J. Black Sea/Mediterranean Environment
Vol. 29, No. 1: 87-120 (2023)

RESEARCH ARTICLE

Biodiversity and structure of macrofauna in the Karaburun-Ildır Bay Special Environmental Protected Area and adjacent waters (Central Aegean Sea-Türkiye)

Çetin Keskin[1*], Onur Gönülal[1, 2], Muammer Oral[1], Bülent Topaloğlu[1, 2], Cem Dalyan[3]

ORCID IDs: Ç.K. 0000-0002-2434-0355; O.G. 0000-0002-1621-0892; M.O. 0000-0001-8658-2651; B.T. 0000-0001-6620-8072; C.D. 0000-0002-7386-5641

[1] Faculty of Aquatic Sciences, Istanbul University, Onaltı Mart Şehitleri Cad. No: 2, 34134 Vezneciler Fatih/Istanbul, TÜRKİYE
[2] Turkish Marine Research Foundation (TUDAV), P.O. Box: 10, Beykoz, Istanbul, TÜRKİYE
[3] Faculty of Science, Istanbul University, 34134, Vezneciler Fatih/Istanbul, TÜRKİYE

***Corresponding author:** seahorse@istanbul.edu.tr

Abstract

In this study, which was carried out in the Karaburun-Ildır Bay Special Environmental Protected Area (SEPA) and adjacent waters, the diversity of marine macrofauna and the structure of demersal assemblages were investigated. The samplings were carried out in May 2022 and September 2022. A total of 179 species were identified (121 fish, 58 invertebrates). *Penaeus pulchricaudatus, Bregmaceros nectabanus, Champsodon nudivittis, Callionymus filamentosus* and *Planiliza haematocheilus* are non-indigenous species in the study area. *Raja radula, Mustelus mustelus, Thunnus thynnus* and *Epinephelus marginatus* are among the threatened fishes in the IUCN Red List. The analysis on demersal community showed that demersal assemblage of the shallow shelf was different from the assemblage of the upper slope and diversity is higher on the shallow shelf than on the upper slope. Species assemblages include commercial species such as *Merluccius merluccius*, *Parapenaeus longirostris*, and *Mullus barbatus*.

Keywords: Bottom trawl survey, demersal fauna, conservation, Eastern Mediterranean Sea

Received: 08.04.2023, **Accepted:** 30.04.2023

Introduction

The protection and management strategies for Mediterranean areas are based on Special Protected Areas (SPAs). These SPAs are governed by two elements: The European Union Directive on the Conservation of Wild Birds and the United Nations Convention on Biodiversity. The latter ensures the conservation of biodiversity and the fair sharing of benefits from genetic resources (UNEP 2021a). Specially Protected Areas of Mediterranean Importance (SPAMIs) are specific sites in the Mediterranean Sea that are crucial for conserving biological diversity. They encompass unique Mediterranean ecosystems, habitats of endangered species, and hold scientific, aesthetic, cultural, or educational significance (MEDPAN 2021).

The Aegean Sea is one of the north extension of oligotrophic Eastern Mediterranean Sea, which has two different biogeographic areas depending on its heterogenic topography and complex oceanography (Stergiou and Pollard 1994). Many gulf and bays along the coast of the Aegean Sea serve as unit habitats that are important areas for biodiversity and nursery areas including sensitive habitats for endangered and vulnerable species from lowest trophic level (e.g. Mediterranean pillow coral) to top predators (e.g. Atlantic bluefin tuna, Mediterranean monk seal, dolphins). Many problems, such as overfishing (Öztürk *et al.* 2001), illegal fishing (Keskin and Aktan 2018) by-catch (Akyol and Kara 2003; Damalas and Vassilopoulou 2011), oil pollution (Öztürk *et al.* 2007), non-indigenous species (Öztürk 2021), eutrophication (Koray and Cihangir 2002; Balopoulos and Friligos 1993), marine litter (Gönülal *et al.* 2016), habitat destruction and modification (Dural *et al.* 2012; Voultsiadou *et al.* 2013) and climate change (Keskin and Pauly 2018; Tsikliras *et al.* 2015) need management plans with holistic approaches to recover systems and components including all trophic levels of marine communities in the Aegean Sea.

Globally, marine protected areas accept the main tool to protect biodiversity, mitigation to effect of climate change (Simard *et al.* 2016) and a management tool for sustainable use of natural resources (FAO 2011; Jones *et al.* 2022). In past decades, 8.33% of the surface area of the Mediterranean Sea (209.303 km^2/1.087 officially) was designated as marine protected areas (Figure 1) (MEDPAN 2021).

In Türkiye, 19 special protected areas have been declared since 1988, out of 11 are both land and marine areas, beside seven of them are on the land, one of them is mainly in Exclusive Economic Zone (EEZ) in the Eastern Mediterranean Sea of Türkiye (Finike Seamount SEPA). Along the coastal areas of the Aegean Sea SEPAs are in Saros Bay in the northern, in Foça and Karaburun-Ildır Bay in the central, and in Gökova and Datça, in the southern part.

To elaborate an effective management plan for the protection of the SEPAs, research and monitoring have been initiated in the areas as well as in its surrounding waters by the Turkish Ministry of Environment, Urbanization and Climate Change. In this framework, a monitoring study in the Karaburun-Ildır Bay SEPA was carried out in May 2021 and September2022 on the research vessel R/V YUNUS-S of Istanbul University. Here, the represented results of the biodiversity and community structures of marine macrofauna is the first monitoring study in the area.

The lack of comprehensive studies on fish species around the Karaburun Peninsula hampers our ability to assess the region's biodiversity accurately. A thorough investigation is crucial to determine the species composition, population dynamics, and ecological interactions of fish in this area. Such research would contribute valuable insights into the conservation and management of marine resources, aiding in the development of sustainable fishing practices and the protection of vulnerable species.

Figure 1. The location of Mediterranean Marine Protected Areas in 2020 (MedPAN 2021). This map was modified to update by adding the newly protected areas in Türkiye; Finike Seamounts SEPA and the Sea of Marmara SEPA designated by TMEUC in 2013 and 2021 respectively.

Materials and Methods

Study area

The Karaburun-Ildır Bay SEPA, which was declared on 15 March 2019 (Official Gazette of the Republic of Turkey No. 30715), is located in the central Aegean Sea. The Karaburun Peninsula is the largest land recess extending towards the Aegean Sea (Soykan *et al*. 1993).

Marine surface area of the SEPA is 503.23 km^2 (total surface is 946.56 km^2 with land), and its maximum depth is about 95 m (Figure 2). Oceanographic characteristics of this area are indicated to be slightly warmer than the North Aegean Sea and colder than the Southern Aegean Sea. The salinity is very close in the southern Aegean Sea waters. In the surface water, salinity ranges from 38.4 to 39.4 psu, and temperature is between 16 -24 ºC (Eronat and Sayın 2014).

The oceanographic features of marine water of the Karaburun-Ildır Bay SEPA are influenced by water characteristics in the outer part of Izmir Bay and the Aegean Sea. The Aegean Sea surface waters flow from the coast of Karaburun to Izmir Bay, and follow the path along the coast up to the Mordoğan Passage. A homogeneous vertical water column due to winter convection in the winter period is characterised with stratified two-layered water masses in the summer period. The temperature difference between the surface and deeper layers is about 10°C, and the thermocline depth is nearly 20 m in this area (Eronat 2017).

Coastal and marine areas in the Karaburun-Ildır Bay SEPA are important habitats and breeding areas for the endangered and internationally protected species (Anonymous 2023).

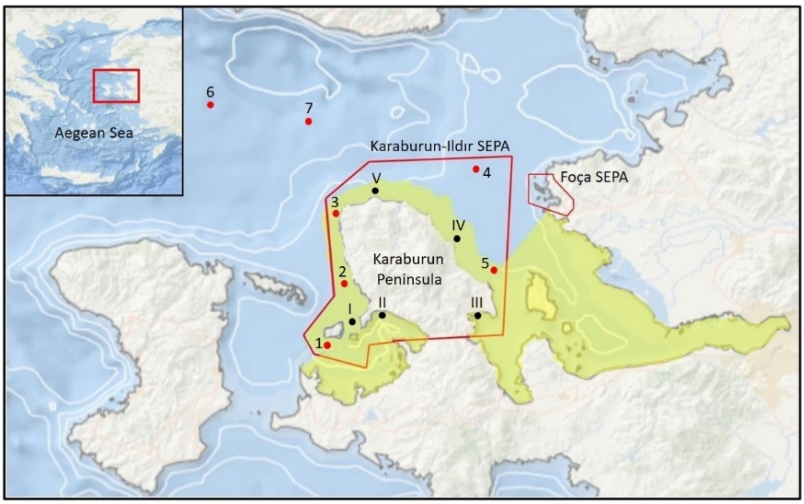

Figure 2. Sampling stations and border of the Karaburun-Ildır Bay SEPA in the Central Aegean Sea. Bottom trawl banned areas was highlighted in yellow colour on the map. (Red dots: Bottom trawl hauls; Black dots: Beam trawl hauls)

Sampling

Two different sampling strategies were employed to study the fish communities in the SEPA and adjacent waters during May and September 2022. The first strategy involved collecting the information on marine macrofauna species using various methods such as bottom trawl, beam trawl, recording visual observations during the surveys, snorkelling in near shore coastal waters within the SEPA, and documenting species sold at fish markets. The second strategy focused on analyzing the demersal community structure using data collected from bottom trawl surveys. The trawl gear used followed the MEDITS protocol (MEDITS 2017). A total of 14 hauls were conducted during daylight hours, covering depths ranging from 58 to 354 m (Table 1). Each trawl lasted between 15 to 30 minutes, with an average towing speed of approximately 2.3 knots. The starting and ending coordinates of each trawl were recorded using a Global Positioning System (GPS). The catch data were standardized to a swept area (km^2) based on the commonly employed methodology for studying demersal assemblages in the Mediterranean, as demonstrated in previous research by Bertrand *et al.* (2002).

Table 1. Locations of sampling stations and characteristics of the hauls examined in Karaburun-Ildır Bay SEPA and adjacent waters in the central Aegean Sea in May and September 2022

Station No*	Latitude (N)	Longitude (E)	Mean depth (m)	Tow duration (hour)	Swept area (km^2)
1)T1 & T8	N 38° 24, 049’ N 38° 24, 488’	E 26° 20, 201’ E 26° 21, 563’	63	0.33	0.014 / 0.014
2)T2 & T9	N 38° 30, 144’ N 38° 31, 110’	E 26° 20, 926’ E 26° 20, 011’	60	0.27	0.012 / 0.014
3)T3**&T10	N 38° 39, 623’ N 38° 38, 947’	E 26° 20, 248’ E 26° 20, 102’	78	0.33	- / 0.014
4)T4 & T11	N 38° 43, 541’ N 38° 43, 371’	E 26° 38, 081’ E 26° 36, 407’	74	0.33	0.014 / 0.014
5)T5& T12	N 38° 33, 629’ N 38° 34, 714’	E 26° 39, 823’ E 26° 37, 943’	58	0.33	- / 0.012
6)T6 & T13	N 38° 49, 936’ N 38° 51, 670’	E 26° 04, 374’ E 26° 11, 223’	280	0.50	0.021 / 0.021
7)T7 & T14	N 38° 48, 464’ N 38° 50, 202’	E 26° 13, 232’ E 26° 19, 972’	354	0.50	0.021 / 0.021
I)A1 & A6	N 38° 27, 085’ N 38° 26, 822’	E 26° 22, 461’ E 26° 23, 168’	70	0.33	- / -
II)A2 & A7	N 38° 27, 463’ N 38° 26, 886’	E 26° 26, 148’ E 26° 26, 909’	48	0.33	- / -
III)A3 & A8	N 38° 27, 833’ N 38° 27, 506’	E 26° 36, 472’ E 26° 37, 288’	26	0.33	- / -
IV)A4 & A9	N 38° 36, 365’ N 38° 35, 910’	E 26° 33, 934’ E 26° 34, 767’	42	0.33	- / -
V)A5 & A10	N 38° 41, 036’ N 38° 41, 296’	E 26° 24, 802’ E 26° 24, 925’	72	0.33	

*T: Bottom trawl stations, A: Beam trawl stations

**The hauls could not be carried out effectively, so the collected species were considered only for biodiversity.

Data analysis

Community analyses were carried out using the PRIMER package (Clarke and Warwick 2001). A standardised abundance data matrix of demersal species was created for 12 hauls. Species encountered only in one sample or considered as pelagic were removed from the data matrix. Macrofaunal assemblages were identified by using Cluster analysis and non-metric multidimensional scaling (MDS) based on the $\log(x + 1)$ transformed data. The Bray–Curtis index was used as a between haul similarity measure. The unweighted pair-group method with arithmetic mean (UPGMA) was determined as the clustering algorithm. Similarity percentage analysis (SIMPER) was applied to determine which species characterise the groups detected. The mean values of abundance (individuals.km^2), species richness, Shannon–Wiener diversity index (H′; Shannon and Weaver 1949) and evenness (J′; Pielou 1969) were estimated for each assemblage detected in the cluster analysis.

Results and Discussion

Macrofauna

In the present study; a total of 179 taxa composed of 121 fishes and 58 invertebrates were recorded from the bottom trawl and beam trawl hauls, observations at the sea surface during the survey from the research vessel, snorkelling in the near shore coastal waters, and fish markets in the Karaburun-Ildır Bay SEPA, and adjacent waters. A taxonomic list of these species, their origin and IUCN categories are shown in Annex. In the last decade, 132 species were reported in the Karaburun-Foça region from bottom trawl surveys (Kınacıgil *et al.* 2013). Higher number of species in the present study may be associated with diverse sampling methods indicated above.

Considering IUCN status of the listed invertebrates, the tall sea pen *Funiculina quadrangularis* and the red sea pen *Pennatula rubra* have been assessed as "Vulnerable" species in the IUCN Red List of Threatened Species (Cerrano *et al.* 2015). The tall sea pen is a highly significant colonial cnidarian, which is adapted to sheltered mud habitats between 20 - 2000 m on the outer continental shelf and slope in the Atlantic Ocean and in the Mediterranean Sea (Cairns and Bayer 2009; Ager 2003). Its tall calcareous axials form dense forests on muddy bottom, and these forests are sensitive and essential habitats for commercially important species, the Norway lobster and the deep-water pink shrimp (Norway lobster and Deep-water rose shrimp, respectively). The red sea pen fields enhance spatial heterogeneity on flat soft bottoms, provide shelter for small sized species in shallow and deeper water on the continental shelf between 40 and 200 m depths. The main threat for soft bottom corals such as sea pens is the mechanical disturbance from demersal fishing activities particularly bottom trawling in the Mediterranean Sea (Hughes 1998; Papacostantinou 1990; Ceriola *et al.* 2008; Chimienti *et al.* 2018).

Among the listed species, the fishes, *Mustelus mustelus* (Jabado *et al.* 2021a), *Raja radula* (Mancusi *et al.* 2016), and *Thunnus thynnus* (Collette *et al.* 2021) are listed as "Endangered" in the IUCN Red List. These are the apex predators having sensitive populations in the area. On the other hand; *Hexanchus griseus* a "Near Threatened" species (Finucci *et al.* 2020) and *Bathytoshia lata*, "Vulnerable" species (Jabado *et al.* 2021b) in the IUCN Red List had been recorded in the previous studies carried out in the area (Kabasakal 2004; and Akyol *et al.* 2017; respectively). In addition, *Prionace glauca* and *Rhinobatos rhinobatos* were previously recorded from adjacent waters of SEPA (Kabasakal 2002). *Prionace glauca* is evaluated as "Near Threatened" category (Rigby et al. 2019), while *Rhinobatos rhinobatos* (Jabado *et al.* 2021c) is evaluated as "Critically Endangered". *Prionace glauca* is also considered as a faunal element that needs to be protected in the Appendix-III of the Bern Convention.

Biodiversity and species composition in the Mediterranean Sea have been changing due to global warming and human impacts, such as the opening of the Suez Canal, in the last decades. Abundance and distribution of subtropical and tropical non-indigenous species in the warm-temperate Mediterranean water increased, due to the combined effect of climate change and anthropogenic actions (Bianchi 2007). Nowadays, non-indigenous species are one of the most effective drivers of biodiversity loss and species extinctions (UNEP 2021b). In the present study, *Penaeus pulchricaudatus* has been found in SEPA. This species was introduced via the Suez Canal, thus its population in the Mediterranean was originated from the Red Sea stock and contributing to the wider phenomenon of Lessepsian migration (Galil 2009; Tsoi *et al.* 2014). The present study reports the cryptic *P. pulchricaudatus* from the central Aegean Sea, providing strong evidence for its establishment in the area.

The population of indigenous penaeid species, such as *Penaeus kerathurus*, has been negatively impacted by the invasion of non-indigenous species (Duruer *et al.* 2008).

In fishes, *Bregmaceros nectabanus, Champsodon nudivittis, Callionymus filamentosus* and *Pterois miles* are non-indigenous species originated from the Indo-Pacific, while *Planiliza haematocheilus* originated from the western Pacific. *Pterois miles* are venomous fish and spread in the Mediterranean Sea from the eastern part to northward. The fish was firstly observed in the southern Aegean Sea in 2015 (Turan *et al.* 2017).

The geographic expansion of Indo-Pacific fishes in the Mediterranean Sea clearly reflects the main hydrological characteristics of particular sub areas. The number of Indo-Pacific species has decreased from the north-eastern Levantine towards the west, and then this decreasing trend continues in the Aegean Sea from south to north (Corsini-Foka *et al.* 2010). Naturally, the number of non-indigenous species were few in the study area, located in the central Aegean Sea, compared with the southern Aegean Sea.

Planiliza haematocheilus is an euryhaline species originating from the western Pacific, which was introduced to the Sea of Azov for aquaculture (Golani *et al.* 2002). Population of the species managed to establish in the Black Sea in the 1990s, and then, crossed the Sea of Marmara and spread in the North Aegean Sea (Minos *et al.* 2010). The fish was recorded from Foça and Homa Lagoon in the central Aegean Sea in 1998 (Kaya *et al.* 1998). Today, this fish is of commercial interest in the Karaburun-Ildır Bay SEPA, and adjacent waters.

Sparisoma cretense, as a thermophilic fish species was also observed in the SEPA. This species is native to the Mediterranean Sea along the eastern and southern coasts. Its ongoing expansion toward northward was related to global warming (Esposito *et al.* 2021). The species was recorded from Dikili Bay coastal waters of the North Aegean Sea in 2019 (Tuncer *et al.* 2020).

Structure of demersal community

Demersal macrofauna was investigated from 12 bottom trawl samplings in May and September 2022 at the depths of 58 to 354 m (Table 2). A total of 5355 individuals (87.11 kg) belonging to 58 invertebrate species were collected from bottom trawl hauls. *Antedon mediterranea, Axinella verrucosa* and *Loligo vulgaris* were common invertebrates while *Echinaster sepositus, Ethusa mascarone, Goneplax rhomboides* and *Marthasterias glacialis* were rarely encountered.

A total of 11242 individuals (349.93 kg) belonging to 88 fish species were collected from bottom trawl hauls, represented by *Serranus hepatus* and *Merluccius merluccius*, with 75% frequency, while *Gaidropsaurus biscayensis, Galeus melastomus, Gymnura altavela, Lepidorhombus whiffiagonis, Myctophum punctatum, Nettastoma melanura, Pteromylaeus bovinus,* and *Scorpaena porcus* were rarely encountered with only one individual (Table 2).

Considering the whole catch, *Diplodus annularis, Mullus barbatus, Cholorophthalmus* agassizi, and *Parapenaeus longirostris* were the most important species, both in terms of number of individuals and weight, followed by *Gadiculus argenteus, Serranus, hepatus*, and *Pagellus acarne*, in terms of abundance, and by *Gymnura altevela* and *Merluccius merluccius*, in terms of biomass (Table 2).

Cluster analysis indicated that the samples could be attributed to two main groups (Figure 3A). The discernible cluster comprised deep-water samples (280-354 m) from upper slope (US) distinct from shallow water samples (58-78 m) (SS: shallow shelf). The MDS confirmed the presence of these two groups of samples (Figure 3B).

Table 2. Invertebrate and fish species caught by bottom trawling around Karaburun-Ildır Peninsula in the Central Aegean Sea. Total number of individuals (N), total wet weight (W, kg), PD: presence degree of species, the frequency of appearance (F, percentage of hauls), D: depth range; *pelagic species.

Invertebrates	**N**	**W (kg)**	**PD**	**F%**	**D**	**Invertebrates**	**N**	**W(kg)**	**PD**	**F%**	**D**
Acanthella acuta	-	0.02	5	42	58-74	*Illex coindetii*	94	10.25	4	33	280-354
Aegaeon lacazei	5	0.01	2	17	280-354	*Luidia sarsii*	9	0.77	4	33	280-354
Alcyonium palmatum	14	0.05	5	42	60-78	*Loligo vulgaris*	23	3.97	6	50	58-78
Antedon mediterranea	46	0.05	7	58	58-78	*Marthasterias glacialis*	1	0.21	1	8	280
Ascidia virginea	72	1.73	5	42	58-78	*Medorippe lanata*	5	0.02	3	25	280-354
Ascidiacea sp.	11	0.04	3	25	60-78	*Munida tenuimana*	3	0.00	2	17	280-354
Astropecten aranciacus	6	0.07	4	33	58-78	*Nephrops norvegicus*	29	1.73	4	33	280-354
Astropecten irregularis	4	0.54	4	33	58-280	Nudibranchia sp.	2	0.07	2	17	78
Axinella verrucosa	13	0.19	7	58	58-78	*Octopus vulgaris*	8	3.94	5	42	58-78
Axinella damicornis	3	0.03	2	17	63-78	Pleurobranchida sp.	1	0.00	1	8	78
Botryllus schlosseri	3	0.12	2	17	58-63	*Parapenaeus longirostris*	3624	27.48	4	33	280-354
Bolinus brandaris	6	0.05	3	25	60-78	*Parastichopus regalis*	22	0.97	3	25	58-354
Bryozoa sp.	0	0.01	1	8	78	*Penaeus kerathurus*	14	1.16	1	8	58
Cacospongia mollior	6	-	4	33	58-280	*Phallusia mammillata*	26	0.71	2	17	74-78
Chlorotocus crassicornis	2	0.00	2	17	280-354	*Pennatula rubra*	3	0.06	1	8	354
Cidaris cidaris	53	0.64	4	33	280-354	*Penaeus pulchricaudatus*	3	0.77	1	8	78
Eledone cirrhosa	72	4.35	2	17	280-354	*Pilumnus hirtellus*	6	0.02	3	25	60-78
Ethusa mascarone	3	0.00	1	8	280	*Plesionika martia*	124	0.31	4	33	280-354
Didemnidae sp.	0	0.04	3	25	58-74	*Pteroeides griseum*	7	0.03	5	42	60-63
Dictyonella sp.	0	0.02	3	25	58-63	*Rondeletiola minor*	35	1.95	4	33	280-354
Echinaster sepositus	1	0.01	1	8	58	*Rossia macrosoma*	101	0.22	4	33	280-354
Eledone cirrhosa	120	8.47	2	17	280-354	*Spatangus purpureus*	2	0.10	1	8	280-354

Table 2. Continued

Invertebrates	N	W	PD	F%	D	Invertebrates	N	W	PD	F%	D
Funiculina quadrangularis	17	0.05	2	17	280-354	*Sepia orbignyana*	29	1.04	4	33	280-354
Galathea dispersa	5	0.00	3	25	280-354	*Sepia officinalis*	11	2.19	5	42	63-78
Goneplax rhomboides	1	0.02	1	8	354	*Solenocera membranacea*	5	0.07	1	8	280
Haliclona mediterranea	34	0.07	4	33	58-74	*Sphaerechinus granularis*	7	0.09	2	17	280-354
Halocynthia papillosa	13	2.02	4	33	58-74	*Spatangus purpureus*	24	0.72	4	33	280-354
Harmothoe sp.	2	0.00	2	17	78-280	*Squilla mantis*	600	9.59	4	33	280-354
Hidrozoa	22	0.06	4	33	280-354	*Suberites domuncula*	3	0.01	2	17	78
Fishes						**Fishes**					
Argentina sphyraena	26	0.42	3	25	280-354	*Gobius bucchichi*	62	0.32	3	25	58-78
Arnoglossus imperialis	14	0.06	1	8	58	*Gobius niger*	96	0.76	2	17	60
Arnoglossus kessleri	17	0.16	2	17	60	*Gymnura altavela*	1	50.28	1	8	78
Arnoglossus laterna	227	1.28	4	33	58-78	*Helicolenus dactylopterus*	14	0.66	2	17	280
Arnoglossus rueppeli	32	0.38	1	8	280	*Hoplostethus mediterraneus*	2	0.01	1	8	28
Arnoglossus thori	102	0.48	3	25	60	*Hymenocephalus italicus*	70	0.25	3	25	280-354
*Belone belone**	4	0.23	1	8	78	*Lepidopus caudatus*	10	1.11	2	17	280-354
Blennius ocellaris	28	0.35	4	33	58-78	*Lepidorhombus boscii*	107	3.44	3	25	280-354
Boops boops	256	5.56	6	50	58-78	*Lepidorhombus whiffiagonis*	1	0.09	1	8	354
Buglossidium luteum	26	0.16	1	8	78	*Lepidotrigla cavillone*	22	0.36	4	33	60-280
Callionymus filamentosus	47	0.58	1	8	354	*Lophius budegassa*	5	8.17	3	25	63-354
Callionymus pusillus	1	0.00	1	8	63	*Macroramphosus scolopax*	13	0.04	3	25	60-354
Capros aper	255	1.07	4	33	58-354	*Merluccius merluccius*	193	19.63	9	75	58-354
Cepola macrophthalma	36	0.57	4	33	58-78	*Microchirus ocellatus*	42	1.12	2	17	60
Champsodon nudivittis	22	0.18	4	33	58-354	*Micromesistius poutassou*	2	0.09	1	8	354
Chelidonichthys lastoviza	25	1.11	4	33	58-74	*Monochirus hispidus*	6	0.14	3	25	63-280

Table 2. Continued

Fishes	N	W	PD	F%	D	Fishes	N	W	PD	F%	D
Chelidonichthys lucerna	18	0.62	4	33	63-354	*Mullus barbatus*	1407	35.66	8	67	58-280
Chelidonichthys cuculus	52	0.80	3	25	74-354	*Mullus surmuletus*	92	4.19	2	17	60-78
Cholorophthalmus agassizi	1462	33.58	4	33	280-354	*Mustelus mustelus*	3	2.15	2	17	60
Citahrus linguatula	179	2.80	7	58	58-78	*Myctophum punctatum*	1	0.00	1	8	354
Coelorinchus caelorhincus	282	5.10	4	33	280-354	*Nettastoma melanura*	1	0.37	1	8	74
Conger conger	8	0.66	5	42	63-354	*Pagellus acarne*	798	15.48	6	50	60-78
Deltentosteus quadrimaculatus	31	0.09	2	17	60-78	*Pagellus bogaraveo*	2	0.07	2	17	58-280
Dentex maroccanus	253	5.13	6	50	58-78	*Pagellus erythrinus*	262	16.81	4	33	60-78
Dentex macrophthalmus	49	3.01	2	17	60-74	*Peristedion cataphractum*	5	0.11	2	17	280
Diplodus annularis	1189	40.64	7	58	58-78	*Phycis blennoides*	115	2.49	4	33	280-354
Diplodus vulgaris	37	2.11	1	8	63	*Pteromylaeus bovinus*	1	1.20	1	8	60
Engraulis encrasicolus	254	2.18	5	42	58-78	*Raja radula*	2	0.74	1	8	60
Gadiculus argenteus	849	4.89	4	33	280-354	*Raja asterias*	3	4.05	1	8	60
Gaidropsarus biscayensis	1	0.01	1	8	280	*Raja clavata*	6	7.27	2	17	60-354
Galeus melastomus	1	0.06	1	8	354	*Raja miraletus*	7	2.34	1	8	60
*Sardina pilchardus**	57	1.01	6	50	58-78	*Spicara smaris*	121	2.83	5	42	58-78
*Sardinella aurita**	6	0.14	1	8	78	*Spondyliosoma cantharus*	3	0.07	1	8	78
*Scomber colias**	2	0.34	1	8	58	*Symphurus nigrescens*	45	0.42	7	58	58-354
Scorpaena notata	53	1.00	7	58	58-78	*Synchiropus phaeton*	84	0.96	2	17	78-280
Scorpaena porcus	1	0.18	1	8	58	*Torpedo marmorata*	14	1.58	4	33	58-78
Scyliorhinus canicula	43	4.90	5	42	58-354	*Trachinus draco*	5	0.60	2	17	60-63
Scyliorhinus stellaris	54	5.77	3	25	58-78	*Trachurus mediterraneus**	14	0.87	3	25	60-78
Serranus cabrilla	40	1.77	6	50	58-78	*Trachurus trachurus**	110	2.53	5	42	58-280
Serranus hepatus	838	7.71	9	75	58-354	*Trigla lyra*	3	0.16	1	8	280
Solea solea	26	8.11	3	25	60-63	*Trigloporus lastoviza*	1	0.06	1	8	63

Table 2. Continued

Fishes	N	W	PD	F%	D	Fishes	N	W	PD	F%	D
Sparus aurata	2	0.27	1	8	63	*Trisopterus capelanus*	4	0.12	1	8	58
Spicara flexuosa	390	7.53	5	42	58-78	*Uranoscopus scaber*	5	1.02	4	33	60-63
Spicara maena	179	5.28	4	33	58-78	*Zeus faber*	8	1.03	5	42	58-280

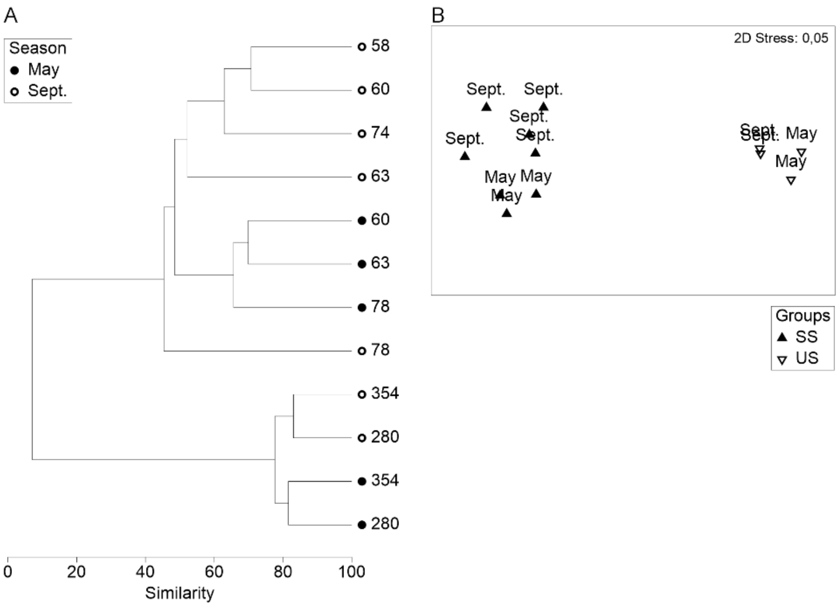

Figure 3. Dendrogram (A) and two-dimensional non-metric multidimensional scaling ordination (B) based on fish standardised species abundance. Labels show the mean depths (m) and sampling period (May 2022 and September 2022) for each sample. The samples were divided into two groups associated with bathymetric strata. SS: 58-78 m, and US: 280-354 m around the Karaburun Peninsula in the Central Aegean Sea.

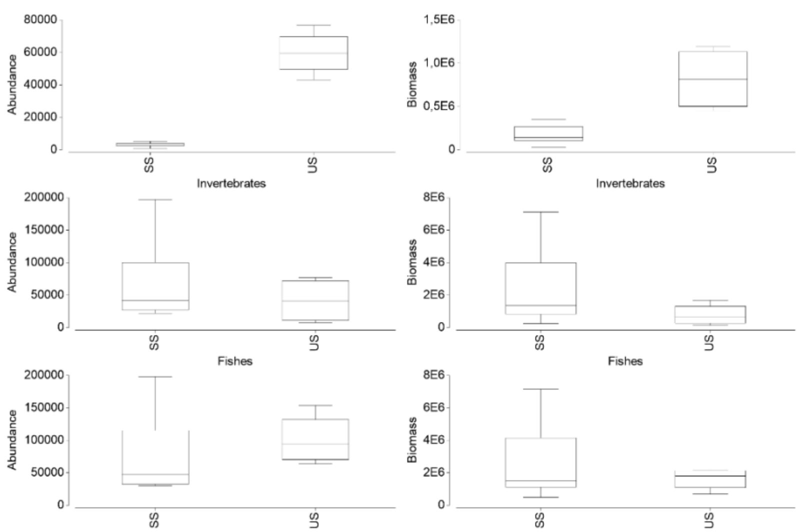

Figure 4. Box-and-whisker plots for the abundance (N/km^2) and biomass (kg/km^2) of trawl samples obtained from cluster analyses. SS: shallow shelf; US: upper slope.

The mean abundance and biomass of fish were higher in the shallow shelf while invertebrates were in the upper slope (Figure 4). According to the results of the SIMPER analysis (Table 3), the average similarity of the SS group was 46.59 %, with *Serranus hepatus, Diplodus annularis, Citharus linguatula* and *Mullus barbatus* the main contributors to this similarity. The average similarity of the US group was 72.22%, and *Parapenaeus longirostris, Squilla mantis, Gadiculus argenteus, Eledona cirrosa, Coelorinchus caelorhincus* and *Plesionika martia* were main contributors in this group. The average dissimilarities between the two groups were 93.44% between SS and US.

Table 3. Similarity percentage analysis results showing the mean abundance (A; log transformed data), biomass (B; log transformed data), average with-in group similarity (Sim), standard deviation of similarity (Sim/SD), the percentage contribution to within-group similarity (Sim%), and the accumulated similarity (∑ Sim%). SS: shallow shelf; US: Upper slope.

SS; Sim= 46.59	**B**	**A**	**Sim**	**Sim/SD**	**Sim%**	**∑ Sim%**
Serranus hepatus	9.62	7.46	3.45	1.65	7.39	7.39
Diplodus annularis	10.14	7.21	3.07	1.52	6.58	13.97
Citharus linguatula	8.64	6.39	2.86	1.63	6.13	20.11
Mullus barbatus	9.70	7.06	2.85	1.54	6.11	26.21
Antedon mediterranea	5.25	5.32	2.43	1.64	5.21	31.43
Pagellus acarne	8.75	6.03	2.13	0.98	4.58	36.01
Scorpaena notata	7.49	4.99	2.12	1.58	4.54	40.55
Axinella verrucosa	6.33	4.16	1.94	1.65	4.17	44.72
Boops boops	7.74	5.26	1.83	1	3.92	48.64
Serranus cabrilla	7.30	4.63	1.72	1.04	3.68	52.33
Dentex maroccanus	7.15	4.94	1.61	1.01	3.45	55.77
Ascidia virginea	6.24	4.3	1.4	0.73	3	58.78
Loligo vulgaris	7.94	3.88	1.35	1.03	2.9	61.68
Merluccius merluccius	7.08	4.28	1.11	0.7	2.38	64.05
Chelidonichthys lastoviza	5,82	3.54	1.04	0.72	2.24	66.3
Symphurus nigrescens	4.68	3.49	0.98	0.72	2.11	68.41
Alcyonium palmatum	4.12	3.22	0.97	0.73	2.07	70.48
US; Sim= 72.22	**B**	**A**	**Sim**	**Sim/SD**	**Sim%**	**∑ Sim%**
Parapenaeus longirostris	12.47	10.64	5.45	15.22	7.55	7.55
Squilla mantis	11.60	8.81	4.46	12.67	6.17	13.72
Gadiculus argenteus	10.72	8.77	4.19	12.61	5.8	19.52
Cholorophthalmus agassizi	12.15	9.03	4.15	9.91	5.75	25.27
Eledone cirrhosa	11.88	7.7	3.91	19.4	5.41	30.68
Coelorinchus caelorhincus	10.59	7.74	3.68	18.93	5.09	35.78
Plesionika martia	8.16	7.21	3.62	16.41	5.02	40.8
Rossia macrosoma	8.87	7.07	3.6	11.63	4.98	45.78
Phycis blennoides	9.96	7.1	3.52	9.4	4.87	50.65
Cidaris cidaris	8.81	6.3	3.08	7.13	4.26	54.91
Illex coindetii	11.66	6.61	3.08	9.26	4.26	59.17
Rondeletiola minor	10.02	6.01	3.06	12.25	4.24	63.41
Spatangus purpureus	9.08	5.63	2.76	8.78	3.82	67.23
Sepia orbignyana	9.10	5.64	2.72	11.09	3.77	71

It has been revealed that the upper slope zone in the Mediterranean consists of two different strata (Massuti and Renones 2005; Keskin *et al.* 2011; Dalyan *et al.* 2012). The community structure in the continental zone, down to 200 m, suddenly changes as it passes into the upper slope zone, and *Cholorophthalmus agassizi* and *Gadiculus argenteus* species are dominant at depths between 200-450 m. The presence and abundance of these species appear as an important separator in similarity (Massuti and Renones 2005). Similarly, the data obtained in the present study conducted around Karaburun Peninsula shows that the most important reason for the significant difference between the shallow shelf zone and the upper slope zone is the presence of *Cholorophthalmus agassizi* and *Gadiculus argenteus* species.

Many studies on biodiversity and demersal assemblages of the Mediterranean Sea state that the depth is the main factor determining the changes of faunal composition and biodiversity on the bottom from the shallow shelf to deepest zones (Haedrich *et al.* 1980; Bianchi 1992; Carney 2005; Massutı´ and Renones 2005; Evagelopoulos *et al.* 2021). The local conditions, such as sediment structure, characteristics of water masses, predator-prey relationships and interspecific competition, fishing activities can determine regional differences of biodiversity and assemblages (e.g. Colloca *et al.* 2003; Moranta *et al.* 2008; Keskin *et al.* 2011; Peristeraki *et al.* 2017).

The comparisons for the ecological parameters between the macrofaunal assemblages detected, and the results revealed that mean species richness, diversity and evenness in SS were higher than in the upper slope (Figure 5). Diversity can be affected by different factors, such as the decrease in water quality (Guidetti *et al.* 2002), and fishing pressure (Jennings *et al.* 1999; Labropoulou and Papaconstantinou 2005). The size-structure of the communities is getting smaller and increasing the relative importance of small ones in the fish populations by harvesting larger individuals (Pauly *et al.* 1998). The higher values obtained (Figure 5) for the diversity indexes *H* and *J''* in the shallow shelf and the upper slope could be related with the high productivity and the bottom characteristics of the shallow shelf and to the fishing strategy followed by the bottom trawl fleet in the area, which exerts higher fishing effort on the the upper slope than on the shallow shelf.

In the region, *Papapenaeus longirostris* and *Merluccius merluccius* are target species*, Mullus barbatus, Illex coindetii, Loligo vulgaris, Dentex maroccanus, Boops boops,* and *Pagellus acarne* has commercial interest in demersal fish assemblages (Kara and Gurbet 1999; Kınacıgil *et al.* 2013). The central Aegean Sea is one of the most important areas for demersal fishery in Turkey (Benli *et al.* 1999). In the present study; 54% of total biomass (4,484.36 kg/km^2) were composed of commercially important species, which include 65.42 % of fish and 34.58% of invertebrates. *Mullus barbatus* (15.18% in total catch), *Merluccius merluccius* (8.34%), *Pagellus erythrinus* (6.34%), and *P. acarne* (5.95%) are economically important fish species. *Parapenaeus longirostris* (13.35%), *Eledona cirrhosa* (6.23%), *Illex coindetti* (4.98%), and *Squilla mantis* (4.66%) are economically important invertebrates.

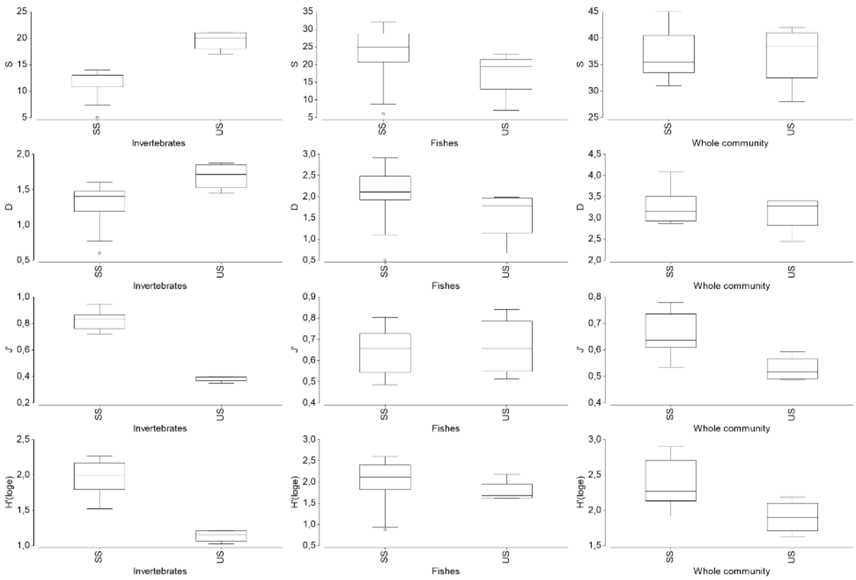

Figure 5. Box-and-whisker plots for diversity indices of trawl samples obtained from cluster analyses. SS: shallow shelf; US: upper slope

The deep-water rose shrimp *Parapenaeus longirostris* is one of the most important key species from a bioecological point of view with its wide distribution, large abundance, and geographically close communities and economic importance in the whole Mediterranean Sea. Its population have been decreased rapidly in the Aegean Sea in the last decades (Bilgin *et al.* 2009) as well as in the Mediterranean Sea (Perdichizzi *et al.* 2022).

Conclusion

The present results describe some indication on the diversity, distribution pattern and characteristics of macrofaunal species on the shallow shelf and the upper slope areas in the Karaburun-Ildır Bay SEPA, and adjacent waters. The identification of the assemblages on the shelf and upper slope can be of great importance for fisheries management and the sustainability of regional fisheries in the area. The species reported in this study, *Mullus barbatus*, *Mullus surmuletus, M. merluccius*, *Pagellus erythrinus, Parapenaeus longirostris* and *Illex coindetti* are some of the species which have shared demersal stocks between Türkiye and Greece (EastMed 2011).

The Karaburun-Ildır Bay SEPA is located in the central Aegean Sea, which is a biogeographic threshold between the north and south Aegean Sea. The protected areas along the Aegean Sea coast, together with proposed high sea protected areas (Öztürk 2009), and their strong interaction directly determine the effectiveness of biological conservation of the whole Aegean ecosystem, not only for the Turkish part but also the Greek part, in terms of transboundary cooperation. For example, the Karaburun-Ildır Bay SEPA is only a few naulitical miles east to the neighbouring fisheries restricted areas of Greece (Petza *et al.* 2017). Common management policies may be more synergetically effective in protecting the biodiversity in the Aegean Sea, especially for highly migratory species, such as swordfish and Atlantic bluefin tuna.

FAO (2022), including the 2030 GFCM strategies, has created the fisheries restricted areas (FRA) to increase the abundance and biomass of the target species, such as *Merluccius merluccius, Nephrops norvegicus, Lopius budegassa* and *Parapenaeus longirostris* to protect them and their sensitive habitats in the ecosystem. Concreated FRAs, such as in the Jabuka Pomo Pit Like FRA in the Adriatic Sea, in the Mediterranean Sea successfully rebuild stock of target species and used effectively in fisheries management (FAO 2022). Following this good example, the Karaburun-Ildır Bay SEPA area and its surroundings may be considered as a FRA. Habitat of economically important species, high biodiversity, endangered species, and vulnerable habitats can be counted among the arguments. In addition, the marine ecosystem of the region needs a management plan, including designation of reserve areas in the SEPA and restriction of industrial fishery activities to protect the biodiversity and fisheries stocks in the shelf and in the upper slope.

Moreover, considering the global threat of biological invasion, protected marine areas have been currently accepted as a tool (Giakoumi and Pey 2017) to control the spread and/or mitigate the impacts of invasiveness such as the species *P. miles* observed in the SEPA. The monitoring studies on protected areas must be carried out to follow the spread of non-indigenous species and to understand their effects of on marine ecosystem and biodiversity.

Finally, the management of bottom trawl fishery in Turkish waters is mainly based on technical measures, such as minimum landing sizes for some species, minimum mesh size (44 mm in the Aegean Sea, diamond mesh type), and closed areas and seasons. Minimum landing size (MLS) is applied to protect recruitment. In the study area, bottom trawling activities are banned around the coast off Karaburun Peninsula to protect small fishes and *Posidonia oceanica* (L.) Delile meadows, which is important nursery areas for juveniles and recruitments. The rest of the marine areas are open to the trawling seasonally. At this point, monitoring studies on spatiotemporal changes of demersal assemblages, and fishing activities are important for effective fisheries management and sustainable fishing practices including protected areas along the Aegean Sea coast and proposed high sea protected areas.

Acknowledgement

This study was funded by the Turkish Ministry of Environment, Urbanization and Climate Change (TMEUC). The authors would like to thank Bayram Öztürk who conducted the surveys. The authors would like to acknowledge with thanks the research team of the project and crew of RV 'Yunus-S' for their help during the sampling study.

Karaburun-Ildır Körfezi Özel Çevre Koruma Bölgesi ve bitişik sularının biyoçeşitliliği ve makrofaunanın yapısı (Orta Ege Denizi-Türkiye)

Öz

Karaburun-Ildır Körfezi ÖÇKB ve çevre sularında gerçekleştirilen bu çalışmada, deniz makrofaunasının çeşitliliği ve demersal tür topluluklarının yapısı incelenmiştir. Örneklemeler Mayıs 2022 ve Eylül 2022 tarihlerinde yapılmıştır. Toplam 179 tür tespit edilmiştir (121 balık, 58 omurgasız). *Penaeus pulchricaudatus, Bregmaceros nectabanus, Champsodon nudivittis, Callionymus filamentosus* ve *Planiliza haematocheilus* çalışma alanında yerli olmayan türlerdir. Ayrıca *Raja radula, Mustelus mustelus, Thunnus thunnus* ve *Epinephelus marginatus* da IUCN kategorisinde nesli tükenmekte olan balıklar arasındadır. Demersal tür topluluğunun analizi, sığ şelfteki demersal toplulukların kıta yamacının üst kısımlarından farklı olduğunu ve çeşitliliğin sığ self bölgesinde daha yüksek olduğunu göstermiştir. Sığ self bölgesi ve üst yamaçtaki tür toplulukları *Merluccius merluccius, Parapenaeus longirostris* ve *Mullus barbatus* gibi ticari türleri içerir.

Anahtar kelimeler: Dip trolü sörveyi, demersal fauna, koruma, Doğu Akdeniz

References

Ager, O.E.D. (2003) *Funiculina quadrangularis* The tall sea pen. In: Marine Life Information Network: Biology and Sensitivity Key Information Reviews, (eds., Tyler-Walters, H., Hiscock, K.), Plymouth: Marine Biological Association of the United Kingdom. Available at: https://www.marlin.ac.uk/species/detail/1154 (accessed 4 Apr 2023).

Akyol, O., Aydın, İ., Ulaş, A., Capape, C. (2017) On the capture of a large pregnant *Bathytoshia lata* (Chondrichthyes: Myliobatiformes: Dasyatidae) from the coast of Çeşme, Izmir (Aegean Sea, Turkey). *Journal of Black Sea/Mediterranean Environment* 23(1): 92-99.

Akyol, O., Kara, A. (2003) An investigation on the determination of catch compositions of the bottom trawling and beach-seining in the Bay of Izmir

(Aegean Sea). *Ege Journal of Fisheries and Aquatic Sciences* 20: 321-328 (in Turkish).

Anonymous (2023) Karaburun-Ildır Bay Special Environmental Protected Area.. Available at: https://tvk.csb.gov.tr/karaburun-ildir-korfezi-i-91579 (accessed 02 Apr 2023) (in Turkish).

Balopoulos, E.Th., Friligos N.Ch. (1993) Water circulation and eutrophication in the northwestern Aegean Sea: Thermaikos Gulf. *Journal of Environmental Science and Health. Part A: Environmental Science and Engineering and Toxicology* 28(6): 1311-1329.

Bertrand, J.A., Gil de Sola, L., Papaconstantinou, C., Relini, G., Souplet, A. (2002) The general specifications of the MEDITS surveys. *Scientia Marina* 66(2): 9-17.

Benli, H.A., Cihangir, B., Bizsel, K.C. (1999) Investigation on demersal fishery resources in the Aegean Sea. *Istanbul University Fisheries Faculty, Journal of Aquatic Products* (Special Print): 301-370.

Bianchi, G. (1992) Study of the demersal assemblages of the continental shelf and upper slope off Congo and Gabon, based on the trawl surveys of the RV 'Dr Fridtjof Nansen'. *Marine Ecology Progress Series* 85: 9-23.

Bianchi, C.N. (2007) Biodiversity issues for the forthcoming tropical Mediterranean Sea. *Hydrobiologia* 580: 7-21.

Bilgin, S., Ozen, O., Ismen, A., Ozekinci, U. (2009) Bathymetric distribution, seasonal growth and mortality of the deep-water rose shrimp *Parapenaeus longirostris* (Decapoda: Penaeidae) in an unexploited stock in Saros Bay, Aegean Sea. *Journal of Animal and Veterinary Advances* 8(11): 2404-2417.

Cairns, S.D., Bayer, F.M. (2009) Octocorallia (Cnidaria) of the Gulf of Mexico. In: Gulf of Mexico - Origins, Waters, and Biota. Biodiversity, (eds., Felder, D.L., Camp, D.K.), Texas A&M University Press, College Station, Texas, pp. 321-331

Carney, R.S. (2005) Zonation of deep biota on continental margins. *Oceanography and Marine Biology: An Annual Review* 43: 211-278.

Ceriola, L., Accadia, P., Mannini, P., Massa, F., Milone, N., Ungaro, N. (2008) A bio-economic indicators suite for the appraisal of the demersal trawl fishery in the Southern Adriatic Sea (Central Mediterranean). *Fisheries Research* 92(2-3): 255-267.

Cerrano, C., Goffredo, S., Bavestrello, G., Garcia, S., Forero, A. (2015) *Funiculina quadrangularis*. The IUCN Red List of Threatened Species 2015: e.T50013368A51217428 (accessed 2 Apr 2023).

Chimienti, G., Angeletti, L., Rizzo, L., Tursi, A., Mastrototaro, F. (2018) ROV vs trawling approaches in the study of benthic communities: The case of *Pennatula rubra* (Cnidaria: Pennatulacea). *Journal of the Marine Biological Association of the United Kingdom* 98(8): 1859-1869.

Clarke, K.R., Warwick, R.M. (2001) Change in Marine Communities: An Approach to Statistical Analysis and Interpretation, 2nd Edition. PRIMER-E, Plymouth.

Collette, B.B., Boustany, A., Fox, W., Graves, J., Juan Jorda, M., Restrepo, V. (2021) *Thunnus thynnus*. The IUCN Red List of Threatened Species 2021: e.T21860A46913402. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T21860A46913402.en. (accessed 8 Apr 2023).

Colloca, F., Cardinale, M., Belluscio, A., Ardizzone, G.D. (2003) Structure and diversity of demersal assemblages in the central Mediterranean Sea. *Estuarine, Coastal and Shelf Science* 56: 469-480.

Corsini-Foka, M., Pancucci-Papadopoulou, M. A., Kalogirou, S. (2010) Is the Lessepsian province in expansion? The Aegean Sea experience. Sub-regional Technical meeting on the Lessepsian migration and its impact on eastern Mediterranean fishery. Nicosia, 7-9 Dec. FAO East Med Tech. Document, pp. 50-59.

Dalyan, C., Yemişken, E., Eryılmaz, L. (2012) A new record of gaper (*Champsodon capensis* Regan, 1908) in the Mediterranean Sea. *Journal of Applied Ichthyology* 28(5): 834-835.

Damalas, D., Vassilopoulou, V. (2011) Chondrichthyan by-catch and discards in the demersal trawl fishery of the Central Aegean Sea (Eastern Mediterranean). *Fisheries Research* 108: 142-52.

Dural, B., Aysel, V., Erduğan, H., Demir, N., Yazıcı, I. (2012) The status of sensitive ecosystems along the Aegean coast of Turkey: *Posidonia oceanica* (L.) Delile meadows. *Journal of the Black Sea/Mediterranean Environment* 18(3): 360-379.

Duruer, E.C., Kinacigil, T., Soykan, O., Tosunoğlu, Z. (2008) Contribution to some biological and fishery aspects of commercial penaeid prawns in Mersin Bay (Northeastern Mediterranean, Turkey). *Crustaceana* 577-585.

EastMed (2011) Report of the first Permanent Working Group on Stock Assessment. GCP/INT/041/EC – GRE – ITA/TD-08.

Eronat, C. (2017) An overview on İzmir Bay physical oceanography. *Ege Journal of Fisheries and Aquatic Sciences* 34(1): 1-9.

Eronat, C., Sayın, E. (2014) Temporal evolution of the water characteristics in the bays along the eastern coast of the Aegean Sea: Saros, İzmir, and Gökova bays. *Turkish Journal of Earth Sciences* 23: 53-66.

Esposito, G., Prearo, M., Menconi, V., Mugetti, D., Meloni, D., Tomasoni, M., Pizzul, E., Piras, P., Renzi, M., Gaspa, D., Pastorino, P. (2021) Northward spread of the parrotfish *Sparisoma cretense* (Teleostei: Scaridae) in the Mediterranean Sea: An update on current distribution with two new records from Sardinia. *Journal of Marine Science and Engineering* 9(5): 536.

Evagelopoulos, A., Batjakas, I.E., Koutsoubas, D. (2021) Structure and diversity of the demersal fish assemblages off Psara Island (Central Aegean Sea) caught by experimental bottom trawling. *Thalassas* 37: 379-391.

FAO (2011) Fisheries Management. 4. Marine Protected Areas and Fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 4, Suppl. 4, FAO, Rome,

FAO (2022) The State of Mediterranean and Black Sea Fisheries 2022. General Fisheries Commission for the Mediterranean. Rome, Italy, doi: https://doi.org/10.4060/cc3370en.

Finucci, B., Barnett, A., Bineesh, K.K., Cheok, J., Cotton, C.F., Dharmadi, Graham, K.J., Kulka, D.W., Neat, F.C., Pacoureau, N., Rigby, C.L., Tanaka, S., Walker, T.I. (2020) *Hexanchus griseus*. The IUCN Red List of Threatened Species 2020: e.T10030A495630. https://dx.doi.org/10.2305/IUCN.UK.2020-3.RLTS.T10030A495630.en. (accessed 8 Apr 2023)

Galil, B.S. (2009) Taking stock: inventory of alien species in the Mediterranean Sea. *Biological Invasions* 11: 359-372.

Giakoumi, S., Pey, A. (2017) Assessing the effects of Marine Protected Areas on biological invasions: A global review. *Frontiers in Marine Science* 4: 49.

Golani, D., Orsi Relini, L., Massutí, E., Quignard, J.P. (2002) CIESM Atlas of Exotic Species in the Mediterranean. Vol. 1. Fishes, (ed., Briand, F.), CIESM Publishers, Monaco.

Gönülal, O., Oz, I., Guresen, S.O., Ozturk, B. (2016) Abundance and composition of marine litter around Gokceada Island (Northern Aegean Sea). *Aquatic Ecosystem Health & Management* 19(4): 461-467.

Guidetti, P., Fanelli, G., Fraschetti, S., Terlizzi, A., Boero, F. (2002) Coastal fish indicate human-induced changes in the Mediterranean littoral. *Marine Environmental Research* 53: 77-94.

Haedrich, R.L., Rowe, G.T., Polloni, P.T. (1980) The megabenthic fauna in the deep sea south of New England, USA. *Marine Biology* 57: 165-179.

Hughes, D.J. (1998) Sea Pens and Burrowing Megafauna (Volume III). An Overview of Dynamics and Sensitivity Characteristics for Conservation Management of Marine Sacs. Scottish Association for Marine Science, Oban (UK Marine SACs Project).

Jabado, R.W., Chartrain, E., Cliff, G., Da Silva, C., De Bruyne, G., Derrick, D., Dia, M., Diop, M., Doherty, P., El Vally, Y., Leurs, G.H.L., Meissa, B., Metcalfe, K., Pacoureau, N., Pires, J.D., Seidu, I., Serena, F., Soares, A.-L., Tamo, A., VanderWright, W.J., Williams, A.B., Winker, H. (2021a). *Mustelus mustelus*. The IUCN Red List of Threatened Species 2021: e.T39358A124405881. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T39358A124405881.en. (accessed 8 Apr 2023).

Jabado, R.W., Chartrain, E., De Bruyne, G., Derrick, D., Dia, M., Diop, M., Doherty, P., Finucci, B., Leurs, G.H.L., Metcalfe, K., Pires, J.D., Seidu, I., Soares, A.-L., Tamo, A., VanderWright, W.J., Williams, A.B. (2021b) *Bathytoshia lata*. The IUCN Red List of Threatened Species 2021: e.T104071039A104072486. https://dx.doi.org/10.2305/IUCN.UK.2021-2.RLTS.T104071039A104072486.en. (accessed 8 Apr 2023).

Jabado, R.W., Pacoureau, N., Diop, M., Dia, M., Ba, A., Williams, A.B., Dossa, J., Badji, L., Seidu, I., Chartrain, E., Leurs, G.H.L., Tamo, A., Porriños, G., VanderWright, W.J., Derrick, D., Doherty, P., Soares, A., De Bruyne, G., Metcalfe, K. (2021c). *Rhinobatos rhinobatos*. The IUCN Red List of Threatened Species 2021: e.T63131A124461877. https://dx.doi.org/10.2305/IUCN.UK.2021-1.RLTS.T63131A124461877.en. (accessed 8 Apr 2023).

Jennings, S., Greenstreet, S.P.R., Reynolds, J.D. (1999) Structural changes in an exploited fish community: a consequence of differential fishing effects on species with contrasting life histories. *Journal of Animal Ecology* 68: 617-627.

Jones, N., McGinlay, J., Kontoleon, A., Maguire-Rajpaul, V.A., Dimitrakopoulos, P.G., Gkoumas, V., Riseth, J.Å., Sepp, K., Vanclay, F. (2022)

Understanding public support for European Protected Areas: A review of the literature and proposing a new approach for policy makers. *Land* 11: 733.

Kabasakal, H. (2002) Elasmobranch species of the seas of Turkey. *ANNALES, Series historia naturalis* 12: 15-22.

Kabasakal, H. (2004) Preliminary observations on the reproductive biology and diet of the bluntnose sixgill shark, *Hexanchus griseus* (Bonnaterre, 1788) (Chondrichthyes: Hexanchidae), in Turkish Seas. *Acta Adriatica* 45: 187-196.

Kara, O.F., Gurbet, R. (1999) Investigation on industrial fishery of the Aegean Sea. The Republic of Turkey, Ministry of Agriculture and Rural Affairs, Bodrum. No: 5. (in Turkish)

Kaya, M., Mater, S., Korkut, A.Y. (1998) A new grey mullet species "Mugil so-iuy Basilewsky" (Teleostei: Mugilidae) from the Aegean Coast of Turkey. *Turkish Journal of Zoology* 22: 303-306.

Keskin, Ç., Aktan, T. (2018) The coverage of illegal fishing in Turkish newspapers. In: Marine and Freshwater Miscellanea, (eds., Pauly, D., Ruiz-Leotaud, V.), Vancouver, BC, University of British Columbia, pp. 38-39.

Keskin, C., Ordines, F., Guijarro, B., Massutí, E. (2011) Comparison of fish assemblages between the Sea of Marmara and the Aegean Sea (north-eastern Mediterranean). *Journal of the Marine Biological Association of the United Kingdom* 91(6): 1307-1318.

Keskin, Ç., Pauly, D. (2018) Reconciling Trends of Mean Trophic Index and Mean Temperature of the Catch in the Eastern Mediterranean and Black Seas. *Mediterranean Marine Science* 19(1): 79-83.

Kınacigil, H.T., Atar, H.H., İlkyaz, A.T., Metin, G. (2013) Determination of Demersal Fish Abundance, Distribution of Commercial Fishing Zones and By-catch Amount of Aegean Sea. The Scientific and Technological Research Council of Turkey Project No: 109Y274. Ege University, Bornova, İzmir. 217p (in Turkish).

Koray, T., Cihangir, B. (2002) Plankton blooming in marine environment, impacts on the fish and fisheries: an example Izmir Bay. In: Coastal and Marine Environmental Areas of Turkey, (eds., Özhan, E., Alpaslan, N.), Ankara, Turkey, pp. 15-20 (in Turkish).

Labropoulou, A., Papaconstantinou, C. (2005) Effects of fishing on community structure of demersal fish assemblages. *Belgian Journal of Zoology* 135: 191-197.

Mancusi, C., Morey, G & Serena, F. (2016) *Raja radula*. The IUCN Red List of Threatened Species 2016: e.T161339A16527984. https://dx.doi.org/10.2305/IUCN.UK.2016-1.RLTS.T161339A16527984.en. (accessed 8 Apr 2023)

Massutí, E., Reñones, O. (2005) Demersal resource assemblages in the trawl fishing grounds off the Balearic Islands (western Mediterranean). *Scientia Marina* 69(1): 167-181.

MEDITS (2017) Handbook. Version n. 9, 2017, MEDITS Working Group.

MEDPAN (2021) The System of Mediterranean Marine Protected Areas in 2020, MedPAN and UNEP/MAP-SPA/RAC. Available at: https://medpan.org/en/system-mediterranean-mpas-2020 (accessed 2 Apr 2023).

Minos, G., Imsiridou, A., Economidis, P.S. (2010) *Liza haematocheilus* (Pisces, Mugilidae) in the northern Aegean Sea. In: Fish Invasions in the Mediterranean Sea: Change and Renewal, (eds., Golani, D., Appelbaum-Golani, B.), Pensoft, Sofia-Moscow, pp. 313-332.

Moranta, J., Quetglas, A., Massutí, E., Guijarro, B., Ordines, F., Valls, M. (2008) Research trends on demersal fisheries oceanography in the Mediterranean. In: Biological Oceanography Research Trends, (eds., Mertens, L.P.), Nova Science Publishers, New York, USA, pp. 9-65.

Öztürk, B. (2021) Non-indigenous Species in the Mediterranean and the Black Sea. Studies and Reviews 87. General Fisheries Commission for the Mediterranean, FAO, Rome.

Öztürk, B. (2009) Marine protected areas in the high seas of the Aegean and Eastern Mediterranean Seas, some proposals. *Journal of the Black Sea and Mediterranean Environment* 15: 69-82.

Öztürk, B., Altuğ, G., Çardak, M., Çiftçi, S.P. (2007) Oil pollution in the surface water of the Turkish side of the Aegean and Eastern Mediterranean Seas. *Journal of the Black and Mediterranean Environment* 13(3): 207-214.

Öztürk, B., Öztürk, A.A., Dede, A. (2001) Dolphin by-catch in the swordfish driftnet fishery in the Aegean Sea. *Rapport de la Commission International pour l'Exploration Scientifique de la Mer Méditerranée* 36: 208.

Papaconstantinou, C. (1990) The spreading of Lessepsian fish migrants into the Aegean Sea (Greece). *Scienta Marina* 54: 313-316.

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R., Torres, Jr.F.C. (1998) Fishing down marine food webs. *Science* 279: 850-863.

Perdichizzi, A., D'Iglio, C., Giordano, D., Profeta, A., Ragonese, S., Rinelli, P. (2022) Comparing life-history traits in two contiguous stocks of the deep-water rose shrimp *Parapenaeus longirostris* (H. Lucas, 1846)(Crustacea: Decapoda) in the Southern Tyrrhenian Sea (Central Mediterranean Sea). *Fisheries Research* 248: 106206.

Peristeraki, P., Tserpes, G., Lampadariou, N., Stergiou, K.I. (2017) Comparing demersal megafaunal species diversity along the depth gradient within the South Aegean and Cretan Seas (Eastern Mediterranean). *PLoS ONE* 12(9): e0184241.

Pielou, E.C. (1969) An Introduction to Mathematical Ecology. John Wiley, New York, pp. 286.

Petza, D., Maina, I., Koukourouvli, N., Dimarchopoulou, D., Akrivos, D., Kavadas, S., Tsikliras, A., Karachle, P., Katsanevakis, S. (2017) Where not to fish – reviewing and mapping fisheries restricted areas in the Aegean Sea. *Mediterranean Marine Science* 18(2): 310-323.

Rigby, C.L., Barreto, R., Carlson, J., Fernando, D., Fordham, S., Francis, M.P., Herman, K., Jabado, R.W., Liu, K.M., Marshall, A., Pacoureau, N., Romanov, E., Sherley, R.B., Winker, H. (2019) *Prionace glauca*. The IUCN Red List of Threatened Species 2019: e.T39381A2915850. https://dx.doi.org/10.2305/IUCN.UK.2019-3.RLTS.T39381A2915850.en. (accessed 8 Apr 2023)

Shannon, C.E., Weaver, W. (1949) The Mathematical Theory of Communication. The University of Illinois Press, Urbana, IL, pp. 1-117.

Simard, F., Laffoley, D., Baxter, J.M. (eds.) (2016) Marine Protected Areas and Climate Change: Adaptation and Mitigation Synergies, Opportunities and Challenges. IUCN, Gland, Switzerland.

Soykan, F., Sezer, L.İ., Işık, Ş. (1993) Natural Features, Historical Geography and Tourism Potential of Karaburun Peninsula. E.Ü. Araştırma Fon Saymanlığı Project no: 1989/002, İzmir. (in Turkish)

Stergiou, K.I., Pollard, D.A. (1994) A spatial analysis of the commercial fisheries catches from the Greek Aegean Sea. *Fisheries Research* 20: 109-135.

Tsikliras, A.C., Peristeraki, P., Tserpes, G., Stergiou, K.I. (2015) Mean temperature of the catch (MTC) in the Greek Seas based on landings and survey data. *Frontiers in Marine Science* doi: 10.3389/fmars.2015.00023.1

Tsoi, K.H., Ma, K.Y., Wu, T.H., Fennessy, S.T., Chu, K.H., Chan, T.Y. (2014) Verification of the cryptic species *Penaeus pulchricaudatus* in the commercially important kuruma shrimp *P. japonicus* (Decapoda: Penaeidae) using molecular taxonomy. *Invertebrate Systematics* 28(5): 476-490.

Tuncer, S., Torcu Koç, H., Kanat, R.E. (2020) Occurence of the thermophilic Mediterranean parrotfish *Sparisoma cretense* (Linneaus, 1758) (Teleostei: Scaridae) in Dikili Bay, northern Aegean Sea, Turkey. *Journal of Anatolian Environmental and Animal Sciences* 5(4): 759-764.

Turan, C., Uygur, N., İğde, M. (2017) Lionfishes *Pterois miles* and *Pterois volitans* in the North-eastern Mediterranean Sea: Distribution, habitation, predation and predators. *Natural and Engineering Sciences* 2(1): 35-43.

UNEP (2021a) Making Peace with Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies. Nairobi, Available at: https://www.unep.org/resources/making-peace-nature. (accessed 8 Apr 2023).

UNEP (2021b) Convention on Biological Diversity. Open Ended Working Group on the Post-2020 Global Biodiversity Framework. Online 23 Agust-3 Sept 2021. CBD/WG2020/3/3/ 5 July 2020.

Voultsiadou, E., Gerovasileiou, V., Dailianis, T. (2013) Extinction trends of marine species and populations in the Aegean Sea and adjacent ecoregions. In: CIESM Workshop Monograph n°45 Marine Extinctions - Patterns and Processes (ed., Briand, F.), CIESM Publisher, Monaco, pp. 59-74.

Annex

The list of recorded species from the study area in the Karaburun-Ildır Bay SEPA and adjacent waters in May and September 2022 with the origin of species and IUCN categories. AM Atlanto-Mediterranean; CG Circumglobal; IP Indo-Pacific; E Mediterranean endemic; **E** Mediterranean and Black Sea endemic; WP-M/ Western Pacific Escape from mariculture venture in Mediterranean. Sampling methods: *Bottom trawling; ** Beam trawling; + Observation by snorkelling; ++Observation at sea surface; mFish market

Phylum	Order	Family	Species	Origin	IUCN status
Porifera	Bubarida	Dictyonellidae	*Acanthella acuta* Schmidt, 1862*	AM	NE
			Dictyonella sp.**		
	Axinellida	Axinellidae	*Axinella damicornis* (Esper, 1794)*	AM	NE
			Axinella verrucosa (Esper,1794) *	AM	NE
	Haplosclerida	Chalinidae	*Haliclona mediterranea* Griessinger, 1971 *	AM	NE
	Dictyoceratida	Thorectidae	*Cacospongia mollior* Schmidt, 1862*	AM	NE
	Suberitida	Suberitidae	*Suberites domuncula* (Olivi, 1792)*	AM	NE
Cnidaria	Malacalcyonacea	Alcyoniidae	*Alcyonium palmatum* Pallas, 1766*	AM	LC
	Scleralcyonacea	Funiculinidae	*Funiculina quadrangularis* (Pallas, 1766)*	AM	VU
	Scleralcyonacea	Pennatulidae	*Pennatula rubra* (Ellis, 1764)*	AM	NE
			Hydrozoa sp.*		
Bryozoa			Bryozoa sp.*		
Annelida	Phyllodocida	Polynoidae	*Harmothoe* sp.*		
Mollusca	Neogastropoda	Muricidae	*Bolinus brandaris* (Linnaeus, 1758)*	AM	NE
	Octopoda	Eledonidae	*Eledone cirrhosa* (Lamarck, 1798)*	AM	LC
	Oegopsida	Ommastrephidae	*Illex coindetii* (Vérany, 1839)*	AM	LC
	Myopsida	Loliginidae	*Loligo vulgaris* Lamarck, 1798*	AM	DD
	Octopoda	Octopodidae	*Octopus vulgaris* Cuvier, 1797*	AM	LC
	Sepiida	Sepiolidae	*Rondeletiola minor* (Naef, 1912)*	AM	DD
			Rossia macrosoma (Delle Chiaje, 1830)*	AM	DD
			Sepia officinalis Linnaeus, 1758*	AM	LC
			Sepia orbignyana Férussac, 1826*	AM	DD

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
			Nudibranchia sp.*		
			Pleurobranchidae sp.*		
Arthropoda	Decapoda	Crangonidae	*Aegaeon lacazei* (Gourret, 1887)*	AM	NE
		Pandalidae	*Chlorotocus crassicornis* (A. Costa, 1871)*	AM	NE
		Ethusidae	*Ethusa mascarone* (Herbst, 1785)*	AM	NE
		Galatheidae	*Galathea dispersa* Spence Bate, 1859*	AM	NE
		Goneplacidae	*Goneplax rhomboides* (Linnaeus, 1758)*	AM	NE
		Dorippidae	*Medorippe lanata* (Linnaeus, 1767)*	AM	NE
		Munididae	*Munida tenuimana* Sars, 1872*	AM	NE
		Nephropidae	*Nephrops norvegicus* (Linnaeus, 1758)*	AM	LC
		Penaeidae	*Parapenaeus longirostris* (Lucas, 1846)*	AM	NE
			Penaeus kerathurus (Forskål, 1775)*	AM	NE
			Penaeus pulchricaudatus Stebbing, 1914*	IP	NE
		Pilumnidae	*Pilumnus hirtellus* (Linnaeus, 1761)*	AM	NE
		Pandalidae	*Plesionika martia* (A. Milne-Edwards, 1883)*	AM	NE
		Solenoceridae	*Solenocera membranacea* (Risso, 1816)*	AM	NE
	Stomatopoda	Squillidae	*Squilla mantis* (Linnaeus, 1758)*	AM	NE
Echinodermata	Comatulida	Antedonidae	*Antedon mediterranea* (Lamarck, 1816)*	AM	NE
	Paxillosida	Astropectinidae	*Astropecten aranciacus* (Linnaeus, 1758)*	AM	NE
			Astropecten irregularis (Pennant, 1777)*	AM	NE
		Luidiidae	*Luidia sarsii* Düben, 1844*	AM	NE
	Cidaroida	Cidaridae	*Cidaris cidaris* (Linnaeus, 1758)*	AM	NE
	Spinulosida	Echinasteridae	*Echinaster sepositus* (Retzius, 1783)*	AM	NE
	Forcipulatida	Asteriidae	*Marthasterias glacialis* (Linnaeus, 1758)*	AM	NE
	Synallactida	Stichopodidae	*Parastichopus regalis* (Cuvier, 1817)*	AM	LC

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
	Spatangoida	Spatangidae	*Spatangus purpureus* O.F. Müller, 1776*	AM	NE
	Camarodonta	Toxopneustidae	*Sphaerechinus granularis* (Lamarck, 1816)*	AM	NE
Chordata/Tunicata	Phlebobranchia	Ascidiidae	*Ascidia virginea* Müller, 1776*	AM	NE
			Phallusia mammillata (Cuvier, 1815)*	AM	NE
	Stolidobranchia	Styelidae	*Botryllus schlosseri* (Pallas, 1766)*	AM	NE
		Pyuridae	*Halocynthia papillosa* (Linnaeus, 1767)*	AM	NE
			Didemnidae sp.*		
Parvphylum	**Suborder**		Ascidiacea sp. *		
Chondrichthyes	Carcharhiniformes	Pentanchidae	*Galeus melastomus* Rafinesque, 1810*	AM	LC
		Scyliorhinidae	*Scyliorhinus canicula* (Linnaeus, 1758)*	AM	LC
			Scyliorhinus stellaris (Linnaeus, 1758)*	AM	NT
		Triakidae	*Mustelus mustelus* (Linnaeus, 1758)*	AM	VU
	Torpediniformes	Torpedinidae	*Torpedo marmorata* Risso, 1810*	AM	LC
	Rhinobatiformes	Rhinobatidae	*Rhinobatos cemiculus* Geoffroy Saint-Hilaire, 1817⁺	AM	CR
	Rajiformes	Rajidae	*Raja asterias* Delaroche, 1809*	AM	NT
			Raja clavata Linnaeus, 1758*	C - CG	NT
			Raja miraletus Linnaeus, 1758*	C - CG	LC
			Raja radula Delaroche, 1809*	AM	EN
	Myliobatiformes	Gymnurydae	*Gymnura altavela* (Linnaeus, 1758)*	AM	CR
		Myliobatidae	*Aetomylaeus bovinus* (Geoffroy Saint-Hilaire, 1817)*	AM	CR
Osteichthyes	Anguilliformes	Nettastomitidae	*Nettastoma melanura* Rafinesque, 1810*	AM	LC
		Congridae	*Conger conger* (Linnaeus, 1758)*	AM	LC
	Clupeiformes	Dorosomatidae	*Sardinella aurita* Valenciennes, 1847*	AM	LC

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
		Alosidae	*Sardina pilchardus* (Walbaum, 1792)*[m]	AM	LC
		Engraulidae	*Engraulis encrasicholus* (Linnaeus, 1758)*	AM	LC
	Argentiniformes	Argentinidae	*Argentina sphyraena* Linnaeus, 1758*	AM	NE
	Aulopiformes	Chlorophthalmidae	*Cholorophthalmus agassizi* Bonaparte, 1840*	C - CG	LC
	Myctophiformes	Myctophidae	*Myctophum punctatum* Rafinesque, 1810*	AM	LC
	Zeiformes	Zeidae	*Zeus faber* Linnaeus, 1758*	C - CG	LC
	Gadiformes	Bregmacerotidae	*Bregmaceros nectabanus* Whitley, 1941**	IP	LC
		Phyciidae	*Phycis blennoides* (Brünnich, 1768)*	AM	LC
		Lotidae	*Gaidropsarus biscayensis* (Collett, 1890)*	AM	LC
		Gadidae	*Gadiculus argenteus* Guichenot, 1850*	AM	LC
			Micromesistius poutassou (Risso, 1827)*	AM	LC
			Trisopterus capelanus (Lacepede, 1800)*	AM	LC
		Merlucciidae	*Merluccius merluccius* (Linnaeus, 1758)*	AM	VU
		Macrouridae	*Coelorinchus caelorhincus* (Risso, 1810)*	AM	LC
			Hymenocephalus italicus Giglioli, 1884*	AM	LC
	Trachichthyiformes	Trachichtyidae	*Hoplostethus mediterraneus* Cuvier, 1829*	C - CG	LC
	Scombriformes	Scombridae	*Scomber colias* Gmelin, 1789*	C - CG	LC
			Thunnus thynnus (Linnaeus, 1758) [++]	AM	EN
		Trichiuridae	*Lepidopus caudatus* (Euphrasen, 1788)*	C - CG	LC
	Syngnathiformes	Centriscidae	*Macroramphosus scolopax* (Linnaeus, 1758)*	C - CG	LC
		Syngnathidae	*Hippocampus guttulatus* Cuvier, 1829**[+]	AM	NT
			Syngnathus acus Linnaeus, 1758[+]	AM	LC
	Dactylopteriformes	Dactylopteridae	*Dactylopterus volitans* (Linnaeus, 1758) [++]	AM	LC
	Callionymiformes	Callionymidae	*Callionymus filamentosus* Valenciennes, 1837*	IP	LC NE

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
			Callionymus pusillus Delaroche, 1809*	AM	LC
			Synchiropus phaeton (Günther, 1861)*	AM	LC
	Mulliformes	Mullidae	*Mullus barbatus* Linnaeus, 1758*	AM	LC
			Mullus surmuletus Linnaeus, 1758*	AM	lC
	Gobiiformes	Gobiidae	*Deltentosteus quadrimaculatus* (Valenciennes, 1837)*	AM	LC
			Gobius bucchichi Steindachner, 1870*	AM	LC
			Gobius geniporus Valenciennes, 1837+	**E**	LC
			Gobius incognitus Kovačić & Šanda, 2016+	AM	-
			Gobius niger Linnaeus, 1758*	AM	LC
			Pomatoschistus bathi Miller, 1982+	E	LC
		Sphyraenidae	*Sphyraena sphyraena* (Linnaeus, 1758) m	AM	LC
	Pleuronectiformes	Citharidae	*Citharus linguatula* (Linnaeus, 1758)*	AM	LC
		Scophthalmidae	*Lepidorhombus boscii* (Risso, 1810)*	AM	LC
			Lepidorhombus whiffiagonis (Walbaum, 1792)*	AM	LC
		Bothidae	*Arnoglossus imperialis* (Rafinesque, 1810)*	AM	LC
			Arnoglossus kessleri Schmidt, 1915*	**E**	DD
			Arnoglossus laterna (Walbaum, 1792)*	AM	LC
			Arnoglossus rueppelii (Cocco, 1844)*	AM	LC
			Arnoglossus thori Kyle, 1913*	AM	LC
		Soleidae	*Buglossidium luteum* (Risso, 1810)*	AM	LC
			Microchirus ocellatus (Linnaeus, 1758)*	AM	LC
			Monochirus hispidus Rafinesque, 1814*	AM	DD
			Solea solea (Linnaeus, 1758)* **	AM	LC

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
		Cynoglossidae	*Symphurus nigrescens* Rafinesque, 1810*	AM	LC
	Carangiformes	Carangidae	*Seriola dumerili* (Risso, 1810)**	C - CG	LC
			Trachurus mediterraneus Steindachner, 1851*	AM	LC
			Trachurus trachurus (Linnaeus, 1758)*	AM	LC
		Echeneidae	*Echeneis naucrates* Linnaeus, 1758**	CT	LC
		Xiphiidae	*Xiphias gladius* Linnaeus, 1758 [m]	C - CG	NT
	Beloniformes	Belonidae	*Belone belone* (Linnaeus, 1760)*	AM	LC
		Exocoetide	*Cheilopogon heterurus* (Rafinesque, 1810)[+]	C - CG	DD
			Hirundichthys rondeletii (Valenciennes, 1847)**	C - CG	lC
	Mugiliformes	Mugilidae	*Chelon auratus* (Risso, 1810)[m]	AM	LC
			Chelon ramada (Risso, 1827) [m]	CR	LC
			Chelon saliens (Risso, 1810) [m]	AM	LC
			Mugil cephalus Linnaeus, 1758[m]	C - CG	LC
			Oedalechilus labeo (Cuvier, 1829) [m]	AM	LC
			Planiliza haematocheilus (Temminck & Schlegel, 1845)[m]	WP- M/	-
	Blenniiformes	Tripterygiidae	*Tripterygion delaisi* Cadenat & Blache, 1970[+]	AM	LC
			Tripterygion tripteronotum (Risso, 1810) [+]	**E**	LC
		Blenniidae	*Blennius ocellaris* Linnaeus, 1758*	AM	LC
	Acanhuriformes	Caproidae	*Capros aper* (Linnaeus, 1758)*	AM	LC
	Lophiiformes	Lophiidae	*Lophius budegassa* Spinola, 1807*	AM	DD
	Acropomatiformes	Champsodontidae	*Champsodon nudivittis* (Ogilby, 1895)*	IP	NE
	Eupercaria	Sparidae	*Boops boops* (Linnaeus, 1758)*	AM	LC

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
			Dentex macrophthalmus (Bloch, 1791)*	AM	DD
			Dentex maroccanus Valenciennes, 1830*	AM	DD
			Diplodus annularis (Linnaeus, 1758)* +	AM	LC
			Diplodus vulgaris (Geoffroy Saint-Hilaire, 1817)* +	AM	LC
			Lithognathus mormyrus (Linnaeus, 1758) +	AM	LC
			Salpa sarpa (Linnaeus, 1758) +	AM	LC
			Pagellus acarne (Risso, 1827)*	AM	LC
			Pagellus bogaraveo (Brünnich, 1768)*	AM	LC
			Pagellus erythrinus (Linnaeus, 1758)*	AM	LC
			Sparus aurata Linnaeus, 1758* +	AM	LC
			Spicara flexuosum Rafinesque, 1810*	AM	NE
			Spicara maena (Linnaeus, 1758)*	AM	LC
			Spicara smaris (Linnaeus, 1758)*	AM	LC
			Spondyliosoma cantharus (Linnaeus, 1758)*	AM	LC
		Sciaenidae	*Sciaena umbra* Linnaeus, 1758**	AM	VU
		Cepolidae	*Cepola macrophthalma* (Linnaeus, 1758)*	AM	LC
		Labridae	*Symphodus cinereus* (Bonnaterre, 1788) +	AM	LC
		Scaridae	*Sparisoma cretense* (Linnaeus, 1758) +	AM	LC
	Perciformes	Trachinidae	*Trachinus draco* Linnaeus, 1758*	AM	LC
		Uranoscopiidae	*Uranoscopus scaber* Linnaeus, 1758*	AM	LC
		Serranidae	*Serranus cabrilla* (Linnaeus, 1758)*	AM	LC
			Serranus hepatus (Linnaeus, 1858)*	AM	LC
			Serranus scriba (Linnaeus, 1758) +	AM	LC
			Epinephelus aeneus (Geoffroy Saint-Hilaire, 1817) +	AM	NT

Annex. Continued

Phylum	Order	Family	Species	Origin	IUCN status
			Epinephelus costae (Steindachner, 1878) +	AM	DD
			Epinephelus marginatus (Lowe, 1834) +	AM	EN
		Sebastidae	*Helicolenus dactylopterus* (Delaroche, 1809)*	AM	LC
		Scorpaenidae	*Scorpaena notata* Rafinesque, 1810*	AM	LC
			Scorpaena porcus Linnaeus, 1758* +	AM	LC
			Scorpaena scrofa Linnaeus, 1758+	AM	LC
			Pterois miles (Bennett, 1828) +	IP	LC
		Triglidae	*Chelidonichthys cuculus* (Linnaeus, 1758)*	AM	LC
			Chelidonichthys lastoviza (Bonnaterre, 1788)*	AM	LC
			Chelidonichthys lucerna (Linnaeus, 1758)*	AM	LC
			Lepidotrigla cavillone (Lacepede, 1801)*	AM	LC
			Trigla lyra Linnaeus, 1758*	AM	LC
		Peristediidae	*Peristedion cataphractum* (Linnaeus, 1758)*	AM	LC