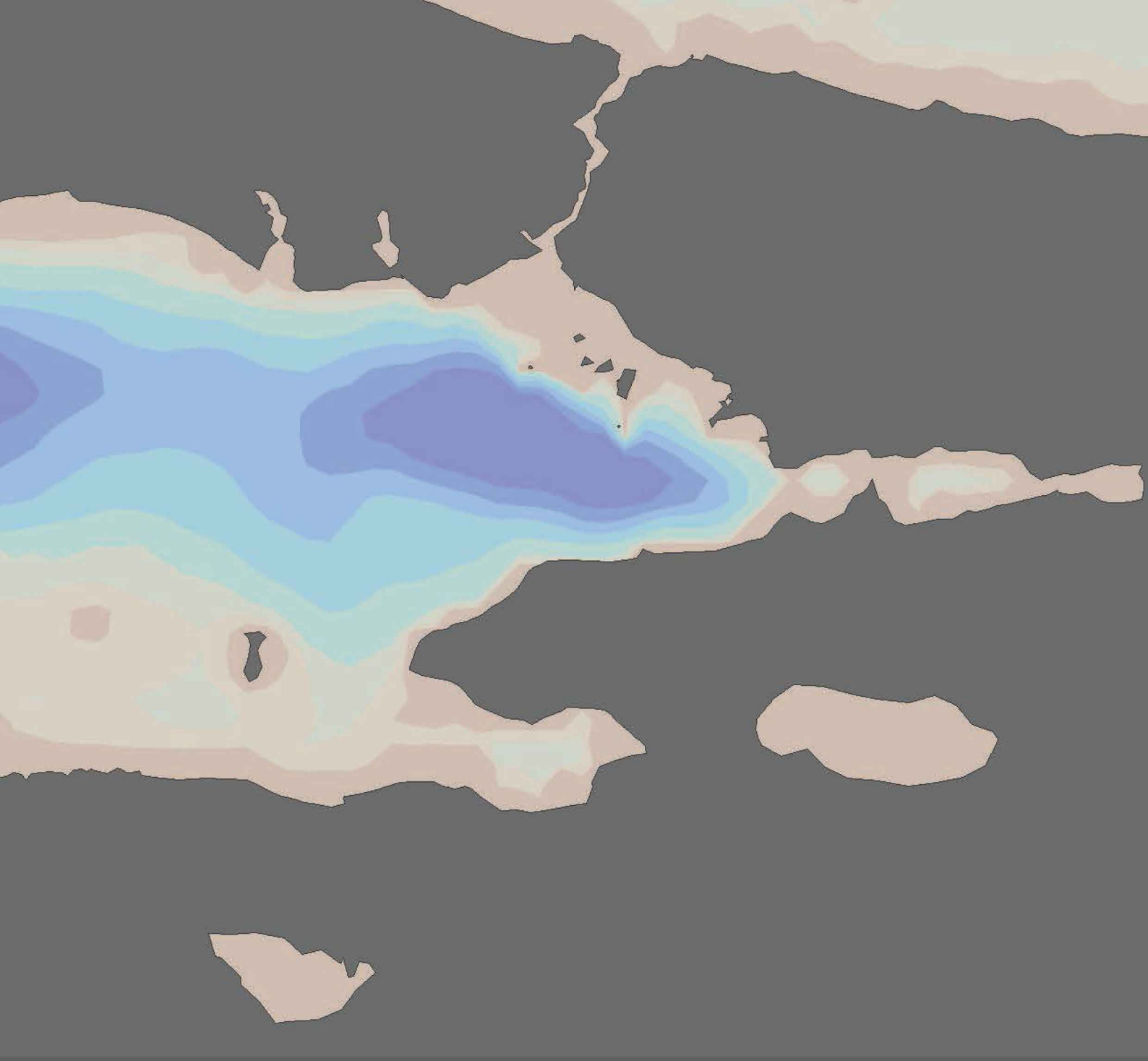

THE SEA OF MARMARA

MARINE BIODIVERSITY, FISHERIES, CONSERVATION AND GOVERNANCE

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Neslihan BALKIS, Nuray BALKIS, Bayram ÖZTÜRK

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DEMERSAL FISHES AND FISHERIES IN THE SEA OF MARMARA

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1. Introduction

The term “demersal fish” defines fish species live near the sea-floor. In general, they are long-lived and slow growing. Demersal fish of commercial interest are mainly confined to the upper 200 m. Main fishing method is called bottom trawling that is towing a net just above the sea bottom.

Marine ecosystems, and the way species interact within them, are complex. Many species occupy different trophic levels throughout their life cycle, while species and/or sizes at the same trophic level often occupy different habitats and ecological niches and are, therefore, not necessarily co-occurring in space and/or time (FAO 2014). However, given the extensive coverage of the world's shelf ecosystems by bottom trawling, generally longer-lived, demersal (bottom) fishes have tended to decline faster than shorter-lived, pelagic (open water) fishes, a trend also indicated by changes in the ratio of piscivorous (mainly demersal) to zooplanktivorous (mainly pelagic) fishes (Pauly *et al.* 1998, Pauly *et al.* 2002). Major fisheries separately target both small pelagics as well as large demersal stocks. The demersal fish resources are to a large extent fully fished to overfished in most of the area in the world (FAO 2014).

The Marmara Sea is a small inter-continental basin. It is connected with Aegean Sea and Mediterranean Sea via Dardanelles Strait and with Black Sea via İstanbul Strait (Bosporus). Turkish Straits System. The hydrography of the Marmara Sea is dominated by the Mediterranean and Black Seas water. Within the strait system two major currents are prevailing. The under current is generated by the Mediterranean waters flows in through the Dardanelles and out through the İstanbul Strait. The surface current is generated by Black Sea waters flows in through the Istanbul and out through the Dardanelles (Beşiktepe *et al.* 1994). Those hydrographical characteristics support to inhabit some demersal Black Sea species, for example gobies, in the Sea of Marmara (Keskin 2010), succeeding in establishing themselves in the Istanbul Strait is an evidence of the optimal environmental conditions in the strait which serves as a biological corridor between the Mediterranean and Black Seas (Öztürk and Öztürk 1996; Keskin 2012). Hence, it represents different types of habitats and mixed species diversity of the Black Sea and Mediterranean Sea.

This chapter aims to evaluate current situation of demersal fishery with total demersal catch statistics, reviewing previous studies and knowledge on some notable demersal fish in the Sea of Marmara.

2. Previous studies of fish fauna and fisheries in the Sea of Marmara

The historical records on fish biodiversity and fisheries method in the Sea of Marmara date back to ancient times. Istanbul Strait and Golden Horn Estuary of Istanbul have had significant socioeconomic importance for centuries with their flourishing natural living resources (Tekin 1996). The entire Istanbul area are known for their important fishing grounds with rich fish biodiversity, with the notable presence of top predators such as dolphins and blue fish from the ancient times (Tekin 1996) until the 1950s (Güvengiriş 1977). Bilecenoğlu *et al.* (2014) reviewed the very early notable studies on ichthyofauna of the Sea of Marmara. According to this important review study, two authors provided significant information on Turkish marine fish during the 17th century. One of them was Evliya Çelebi (1611–ca. 1682), who mentioned the occurrence of some 20 species by their common Turkish names along the Marmara coastline in his 10 volume travelogue (Seyâhatnâme), followed by the Italian naturalist Count Luigi Ferdinando Marsigli (1658– 1730), who carried out extensive oceanographical surveys at the Bosphorus, emphasizing also local fish species and their migratory behavior to the Black Sea (Bilecenoğlu *et al.* 2014).

Since 1950's, several researches have been conducted and contributed the literature on the taxonomy, distribution, biology catch composition of the demersal fishes of the Sea of Marmara. Artüz (1957) conducted eco-survey studies to determine the spawning area of important fish species in the Sea of Marmara. Demir (1958) published systematics of 3 deep sea fish and identification of their eggs and larvae in the north-eastern part of the sea. Since the 1960s, several researches were performed on biology of various fish species.

Eryılmaz and Meriç (2005) examined earlier fish biodiversity studies by Ninni (1923) and Devedjian (1926) who was the first director of Fish Market in Istanbul. They listed 230 fish species in the Sea of Marmara. Later, Keskin and Eryılmaz (2010) added 5 new records to listed fish species. According to latest study, 415 fish species inhabited in the Sea of Marmara with new records including Indo-Pasific originated fishes also known as Lessepsian migrants (Bilecenoğlu *et al.* 2014). Over half of 415 fish species are recognized demersal (Tıraşın and Ünlüoğlu 2013).

Notable researches on demersal fish of the Sea of Marmara are chronologically listed as biology of common sole (*Solea solea*) (Oral 1996), catch composition and biology of tub gurnard (*Chelidonichthys lucerna*)in the southern part (Eryılmaz 1999), biology of surmullet (*Mullus surmuletus*) in the northern part (Moldur 1999),

composition and population of juvenile fish in Erdek Bay (Keskin 2002), comparative study on stomach contents of some teleost fishes (Gönülal 2006), biology of picarel (*Spicara smaris*) in the northern part (Çorbacı 2008), feeding habits of Eurepean hake (*Merluccius, merluccius*) in the northern part (Murat-Dalkara 2009), length-weight relationship of some fish species (Keskin and Gaygusuz 2010; Bök *et al.* 2011; Demirel and Murat-Dalkara 2012a), distributional patterns of demersal fishes (Keskin 2010; Keskin *et al*. 2011), juvenile fish population in the Istanbul Strait (Keskin 2012), age and growth of blotched picarel and picarel (*Spicara maena* and *Spicara smaris*) (Saygılı *et al.* 2014), distribution and bioecology of brown comber (*Serranus hepatus*) (Yazıcı 2015) and population structure of European hake (Gül *et al.* 2016). Some ichthyoplankton studies performed to determine distribution and abundance of pelagic fish eggs and larvae of some teleost fish in order to consider important spawning grounds (Yüksek 1993; Okuş *et al.* 1998; Demirel 2004). Compatible results of those studies pointed out that northern part of the Sea of Marmara, Around Princes Islands and the entrance of Gemlik Bay were important spawning grounds with high diversity and abundance of fish eggs and larvae. In addition, several researches contributed to update the fish fauna with identifying new species and/or observing alien fish species. Besides that, some researches focused fish parasites, fatty acid contents of commercial fish. There are also many researches for pollution level such as heavy metal accumulation and organochlorine level in the consumed demersal fishes of the Sea of Marmara.

The first research on demersal catch composition was obtained by the support of Japan International Cooperation Agency (JICA) in 1993. Afterwards, Kocataş *et al.* (1993) performed a research to review the fishery resources. Gözenç *et al.* (1997) estimated total demersal stock size 6000 tonnes in 1992 and 1200 in 1994. Their results pointed out that, European hake (*Merluccius merliccius*) constituted the main portion of the catch composition with the following other demersal fish such as whiting, tub gurnard, piper gurnard, red mullet, turbot, sole. Gözenç *et al.* (1997) discussed the decline of catch due to overfishing and demographic growth and urbanization with the load of solid waste on the sea-bed.

Akyol *et al.* (2009) directly focused on the demersal fishery and main resources and performed an investigation on coastal fisheries and fishery resources around Marmara Island. Yığın and İşmen (2012) classified fisheries type and gears into 4 categories such as pelagic, artisanal, shrimp and sea snail fisheries.

There is also very important problem of the demersal fishery namely bycatch and discards. Previous studies and important results were evaluated under the “Discards” section.

Although, its contribution is important for Turkish fishery, unfortunately, stock assessment researches and related management strategies for fisheries in the Sea of Marmara are very limited.

3. Demersal fish fauna and catch landings of demersal fish species in the Sea of Marmara

Demersal fishery in Turkey mainly constitutes 41 fish species (Tıraşın and Ünlüoğlu 2013), and the Sea of Marmara contributed with 29 demersal fish (Table 1). Of the 29 demersal fish, 80% percent of catch provided by 6 notable species such as whiting (*Merlangius merlangus*) with 33%, surmullet (*Mullus surmuletus*) with 13%, goatfish (*Mullet spp*.) with 12%, European hake (*Merluccius merluccius*) with %7, anglerfish (*Lophius piscatorius*) with 6% and salema (*Sarpa salpa*) with %6 (TÜİK 2015).

Demersal fish production was 3% of the total fish production in 2015 (Figure 1). Comparison of the catch statistics between 1990 and 2015 show significant difference and low amounts in demersal fish production in the Sea of Marmara (Table 1). In addition, annual catch statistics show decreasing pattern since 2000s (Figure 2).

Turbot is a highly valuable fish with high market prices. Its production is significantly decreasing since mid-2000s and catch size mostly constitutes juvenile fish. Similar decreasing pattern also can be seen in production of another valuable fish, common sole since 2007 (Figure 3).

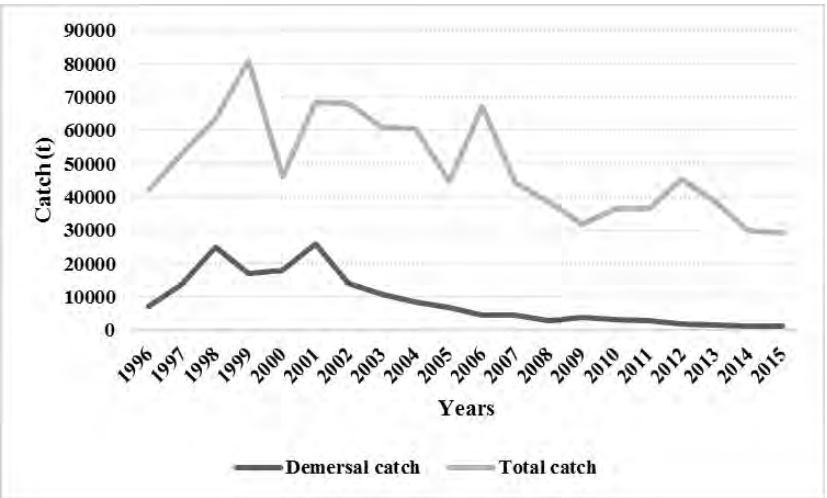

Figure 1. Annual catch statistics of total and demersal fish in the Sea of Marmara.

Table 1. Comparison of the demersal fish catch in the years 1990 and 2015 in the Sea of Marmara.

Scientific name	Turkish name	Common name	Catch (t) 1990	Catch (t) 2015
Merlangius merlangus	Mezgit	Whiting	2047	351
Mullus surmuletus	Tekir	Striped red	676	135
Mugil spp.	Kefal	-	1631	132
Merluccius merluccius	Berlam	European hake	937	81
Lophius piscatorius	Fener balığı	Angler fish	-	66.9
Salpa Salpa	Sarpa	Saupe	69	62.6
Solea solea	Dil	Common sole	358	37
Lithognathus mormyrus	Mırmır	Striped seabream	126	20.1
Scorpaena porcus	İskorpit	Black scorpion fish	68	18.8
Spicara smaris	İzmarit	Picarel	1074	17.1
Diplodus annularis	İsparoz	Annular seabream	110	15.1
Scophthalmus maximus	Kalkan	Turbot	43	14.5
Dicentrarchus labrax	Levrek	Seabrass	297	13.9
Chelidonichthus lucerna	Kırlangıç	Tub gurnard	245	13.2
Boops boops	Kupez	Bogue	279	12.8
Sparus aurata	Çipura	Seabream	18	11.9
Diplodus vulgaris	Karagöz	Two banded bream	221	6.5
Pagellus spp.	Mercan	Seabream	33	6.5
Trigla lyra	Öksüz	Piper	-	5.4
Mullus barbatus	Barbunya	Red mullet	91	5
Zeus faber	Dülger	Jonh dory	-	2.9
Umbrina cirrosa	Minekop	Croaker	162	2.4
Pleuronectes spp.	Pisi	-	-	1.8
Dentex dentex	Sinagrit	Dentex	24	1.5
Trigloporus Lastoviza	Kırlangıç (Mazak)	-	-	0.7
Scorpaena scrofa	Lipsöz	Red scorpion-fish	29	0.6
Oblada Melanura	Melanurya	Saddled seabream	-	0.6
Spondyliosoma cantharus	Sarıgöz	Black Sea-bream	-	0.2
Gaidropsarus sp.	Gelincik	Rockling	13	0.1

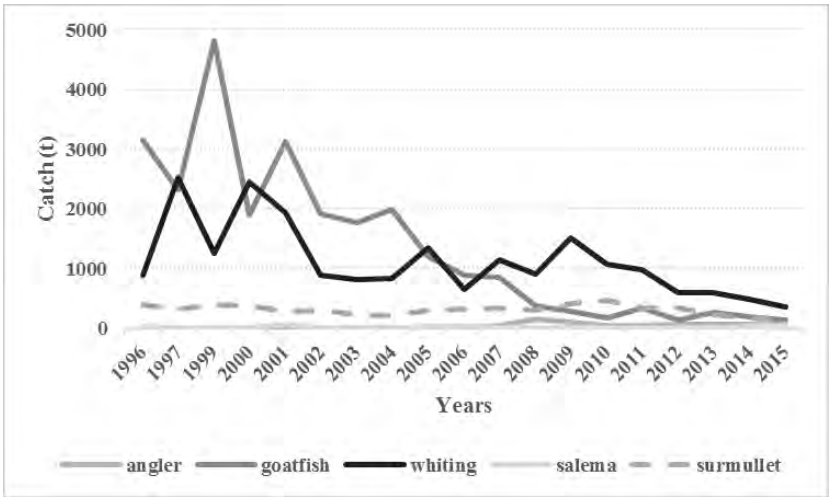

Figure 2. Annual catch statistics of 5 important demersal fish species in the Sea of Marmara. European hake was not included.

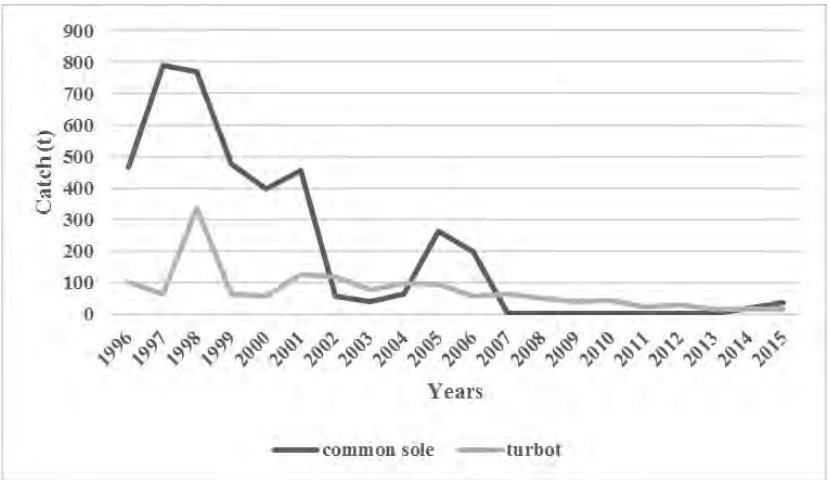

Figure 3. Annual catch statistics of common sole and turbot in the Sea of Marmara.

4. European hake (M*erluccius merluccius*) and its fishery in the Sea of Marmara

European hake has an important role on the food web with 4.4 trophic level is of namely a top predator in demersal zone (Froese and Pauly 2016). This species is mainly distributed eastern coast of Atlantic Ocean including Mediterranean Sea. The maximum length and weight of this medium-large gadoid species are about 140 cm and 15 kg, respectively with the maximum age of 12 + (Murua 2010). The biggest size was

recorded 75 cm TL in early 1990s and 65 cm TL in 2009 in the Sea of Marmara (JICA 1993, Murat-Dalkara 2009). Juvenile and small European hake usually live on muddy beds on the continental shelf, whereas large adult individuals are found on the shelf slope, where the bottom is rough and associated with canyons and cliffs. Juveniles (around 10 cm TL) mainly feed on echinoids and adults (>25 cm TL) feed on other teleosts (Murat-Dalkara 2009).

Certainly, the most important demersal fish species is the European hake in the Sea of Marmara. Its production occupied around %50 percent of demersal fishery in the Sea of Marmara in mid-90s. Decreasing started in mid-2000s and drastically deteriorated below 10% percent in 2015 (Figure 4). According to TUIK (2015) catch statistics, only 81 tonnes European hake caught in the Sea of Marmara last year.

There are several researches conducted to determine catch composition and fishery resources in the Sea of Marmara. European hake were always reported dominated species in the catch composition according to results of several research until 2011 (JICA 1993; Kocataş *et al.* 1993; Gözenç *et al.* 1997; Okuş *et al.* 1997; Torcu-Koç *et al.* 2012; Demirel *et al.* 2016).

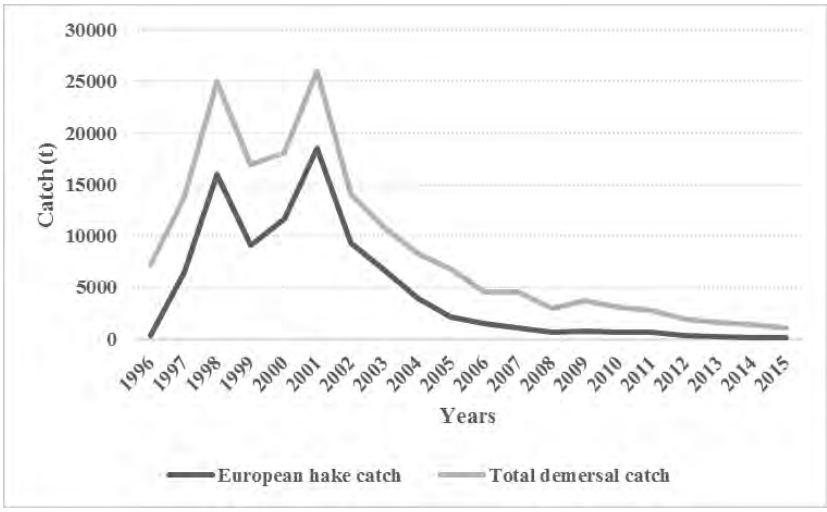

Figure 4. Annual catch statistics of European hake and total demersal fish in the Sea of Marmara.

5. Fishing fleet and fisheries regulation in the Sea of Marmara

Main fishing vessels can be classified 4 types as trawler, purseiner, beam trawlers and carrier vessels. Today, there are 14340 registered fishing vessels in various size in Turkey and 17% percent of them are operating in the Sea of Marmara (Table 2).

According to Turkish fisheries law, any kind of trawling (mid and bottom) is strictly forbidden in The Turkish Strait System (Sea of Marmara Sea and both Dardanelles and Istanbul Straits). However, coast-guard records show illegal trawling activity while data obtained from TUIK (2015) indicates the three times increase of fleet size in the past 20 years (Figure 5).

Table 2. Comparison of the number of fishing vessels in various types between Turkish waters and the Sea of Marmara in 2015.

Vessel type	Turkey	The Sea of Marmara
Trawler	650	131
Purseiner	411	117
Carrier vessels	93	22
Beam trawlers	418	177
Other	12768	1268
Total vessels	14340	2493

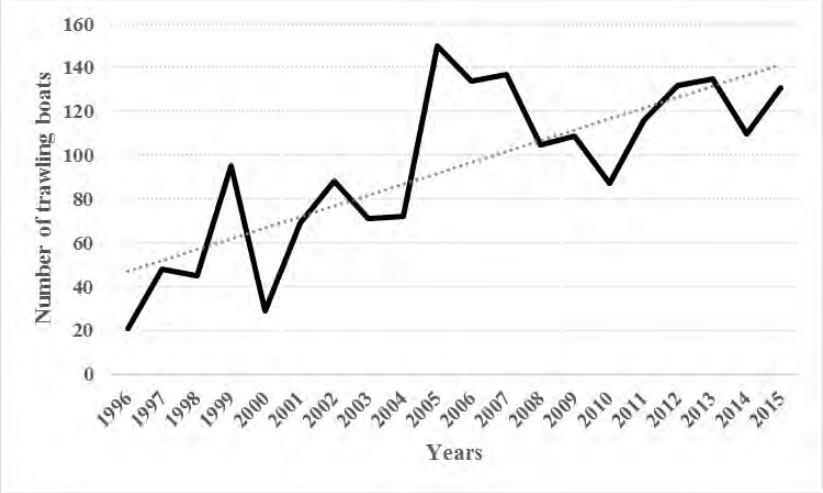

Figure 5. Annual changes in number of registered trawling boats in the Sea of Marmara.

6. Discards

The term “discards” is defined as the portion of marine animals and plants caught in fishing activity and dumped back at sea (Sarda *et al.* 2013). Discards in fisheries have been considered a serious problem for 20 years. Kelleher (2005) estimated worldwide discards at an average of 7.3 million tonnes per year, or around 8% of the total catch, although the discard rate was much higher in certain fisheries. Fishery by-catch and discarding have attracted serious attention in the world fisheries

research recently due to the increasing recognition of their negative impact on marine ecosystems. Today good fisheries management is referred as considering ecosystem health and providing necessary regulation to reduce discards. Discard problem carries several relational subproblems for social, economic and enironmental objectives. Kelleher (2005) listed policy implications for discard problem as follows:

- ✓ "the moral problem of responsible stewardship of marine resources;
- ✓ designing a management regime that limits or prevents discarding,
- ✓ the practical problem of enforcing regulations designed to prevent or minimize discards,
- ✓ the technical problems of gear selectivity and utilization of species with a low market demand through transformation or adding value; and
- ✓ the economic problems posed by efforts to reduce bycatch, increase landing of bycatch or increase utilization of bycatch."

Very common fishing methods, trawling and dredging are responsible approximately half of the total discarded fish worldwide. Bottom trawling causes seriously chronic and widespread problems on the demersal zone with the removal of growing epifauna, damaging and shifting the habitat and benthic community and demersal fish fauna.

Although trawling is prohibited with law in Turkish Strait System, shrimp fisheries with beam trawl method is allowed certain part of the Sea of Marmara. Whereas, it has been reported that the longline fishing has the lowest while shrimp fisheries has the highest discard ratio due to low net selectivity with smaller mesh size. Bottom-trawled catches produced greater species diversity and higher discard rates while longline catches produced larger specimens of teleost fish (Connoly and Kelly 1996). Yazıcı *et al.* (2006), contributed a research to determine catch composition and discards in shrimp fisheries. According to their results, besides the target species, deep water rose shrimp (*Parapenaeus longirostris*), half of the catch composition constituted demersal fish (%30.9) with hake, whiting, common sole, thornback ray (*Raja clavata*) and echinoids (15.3%). Zengin *et al.* (2004) reported catch composition of beam trawling with the discard ratio of %12 in abundance and 24% in biomass. Bayhan *et al.* (2006) conducted an experimental study with different mesh sizes in shrimp beam trawl and determined 35% of the catch composition was discarded fish species. Zengin and Akyol (2009) reported that the highest discard ratio (0.6:1) was in the Sea of Marmara while the ratio was 2-3 times lower in other Turkish waters, i.e. eastern Mediterranean Sea (Kınacıgil *et al.* 1999). Bök *et al.* (2011), reported that every 1 kg of targeted catch responded 1.5 kg of discarded species in the catch composition. Demirel and Murat-Dalkara (2012b) performed three demersal trawl surveys in 40 different locations in the

Sea of Marmara. They determined that 55% of total catches was discards which consisted of mostly rays, sharks, tiny crabs, ascidians, annelids, and sea stars.

There are also several studies established differences in selectivity of mesh size and type to provide better practice reducing discard ratio (Deval *et al.* 2006; Ateş *et al.* 2010; Bök *et al.* 2011).

7. Discussion

The aim of ecosystem based fisheries management is to provide the maximum sustainable take of target organisms with the minimum impact on other ecosystem components. The main challenge of the approach is that in the developing countries, including Turkey, stock assessments have been made only for a tiny minority of stocks with the rest of these being categorized as “data poor species”. This is mainly because of the insufficient fish market data as well as the discontinuity of already-few stock assessment projects. As a result, many commercial species including the most important demersal one, hake, are categorized as "data poor species" in Turkey. These shortcomings, in turn, pose an obstacle to the healthy management of fisheries (Demirel 2016). Based on this motivation, we should focus on the question: Can we successfully develop an ecosystem based management scheme for the data-poor fish of Turkey?

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