

RESEARCH ARTICLE

**A preliminary study on marine top predators inhabiting  
Gökçeada Island, the North Aegean Sea**

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**Abstract**

Marine top predators, such as sharks, teleosts and cetaceans, are great indicators of a healthy ecosystem. The primary goal of this paper is to fill the knowledge gaps on top predators in Gökçeada Island located in the North Aegean Sea. Data on marine top predators were collected through Local Ecological Knowledge. Besides, visual and acoustic field surveys were carried out in the summer and autumn of 2019 and winter of 2020. According to the results of the current study, a total of 464 individuals were reported via social media platforms and questionnaires applied to stakeholders as fishermen, divers and harpooners. *Delphinus delphis* Linnaeus, 1758, *Tursiops truncatus* (Montagu, 1821) and *Physeter macrocephalus* Linnaeus, 1758 were detected during approximately 15 hours of acoustic recording. The records of *Carcharodon carcharias* (Linnaeus, 1758), *Isurus oxyrinchus* Rafinesque, 1810, *Xiphias gladius* Linnaeus, 1758, *Thunnus thynnus* (Linnaeus, 1758), *D. delphis*, *Stenella coeruleoalba* (Meyen, 1833), *T. truncatus*, *Grampus griseus* (Cuvier, 1812), *P. macrocephalus*, *Ziphius cavirostris* (Cuvier, 1823), *Monachus monachus* (Hermann, 1779) were listed in this study. A total of 358 individuals of *X. gladius* and *T. thynnus* were reported between the years 2017-2020, being the most abundant top predators in the area.

**Keywords:** Marine apex predators, sharks, large teleosts, marine mammals, local ecological knowledge

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## Introduction

Top predators occupy the higher trophic levels in the food web. They are generally large-sized, long-living animals that are commonly characterized by late sexual maturity and their populations are relatively stable (Sergio *et al.* 2008). They play a key role as ecosystem regulators by inhibiting the population irruptions of prey and other smaller predators (Wallach *et al.* 2015). Today, it is known that top predators also promote species richness and they are spatio-temporally associated with it for a couple of reasons, such as their dependence on ecosystem productivity and sensitivity to dysfunctions (Sergio *et al.* 2008). Therefore, predator-centered conservation is believed to help reach certain biodiversity goals and contributes to the protection of the surrounding ecosystem.

Gökçeada Island, located in the North Aegean Sea, harbours a wide range of diverse ecosystems and offers a variety of habitats for many top predators. Many chondrichthyans (Kabasakal 2019); large teleosts (Ceyhan 2001; Yüncü *et al.* 2021); cetaceans (Öztürk and Tonay 2019) and the Mediterranean monk seal (Öztürk 1992; Dede *et al.* 2019) are known to inhabit the island. One of the most important groups among the top predators is a mammalian order Cetacea which includes whales, dolphins and porpoises, also defined as the charismatic megafauna that represents an essential component of the marine biodiversity (Pace *et al.* 2015). The Aegean Sea is one of the places where it holds potential important habitats for cetaceans as well as for other top predators. Several systematic surveys have been carried out since the 1990s in the area (Carpentieri *et al.* 1994; Öztürk and Öztürk 1998; Frantzis *et al.* 1999, 2003, 2014; Altuğ *et al.* 2011; Cañadas and Notarbartolo di Sciara 2018).

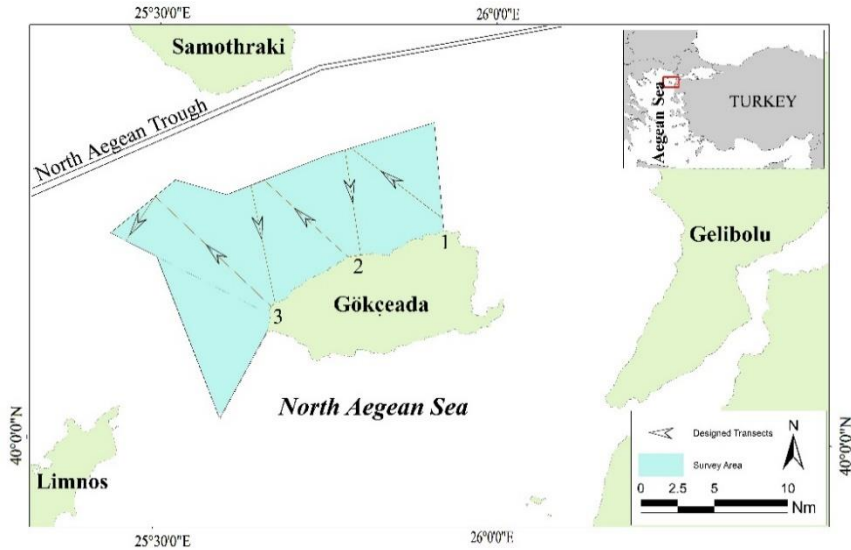
Due to their k-selected lifestyle, top predators are less abundant, but larger in size compared to other species. Hence, they are much likely to be encountered by people who spend a large amount of their time at sea such as fishermen, divers, harpooners etc. For this reason, it is important to involve these people into data collection. Local Ecological Knowledge (LEK) has emerged as an alternative information source in the last two decades and can be defined as information that a group of people possess about local ecosystems (Azzurro 2018). This knowledge fulfils a considerable amount of research gap especially in need of long-term monitoring, assessment and management of natural resources.

The aim of this study is to document the presence and distribution of top predators in the Turkish waters of the North Aegean Sea. In order to do so, LEK was used as a supporting tool for increasing our knowledge on these species. Besides, visual and acoustic surveys were conducted.

## Materials and Methods

### *Survey Area*

The Aegean Sea is located in the eastern Mediterranean Sea and it is topographically divided into two basins: the northern and the southern basin (Aker 2015). The northern basin has a strong interaction with the Sea of Marmara and the Black Sea through the Istanbul and Çanakkale Straits. Therefore, it is more productive due to the incoming Black Sea current which is characterized by higher nutrient concentrations and colder temperatures (Öztürk 2009). Gökçeada Island, located in the North Aegean Sea ( $40^{\circ}05'N - 40^{\circ}14'N$ ,  $25^{\circ}40'E - 26^{\circ}02'E$ ), is the biggest island of Turkey with a coastline of 92 km (Figure 1). The island harbors a highly biodiverse marine ecosystem and has the only protected area (Gökçeada Marine Park) of Turkey, located in the northeast coast of the island. General ichthyofauna of the island has been relatively well studied but there are no comprehensive studies on the megafauna of the island.



**Figure 1.** The study area (Gökçeada Island) and the transects followed during the boat surveys. Land observation spots are also shown as 1-Kaleköy, 2-Tepeköy, 3-Uğurlu.

### *Data Collection*

#### Local Ecological Knowledge (LEK)

Thirteen fishermen, one harpooner and two SCUBA divers were considered as target stakeholders for LEK in Gökçeada Island. Questionnaires were used in order to gather information from the stakeholders. According to the procedure described by Azzurro (2018) and Azzurro *et al.* (2019), a semistructured questionnaire was used to reconstruct the presence and abundance of the target species. Besides, social media platforms were analyzed, covering the period from

2017 to 2020. The information taken from social media platforms included encountered species, location and date.

### Boat Surveys

While visual observations were performed at intervals for seven days in July and August 2019, acoustic surveys were conducted for two complete days in September 2019. Using an 11-m sailing boat and two different trawling vessels (18-m and 30-m), the selected transects were followed with an average speed of 4 knots (Figure 1). Logger 2010 software was used to record the boat route, sighting information and environmental status.

Visual effort started half an hour before sunrise and finished half an hour after sunset. Visual observations were carried out only in conditions up to Beaufort sea state 4. Observers reported encountered species, group size, behaviour and their estimated distance from the boat as well as anthropogenic presence (boat type and activity in the area). Beaufort sea state, wave and swell height, weather, cloud cover, visibility, barometer, wind speed, wind direction, glare and its intensity, sail angles were recorded every hour and in case that conditions changed. Nikon Action Binoculars (8x42) and a Hooway 7x50 Waterproof Floating Marine Binocular were used for visual sightings.

Acoustic surveys are important due to the low visual encounter rates of these animals. A towed hydrophone array was deployed during surveys. A hydrophone array (Vanishing Point, 30 UK) consisted of four omni-directional broadband hydrophone elements for high and low frequency monitoring mounted within a streamlined housing and towed on a 200 m strengthened cable. PAMGuard software ran on a laptop computer making continuous full bandwidth recordings. One survey team member acting as the PAM operator was responsible for logging the species presence and environmental and anthropogenic noise of the area every 15 minutes, along with the vessel speed.

### Land Observations

Land observations were conducted in July, August and September 2019, and in January 2020 intermittently for 19 days, from the determined high grounds of the island, namely Kaleköy, Tepeköy and Uğurlu (Figure 1), by a group of minimum three researchers. The field team included an observer with a telescope, a behavior and sightings data collector, and a spotter responsible for scanning the sea surface in search of these animals. A telescope (Swarowski – 20x80) was used together with the rangefinder and binoculars.

## **Results**

During the visual surveys conducted in 2019, two individuals of *Xiphias gladius*, nine individuals of *Thunnus thynnus*, a group of *Delphinus delphis* and *Tursiops truncatus* were encountered. Approximately 15 hours of acoustic recording were

carried out. Over 100 acoustic signals (whistles and clicks) of *D. delphis*, *T. truncatus* and *Physeter macrocephalus* were detected (Table 1).

**Table 1.** Number of sightings and acoustic detections recorded in the present study (WT: Winter, SM: Summer, SP: Spring, AU: Autumn)

	SM/2019	AU/2019	WT/2020
<b>SIGHTINGS</b>			
<b>Teleostei</b>			
<i>Xiphias gladius</i>		1	1
<i>Thunnus thynnus</i>	3		6
<b>Mammalia</b>			
<i>Delphinus delphis</i>		20	
<i>Tursiops truncatus</i>		5	
<b>ACOUSTIC DETECTIONS</b>			
<b>Mammalia</b>			
<i>Delphinus delphis</i>		>1	
<i>Tursiops truncatus</i>		>1	
<i>Physeter macrocephalus</i>		>1	

As a result of the interviews and applied questionnaires to the stakeholders together with the records compiled from the relevant social media accounts, a total of 464 individuals were reported. Among them, 103 specimens belonged to seven species of marine mammals (*D. delphis*, *Stenella coeruleoalba*, *T. truncatus*, *P. macrocephalus*, *Ziphius cavirostris*, *Grampus griseus*, *Monachus monachus*) and three specimens to two species of elasmobranchs (*Carcharodon carcharias*, *Isurus oxyrinchus*). Additionally, a total of 358 individuals of two teleost species (*X. gladius*, *T. thynnus*) were reported between the years 2017-2020 (Table 2).

**Table 2.** Species reported with the number of sighted individuals via Local Ecological Knowledge (W: Winter, SM: Summer, SP: Spring, A: Autumn)

Species	2020			2019				2018		2017			Σ
	W	SM	SP	W	SM	A	SP	W	SP	W	SM	SP	
<b>Chondrichthyes</b>													
<i>Carcharodon carcharias</i>							1						1
<i>Isurus oxyrinchus</i>								1				1	2
<b>Teleostei</b>													
<i>Xiphias gladius</i>	1		65				40	41				39	186
<i>Thunnus thynnus</i>	47			40		5	40			40			172
<b>Mammalia</b>													
<i>Delphinus delphis</i>											8		8
<i>Tursiops truncatus</i>			3										3
<i>Stenella coeruleoalba</i>			8	10			6	12					36
<i>Grampus griseus</i>			7	11	12			8			9		47
<i>Physeter macrocephalus</i>				3			2						5
<i>Ziphius cavirostris</i>							2						2
<i>Monachus monachus</i>				1			1						2

According to the LEK results, *S. coeruleoalba* and *G. griseus* were the most encountered cetacean species in spring, while only three specimens of sharks were recorded. Two individuals of *M. monachus* were sighted; one of them close to the shore of Gökçeada Island (Kuzulimanı) and the other between Gökçeada and Samothraki Island.

#### *Remarks on some species*

##### Shortfin mako shark (*Isurus oxyrinchus*)

Two individuals of the species were recorded via social media platform. The first one was filmed in the west of the island on 23 May 2017. It is estimated to be greater than 2.5 m from the video. The picture of the other individual was shared on 4 April 2020 (Figure 2). The size of the photographed individual was estimated about 2 m. According to the morphological characteristics of the individuals in visual materials, the specimens were identified as shortfin mako shark.



**Figure 2.** An individual of shortfin mako, *Isurus oxyrinchus*, reported by a fisherman on 4 April 2020

##### Great white shark (*Carcharodon carcharias*)

In Spring 2019, an individual identified to be a great white shark, based on the fisherman's description as the specimen's comparatively high body depth and its size being larger than 5 m, it was listed as the second lamnid observed in the area.

##### Swordfish (*Xiphias gladius*)

In total 186 individuals were observed in the area and most of them were recorded by harpooners in the last three years. Swordfish fishing season in the island is between March and June. Therefore most of the observations belong to spring season.

Atlantic bluefin tuna (*Thunnus thynnus*)

After the swordfish in the region, the second most common marine top predator is the Atlantic bluefin tuna. The numbers of the observed individuals were 172. The species was frequently encountered in the north and west of the island during the winter months.

Common dolphin (*Delphinus delphis*)

More than 20 individuals of common dolphins were acoustically detected and visually sighted while following the transects in October 2019. In the summer of 2017, they were also sighted by fishermen in a group of 7 (LEK).

Bottlenose dolphin (*Tursiops truncatus*)

Three individuals of bottlenose dolphins were reported by a diver from the north of the island (Tepeköy) in the summer of 2020 (LEK). Five individuals were encountered at the same spot (Tepeköy), during the land observations in October 2019, swimming very close to the shore.

Striped dolphin (*Stenella coeruleoalba*)

A total of 36 striped dolphins were reported around the island by divers in the spring of 2017, 2018, 2019, 2020 and summer of 2020.

Risso's dolphin (*Grampus griseus*)

In the summers of 2017, 2019 and 2020, a total of 28 Risso's dolphins were recorded while another 19 of them were recorded in the spring of 2018 and 2020 (Figure 3).



**Figure 3.** Risso's dolphin, *Grampus griseus*, swimming close to a diver in the north of Gökçeada (Photographer: Selim Konya, June 18, 2017).

Sperm whale (*Physeter macrocephalus*)

During the survey in 2019, sperm whales were acoustically detected. According to the LEK results, in the spring of 2019 and 2020 five sperm whales were visually encountered. Three of them were encountered on the North Aegean Trough, close to Limnos Island in 2020, while the other two were encountered off to Saros Bay in 2019.

Cuvier's beaked whale (*Ziphius cavirostris*)

Two individuals of Cuvier's beaked whale, one being a calf, were encountered on the North Aegean Trough.

Mediterranean monk seal (*Monachus monachus*)

One Mediterranean monk seal specimen was encountered swimming very close to the shore of Kuzulimanı in the autumn of 2019, while another one was encountered by a swordfish harpooner between Samothraki and Limnos Islands.

## Discussion

According to the results of this study, more than 500 individuals belonging to three main groups (Chondrichthyes, Osteichthyes, Mammalia) were reported through LEK and field surveys conducted in and around Gökçeada Island.

Among chondrichthyans, the information on *C. carcharias* and *I. oxyrinchus* was provided by fishermen. These species constitute the family Lamnidae together with *Lamna nasus* (Bonnaterre, 1788); three top predators of the Mediterranean Basin. Kabasakal and Kabasakal (2013) and Tunçer and Kabasakal (2016) gave the first records of *I. oxyrinchus* in the North Aegean Sea. Later, its occurrence was verified with several records, which suggested the area as a possible mating region for the Lamniform sharks (Kabasakal 2015). Besides, the presence of *L. nasus* was previously confirmed by Kabasakal and Kabasakal (2004) from Bozcaada Island. However, we could not obtain any data on the encounter of this rare lamnid from Gökçeada Island. Additionally, all of the recent records of the *I. oxyrinchus* and the *C. carcharias* were reported from the North Aegean Sea along the Turkish waters. Besides them, there are more species to be found in the region such as *Prionace glauca*, *Alopias vulpinus*, *Sphyrna zygaena* and *Carcharias taurus* (Ulutürk 1987; Kabasakal and Kabasakal 2004; İşmen *et al.* 2009; Gönülal 2017; Kabasakal 2019, 2020).

The results of this study also revealed that several vulnerable species are commonly observed around Gökçeada Island, such as *X. gladius* (186), *T. thynnus* (172), *G. griseus* (47) and *S. coeruleoalba* (36). Among them, *X. gladius* is caught by traditional methods (harpooning) in the island. In the 1980s, harpooning became very popular in Gökçeada Island (Akyol 2014) and it is the only spot in Turkey where swordfish harpooning still takes place. The catch of *X. gladius* which is highly valuable both in terms of ecosystem and commercial interest is regulated by the ICCAT (The International Commission for the Conservation of Atlantic Tunas). We have received 186 sighting reports of *X. gladius* in the last three years from fishermen and harpooners.

Another commonly observed species, *T. thynnus*, was reported by fishermen during the winter season. They stated that they encounter tunas very often at the north of the island. Conversations with the fishermen implied that tunas are



probably much more abundant than they have been recorded, but long-term monitoring effort is needed to achieve reliable data. Another reason they were mostly encountered in the winter season may be due to the fishing ban during spring and summer.

According to the LEK results, we have concluded that fishermen do not observe any specific distinctions among the dolphin species; the only distinction they notice is between dolphins and whales. On the other hand, harpooners and divers are more interested in these species, hence they recognize almost all top predators at the species level.

During the visual and acoustic surveys, we detected over 100 acoustic signals. However, we only sighted two different groups of *D. delphis* and *T. truncatus* visually. Therefore, the acoustically detected delphinids could not be presented with a specific number of individuals and shown as “>1”. Besides, there can be whistle similarities as well as whistle separations within the group members of the same species of delphinids due to geographic and/or social isolations, or distinct environmental conditions such as ambient noise levels (Zaretsky *et al.* 2005). Two individuals of *P. macrocephalus* were also acoustically detected. However, the detection was out of the range of the hydrophone to record the click trains. Up to date, there were two records of *P. macrocephalus* around Gökçeada Island (Öztürk *et al.* 2013). The first acoustic survey carried out in the North Aegean Sea in 2013, however, did not detect any *P. macrocephalus* (Ryan *et al.* 2013). This study, thus, provides the first acoustic detection of a sperm whale in the North Aegean Sea and provides the third record after nine years since the last record in the Turkish waters. Furthermore, *Pseudorca crassidens* (Dede *et al.* 2020) and *Z. cavirostris* (Öztürk *et al.* 2011, Öztürk and Tonay 2019) which are considered as top predators also inhabit the island surroundings. Yet, no recent data on these species were obtained in this study.

Even though the LEK surveys may embody perceptions or concerns of local communities (Azzurro 2018), stakeholders such as fishermen can provide important observations, especially to document changes in marine ecosystems (Damalas *et al.* 2015) without conducting long-term monitoring studies. The Mediterranean Sea offers an interesting field of research in this sense, by providing valuable information for assessing poorly studied localities and filling the knowledge gaps on data deficient species (Azzurro *et al.* 2011). In the Mediterranean, LEK has become a very popular tool to collect information on a variety of subjects that need long-term monitoring efforts (Azzurro *et al.* 2011, 2019; Boughedir *et al.* 2015; Azzurro and Bariche 2017; Crocetta *et al.* 2017; Giovos *et al.* 2019; Sbragaglia *et al.* 2020; Spyridopoulou *et al.* 2020). However, few studies have been conducted in the Turkish waters (Killi *et al.* 2018; Mavruk *et al.* 2018; Kabasakal and Bilecenoğlu 2020) and the current study is among the very few in the area.

Studies on the presence of the marine top predators mostly present first records or range expansions. There has been only one research that subjected all top predators in the Turkish waters up to date (Ceyhan *et al.* 2020). Hence, this is the second study on marine top predators with a holistic approach, in the Turkish waters. Besides, the paper provides a new perspective regarding future management or conservation actions for marine top predators in Gökçeada Island through the scientific data collection and LEK.

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## Gökçeada (Kuzey Ege Denizi) etrafındaki denizel üst predatörler üzerine bir ön çalışma

### Öz

Köpekbalıkları, teleostlar ve deniz memelileri gibi denizel üst predatörler, sağlıklı bir ekosistemin göstergeleridir. Bu araştırmanın amacı, yeterince çalışılmamış bir alan olan ve Kuzey Ege Denizi'nde bulunan Gökçeada etrafındaki üst predatörler ile ilgili bilgi eksikliğini tamamlamaktır. Denizel üst predatörler hakkındaki verinin büyük bir kısmı Yerel Ekolojik Bilgi aracılığıyla toplanmıştır. Ayrıca 2019 yaz ve sonbaharında ve 2020 kışında görsel ve akustik arazi çalışmaları gerçekleştirilmiştir. Sosyal medya platformları ve paydaş anketleri ile toplam 464 birey rapor edilmiştir. Yapılan gözlemler sırasında iki birey *Xiphias gladius*, dokuz birey *Thunnus thynnus*, bir grup *Delphinus delphis* ve *Tursiops truncatus* ile karşılaşmıştır. Yaklaşık 15 saatlik akustik kayıt sırasında *D. delphis* ve *T. truncatus* 'un yanında *Physeter macrocephalus* tespit edilmiştir. *Carcharodon carcharias*, *Isurus oxyrinchus*, *X. gladius*, *T. thynnus*, *D. delphis*, *Stenella coeruleoalba*, *T. truncatus*, *Grampus griseus*, *P. macrocephalus*, *Ziphius cavirostris*, *Monachus monachus* türleri listelenmiştir. 2017-2020 yılları arasında toplam 358 birey ile en fazla *X. gladius* ve *T. thynnus* türlerine rastlanmıştır.

**Anahtar kelimeler:** Denizel üst predatör, köpekbalıkları, büyük kemikli balıklar, deniz memelileri, yerel ekolojik bilgi

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