of the Shallows: Coastal Species in Florida and the Bahamas*. Johns Hopkins University Press, Baltimore, Maryland, 112 pp.
- Casey, J.G., Pratt, H.L., Stillwell, C.E., 1985. Age and growth of the sandbar shark (*Carcharhinus plumbeus*) from the Western North-Atlantic. *Canadian Journal of Fisheries and Aquatic Sciences*, 42 (5), 963-975.
- Castro, J.I., 1993. The shark nursery of Bulls Bay, South-Carolina, with a review of the shark nurseries of the Southeastern Coast of the United-States. *Environmental Biology of Fishes*, 38 (1-3), 37-48.
- Cliff, G., Dudley, S.F.J., Davis, B., 1988. Sharks caught in the protective gill nets off Natal, South-Africa1. The sandbar shark *Carcharhinus plumbeus* (Nardo). *South African Journal of Marine Science-Suid-Afrikaanse Tydskrif Vir Seewetenskap*, 7 (1), 255-265.
- Compagno, J., 1984. *Sharks of the world: An annotated and illustrated catalogue of shark species known to date, Vol. 4, Part 1, Hexanchiformes to Lamniformes*. FAO Fisheries Synopsis, No.125, 655 pp.
- Costantini, M., Affronte, M., 2003. Neonatal and juvenile sandbar sharks in the northern Adriatic Sea. *Journal of Fish Biology*, 62 (3), 740-743.
- Davenport, M.J., 2016. New Jersey Endangered and Threatened Species Field Guide. <http://www.conservewildlifenj.org/species/fieldguide> (Accessed 9 December 2020)
- Diatla, Y., Seck, A. A., Reynaud, C., Guelorget, O., Capapé, C., 2008. New biological observations on the sandbar shark *Carcharhinus plumbeus* (Chondrichthyes: Carcharhinidae) from the coast of Senegal (Eastern Tropical Atlantic). *Cahiers De Biologie Marine*, 49 (2), 103-111.
- Dulvy, N.K., Allen, D.J., Ralph, G.M., Walls R.H.L., 2016. *The conservation status of sharks, rays and chimaeras in the Mediterranean Sea [Brochure]*. IUCN Centre for Mediterranean Cooperation, Malaga, Spain, 14 pp.
- Enajjar, S., Saïdi, B., Bradaï, M.N., 2015. The Gulf of Gabes (central Mediterranean Sea): A nursery area for sharks and batoids (Chondrichthyes: Elasmobranchii). *Cahiers De Biologie Marine*, 56 (2), 143-150.
- Ferretti, F., Myers, R.A., Serena, F., Lotze, H.K., 2008. Loss of large predatory sharks from the Mediterranean Sea. *Conservation Biology*, 22 (4), 952-64.
- Frisk, M.G., Miller, T.J., Fogarty, M.J., 2002. The population dynamics of little skate *Leucoraja erinacea*, winter skate *Leucoraja ocellata*, and barndoor skate *Dipturus laevis*: predicting exploitation limits using matrix analyses. *ICES Journal of Marine Science*, 59 (3), 576-586.
- Garrick, J., 1982. *Sharks of the genus Carcharhinus*. NOAA Technical Report NMFS, Circular 445, US Department of Commerce Rockville, Maryland, 195pp.
- Golani, D., Öztürk, B., Başusta, N., 2006. *Fishes of the Eastern Mediterranean-Turkish Marine Research Foundation (Publication No. 24)*. Turkish Marine Research Foundation, Istanbul, Turkey, 259 pp.
- Grubbs, R.D., Musick, J.A., Conrath, C.L., Romine J.G., 2007. Longterm movements, migration, and temporal delineation of a summer nursery for juvenile sandbar sharks in the Chesapeake Bay region. *American Fisheries Society Symposium*, 50, 87-107.
- Heist, E.J., Graves, J.E., Musick, J.A., 1995. Population genetics of the sandbar shark (*Carcharhinus plumbeus*) in the Gulf of Mexico and mid-Atlantic Bight. *Copeia*, (3), 555-562.
- Heithaus, M.R., 2007. Nursery areas as essential shark habitats: a theoretical perspective. *American Fisheries Society Symposium*, 50, 3-13.
- Heupel, M.R., Carlson, J.K., Simpfendorfer, C.A., 2007. Shark nursery areas: concepts, definition, characterization and assumptions. *Marine Ecology Progress Series*, 337, 287-297.
- Holden, M., 1974. Problems in the rational exploitation of elasmobranch populations and some suggested solutions.

- p. 117-137. In: *Sea Fisheries Research*. Harden-Jones F.R. (Ed). Logos Press, London.
- Kabasakal, H., 2002. Elasmobranch species of the seas of Turkey. *Annales, Series Historia Naturalis*, 12 (1), 15-22.
- Kabasakal, H., Karhan, S.U., Sakinan, S., 2017. Review of the distribution of large sharks in the seas of Turkey (Eastern Mediterranean). *Cahiers De Biologie Marine*, 58 (2), 219-228.
- Kızılkaya, Z., 2019. Marmaris Bay dedicated to sharks for protection - *Hürriyet Daily News*. <https://www.hurriyetdailynews.com/marmaris-bay-dedicated-to-sharks-for-protection-145725> (Accessed 9 December 2020).
- Lesinski, T., 2011. Animal Diversity Web. https://animaldiversity.org/accounts/Carcharhinus_plumbeus/ (Accessed 31 October, 2020).
- Lipej, L., Mavrič, B., Dobrajc, Ž., Capapé C., 2008. On the occurrence of the sandbar shark, *Carcharhinus plumbeus* (Chondrichthyes: Carcharhinidae) off the Slovenian coast (northern Adriatic). *Acta Adriatica: International Journal of Marine Sciences*, 49 (2), 137-145.
- McAuley, R., Lenanton, R., Chidlow, J. Allison R., Heist E., 2005. *Biology and stock assessment of the thickskin (sandbar) shark, Carcharhinus plumbeus, in Western Australia and further refinement of the dusky shark, Carcharhinus obscurus, stock assessment*. Final FRDC Report- Project 2000/134, Fisheries Research Report No. 151, Department of Fisheries, Western Australia, 132 pp.
- Merson, R., 1998. *Nursery grounds and maturation of the Sandbar Shark in the western North Atlantic*. PhD thesis. University of Rhode Island, Kingston, 150 pp.
- Merson, R.R., Pratt, H.L., 2001. Distribution, movements and growth of young sandbar sharks, *Carcharhinus plumbeus*, in the nursery grounds of Delaware Bay. *Environmental Biology of Fishes*, 61 (1), 13-24.
- Musick, J., Colvocoresses, J., 1986. Seasonal recruitment of subtropical sharks in Chesapeake Bight, USA. p. 301-311. In: *Intergovernmental Oceanographic Commission Workshop. on recruitment in tropical coastal demersal communities*. Report 44. FAO/UNESCO, Campeche, Mexico, 21-25 April 1986.
- Musick, J.A., Stevens, J.D., Baum, J.K., Bradaï, M., Clò, S. et al., 2009. *Carcharhinus plumbeus*. The IUCN Red List of Threatened Species 2009: e.T3853A10130397.
- Nieto, A., Ralph, G.M., Comeros-Raynal, M.T., Kemp, J., García Criado, M. et al., 2015. *European Red List of marine fishes*. Publications Office of the European Union, Luxembourg, 84 pp.
- Norris, D.O., Lopez, K.H., 2010. *Hormones and reproduction of vertebrates. Vol. 1*. Academic Press, London, 210 pp.
- Onate-González, E.C., Sosa-Nishizaki, O., Herzka, S.Z., Lowe, C.G., Lyons, K. et al., 2017. Importance of Bahia Sebastian Vizcaino as a nursery area for white sharks (*Carcharodon carcharias*) in the Northeastern Pacific: a fishery dependent analysis. *Fisheries Research*, 188, 125-137.
- Peschak, T.P., 2014. *Sharks and people: Exploring our relationship with the most feared fish in the sea*. University of Chicago Press, Chicago, 256 pp.
- Pinet, P.R., 2012. *Essential invitation to oceanography*. Jones & Bartlett Learning Publishers, Burlington, 481 pp.
- Romine, J.G., Grubbs, R.D., Musick, J.A., 2006. Age and growth of the sandbar shark, *Carcharhinus plumbeus*, in Hawaiian waters through vertebral analysis. *Environmental Biology of Fishes*, 77 (3-4), 229-239.
- Saïdi, B., Bradaï, M.N., Bouaïn, A. Guélorget O., Capapé C., 2005. The reproductive biology of the sandbar shark, *Carcharhinus plumbeus* (Chondrichthyes: Carcharhinidae), from the Gulf of Gabès (southern Tunisia, central Mediterranean). *Acta Adriatica: International Journal of Marine Sciences*, 46 (1), 47-62.
- Saïdi, B., Enajjar, S., Karaa, S., Echikhi, K., Jribi I. et al., 2019. Shark pelagic longline fishery in the Gulf of Gabes: Inter-decadal inspection reveals management needs. *Mediterranean Marine Science*, 20 (3), 532-541.
- Springer, S., 1960. *Natural history of the sandbar shark, Eulamia milberti*. US Fish Wildlife Services, Washington DC, 38pp.
- Stevens, J.D., McLoughlin, K.J., 1991. Distribution, size and sex composition, reproductive-biology and diet of sharks from Northern Australia. *Australian Journal of Marine and Freshwater Research*, 42 (2), 151-199.
- Taniuchi, T., 1971. Reproduction of the sandbar shark, *Carcharhinus milberti*, in the East China Sea. *Japanese Journal of Ichthyology*, 18 (2), 94-98.
- UNDP, 2016. *Mediterranean Conservation Society, Turkey. Equator Initiative Case Study Series*. New York, 16pp. (https://www.equatorinitiative.org/wp-content/uploads/2017/05/case_1471988630_EN.pdf)
- Vannuccini, S., 1999. *Shark utilization, marketing, and trade*. FAO, 389, 5 pp.
- Ward, C.H., 2017. *Habitats and Biota of the Gulf of Mexico: Before the Deepwater Horizon Oil Spill: Volume 2: Fish Resources, Fisheries, Sea Turtles, Avian Resources, Marine Mammals, Diseases and Mortalities*. Springer, London, 992 pp.
- Yilmaz, A., Bastürk, Ö., Saydam, C., Ediger, D., Yilmaz, K. et al., 1992. Eutrophication in Iskenderun Bay, north-eastern Mediterranean. *Science of the Total Environment, Supplement*, 705-717.
- Yilmaz, H.K., Sönmez, H., 2018. Environmental problems and precautions of Iskenderun Gulf in Eastern Mediterranean region. *Acta Biologica Turcica*, 31 (3), 69-81.