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REVIEW ARTICLE

Chondrichthyan species as by-catch: A review on species inhabiting Turkish waters

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Abstract

Chondrichthyan or cartilaginous species, throughout the world, are found among fisheries by-catch. In this study, 52 studies conducted between 1991 and 2018 in Turkish waters were reviewed to assess the status of chondrichthyan species as by-catch. Geographic coverage was grouped as; Black Sea (the number of studies 5), Sea of Marmara (6), Aegean Sea (25), and Levantine Sea (16). Results showed that there were differences in by-catch amounts when sharks, rays and chimaeras were compared according to geographical grouping. When by-catch ratios of listed species were analyzed it showed that almost half of the by-catch was comprised of small spotted catshark, *Scyliorhinus canicula* (Linnaeus, 1758), followed by blackmouth catshark, *Galeus melastomus* Rafinesque, 1810. In case of rays, the most common species of by-catch was thornback ray, *Raja clavata* Linnaeus, 1758, followed by common stingray, *Dasyatis pastinaca* (Linnaeus, 1758). Among all reported species concerned, 9 were Critically Endangered, 8 Endangered, 7 Vulnerable, 13 Near Threatened, 8 Least concern, 9 were Data Deficient, according to IUCN Red List, corresponding to half of the Turkish cartilaginous fauna. This review aims to provide on the by-catch of cartilaginous species caused by scientific or commercial fisheries activities in the Turkish waters emphasizing on long-needed conservation action plans for future sustainability of these cartilaginous species.

Keywords: Chondrichthyan species, by-catch, Turkish waters, threatened species

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Introduction

Chondrichthyan species, more popularly known as sharks, rays and chimaeras, are found among fisheries by-catch although they are top predators and fairly large in size. Worldwide, approximately half of the global shark catch is composed of by-catch individuals by pelagic longline or trawler fisheries due to

intense effort and operations overlap with sharks' habitats (Huse *et al*. 2000; Kettemer 2012). By-catch composition or rates of each gear type also changes due to species depth, size class, gear selectivity, location, extent of effort and food preferences (Huse *et al*. 2000; Jordan *et al.* 2013). Nets and longlines are considered more selective than trawlers because of their operational functioning (Huse *et al.* 2000). Nevertheless due to species opportunistic feeding preference longlines have one of the highest cartilaginous by-catch numbers (Wetherbee *et al.* 1990; Oliver *et al.* 2015; Bengil *et al.* 2018). In purse-seiners case it could be very low, from which chondrichthyans comprise lower than 1 % of the total catch. However, by-catch of a multi-species trawl fishery can comprise almost 15 % of the total catch (Amandè *et al*. 2010; Damalas and Vassilopoulou 2011; Oliver *et al*. 2015). On the other hand, in the trammel net fishery, chondrichthyan by-catch can account for up to 97 % of the total catch (Ceyhan *et al.* 2010).

Main reasons driving chondrichthyans to extinction in the Mediterranean Sea can be listed as activities of tourism and recreation, oil and gas industry as well as pollution but the most effecting pressure is their being taken as by-catch by large- and small-scale fisheries (Dulvy *et al.* 2016). As a consequence, the numbers of these species are in a declining trend and due to increase number of incidental as well as targeted catches there have been local extinctions especially in the northwestern Mediterranean Sea (Ferretti *et al*. 2015; Dulvy *et al.* 2016). While the amount of local extinction is higher in the northeastern Mediterranean, the eastern Mediterranean is a habitat for between 28 and 33 threatened species (Critically endangered, Endangered and Vulnerable based on IUCN Red List (IUCN 2012)) (Dulvy *et al.* 2016), highlighting the importance of the area as a stronghold for these species.

A current checklist of cartilaginous species of Turkish waters was compiled in 2015 from the studies dating back to the 1970's and it reported 66 cartilaginous species that represented 75 % of cartilaginous fauna of the Mediterranean (Eronat and Bizsel 2015). However, these past three years new species have been entering the Mediterranean Sea, such as *Mobula japanica* (Müller & Henle, 1841) reported by Sakalli *et al*. (2016) and *Himantura leoparda* (Manjaji-Matsumoto & Last, 2008) reported by Yücel *et al.* (2017), making the number increase to 68 and the ratio to 78 %.

In the Mediterranean Sea, chondrichthyan distribution is not homogenous (Serena 2005) as in the Turkish waters. For instance, with the new records there are 64 species inhabiting the Levantine Sea where as in the Black Sea only 9, and Sea of Marmara and Aegean Sea, 36 and 61, respectively (Eronat and Bizsel 2015; Sakalli *et al.* 2016; Yücel *et al.* 2017). In addition, the Aegean and Levantine Seas (the northeastern Mediterranean) are known to be important habitats for cartilaginous fish as breeding and nursery grounds (Bilecenoğlu 2008; Turan *et al.* 2016; Bengil 2018). According to previous studies, 38 chondrichthyans have

commercial value either for local consumption in touristic areas or for exportation (Filiz and Toğulga 2002; Ceyhan *et al*. 2010). All these facts, when added up, bring once again the importance of certain geographic regions for cartilaginous species, especially in the context of species conservation.

The aim of this study is to evaluate chondrichthyans by-catch composition and ratios in the Turkish Sea based on previously reported data. Obtaining baseline information or at least increasing the understanding of fisheries pressure on these species will provide a path to develop practical management plans for these species' conservation. This method makes it possible to monitor the pressure continuously by adding future researches. Furthermore, an inherent assessment system can be implemented in order to measure effectiveness of practical management plans.

Data collection

Turkish seas surrounding three sides of Turkey are divided into four regions; Black Sea in the north, Sea of Marmara in the north-west, Aegean Sea to the west and in the south the Levantine Sea, comprising the 8333 km-long coastline (Irtem *et al.* 2005). The target studies population composed of that provided information on species with number of individuals. Research results, such as peer-reviewed articles, unpublished dissertations, and scientific project reports conducted between 1991 and 2018 were used for further analysis. Information, regarding chondrichthyan species, was extracted and where possible, metadata on sampling year and study area were also recorded. Gear types were grouped into trawl, purse seine, net (gill net, trammel net, etc.) and longline. Geographic coverage of each study was grouped as; Black Sea, Sea of Marmara, Aegean Sea, and Levantine Sea (Figure 1). The name and taxonomy of the species were updated according to World Register of Marine Species (2018; http://www.marinespecies.org/).

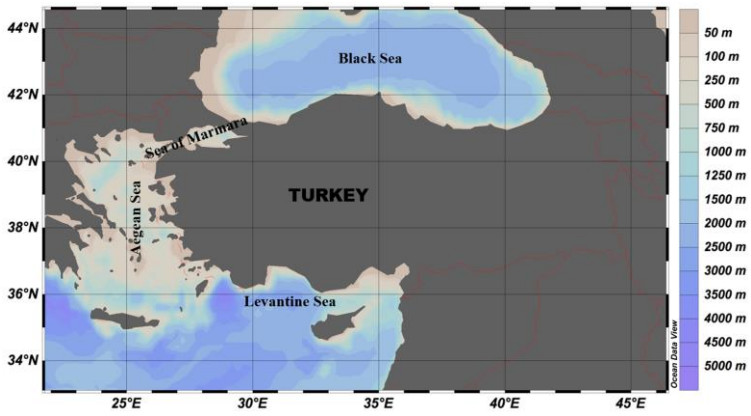

Figure 1. Four seas surrounding Turkey

Gear type and geographical distribution of the studies

There were five, six, 25 and 16 studies that provided data from the Black Sea, Sea of Marmara, the Aegean Sea and the Levantine Sea, respectively (Table 1). Numbers of each gear group were 35 trawl, 4 purse seine, 26 net, and 8 longline. High number of by-catch in trawlers is expected due to its operational methodology as well as its proportions when compared to other gears mentioned. However, more stationary fishing methodology such as longlines and nets (gill, trammel etc.), can catch up to 72 % and 97 % chondrichthyans, respectively (Ceyhan *et al*. 2010). In case of longlines it is also logical to observe noticeable by-catch numbers due to these species' opportunistic feeding preference as other cartilaginous species (Wetherbee *et al.* 1990; Oliver *et al.* 2015; Bengil *et al.* 2018).

Table 1. List of reviewed studies

Author (year)	Sampling period	Fishing gear	Species
BLACK SEA			
Avsar 2001	2001	Trawl	*Squalus acanthias*
Demirhan *et al*. 2005	2002-2003	Longline, Purse seine	*Raja clavata*
Demirhan & Can 2007	2002	Trawl	*Raja clavata*
Sağlam & Bascinar 2008	2009	Trawl	*Raja clavata*
Yıldız & Karakulak 2017	2012-2014	Trawl	*Squalus acanthias, Dasyatis pastinaca, Raja clavata*
SEA OF MARMARA			
Yaka 2006	2004-2005	Trawl, Purse seine, Nets	*Oxynatus centrina, Raja clavata, Raja radula*
Özen *et al.* 2008	2007	Net	*Dasyatis pastinaca, Myliobatis aquila, Raja miraletus, Raja radula, Squatina oculata, Torpedo marmorata*
Bök *et al.* 2011	2006-2007	Trawl	*Squalus acanthias, Squalus blainville, Raja asterias, Raja clavata*
Kabasakal & Dalyan 2011	2005-2009	Trawl, Net	*Echinorhinus brucus*
Acarlı & Ayaz 2015	2011-2013	Nets	*Dasyatis pastinaca, Raja clavata*
Kabasakal & Kabasakal 2014	2014	Net	*Squatina squatina*
AEGEAN SEA			
Torcu & Aka 2000	1996-1997	Trawl	*Mustelus mustelus, Scyliorhinus canicula, Dasyatis pastinaca, Raja asterias, Raja clavata, Raja miraletus, Raja naevus, Raja radula, Torpedo marmorata*
Filiz & Mater 2002	1999-2000	Trawl	*Mustelus mustelus, Scyliorhinus canicula, Squalus acanthias, Dasyatis pastinaca, Raja clavata, Raja miraletus, Torpedo marmorata*

Table 1. Continued

Eryilmaz 2003	2000-2001	Trawl, Net	*Mustelus asterias, Mustelus mustelus, Oxynotus centrina, Scyliorhinus canicula, Scyliorhinus stellaris, Squalus acanthias, Myliobatis aquilla, Rostraja alba, Raja clavata, Raja radula, Raja montagui, Raja miraletus, Raja naevus, Torpedo marmorata*
Filiz & Bilge 2004	2003	Trawl	*Chimaera monstrosa, Mustelus mustelus, Scyliorhinus canicula, Squalus acanthias, Dipturus oxyrinchus, Dasyatis pastinaca, Gymnura altavela, Raja clavata, Raja miraletus, Myliobatis aquila, Torpedo marmorata,*
Filiz *et al*. 2005	2005	Trawl	*Squatina aculeata*
Karakulak *et al*. 2006	2004-2005	Nets	*Dasyatis pastinaca, Raja radula, Torpedo marmorata*
Ismen *et al*. 2007	2005-2006	Trawl	*Etmopterus spinax, Galeus melastamus, Heptranchias perlo, Hexanchus griseus, Mustelus mustelus, Scyliorhinus canicula, Squalus blainvillei, Dasyatis pastinaca, Myliobatis aquila, Raja clavata, Raja miraletus, Raja radula, Rostroraja alba, Torpedo marmorata*
Özaydın *et al*. 2007	2005	Trawl	*Mustelus mustelus, Scyliorhinus canicula, Dasyatis pastinaca, Gymnura altavela, Raja miraletus, Rostraja alba, Torpedo marmorata*
Hepkafadar 2008	2006-2007	Longline, Net	*Squalus acanthias, Scyliorhinus stellaris, Scyliorhinus canicula, Myliobatis aquila, Raja radula, Dipturus oxyrinchus, Raja clavata, Raja asterias*
Filiz 2009	2006-2007	Trawl	*Mustelus mustelus*
Ismen *et al*. 2009	2005-2008	Trawl	*Carcharias taurus, Centrophorus granulosus, Etmopterus spinax, Galeus melastomus, Scyliorhinus canicula, Scyliorhinus stellaris, Hexanchus griseus, Heptranchias perlo, Mustelus asterias, Mustelus mustelus, Mustelus punctulatus, Oxynotus centrina, Squalus acanthias, Squalus blainville, Squatina squatina*
Kabasakal 2009	2009	Nets	*Cetarhinus maximus*
Kabasakal *et al*. 2009	2009	Trawl	*Carcharodon carcharias*
Özütemiz *et al*. 2009	2007	Trawl	*Galeus melastomus, Squalus blainvillei*
Türetken 2009	2008-2009	Trawl	*Chimaera monstrosa, Dalatias licha, Etmopterus spinax, Galeus melastomus, Mustelus mustelus, Oxynotus centrina, Scyliorhinus canicula, Squalus blainvillei, Dipturus oxyrinchus, Raja clavata,*
Yarmaz 2009	2007-2009	Trawl, Nets	*Carcharodon carcharias, Cetorhinus maximus, Galeorhinus galeus, Mustelus mustelus, Scyliorhinus canicula, Scyliorhinus stellaris, Squalus acanthias, Dasyatis pastinaca, Gymnura altavela, Leucoraja naevus, Raja clavata, Raja miraletus, Raja radula, Rostroraja alba, Myliobatis aquila, Torpedo marmorata,*

Table 1. Continued

Bilge *et al.* 2010	2003-2004	Trawl	*Etmopterus spinax*
Akyol *et al.* 2012	2008-2010	Net	*Mobula mobular, Dasyatis violacea*
Eronat 2012	2009-2011	Trawl	*Mustelus mustelus, Mustelus punctulatus, Scyliorhinus canicula, Scyliorhinus stellaris, Raja clavata, Raja radula, Torpedo marmorata*
Akyol & Capapé 2014	2013	Nets	*Glaucostegus cemiculus*
Eronat & Özaydın 2014	2008-2009	Trawl	*Chimaera monstrosa, Dalatias licha, Etmopterus spinax, Galeus melastomus, Galeorhinus galeus, Heptranchias perlo, Mustelus mustelus, Mustelus punctulatus, Oxynotus centrina, Scyliorhinus canicula, Scyliorhinus stellaris, Squalus blainvillei, Dipturus batis, Dasyatis pastinaca, Dasyatis tortonesei, Dipturus oxyrinchus,Gymnura altavela, Leucoraja fullonica, Leucoraja naevus, Myliobatis aquila, Pteromylaeus bovinus, Raja asterias, Raja clavata, Raja miraletus, Raja montagui, Raja polystigma, Raja radula, Rostroraja alba, Torpedo marmorata, Torpedo nobiliana*
Dereli *et al.* 2015	2009-2011	Net, Longline	*Mustelus mustelus*
Kara *et al.* 2017	2010-2014	Nets	*Raja clavata, Squatina squatina*
Akyol *et al.* 2017	2016	Trawl	*Aetomylaeus bovinus*
Bengil 2018	2016-2018	Trawl, Net, Longline	*Carcharhinus plumbeus, Dasyatis pastinaca, Glaucostegus cemiculus, Gymnura altavela, Isurus oxyrinchus, Mustelus mustelus, Mustelus punctulatus, Torpedo marmorata, Squatina squatina*
LEVANTINE SEA			
Başusta 1997	1994-1996	Trawl, Net, Longline	*Carcharhinus altimus, Carcharhinus plumbeus, Hexanchus griseus, Mustelus mustelus, Oxynotus centrina, Scyliorhinus canicula, Dasyatis centroura, Dasyatis pastinaca, Gymnura altavela, Raja asterias, Raja clavata, Raja radula, Rhinobatos rhinobatos, Rhinoptera marginata, Squatina oculata, Pteromylaeus bovinus, Taeniura grabata, Torpedo marmorata, Torpedo nobiliana*
Başusta *et al.* 1998	1997	Trawl	*Himantura uarnak, Taeniura grabata,*
Başusta 2002	1997	Trawl	*Squatina aculeata*
Başusta *et al.* 2007	2004-2005	Trawl	*Rhinobatos rhinobatos*
Yeldan *et al.* 2008	1999-2003	Trawl	*Raja clavata*
Kebapçioglu *et al.* 2010	2009	Trawl	*Mustelus mustelus, Dasyatis pastinaca, Gymnura altavela, Raja clavata, Rhinobatos rhinobatos*

Table 1. Continued

Saygu 2011	2009-2011	Trawl	*Dasyatis centroura, Dasyatis tortonosei, Dasyatis pastinaca, Dipturus oxyrinchus, Gymnura altavela, Leucoraja circularis, Raja clavata, Raja miraletus, Raja radula, Rhinobatos rhinobatos, Pteroplatytrygon violacea, Torpedo marmorata*
Guven *et al*. 2012	2009-2010	Trawl	*Carcharhinus plumbeus, Dalatias licha, Etmopterus spinax, Galeus melastomus, Heptrancias perlo, Mustelus mustelus, Oxynotus centrina, Scyliorhinus canicula, Squalus blainvillei*
Başusta & Başusta 2015	2014	Purse seine	*Hexanchus griseus*
Özcan & Başusta 2015	2012-2014	-	*Scyliorhinus canicula*
Özbek *et al*. 2015	2009-2010	Trawl	*Dasyatis centroura, Dasyatis marmorata, Dasyatis pastinaca, Dasyatis tortonesei*
Başusta 2016a	2010-2014	Trawl, Longline	*Carcharhinus plumbeus*
Başusta 2016b	2015	Trawl	*Etmopterus spinax, Heptranchias perlo, Squatina aculeata*
Özbek *et al*. 2016	2009-2011	Trawl	*Gymnura altavela*
Bayhan *et al*. 2018	2014	Trawl	*Chimaera monstrosa, Etmopterus spinax, Galeus melastomus, Hexanchus griseus, Oxynotus centrina, Scyliorhinus canicula, Squalus blainvillei, Dipturus oxyrinchus, Raja clavata*
Bengil 2018	2016-2018	Trawl, Longline	*Carcharhinus plumbeus, Glaucostegus cemiculus*

Chondrichthyans as by-catch

By-catch ratios of listed species showed that almost half of the by-catch was comprised of small spotted catshark, *Scyliorhinus canicula* (Linnaeus, 1758). The reason for this could be that this species can spawn all year round and common in the sampling areas. The second highest shark by-catch was blackmouth catshark, *Galeus melastomus* Rafinesque, 1810 (Figure 2). In case of rays, the highest was thornback ray, *Raja clavata* Linnaeus, 1758, and the second was common stingray, *Dasyatis pastinaca* (Linnaeus, 1758) (Figure 2). Species that were reported but were less than 1% are not shown in Figure 2.

Regarding geographical areas, sharks have higher by-catch percentage in the Aegean and Levantine Seas compared to rays. On the other hand, in the Black Sea and Sea of Marmara, rays have the higher by-catch percentage when compared to sharks. Results show that among species group, sharks, rays and chimaera, sharks had the highest by-catch percentage, more than twice of rays (Figure 3).

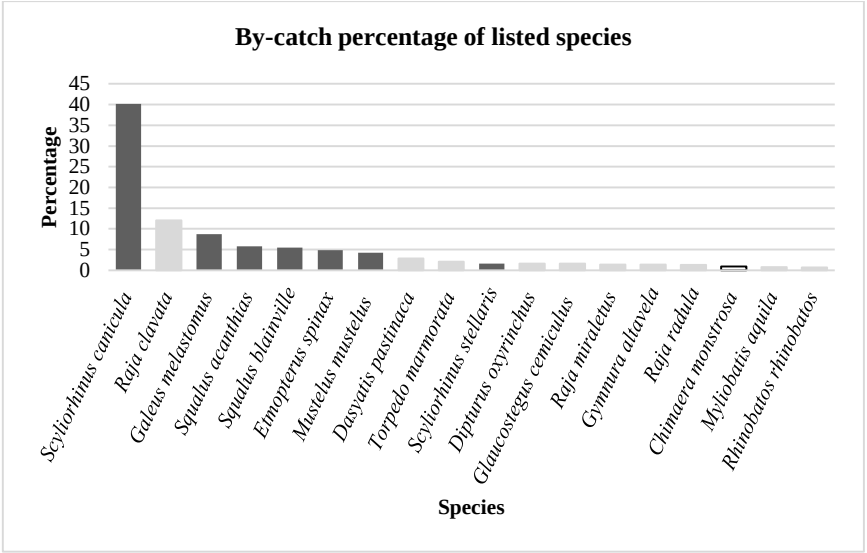

Figure 2. By-catch percentages of compiled species list
(Dark grey: sharks, light grey: rays, white with black frame: chimaera species)

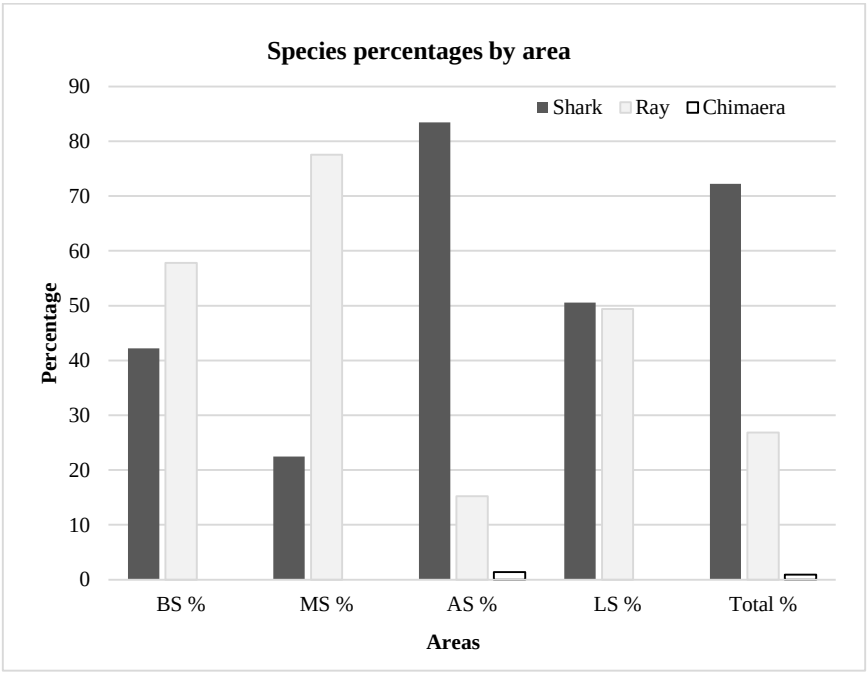

Figure 3. Catch proportion of shark, ray and chimaera of each area (BS: Black Sea; MS: Sea of Marmara; AS: Aegean Sea; LS: Levantine Sea)

Chondrichthyans as threatened species

As stated by Dulvy *et al.* (2016), at least half of the rays (50%) in the Mediterranean Sea face an elevated risk of extinction, as well as 54% of sharks, whereas the only chimaera species inhabiting Mediterranean Sea is considered as Least Concern. This study presents the species with IUCN criteria as follows: 9 Critically Endangered (CR), 8 Endangered (EN), 7 Vulnerable (VU),13 Near Threatened (NT), 8 Least concern (LC), 9 Data Deficient (DD) (Table 2), and these threatened species (CR, EN, and VU) corresponds to half of (53%) of the Turkish cartilaginous fauna, according to the checklist by Eronat and Bizsel (2015) with two additions by Yücel *et al.* (2017) and Sakalli *et al.* (2016). Keeping this in mind, since 41-49 % of eastern Mediterranean chondrichthyans are threatened species (Dulvy *et al.* 2016), half of Turkish cartilaginous fauna being threatened becomes a worrying result for chondrichthyans future in the eastern Mediterranean.

Table 2. Compiled list of by-catch amounts and ratios of species by areas (BS: Black Sea; MS: Sea of Marmara; AS: Aegean Sea; LS: Levantine Sea) is listed according to high risk to low risk IUCN status (Critically Endangered: CR, Endangered: EN, Vulnerable: VU, Near Threatened: NT, Least concern: LC, Data Deficient: DD, No information: NI)

Species	IUCN	BS	MS	AS	LS	BS %	MS %	AS %	LS %	Total %
Shark										
Carcharias taurus	CR	0	0	1	0	0.00	0.00	0.01	0.00	0.01
Isurus oxyrinchus	CR	0	0	4	1	0.00	0.00	0.03	0.02	0.03
Oxynotus centrina	CR	0	2	8	5	0.00	1.36	0.07	0.11	0.08
Carcharhinus plumbeus	EN	0	0	1	59	0.00	0.00	0.01	1.24	0.34
Carcharodon carcharias	EN	0	0	5	0	0.00	0.00	0.04	0.00	0.03
Odontaspis ferox	EN	0	0	0	0	0.00	0.00	0.00	0.00	0.00
Squalus acanthias	EN	346	8	674	0	42.20	5.44	5.61	0.00	5.80
Hexanchus griseus	NT	0	0	12	0	0.00	0.00	0.10	0.00	0.07
Scyliorhinus stellaris	NT	0	0	284	0	0.00	0.00	2.36	0.00	1.60
Heptranchias perlo	VU	0	0	33	13	0.00	0.00	0.27	0.27	0.26
Galeorhinus galeus	VU	0	0	3	0	0.00	0.00	0.02	0.00	0.02
Mustelus asterias	VU	0	0	9	1	0.00	0.00	0.07	0.02	0.06
Mustelus mustelus	VU	0	2	612	129	0.00	1.36	5.09	2.72	4.19
Cetorhinus maximus	VU	0	0	1	0	0.00	0.00	0.01	0.00	0.01
Centrophorus granulosus	VU	0	0	1	56	0.00	0.00	0.01	1.18	0.32
Galeus melastomus	LC	0	0	1002	544	0.00	0.00	8.34	11.48	8.72
Scyliorhinus canicula	LC	0	0	5871	1253	0.00	0.00	48.86	26.44	40.20
Etmopterus spinax	LC	0	0	696	155	0.00	0.00	5.79	3.27	4.80
*Chimaera monstrosa**	NT	0	0	162	0	0.00	0.00	1.35	0.00	0.91
Carcharhinus altimus	DD	0	0	0	1	0.00	0.00	0.00	0.02	0.01
Mustelus punctulatus	DD	0	0	24	0	0.00	0.00	0.20	0.00	0.14
Dalatias licha	DD	0	0	11	3	0.00	0.00	0.09	0.06	0.08
Echinorhinus brucus	DD	0	3	0	0	0.00	2.04	0.00	0.00	0.02
Squalus blainville	DD	0	18	773	177	0.00	12.24	6.43	3.73	5.46
Ray										
Dipturus batis	CR	0	0	2	0	0.00	0.00	0.02	0.00	0.01
Gymnura altavela	CR	0	0	32	209	0.00	0.00	0.27	4.41	1.36
Rostroraja alba	CR	0	0	68	0	0.00	0.00	0.57	0.00	0.38
Squatina oculata	CR	0	0	0	1	0.00	0.00	0.00	0.02	0.01

Table 2. Continued

Squatina squatina	CR	0	1	7	0	0.00	0.68	0.06	0.00	0.05
Squatina aculeata	CR	0	0	1	2	0.00	0.00	0.01	0.04	0.02
Leucoraja circularis	EN	0	0	0	3	0.00	0.00	0.00	0.06	0.02
Mobula mobular	EN	0	0	2	30	0.00	0.00	0.02	0.63	0.18
Glaucostegus cemiculus	EN	0	0	124	157	0.00	0.00	1.03	3.31	1.59
Rhinobatos rhinobatos	EN	0	0	0	117	0.00	0.00	0.00	2.47	0.66
Dasyatis centroura	NT	0	0	0	5	0.00	0.00	0.00	0.11	0.03
Dasyatis pastinaca	NT	7	14	209	277	0.85	9.52	1.74	5.85	2.86
Dipturus oxyrinchus	NT	0	2	137	145	0.00	1.36	1.14	3.06	1.60
Leucoraja naevus	NT	0	0	4	0	0.00	0.00	0.03	0.00	0.02
Myliobatis aquila	NT	0	22	113	0	0.00	14.97	0.94	0.00	0.76
Pteromylaeus bovinus	NT	0	0	6	2	0.00	0.00	0.05	0.04	0.05
Pteroplatytrygon violacea	NT	0	0	9	1	0.00	0.00	0.07	0.02	0.06
Raja clavata	NT	467	28	485	1154	56.95	19.05	4.04	24.35	12.04
Raja polystigma	NT	0	0	2	0	0.00	0.00	0.02	0.00	0.01
Rhinoptera marginata	NT	0	0	0	1	0.00	0.00	0.00	0.02	0.01
Dasyatis tortonesei	VU	0	0	0	1	0.00	0.00	0.00	0.02	0.01
Torpedo marmorata	LC	0	3	350	6	0.00	2.04	2.91	0.13	2.03
Torpedo torpedo	LC	0	0	2	0	0.00	0.00	0.02	0.00	0.01
Raja miraletus	LC	0	3	88	155	0.00	2.04	0.73	3.27	1.39
Raja asterias	LC	0	30	20	1	0.00	20.41	0.17	0.02	0.29
Raja montagui	LC	0	0	3	0	0.00	0.00	0.02	0.00	0.02
Torpedo nobiliana	DD	0	0	10	1	0.00	0.00	0.08	0.02	0.06
Leucoraja fullonica	DD	0	0	3	0	0.00	0.00	0.02	0.00	0.02
Raja radula	DD	0	11	153	63	0.00	7.48	1.27	1.33	1.28
Taeniura grabata	DD	0	0	0	1	0.00	0.00	0.00	0.02	0.01
Himantura leoparda	NI	0	0	0	1	0.00	0.00	0.00	0.02	0.01
Mobula japanica	NI	0	0	0	9	0.00	0.00	0.00	0.19	0.05

*Though chimaeras are not under Elasmobranchii it was listed in this table as shark.

Chondrichthyans under the scope of conservation actions

Current knowledge output of this study indicates that an urgent conservation actions are required regarding sustainability of current populations of chondrichthyans in the eastern Mediterranean. As previously reported, by-catch volumes and species composition are insufficiently documented, the numbers of chondrichthyans caught as by-catch can only be crudely estimated (Camhi *et al.* 1998), these results will play a significant role in future developing practical management plans on conservation of these species throughout the Turkish seas as well as for the projections in the eastern Mediterranean. Additionally, this information will also help with by-catch mitigation measures as well by showing where to focus and on which species.

In conclusion, chondrichthyan species are a big part of the by-catch in Turkish seas, as in other seas of the world. Even though the result were only complied from previous researches, it sheds some light on the issue and gives an idea about the scale of by-catch caused by scientific or commercial fisheries activities for Turkish waters, emphasizing on long-needed action plans for the sustainability of cartilaginous species.

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Hedef dışı olarak kıkırdaklı balık türleri: Türkiye denizleri kıkırdaklı balıklar üzerine bir değerlendirme

Öz

Dünyada olduğu gibi kıkırdaklı balık türleri de hedef dişi avlanan türler arasındadır. Bu çalışmada hedef dışı olarak kıkırdaklı balık türlerinin durumunu değerlendirebilmek için Türkiye sularında 1991-2018 yılları arasında gerçekleştirilmiş 52 çalışma incelenmiştir. Coğrafik olarak çalışmalar; Karadeniz, Marmara Denizi, Ege Denizi ve Levanten Denizi olarak gruplanmıştır. Çalışmaya uygun sırasıyla Karadeniz, Marmara Denizi, Ege Denizi ve Levanten Denizi'nde beş, altı, 26 ve 16 çalışma tespit edilmiştir. Sonuçlar, köpekbalıkları, vatozların ve chimaera türlerinin coğrafi gruplamaya göre karşılaştırılması durumunda, hedef dışı avlanma miktarlarında farklılık olduğunu göstermiştir. Türetilen listesindeki türlerin hedef dışı avlanma oranlarına bakıldığında neredeyse hedef dışı avın yarısını kedibalığı *Scyliorhinus canicula* (Linnaeus, 1758), ikinci sırada ise, lekeli kedibalığı *Galeus melastomus* Rafinesque, 1810 oluşturmaktadır. Vatozlarda ise en yaygın olan dikenli vatoz, *Raja clavata* Linnaeus, 1758 ve ikinci olarakta rina, *Dasyatis pastinaca* (Linnaeus, 1758) bulunmuştur. Tüm rapor edilen türler arasında tüm Türkiye kıkırdaklı faunasının yarısına denk gelen 9 Kritik Tehlikede, 8 Tehlikede, 7 Hassas durumda, 13 Yakın Tehlikede, 8 Tehlikede Değil ve 9 Veri Eksik tür tespit edilmiştir. Bu değerlendirme uzun zamandır gerekli olan, kıkırdaklı balık türlerinin gelecekteki sürdürülebilirliği için koruma faaliyet planlarının gerekliliğini vurgulayarak, Türkiye sularında gerçekleştirilen ticari ve bilimsel balıkçılık faaliyetlerinin neden olduğu bilinmeyen hedef dışı kıkırdaklı balıkların bir resmini gözler önüne sermeyi hedeflemektedir.

Anahtar kelimeler: Kıkırdaklı türler, hedef dışı avcılık, Türk suları, tehdit altındaki türler

References

Acarlı, D., Ayaz, A. (2015) Using concrete artificial reef as a tool to enrich the new marine habitat in Erdek-Ocaklar Bay (Marmara Sea, Turkey). *Fresenius Envir Bull* 24(2): 602-609.

Akyol, O., Aydın, I., El Kamel Moutalibi, O., Capapé, C. (2017) Bull ray, *Aetomylaeus bovinus* (Geoffroy Saint - Hilaire, 1817) (Myliobatidae) in the Mediterranean Sea and captures of juveniles from Izmir Bay (Aegean Sea, Turkey). *J Appl Ichthyol* 33(6): 1200-1203.

Akyol, O., Capapé, C. (2014) Distribution of blackchin guitarfish *Rhinobatos cemiculus* E. Geoffroy Saint-Hilaire, 1817 (Elasmobranchii: Rhinobatidae) with first records from İzmir Bay (Turkey, northeastern Aegean Sea). *Turk J Zool* 38: 460-465.

Akyol, O., Ceyhan, T., Erdem, M. (2012) Turkish pelagic gillnet fishery for swordfish and incidental catches in the Aegean Sea. *J. Black Sea/Mediterr Environ* 18(2): 188-196

Amandè, M.J., Ariz J., Chassot E, Delgado de Molina, A., Gaertner, D., Murua, H., Pianet, R., Ruiz, J., Chavance, P. (2010) By-catch of the European purse seine tuna fishery in the Atlantic Ocean for the 2003-2007 period. *Aquat Living Resour* 23: 353-362.

Avsar, D. (2001) Age, growth, reproduction and feeding of the spurdog (*Squalus acanthias* Linnaeus, 1758) in the South-eastern Black Sea. *Estuar Coast Shelf Sci* 52(2): 269-278.

Başusta, N. (1997) Pelagic and Demersal Fish Species Inhabiting Iskenderun Bay. Doctorate Thesis. Institute of Science, Çukurova University (in Turkish).

Başusta, N. (2002) Occurrence of a sawback angelshark (*Squatina aculeata* Cuvier, 1829) off the Eastern Mediterranean coast of Turkey. *Turk J Vet Anim Sci* 26: 1177-1179.

Başusta, N. (2016a) Length-weight relationship of sandbar shark *Carcharhinus plumbeus* (Nardo, 1827) in Iskenderun Bay (North-Eastern Mediterranean Sea). *Rapp Comm int Mer Medit* 41: 318.

Başusta, N. (2016b) New records of neonate and juvenile sharks (*Heptranchias perlo*, *Squatina aculeata*, *Etmopterus spinax*) from the north-eastern Mediterranean Sea. *Mar Biodivers* 46 (2): 525-527.

Başusta, N., Başusta, A. (2015). Additional record of the bluntnose six-gill shark, *Hexanchus griseus* (Bonnaterre, 1788) from Iskenderun Bay with its morphometric measurements. *J Black Sea/Mediterr Environ* 21(2): 224-226.

Başusta, N., Demirhan, S. A., Karalar, M., Cekic, M. (2007) Diet of common guitarfish (*Rhinobatos rhinobatos* l., 1758) in the Iskenderun Bay (northeastern Mediterranean). *Rapp Comm int Mer Médit* 38: 426.

Başusta, N., Erdem U., Kumlu M. (1998) Two new fısh records for the Turkish seas: round stingray *Taenıura grabata* and skate stingray *Himantura uarnak* (Dasyatidae). *Isr J Zool* 44(1): 65-66.

Başusta, N., Özbek, E. Ö. (2017) New record of giant devil ray, *Mobular mobular* (Bonnaterre, 1788) from the Gulf of Antalya (Eastern Mediterranean Sea). *J Black Sea/Mediterr Environ* 23(2): 162-169.

Bayhan, Y. K., Ergüden, D., Cartes, J. E. (2018) Deep sea fisheries in Mersin Bay, Turkey, Eastern Mediterranean: diversity and abundance of shrimps and benthic fish fauna. *Acta Zool Bulg* 70(2): 259-268.

Bengil, E. G. T. (2018) Genetic Features of Some Cartilaginous Species Inhabiting Aegean and Mediterranean Sea and Bio-ecological Features of *Glaucostegus cemiculus* (Geoffroy Saint-Hilaire, 1817). Ege University, Institute of Science, PhD Thesis (in Turkish).

Bengil, F., Bengil, E. G., Mavruk, S., Heral, O., Karaman, O. D., Ozaydin, O. (2018) Feeding ecology of four demersal shark species (*Etmopterus spinax, Galeus melastomus, Scyliorhinus canicula and Squalus blainville*) from the Eastern Aegean Sea. *Turk J Fish And Aquat Sci* 19(6). doi: 10.4194/1303-2712-v19_6_03

Bilecenoğlu, M. (2008) Conservation and Monitoring Project of Sandbar Sharks (*Carcharhinus plumbeus*) in Boncuk Bay, Gökova Special Environmental Protection Area. Environmental Protection Agency for Special Areas, Republic of Turkey Ministry of Environment and Forestry, Ankara, 32 pp.

Bilge, G., Filiz, H., Tarkan, A. N. (2010) Length-weight relationship of velvet belly lantern shark *Etmopterus spinax* (Linnaeus, 1758) in Sigacik Bay (Aegean Sea). *Turk J Fish and Aquat Sci* 25(1): 1-8 (in Turkish).

Bök, D.T., Göktürk, D., Kahraman, A. E., Alılçı, T. Z., Acun, T., Ateş, C. (2011) Length-weight relationships of 34 fish species from the Sea of Marmara, Turkey. *J Anim Vet Adv* 10 (23): 3037-3042.

Camhi, M.D., Fowler, S.L., Musick, J.A., Bräutigam, A., Fordham, S.V. (1998) Sharks and Their Relatives: Ecology and Conservation. IUCN/SSC Shark Specialist Group, Gland, Switzerland and Cambridge, UK.

Ceyhan, T., Hepkafadar, O., Tosunoglu, Z. (2010) Catch and size selectivity of small-scale fishing gear for the smooth-hound shark *Mustelus mustelus* (Linnaeus, 1758) (Chondrichthyes: Triakidae) from the Aegean Turkish coast. *Mediterr Mar Sci* 11(2): 213-224.

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

Demirhan, S. A., Can, M. F. (2007) Length–weight relationships for seven fish species from the southeastern Black Sea. *J Appl Ichthyol* 23(3): 282-283.

Demirhan, S. A., Engin, S., Seyhan, K., Akamca, E. (2005) Some biological aspects of thornback ray (*Raja clavata* L., 1758) in the southeastern Black Sea. *Turk J Fish and Aquat Sci* 5(2): 75-83.

Dereli, H., Tosunoğlu, Z., Göncüoğlu, H., Ünal, V. (2015) Catch per unit effort (CPUE) and catch composition of small-scale fisheries in Gökova Bay. *Ege J Fish Aqua Sci* 32(3): 135-143.

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, Malaga, Spain.

Eronat, E.G.T. (2012) Determination of Dietary Features of Chondrichthyes (Cartilaginous Fishes) Species from Central Aegean Sea. Ege University, Institute of Science, Master Thesis (in Turkish).

Eronat, E.G.T., Bizsel, K.C. (2015) Diversity in Fish Fauna of Turkish Seas. DEVOTES-EUROMARINE Summer School "Marine ecosystem services, management and governance: linking social and ecological research" 9-11 June 2015 - Aquarium of Donostia- San Sebastián, Spain.

Eronat, E.G.T., Özaydın, O. (2014) Length-weight relationship of cartilaginous fish species from Central Aegean Sea (Izmir Bay and Sığacık Bay) *Ege J Fish Aqua Sci* 31(3): 119-125.

Eryilmaz, L. (2003) A study on the fishes of Bozcaada Island (North Aegean Sea). *J Black Sea/Mediterr Environ* 9(2): 121-137.

Ferretti, F., Morey, G, Serena, F., Mancusi, C., Fowler, S.L., Dipper, F., Ellis, J. (2015) *Squatina squatina*. The IUCN Red List of Threatened Species 2015: e. T39332A48933059. doi: 10.2305/IUCN.UK.2015-1.RLTS.T39332A48933059.en. (accessed 12 April 2017).

Filiz, H. (2009) Diet composition of smooth-hound, *Mustelus mustelus* (Linnaeus, 1758), in Aegean Sea, Turkey. *Belg J Zool* 139(1): 81-84.

Filiz, H., Bilge, G. (2004) Length–weight relationships of 24 fish species from the North Aegean Sea, Turkey. *J Appl Ichthyol 20*(5): 431-432.

Filiz, H., Irmak, E., Mater, S. (2005) Occurence of *Squatina aculeata* Cuvier, 1829 (Elasmobranchii, Squatinidae) from the Aegean Sea, Turkey. *Ege J Fish Aqua Sci* 22(3-4): 451-452.

Filiz, H., Mater, S. (2002) A preliminary study on length-weight relationships for seven elasmobranch species from North Aegean Sea, Turkey. *Ege J Fish Aqua Sci* 19(3-4): 401-409.

Filiz, H., Togulga, M. (2002) Commercial elasmobranch species in Turkey's waters, their Fisheries and Management. İn: Proceedings of IV. National Conference on Turkey's Coastal and Marine Areas *2*: 5-8 (in Turkish).

Guven, O., Kebapcioglu, T., Deval, M.C. (2012) Length-weight relationships of sharks in Antalya Bay, eastern Mediterranean. *J Appl Ichthyol* 28: 278-279.

Hepkafadar, O. (2008) Research on Fishery and Some Biological Aspects of Smooth-Hound Shark (*Mustelus mustelus* L., 1758) in Izmir bay. PhD Thesis. Ege Üniversity (in Turkish).

Huse, I., Lokkeborg, S., Soldal, A.V. (2000) Relative selectivity in trawl, longline and gillnet fisheries for cod and haddock. *ICES J Mar Sci* 57: 1271-1782.

Irtem, E., Kabdasli, S., Azbar, N. (2005) Coastal zone problems and environmental strategies to be implemented at Edremit Bay, Turkey. *J Environ Manage* 36(1): 37-47.

Ismen, A., Cigdem Yigin, C., Altinagac, U., Ayaz, A. (2009) Length–weight relationships for ten shark species from Saros Bay (North Aegean Sea). *J Appl Ichthyol* 25: 109-112.

Ismen, A., Ozen, O., Altinagac, U., Ozekinci, U., Ayaz, A. (2007) Weight–length relationships of 63 fish species in Saros Bay, Turkey. *J Appl Ichthyol* 23(6): 707-708.

IUCN. (2012) IUCN Red List Categories and Criteria: Version 3.1. Second edition. Gland, Switzerland and Cambridge, UK: IUCN. IV 32pp

Kabasakal, H. (2009) On the capture of a large basking shark *Cetorhinus maximus* (Chondrichthyes: Cetorhinidae) in the Bay of Edremit (northeastern Aegean Sea) *Annales Series Historia Naturalis* 19(1): 11-16.

Kabasakal, H., Dalyan, C. (2011) Recent records of the bramble shark, *Echinorhinus brucus* (Chondrichthyes: Echinorhinidae), from the Sea of Marmara. *Mar Biodivers* 4: doi: 10.1017/S1755267211000108

Kabasakal, H., Kabasakal, O. (2014) Status of angelshark, *Squatina squatina* (Elasmobranchii: Squatiniformes: Squatinidae) in the Sea of Marmara. *Annales Series Historia Naturalis* 24(1): 41-46.

Kabasakal, H., Yarmaz, A., Gedikoğlu, S. Ö. (2009) Two juvenile great white sharks, *Carcharodon carcharias* (Linnaeus, 1758) (Chondrichthyes; Lamnidae), caught in the northeastern Aegean Sea. *Annales Series Historia Naturalis* 19(2): 127-134.

Kara, A., Sağlam, C., Acarli, D., Cengiz, Ö. (2017) Length-weight relationships for 48 fish species of the Gediz estuary, in İzmir Bay (Central Aegean Sea, Turkey). *J Mar Biol Assoc UK*. 98(4): 879-884.

Karakulak, F. S., Erk, H., Bilgin, B. (2006) Length–weight relationships for 47 coastal fish species from the northern Aegean Sea, Turkey. *J Appl Ichthyol* 22(4): 274-278.

Kebapçioglu, T., Özgür, E., Çardak, M., Gökoglu, M., Begburs, C. R. (2010) The status of the demersal fish community in the Gulf of Antalya, Turkey (Levantine Sea). *Rapp Comm int Mer Médit* 39: 364.

Kettemer, L.E. (2012) Global Estimate of Shark Mortality Induced by Longline Fisheries. Albert Ludwigs Universität Freiburg. PhD Thesis. Albert-Ludwigs-Universität Freiburg. 30 pp.

Jordan, L. K., Mandelman, J. W., McComb, M. D., Fordham, S. V., Carlson, J. K., Werner, T. B. (2013) Linking sensory biology and fisheries bycatch reduction in elasmobranch fishes: a review with new directions for research. *Conserv Physiol* 1(1). doi: 10.1093/conphys/cot002

Oliver, S., Braccini, M., Newman, S. J., Harvey, E.S. (2015) Global patterns in the by-catch of sharks and rays. *Marine Policy* 54: 86-97.

Özaydın, O., Uçkun, D., Akalın, S., Leblebici, S., Tosunoğlu, Z. (2007) Length–weight relationships of fishes captured from Izmir Bay, Central Aegean Sea. *J Appl Ichthyol* 23(6): 695-696.

Özcan, E.I., Başusta, N. (2015). Stomach contents of the lesser spotted dogfish, (*Scyliorhinus canicula* (Linnaeus, 1758)) inhabiting Northeastern Mediterranean. *Ege J Fish Aqua Sci* 32 (4): 193-195.

Özbek, E.Ö., Çardak, M., Kebapçıoğlu, T. (2015) Spatio-temporal patterns of abundance, biomass and length-weight relationships of *Dasyatis* species (Pisces: Dasyatidae) in the Gulf of Antalya, Turkey (Levantine Sea). *J Black Sea/Mediterr Environ* 21(2): 169-190.

Özbek, E.Ö., Çardak, M., Kebapçıoğlu, T. (2016) Spatio-temporal patterns of abundance, biomass and length-weight relationships of *Gymnura altavela* (Linnaeus, 1758) (Pisces: Gymnuridae) in the Gulf of Antalya, Turkey (Levantine Sea). *J Black Sea/Mediterr Environ* 22(1): 16-34.

Özen, Ö., İşmen, A., Özekinci, U., Ayaz, A., Altınağaç, U., Ayyıldız, H., Cengiz, Ö., (2008) Population Dynamics of Economically Valuable Young Fish Species and Fish Biodiversity of Shallow waters of Canakkale. TÜBİTAK TBAG Project 106T123, pp.125 (in Turkish).

Özütemiz, Ş., Kaya, M., Özaydın, O. (2009) A preliminary study on the Length-weight relationship and diet of two species of sharks [*Galeus Melastomus* Rafinesque, 1810 and *Squalus Blainvillei* (Risso, 1826)] found in the Siğacık Bay(Aegean Sea), *Ege J Fish Aqua Sci* 26(3): 211-217 (in Turkish).

Sağlam, H., Bascinar, N.S., (2008) Feeding ecology of thornback ray (*Raja clavata* Linnaeus, 1758) on the Turkish coast of the south-eastern Black Sea, *Mar Biol Res* 4(6): 451-457.

Sakalli, A., Yucel, N., Capapé, C. (2016) Confirmed occurrence in the Mediterranean Sea of *Mobular japanica* (Müller and Henle, 1841) with a first record off the Turkish coasts. *J Appl Ichthyol* 32(6): 1232-1234.

Saygu, I. (2011) Determination of By-Catch Rays and Their Survival Rates Caught by Demersal Trawl Fishery in Antalya Bay. Akdeniz University. Master Thesis, 92 pp. (in Turkish).

Serena, F. (2005) Field Identification Guide to the Sharks and Rays of the Mediterranean and Black Sea. FAO Species Identification Guide for Fishery Purposes. FAO, Rome, 97 pp.

Torcu, H., Aka, Z. (2000) A Study on the Fishes of Edremit Bay (Aegean Sea) *Turk. J Fish and Aquat Sci* 24(1): 45-62.

Turan, C., Salihoğlu, B., Özgür Özbek, E., Öztürk, B. (Eds.) (2016) The Turkish Part of the Mediterranean Sea; Marine Biodiversity, Fisheries, Conservation and Governance. Turkish Marine Research Foundation (TUDAV), Publication No: 43, Istanbul, TURKEY.

Türetken, K. F. (2009) Quantitive-qualitive analysis of deep sea fishes around Gökçeada island (Northern Aegean sea). Master Thesis. Institute of Science Istanbul University, (in Turkish).

Wetherbee, B., Grubber, S., Cortés, E. (1990) Food consumption and feeding habits. In: Biology of Sharks and Their Relatives, (eds., Carrier, J., Musick, J., Heithaus, M.), CRC Press, Boca Raton, pp. 239-264.

Yaka, U. (2006) Research and morphological properties of Izmit Bay fishes. Biology Department, Institute of Pure and Applied Sciences, Marmara University, 108 pp. (in Turkish).

Yarmaz, A. (2009) Some biological properties of cartilaginous fish living in Edremit Bay and their vicinity. Balıkesir University, Institute of Science, Department of Biology, Master Thesis (in Turkish).

Yeldan, H., Avşar, D., Manaşırlı, M. (2008) Some biological peculiarities of thornback ray, *Raja clavata* (Linnaeus, 1758) in the northeastern Mediterranean. *Ege J Fish Aqua Sci* 25(3): 221-228.

Yıldız, T., Karakulak, F. S. (2017) Discards in bottom - trawl fishery in the western Black Sea (Turkey). *J Appl Ichthyol* 33(4): 689-698.

Yücel, N., Sakalli, A., Karahan, A. (2017) First record of the honeycomb stingray *Himantura leoparda* (Manjaji - Matsumoto and Last, 2008) (Myliobatoidei: Dasyatidae) in the Mediterranean Sea, confirmed by DNA barcoding. *J Appl Ichthyol* 33(3): 530-532.