

THE STATE OF THE TURKISH FISHERIES

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PREFACE

This book aims to make a brief introduction to the Turkish fisheries. In this concept, some information related to the fisheries industry in general have been included along with the current status and potential of fisheries in order to construct a comprehensive resource on Turkish fisheries.

“The State of the Turkish Fisheries” which is a publication of the Turkish Marine Research Foundation (TUDAV), reflects in 5 chapters the general characteristics and status of the Turkish fisheries as well as some current topics covered in 33 articles by 44 researchers from various institutions and disciplines such as fishery faculties of different universities around Turkey, institutes of marine sciences and technologies, as well as marine scientists, biologists, agricultural engineers, fishery technologists, nutrition scientists and fishery economists from the national fisheries research institutes of the Turkish Ministry of Food, Agriculture and Livestock.

The first chapter covers the current situation of the live marine resources and a general outlook on the small pelagic fish and fisheries, demersal and deep-sea fisheries resources and alien species in the Turkish seas as well as the Turkish inland fisheries. Chapter 2 discusses the Turkish fisheries sector and covers subject such as classification of gears and methods used in commercial fisheries in Turkey, introduction of fisheries in the seas of Turkey (Black Sea, Sea of Marmara, Aegean Sea and Mediterranean Sea), fisheries management and processing technologies. In Chapter 3, different fisheries are discussed in terms of fishing gears, such as trawls, purse seines and gill nets through which almost the entire span of marine catch production is realized. Chapter 4 provides details on a species-specific fishery such as tuna, sword fish, bluefish, octopus, turbot, eel, sponge, bivalve, mussel, lobster and blue crab on which there are very limited publications to date. The last chapter of the book mentions some special researches and other related topics.

The publication of this book was decided by the editors in the last days of 2009 and the book was completed in two years (2010-2011). We hereby thank all the authors for their full support and contribution.

We also remember and cherish the memory of our dear friend and one of the authors in this book, Mustafa Erdem, whom we lost very shortly before the publication of this book, whose loss deeply, saddens us.

Adnan TOKAÇ
Ali Cemal GÜCÜ
Bayram ÖZTÜRK
May, 2012

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SMALL PELAGIC FISH AND FISHERIES IN TURKEY

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1. Introduction

World's total capture fish production leveled off around 80 million tones in early 1980s and undulates around this figure since then. The international bodies dealing with fisheries management, including Food and Agriculture Organization have agreed on the fact that around 80% of the world's fish stocks have been over-exploited. The small pelagic fishes account for about 30% of the total landings and they are the only group which could stand against high fishing pressure worldwide. This figure is even more striking in the seas surrounding Turkey. Overall, they exceed 450 thousand tons in some years composing 80% of the total catch (Figure 1). Anchovy alone comprise 65% of the fish caught by the fishing fleet. The landing statistics shows that their share in the catch has always been very high in the Black Sea; however displayed significant changes in the other seas (Figure 1).

The fishes classified as small pelagic are generally planktivorous and provide food for the upper trophic levels in the ecosystem. Therefore their importance is not limited to fisheries, they also play a key role in the energy transfer between lower and higher trophic level in the ecosystems.

Their short lifespan, fast growth rate and consequent high turnover rate helps them to tolerate very high fishing pressure. This opportunistic feature, to a great extent, protects them from recruitment failure. On the other hand, this doesn't mean that small pelagic fish stocks never collapse; there are several episodic collapses reported in the world oceans which resulted in dramatic changes in the entire ecosystem. The very sharp decline in the landings experienced in the Black Sea in 1989-90 is only a single example to such crises. With a very rough calculation it can be estimated that the economic loses of Turkey due to 1989-90 crises was around 500 million dollars.

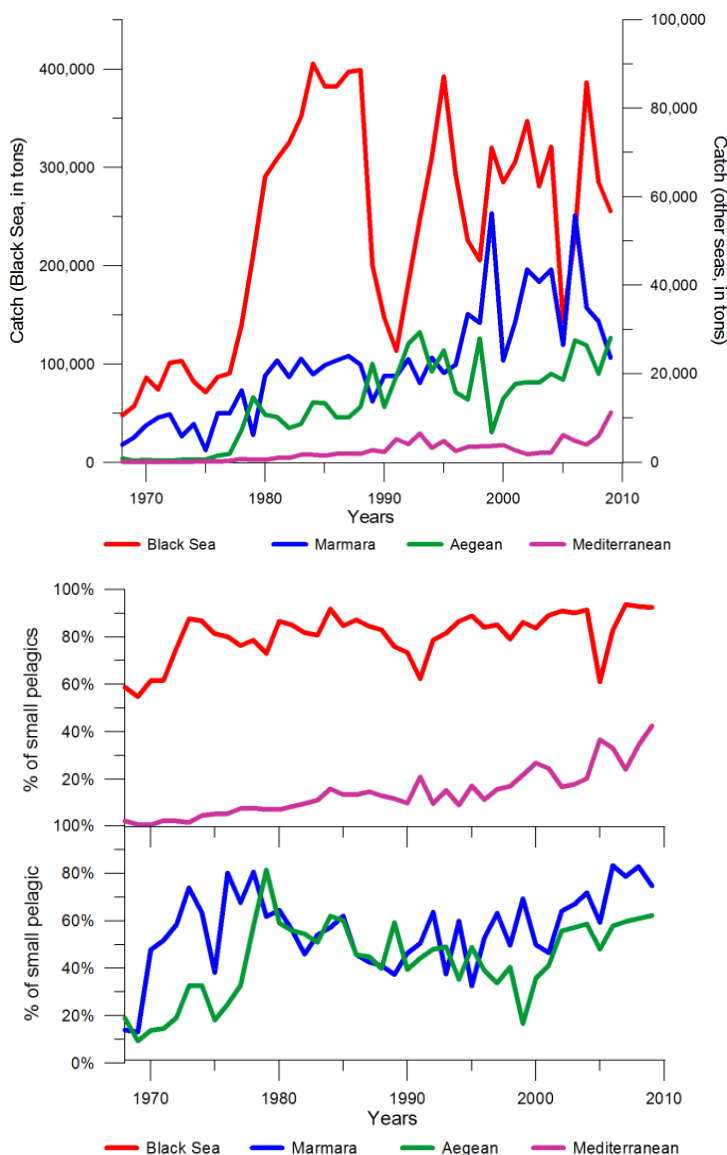


Figure 1. Small pelagic landings and their percentages in the total annual landings by region

The actual figure would be higher if the losses of the side sectors depending on anchovy (i.e. fish processing factories, fish market, transporters, wholesalers, shipyards) are included. The short lived nature of small pelagic fishes enables them to response to the environmental changes and to rapidly benefit favorable conditions. On the other hand the same features increase the dependence on recruitment success. Given their linking role between lower and

upper trophic levels, consequences of recruitment failure may be dramatically severe not only on the small pelagic but also on the entire ecosystem and on the economy depends on these species.

Despite their commercial and ecological importance, this group is least studied fishes in Turkish seas. One of the very first studies on the small pelagic fishes is the work done by Einerson and Gürtürk (1960). In their extensive work they investigated the egg and larvae distribution of pelagic fishes in the Black Sea. In contrary to the common belief, they represented that the Black Sea anchovy spawns almost on the entire basin and the core spawning areas are located near to the southern coast of the sea. A supporting study on the anchovy's spawning area has been carried out by Niermann *et al.* (1994) who observed in two successive years that the main spawning concentrations of anchovy were located almost an the same spots pointed in the former work. The first biomass estimation studies in the country go back to 1970s. Johannesson and Losse (1973) conducted an acoustical survey on anchovy and horse mackerel in the central Black Sea coast of Turkey. This study has long been an important reference to the distribution and overwintering migration of small pelagic species in the Black Sea. Another acoustical survey on the small pelagic fishes of Black Sea has been carried 20 years later (Bingel *et al.*, 1995; 1996). In this study, anchovy's main overwintering grounds were mapped along with hibernating biomass estimations. In addition to these studies there are various others concerning the biology of the important small pelagic species.

2. State of the Pelagic Fish Stocks in Turkey

There are almost twenty small pelagic fish species commercially exploited in the Turkish seas and this number is being increased due to lessepsian migration (Table 1). Despite this high species diversity, anchovy, *Engraulis encrasicolus* is by far the greatest contributor to the landings (Table 2). This species alone makes up 45% of the total landings of the country. Together with other small pelagic fishes, their overall contribution to catch is about 85%.

Table 1.Some of the small pelagic fishes commercially exploited

Native	Exotic
<i>Alectis alexandrinus</i>	<i>Alepes djedaba</i>
<i>Alosa spp.</i>	<i>Decapterus russelli</i>
<i>Caranx crysos</i>	<i>Dussumieria elopsoidea</i>
<i>Caranx rhonchus</i>	<i>Etrumeus teres</i>
<i>Engraulis encrasicolus</i>	
<i>Sardina pilchardus</i>	
<i>Sardinella aurita</i>	
<i>Sardinella madarensis</i>	
<i>Scomber japonicus</i>	
<i>Sprattus sprattus</i>	
<i>Trachurus mediterraneus</i>	
<i>Trachurus picturatus</i>	
<i>Trachurus trachurus</i>	

Table 2.Percentage of small pelagic species in the total fish landing according to the latest statistics available (2009)

Black Sea Σ landing: 25, 000 tons SP: 92%		Marmara Sea Σ landing: 24,000 tons SP: 75%		Aegean Sea Σ landing: 28,000 tons SP: 62%		Mediterranean Σ landing: 11,000 tons SP: 42%	
Anchovy	67%	Anchovy	35%	European sardine	31%	Rounded Sardine	36%
Sprat	19%	Horse mackerel	22%	Anchovy	17%	Horse mackerel	5%
Horse mackerel	6%	Sardine	16%	Horse mackerel	9%	Anchovy	1%
				Rounded Sardine	4%		

Black Sea, because of its very narrow continental shelf; very thin oxygenated upper layer and eutrophic nature, favors pelagic fishes. This is reflected in the catch composition of the landings, in which small pelagic fish forms more than 90% of the total catch. The landing figure fluctuates dramatically, particularly after the collapse experienced in 1989's. There are several contradicting arguments concerning the collapse. Gücü (2002) presented that turning from oligotrophic to eutrophic state, carrying capacity of the planktivorous pelagic fishes has been uplifted by increased food availability.

The depletion of apex predators in the ecosystem helped small pelagic fish to increase their population size in the Black Sea in 1980's. Later, rapid development of the purse seine fishery increased the fishing intensity beyond the level that anchovy stocks could tolerate and eventually collapsed. The place occupied by anchovy in the Black Sea ecosystem was first replaced by a scyphozoan jelly fish, *Aurelia aurata* and then by ctenophore, *Mnemiopsis leidyi* (Figure 2).

In a counter scenario proposed by Vinogradov *et al.* (1989), ctenophores depleted the anchovy's main food source during the *M. leidyi* outbreak. The starving anchovies could not deposit enough fat in their body to fuel the overwintering migration (Shulman, 2002).

Whatever the reason was, it is clear that the Black Sea anchovy is in a new state different than that of 1980s with more pronounced pelagic dominancy. According to Bingel and Gücü (2010) in this new state, the size of the anchovy stock is, to a great extent, determined by the quantity of anchovy taken from the stock in the preceding year. They demonstrated that catch exceeding 290,000 tons, is followed by the sharp decline in the preceding year.

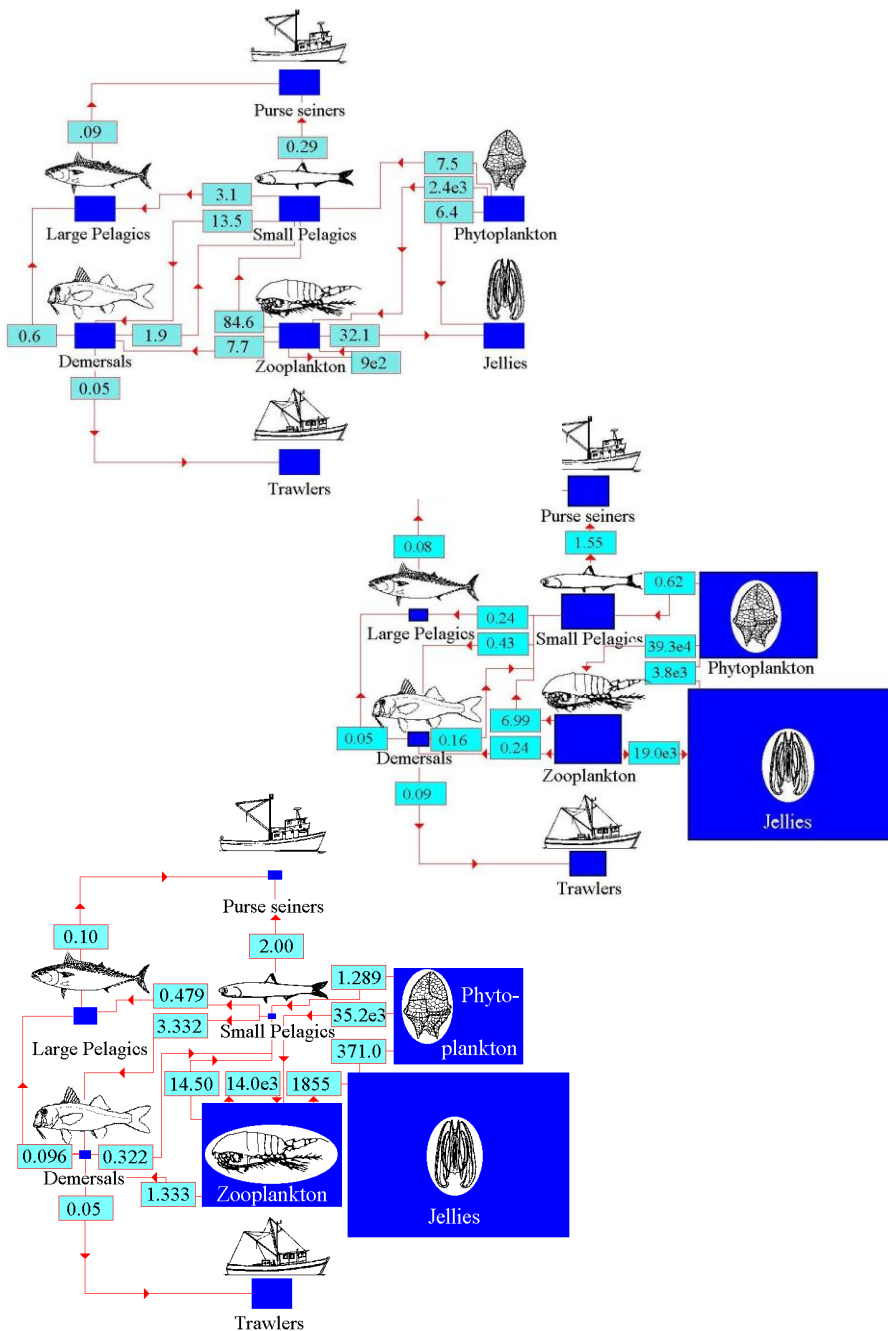


Figure 2. Changes in the Black Sea ecology and the response of ecosystem compartments. Upper left: Pristine/Oligotrophic state in 1950-1970s; upper right: eutrophic state in 1980s; lower: fisheries crisis in 1990s. Changes in the size of the blue boxes indicates changes in the biomass with respect to pristine state in 1970's (Gücü, 2002)

As oppose to fluctuating flat state in the Black Sea, the landings of small pelagic in the other seas represent an undulating increase (Figure 1). The Sea of Marmara usually displays the second largest catch figure except some years when the catch obtained from Aegean Sea, mainly due to sardine, shows an increase and/or the catch from this sea is unexpectedly low. The low figures coincide with the years of extreme mucilage formation (Tüfekçi *et al.*, 2010). The adverse effects of mucilage on fishery may be given as i) direct impact on fish by clogging the gills; ii) indirectly by its detrimental effect on the food chain; iii) and finally by clogging the fishing devices. Like in the Black Sea, anchovy is the major species in the Marmara Sea. Scientists believe that anchovy caught in the Marmara Sea forms a separate stock expanding into the Black Sea (Gordina *et al.*, 1997).

In the Aegean Sea, the most abundant species is the European Sardine and it forms more than 1/3rd of the total landings. This species shares the same habitats with anchovy; however as oppose to the former species European sardine is a winter spawning cold water species. Due to differences in the temperature requirements of these two species climate plays significant role in shaping habitat and resource partitioning. This, in turn, determines the size of their populations. Figure 3 may be a very good example of the impact of climatic shift over the sardine/anchovy dominancy. The figure displays the catches of both species in the Aegean Sea. Sardine has increased with increased fishing intensity and reached a maximum in the first half of 1990s and dropped remarkably leaving its place to anchovy. The period when the highest sardine catch was recorded is period of negative temperature anomalies (Figure 4). The cold period apparently favors the cold loving sardine whereas anchovy enjoys the warmer period.

Another striking case illustrating the impact of climate on the small pelagic is the gradual increase in the rounded sardine. Rounded sardine (*Sardinella aurita*) is another warm water component of the small pelagic fish fauna and characterizes the warmer climatic regimes in the Mediterranean (Sabates *et al.*, 2006). Their distribution in the Aegean Sea is limited to the warmer southern part and expanded towards north with warming in the recent years (Tsikliras, 2008). Figure 3 shows the landings of both sardine species caught in the Aegean Sea by the Turkish fishing fleet. Roundedsardine displays a sudden increase in 1990-1994. This is actually a cold period representing negative temperature anomaly (Figure 4). It is also the period when the Eastern Mediterranean Transient; EMT has occurred (Roether *et al.*, 1996). EMT

phenomena occurred when Asia Minor Current, which flows along the southcoast of Turkey, carries saline and more importantly warm waters of the Mediterranean, diverted its path into the Aegean Sea.

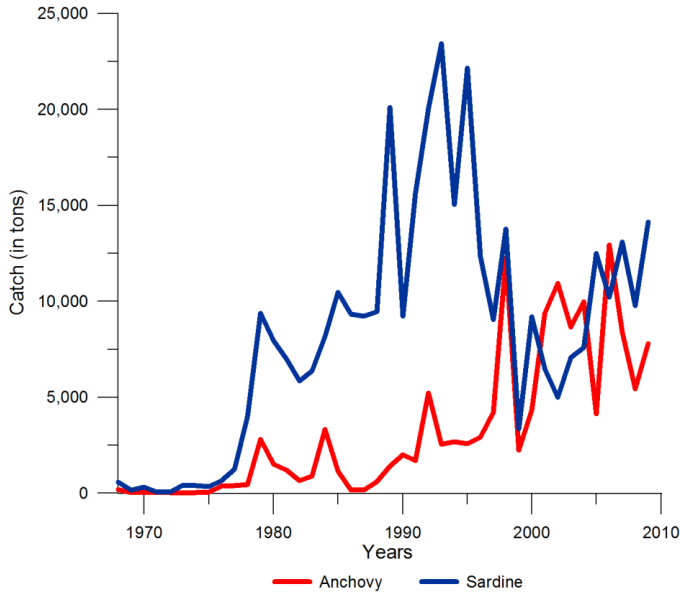


Figure 3. Anchovy and sardine catches of Turkish fishing fleet operated in the Aegean Sea.

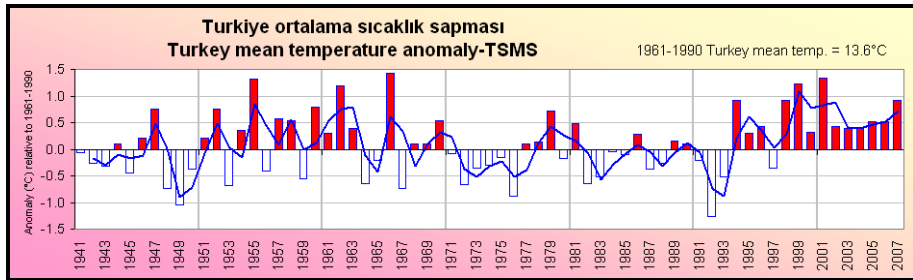


Figure 4. Mean temperature anomalies recorded between 1941-2007 (taken from Turkish State Meteorological Service)

The warm waters of the eastern Mediterranean intruded into the Aegean Sea probably carried along the rounded sardines, so that the geographical range of the species has been expanded towards north. Because it was a cold period, European sardine seem to get benefited and both species displayed a parallel increase. When EMT is over rounded sardine disappeared synchronously, while

catch of the European Sardine was still high. Following the series of exceptionally warm years, European sardine declined and rounded sardine begun to increase again. This fluctuating pattern may present the importance of climate on the species composition of small pelagics in the Aegean Sea.

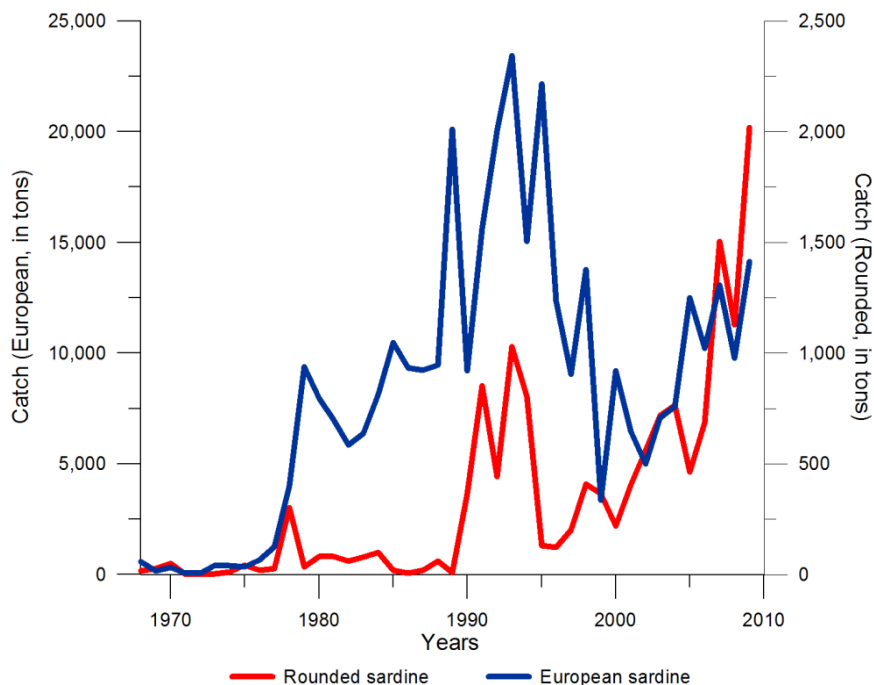


Figure 5. European and Rounded Sardine catches of Turkish fishing fleet operated in the Aegean Sea

The almost synchronous increase in the warm water, summer spawning fishes in the last decade (Figure 3 and 5) may be a sign of a remarkable change in the Aegean Sea small pelagic fish composition in the near future. The consequences of such a change would be critical on the Aegean Sea ecosystem when the role of small pelagic fish in the energy transfer within the ecosystem is considered. Such a change may alter the seasonality in the abundance of small pelagics. It is known that piscivorous fish synchronize its ontogenetic moves with the food availability (Mahe *et al.*, 2007). A shift in the timing of small pelagic fish abundance, would eventually influence the higher trophic level fishes feeding on small pelagic fishes.

The south coast of Turkey is a shore to extremely oligotrophic and warm Mediterranean Sea, which is unfavorable for pelagic fish stocks. However there are some local exceptions in which nutrients of land origin enhances productivity and sustain remarkable small pelagic fish stocks. Gulfs of Iskenderun, Mersin and Antalya hold examples of such. On the other hand there is almost no commercial interest for these local populations. Consequently their importance in the ecosystem has been overlooked until 1990s. Avşar (2000) carried out an assessment study on *Sardinella aurita* in the northeastern Mediterranean. Referring to very low local interest to this species he suggested increasing the fishing pressure on this species. However in another study addressing trophodynamic relations within the northeastern Mediterranean ecosystem, it was found that almost all major commercially important components within the ecosystem depends of small pelagic fishes (Gücü, 1995). Their share to the total energy circulation within the fisheries ecosystem is higher than the sum of the shares of all other compartments (Figure 6). Their impact on the functioning of the ecosystem is so significant that the balance between cold adopted European sardine and warm adopted rounded sardine may determine the dominant piscivorous fishes. Gücü and Bingel (2011) showed that high abundance of European sardine attracts continental slope inhabitant juvenile hake, *Merluccius merluccius* into the continental slope, while shelf inhabitant lessepsian lizardfish, *Saurida undosquamis* is suppressed by the occurrence of hake.

The eastern Mediterranean ecosystem is under the pressure of the lessepsian immigrants and several new fish species has established stocks that are exploited on commercial species. However as oppose to the great number of demersal immigrant fish, only four small pelagic fish has been successful in colonizing in the northeastern Mediterranean and attracted commercial interest (Table 1). Their involvement is around 5-7% of the total small pelagic catch, which is a surprisingly low value as compared to demersal colonizers which forms more than 30% of the total demersal catch in the region. The successful adaptive feeding and spawning strategies of the thermophilic dominant native small pelagic fish, *Sardinella aurita* that seems to benefit from the eutrophic and subtropical nature of the area, may possibly enhance its resilience against intruders (Gücü *et al.*, 2010).

been taken (TUIK web site). However total number of fishing boat regardless of their operation type is available and it shows that the size of the fleet has been exponentially developed after 1980's (Figure 7). Extensive use of sonar and other auxiliary equipment intensified the fishing power of the fleet and consequently a drastic fisheries crisis was experienced in 1989-1990. The fleet size kept increasing until consequences of overcapitalization in the fishing fleet on the stocks are finally recognized. Only then, MARA stopped issuing new licenses for the new fishing vessels. As can be seen from the fluctuating fleet size depicted in Figure 7 and 8, it took several years until the license limitation is fully enforced due primarily to the strong impact of fishermen lobby on the government. Only after 2002 the size of the fleet has been kept under control.

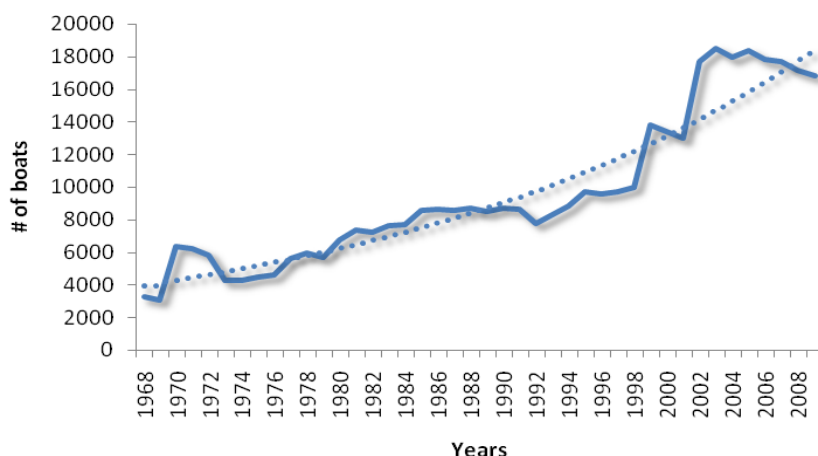


Figure 7. Development of the fishing fleet in Turkey

On the other hand the same regulation permits refit and/or engine size modifications in the licensed boats. Due to this tricky gap in the regulation, the average size of the purse seine boats and total engine power of the fleet has been doubled and are still increasing (Figure 9). Figure 10 represents catch obtained per unit of HP. Given that the fuel consumption of an engine increases with the HP, growth in the mean engine power increased the cost of fishery operations. Therefore the same figure may also be used to evaluate efficiency/profitability of the fishery, which represents a clear decreasing trend within the last 15 years. The negative trend indicates that more and more fuel is needed to catch the same quantity of fish.

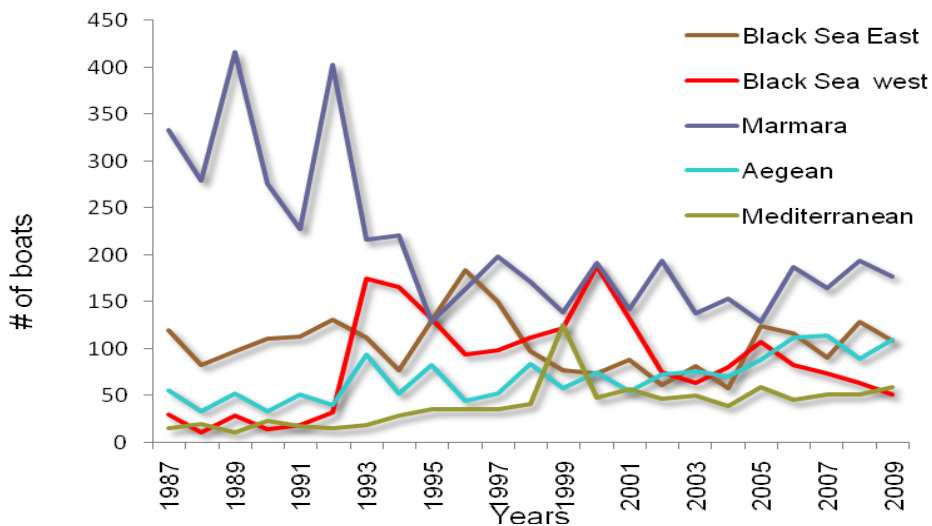


Figure 8.Number of purse seiners by region

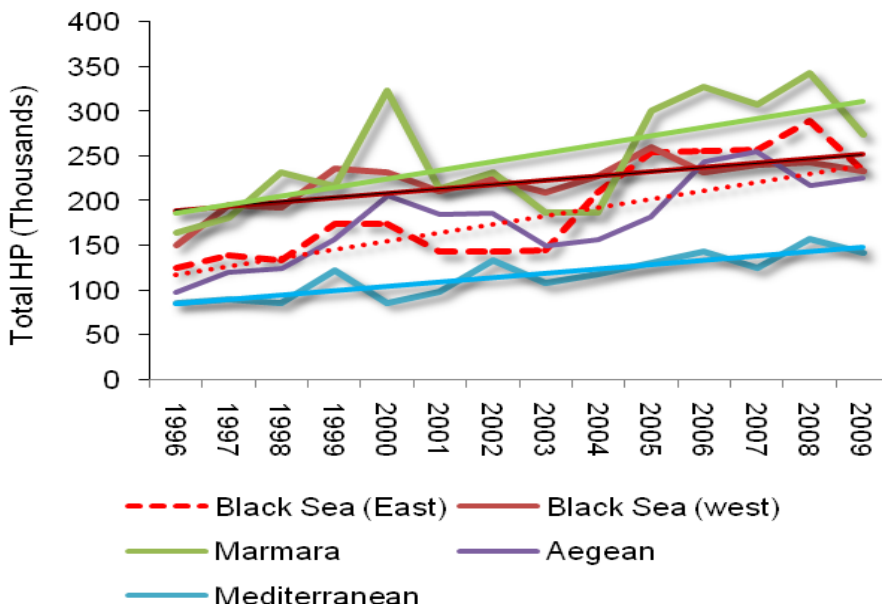


Figure 9.Increase in the total engine power (HP) of the purse seine boats by region (straight line is the linear trend)

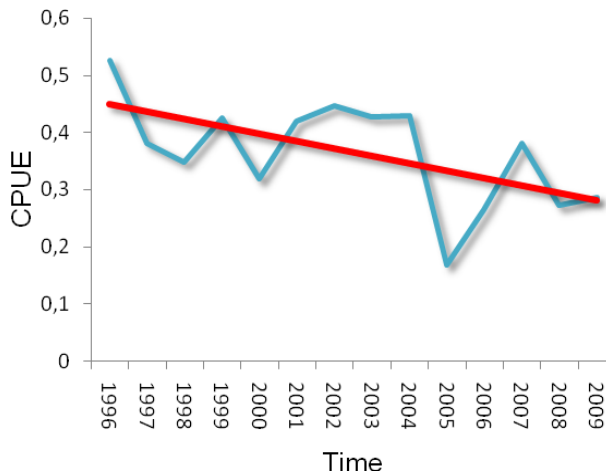


Figure 10. Changes in the Catch Per Unit Effort (HP) of small pelagic fish caught in the Turkish Seas

With no scientific backing; but with pure political concern, the Turkish government applied two major measures in order to reduce the cost of fishery by; i) Tax Relief Scheme for Diesel Oil Used in Fishing Vessels and ii) Subsidized Credit Scheme for Fishermen. Reducing the cost of fishing relieved fisheries economy to a certain extent, however the impact of this populist decision on the fish stocks has been detrimental. One of the most remarkable consequences is shortening in the duration of the actual fishing seasons. As an example, the fishing regulation applied in the country permits anchovy fishery from September to April. Despite this eight months fishing permit, the overwintering anchovy stock concentrated on the Turkish coast of Black Sea is depleted within two months. The majority of the purse seine boats are then either concludes the fishing season and harbor or move to new fishing grounds, such as in Georgia.

Another aspect of subsidizing fishery is ecological consequences of increased fuel consumption on the overall health of the planet. In an era that urges significant reduction in carbon emission, a strategy facilitating use of more fuel to catch the same amount of fish should be treated with great care.

As explained above, the stocks of the small pelagic fishes in the Black Sea showed drastic fluctuations especially within the last 3 decades. These changes are believed to be driven by four major factors; the first is the changes

in the climatic regime; changes in the trophic structure in ecosystem due to eutrophication, and malfunctioning of food web; deterioration of prey-predator relations due to selective and over fishing; and introduction of invasive alien species. At present it is not possible to state on the level of contribution of these factors on the ecosystem fluctuations; however the studies carried out until now point out that the changes in the ecosystem occurred due to eutrophication and over fishing has been very rapid and severe; whereas changes due to climate change are slow but radical and irreversible. As stated above, several Mediterranean species inhabiting at the opposite end of the Turkish Straits could not pass to the other end of the strait due mainly to the temperature barrier. Within the last three decades several thermophilic fish species which are abundant in the Mediterranean; however had rarely been observed in the Black Sea, such as *Boops boops*, *Sardina pilchardus* and *Caranx crysos* has recently increased and are being exploited at commercial scale. The increase of thermophilic species in the Black Sea may be linked to global warming and it may be further postulated that with the increase of the temperature the Mediterraneanization of the Black Sea may possibly be accelerated.

The ever worsening water quality in the sea of Marmara seems to reached an alarming level. The abrupt changes in the small pelagic fish landings may signify that the eutrophication, which until recently helped small pelagic fishes built up their carrying capacity in the Marmara, has reached to a state hindering the growth of the stocks. The close correlation between low catch and mucilage events may be seen as an important case that deserves further consideration.

Some example on the impact of climate change and the increase of temperature on the Aegean small pelagic fishery has been presented above. The data shows that the species composition is prone to remarkable changes in the near future and the warm waters species may attain to higher abundance values. If this situation is further intensified a change in the dominant species may be expected. Given that the current fisheries regulations applied in the country aim at protecting the spawn of the dominant fishes, their effectiveness should be reevaluated.

In the Mediterranean Sea, similar concerns are also valid. Besides, the lessepsian immigrant seems to be a potential risk not only on the ecosystem, but also on the entire coastal ecosystem which are linked to the small pelagic fishes.

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THE STATUS OF FISHERIES FOR SMALL TUNAS IN TURKEY

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1. Introduction

Small tunas include the following species in Turkish waters: Atlantic bonito (*Sarda sarda* Bloch, 1793), Atlantic little tunny (*Euthynnus alletteratus* Rafinesque, 1810), bullet tuna (*Auxis rochei* Risso, 1810), albacore (*Thunnus alalunga* Bonnaterre, 1788), plain bonito (*Orcynopsis unicolor* Geoffroy Saint-Hilaire, 1817), and narrow-barred Spanish mackerel (*Scomberomorus commerson* Lacepède, 1800). Of these species, there are four small tunas (bonito, little tunny, bullet tuna, and albacore) that have a commercial value in Turkish fisheries.

Table 1. Catches (t) of small tunas species (2002-2009) (ICCAT, 2010)

Species	2002	2003	2004	2005	2006	2007	2008	2009
Atlantic bonito	6286	6000	5701	70797	29690	5965	6448	7036
Little tunny	0	0	568	507	1230	785	1072	1309
Bullet tuna	0	0	284	1020	1031	993	836	1873
Albacore	0	0	27	30	73	852	208	631

The presence of small tunas and their fisheries in the Mediterranean Sea have been known very well since ancient times. Small tunas are very common species especially in small scale fisheries in Turkish waters. However, the catching amounts of these species have regularly been recorded since 2004 (Table 1). In addition to this, there are no any statistical records available for plain bonito and narrow-barred Spanish mackerel because the two species are often sold on local markets or for subsistence.

This chapter on small tunas in Turkish waters takes into account the four species (bonito, little tunny, bullet tuna, and albacore), and it includes the biological and ecological information by species, the fisheries aspects as well as some management considerations of small tunas.

2. Atlantic bonito – BON (*Sarda sarda* Bloch, 1793)

Atlantic bonito is an epipelagic neritic schooling species. The maximum length in the Atlantic is 91.4 cm (Collette and Nauen, 1983), in the Mediterranean Sea it is 96 cm (De Metrio *et al.*, 1998) and in the Black Sea is 90 cm (Kara, 1979). It is widely distributed in tropical and subtropical waters of Atlantic, Mediterranean and Black Seas (ICCAT, 2010). This species can adapt to different temperatures 12 to 27 °C and salinities 14 to 39 ‰ (Bianchi *et al.*, 1999).

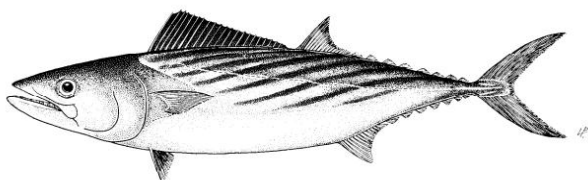


Figure 1. Atlantic bonito (*Sarda sarda* Bloch, 1793)

From the end of April till the middle of August, BON migrates for reproduction and feeding from the Aegean Sea to the Sea of Marmara and then to the Black Sea. With decreasing water temperatures in September in the Black Sea, it returns to the Aegean Sea especially in November and December. This species stay in the thermocline layer throughout the winter period (Kutaygil, 1979). According to Nümann (1954) and Artüz (1958), small numbers of the migrating BON stay in the Black Sea during the whole year.

BON is the species with the highest economic value among the pelagic fish in the Black Sea. Until the beginning of the 70's, the total catches of BON from the Black Sea countries amounted to a maximum of 20,000 tons in 1969. With the exception of Turkey and Bulgaria, BON catches are not observed in the fishery statistics of other countries especially after this date. In this process the annual BON catch amount in Bulgaria was reported in a quite low level and it was not over 50 tons except 1981 (190 tons). Reportedly, the most significant reasons for this event are the considerable increase the pollution in the northwest Black Sea and that the BON population does not migrate to this area (BSEP, 2003).

The catch data of the last 20 years of the Black Sea countries indicate that significant amounts of the total BON captures were landed by Turkish vessels (Prodanov *et al.*, 1997; BSEP, 2003). However, when the catch statistics of historical period are examined, it is observed that there are significant

fluctuations in the catch amounts in Turkish waters, and the catch amounts within the last 10 years vary between 5,000-70,000 tons/year (Table 1).



Figure 2. Bonito fishing by purse seines

BON is generally caught by purse seiners, trammel nets, drift nets, hand lines, and set net (traps). The fishery is carried out in the Black Sea, the Sea of Marmara, and the northern Aegean Sea from the middle of August to February. Furthermore, BON is mostly caught especially in September and October.

3. Atlantic little tunny – LTA (*Euthynnus alletteratus* Rafinesque, 1810)

Atlantic little tunny is an epipelagic and neritic fish typically occurring in inshore waters, more coastal and also less migratory than other tuna species. This species lives in school by size together with other Scombrid species, but has a tendency to scatter during certain periods of the year. Usually found in coastal waters with swift currents, near shoals and around the warmer waters of thermal fronts and upwelling. It is most abundant in the tropical Atlantic where the water temperature is 24 to 30 °C, and distributed in both sides of the tropical and subtropical Atlantic Ocean, including the Mediterranean, Caribbean Sea and Gulf of Mexico (ICCAT, 2010).

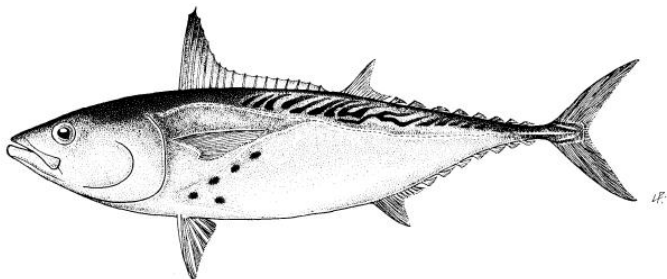


Figure 3. Atlantic little tunny (*Euthynnus alletteratus* Rafinesque, 1810)

Unlike bluefin tuna fishery, there is no any comprehensive and satisfactory knowledge about the history of LTA fishery in Turkey. The only thing we know well is that this species was mostly caught by the commercial BFT purse seiners as by-catch. However, LTA has become a target species during the last decade. From the official data, it is understood that this species was first exported to France, Japan, Spain, and Italy in 1989 as fresh, frozen, and fillet (Anonymous, 2001; Kahraman, 2005). Indeed, LTA is a commercial species in Turkish fisheries and also a desirable species especially for the canning industry (Di Natale *et. al.*, 2009)

In Turkish waters, fishing grounds of LTA are the Bay of İskenderun, Bay of Antalya, the area between the Bay of Güllük and Turgutreis, around Foça, Aliğa, Badem Islands, the Bay of Edremit, the area between Cape Kadirga and Babakale, and around Gökçeada and Bozcaada Islands (Kahraman and Oray, 2001). The fishery of the species is more or less coastal, and it is generally caught by purse seines, set nets, and driftnets. In April and May, fishing is carried out intensively, and in this period, it is mostly caught by the commercial purse-seiners.

After Turkey became a member of the International Commission for the Conservation of Atlantic Tunas (ICCAT) in 2003, the catch statistics for this species were recorded separately from other tuna species. A significant increase is observed in recent catch amounts of this species (Table 1).

4. Bullet tuna – BLT (*Auxis rochei* Risso, 1810)

Bullet tuna is an epipelagic and neritic fish species. Its maximum size in the eastern Atlantic is 51 cm fork length (Neves dos Santos and Garcia, 2006). Common size is 35 cm (Collette and Nauen, 1983). This species is distributed in both sides of the tropical and subtropical Atlantic Ocean, including the Mediterranean, Caribbean Sea and Gulf of Mexico.

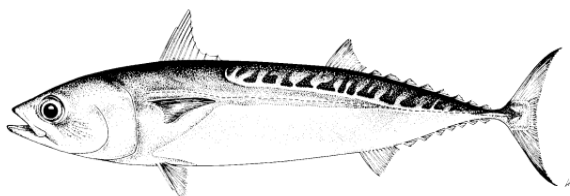


Figure 4. Bullet tuna (*Auxis rochei* Risso, 1810)

BLT is mainly exploited by surface gears and artisanal fisheries as handlines, driftnets, a wide variety of nets, and purse seines. BLT is mostly

caught in the Gulf of Edremit, Ayvalık, İzmir, Güllük, Fethiye, Antalya, and Iskenderun (Bök and Oray, 2001). Fishing activity is mostly carried out between November and March, and in this period, this species is mainly caught by the commercial purse seiners.

Like LTA, after the membership of Turkey to ICCAT, the catch statistics for this species were also recorded, separately. It is clear from these records that there is a significant increase in recent catch amounts of this species. (Table 1).

5. Albacore – ALB (*Thunnus alalunga* Bonnaterre, 1788)

Albacore is one of the smaller tuna species. The most distinctive feature of ALB among other tuna species is longer pectoral fin. Maximal length was established by Collete and Nauen (1983) in 127 cm and Le Gall (1974) estimated 130 cm as a likely maximal length in the Atlantic. It is widely distributed in temperate and tropical waters of all oceans, including the Mediterranean Sea. Geographical limits are from 45-50 °N to 30-40 °S, but it is less abundant in surface waters between 10 °N and 10 °S (Collette and Nauen, 1983). Its temperature preference range was determined as 10–20 °C (Graham and Dickson, 1981; Laurs and Lynn, 1991); however, the species is able to stay in different temperatures for short periods.

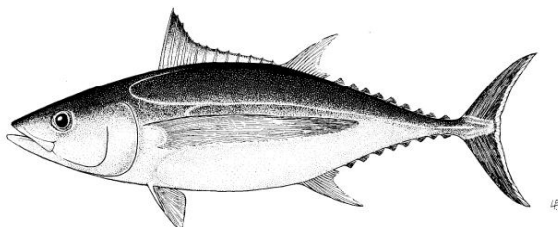


Figure 5. Albacore (*Thunnus alalunga* Bonnaterre, 1788)

Since 1980s, the fishery of bluefin tuna and other tuna species in our country increased and these species have become the most important fish export products (Karakulak, 2004). Although ALB fishery was carried out by Turkish fishermen and the species are especially exported to France, the catch amount was not recorded separately in the statistics for a long period of time. The export was made under the name of “tuna fish”, and the species was recorded in the statistics together with the bluefin tuna (Mert *et al.*, 2000). Furthermore, there was confusion in the name of this species as it was given different names by regional fishermen as “tulina, patlakgöz, and beyaz ton balığı”. After the

membership of Turkey to ICCAT, the catch statistics for this species were recorded separately from other tuna species. While the catch amount in 2004 was 27 tons, this value reached to 852 tons in 2007 (Table 1).

ALB fishery in Turkish waters is carried out in the Aegean and Mediterranean Sea with driftnets, purse seines and longlines. While the fishing activities in the Aegean Sea are conducted in winter months, these activities in the Mediterranean Sea are mainly in spring and summer months (May, June, and July) (Karakulak *et al.*, 2007).



Figure 6. Albacore fishing by driftnets

6. Management

The International Commission for the Conservation of Atlantic Tunas (ICCAT) is responsible for the management of small tuna fisheries. Actually, there are no ICCAT regulations in effect for small tunas except for albacore. However, several regional and national regulations are available.

Bonito fishing by all gear types including stake nets is banned between 1 April and 31 August throughout the territorial waters. However, handlining for bonito is allowed between 15-31 August. It is stated that the minimum landing size is 25 cm (Anonymous, 2008).

Fishing for little tunny, bullet tuna, and albacore by set nets is permitted throughout the fishing season within territorial waters. Purse seiners are allowed to harvest the species between 15 April and 15 May in the territorial waters between Mıhlı Creek and Syrian border. Furthermore, in the Aegean Sea; little tunny, bullet tuna, and albacore landings are prohibited in the territorial waters to the east of the line between the mouth of River Meriç and Boztepe Cape, Büyük Kemikli Cape, Bozcaada West Cape, Babakale, and Mıhlı Stream in 15th April – 31st August (Anonymous, 2008).

In the Atlantic Ocean, the three stocks of ALB are considered for management purposes, a North Atlantic, a South Atlantic and a Mediterranean stock (ICCAT, 2010). The northern and southern stocks were separated based on knowledge about spawning areas, spatial distribution of adults and larvae, and morphometric analyses (Beardsley 1969; Dicenta, 1975; Arena *et al.*, 1980; Megalofonou, 2000). Since 1983, there is a decrease in ALB stocks in the Atlantic due to the fishing of juvenile individuals and overfishing. In 1999, ICCAT established a total allowable catch (TAC) for south Atlantic ALB stock. Then, in 2001, TAC was established for the north Atlantic stock as well. While a stock assessment is made on the Atlantic ALB stocks every four years, there is no any assessment has been made on the Mediterranean stock, so far.

7. Conclusions

In Turkey, small tunas are exploited mainly by coastal fisheries (especially by purse seiners). Because these species except for BON and ALB are not very good in meat quality, they are often perceived to have little economic importance particularly compared to BFT. However, they have a very high relevance from a socio-economic point of view, because they are important for both many coastal communities and canning industry. On the other hand, there is little information available to determine the stock structure of these species.

Recently, a significant decrease in catch amounts of BON, which is a quite important species in our country's fishery. It is observed that the landing amounts mainly consist of the young individuals in 0 and 1+ age groups; that is, there has been a recruitment overfishing (Zengin *et al.*, 2005). Towards the aim of sustainable fishery, it is required that BON stocks be monitored more closely and that the comprehensive studies be conducted.

In 2002, the European Union banned the use of driftnets in the Mediterranean Sea in terms of ecosystem and fish stock dynamic. This ban was accepted by ICCAT and General Fisheries Commission for the Mediterranean (GFCM) in 2003. In our country, even though the Ministry of Agriculture and Rural Affairs banned the use of driftnets in the circular (Anonymous, 2002), these nets are still being used illegally in BON and ALB fishery (Akyol *et al.*, 2008; Karakulak, 2007).

It was observed in 2006 that Italian fishing boats illegally used driftnets in the Tyrrhenian and Ionian Seas (Greenpeace, 2006). In 2007, it was stated by Environmental Justice Foundation (EJF) that there were 600 vessels in the

Mediterranean Sea that conducted illegal driftnet fishery, and also reported that more than 100 vessels related with this fishery were in Italy, 70-100 vessels in France, 150-300 vessels in Morocco and over 110 vessels in Turkey (EJF, 2007).

In Turkey, it is required that some compensation be paid to fishermen using driftnets in order to stop this fishing activity. The EU funds may be used for this aim. Convenience may be made to the fishermen in transition to the longline system, which is more modernized and mechanical.

There is an improvement in the availability of catch and biological data for small tuna species caught from the Turkish waters. However, biological information, catch and effort statistics for small tunas particularly for plain bonito and narrow-barred Spanish mackerel remain incomplete. Given that, these species are of high importance to coastal fishermen, both economically and often as a primary source of protein. Thus, it is strongly recommended that further studies should be conducted on small tuna species.

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DEMERSAL and DEEP WATER FISHERIES RESOURCES IN TURKISH SEAS

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1. Introduction

Turkey is located at the easternmost section of the Mediterranean Sea and surrounded by four large water masses, i.e. the Black Sea, the Marmara Sea, the Aegean Sea and the Mediterranean Sea (the Levantine Sea), all bearing different climatic and hydrographical regimes, geomorphologic structures, oceanographic conditions etc (Oğuz & Tuğrul, 1998; Bilecenoğlu et al., 2002). All these factors induce different ecological conditions with varying habitats in every sea and allow a wide number of species from different taxonomic groups to inhabit them (Kocataş & Bilecik, 1992). Despite this high diversity, only a small fraction of the total number of species is of commercial value. The larger number of these commercial species is directly consumed by humans and a relatively smaller number goes into industrial use as raw material for animal food, pharmaceuticals etc. The majority of the commercially valuable species comprises basically a few major taxonomic groups such as molluscs (clams, sea-snails and squids), crustaceans (shrimps, prawns, lobsters and crabs) and bony fishes. In terms of fishery catch statistics, over 90% of Turkey's total production of seafood is composed of bony fishes (Figure 1) (SIS, 1985-2003; TurkStat, 2004-2009).

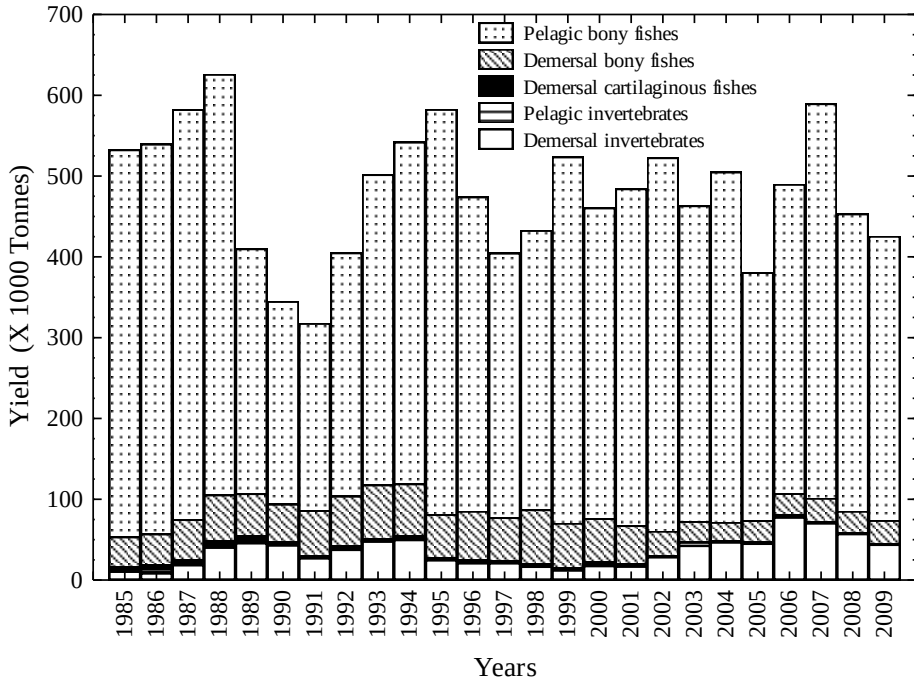


Figure 1. Time series of total annual production of the marine capture fisheries in Turkey from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Based upon recent reviews of Bilecenoğlu et al. (2002), Fricke et al. (2007) and Çınar et al. (2011) the present number of bony fish species living in the Turkish seas is 415 (Appendix 1). This figure may, however, still increase in the near future as a result of the Lessepsian migration and ongoing ichthyofaunal investigations. The species richness in the Turkish Seas decreases from south to north. With a total number of 359 species, the most diverse bony fish fauna is observed in the Mediterranean Sea. The Aegean Sea bony fish fauna is almost as rich as the Mediterranean and includes a total of 344 species. A considerably lesser number of bony fish species, 222, live in the Marmara Sea. Finally, the Black Sea is inhabited by the least diverse bony fish fauna consisting of a total of only 147 species, less than half of that recorded for the Mediterranean and the Aegean Seas. Interestingly, in spite of this low species richness, nearly $\frac{3}{4}$ of the total marine fish catch of Turkey is taken from the Black Sea (SIS, 1985-2003; TurkStat, 2004-2009).

The majority of the 415 bony fish species in the Turkish Seas are demersal in habitat selection and lives on or close to the bottom (Table 1). While some of

these species dwell in shallow waters nearby the shore (many gobies, blennies, wrasses etc), some live at depths down to 200-300 m (some soles, sea breams, goatfishes etc), and still others (mesopelagics, bathypelagics and bathydemersals) inhabit even deeper zones (anglerfish, grenadiers etc). All these species are often caught by bottom trawling and constitute a large portion of Turkey's demersal fishery resources.

Despite this striking richness of demersal bony fish fauna, in terms of biomass, on average above 70% of the overall annual marine fish catch in Turkey is made up of a few small pelagic species such as anchovy, pilchard and horse mackerels (Figure 1) (SIS, 1985-2003; TurkStat, 2004-2009). The demersal fishes have, on the other hand, much higher commercial value compared with the pelagics. For instance, according to the 2009 statistics (TurkStat, 2009), the monetary value of one kg of red mullet was more than that of ten kg of anchovy. Therefore, even though the demersal bony fishes, on average, account for less than 10% of the annual total marine fish catch (Figure 1), they make a significant contribution to Turkey's fisheries due to their high commercial value.

Table 1. Distribution of Turkey's bony fish fauna by sea and habitat selection (BS: the Black Sea, MS: the Marmara Sea, AS: the Aegean Sea, MTS: the Mediterranean Sea, N: the number of individual species).

		BS		MS		AS		MTS		All Seas	
		N	%	N	%	N	%	N	%	N	%
Pelagics	Epipelagic	33	22.4	42	18.9	60	17.4	68	18.9	77	18.6
	Semi-pelagic	3	2.0	4	1.8	6	1.7	6	1.7	7	1.7
	Mesopelagic	0	0.0	3	1.4	3	0.9	4	1.1	5	1.2
	Bathypelagic	0	0.0	10	4.5	30	8.7	27	7.5	37	8.9
Demersals	Benthopelagic	16	10.9	22	9.9	42	12.2	40	11.1	44	10.6
	Benthic	93	63.3	137	61.7	189	54.9	204	56.8	229	55.2
	Bathydemersal	2	1.4	4	1.8	14	4.1	10	2.8	16	3.9
Total Bony Fish		147		222		344		359		415	

The most recent Turkish official fishery statistics provides catch information on only a total of 84 commercially important marine organisms (TurkStat, 2009): 62 bony fish species, 3 cartilaginous fish groups and 19 invertebrate species. Of these 62 species of bony fish, 41 are demersal species (Table 2). It should be noted, however, that the organism names given in these statistics do not always strictly correspond to the distinct biological species. Sometimes, data on several closely related species are merged and presented under one name only, such as gobies, combers, flounders, groupers etc. The same applies to the cartilaginous fishes. Although there are 54 demersal cartilaginous fish species in the Turkish Seas (Appendix 1), solely a total of 3 groups are referred to in the official statistics: sharks, rays and angle sharks (TurkStat, 2009). Thus, the actual total demersal fish catch in the Turkish Seas is much more diverse than that stated in the statistics. The demersal cartilaginous fishes, on average, comprise barely 1% of the annual total marine fish landings (Figure 1) (SIS, 1985-2003; TurkStat, 2004-2009). By considering this low catch ratio and their low commercial value, the overall contribution of these fish to Turkey's fisheries is quite negligible. The 19 commercial invertebrate species included in the most recent official statistics are all demersal in nature. Striped venus, sea snail, deep water rose shrimp, giant gamba prawn and cuttlefish are the most notable invertebrate species by total production and commercial value (TurkStat, 2009).

Table 2. The common (English and Turkish) and Latin names and distributions of commercially important bony fish species in Turkish seas whose catch data are collected and published by the Turkish official fishery statistics (TurkStat, 2009). The common names are presented here as they appeared in TurkStat (2009) (BS: the Black Sea, MS: the Marmara Sea, AS: the Aegean Sea, MTS: the Mediterranean Sea)

TurkStat Name	Species Name	BS	MS	AS	MTS
Hake-European hake Bakalorya-Berlam	<i>Merluccius merluccius</i>	*	*	*	*
Red mullet Barbunya	<i>Mullus barbatus</i>	*	*	*	*
Golden banded Barbunya-Paşa barbunu	<i>Upeneus moluccensis</i>			*	*
Seabream Çipura	<i>Sparus aurata</i>	*	*	*	*

Table 2 continued

Common sole Dil-Pisi	<i>Solea solea</i>	*	*	*	*
John dory Dülger	<i>Zeus faber</i>	*	*	*	*
Common seabream Fangri	<i>Pagrus pagrus</i>		*	*	*
Angler fish Fener balığı	<i>Lophius piscatorius</i>	*	*	*	*
Shore rockling Gelincik	<i>Gaidropsarus mediterraneus</i>	*	*	*	*
Meagre Grenyüz	<i>Argyrosomus regius</i>	*	*	*	*
Painted comber Hani	<i>Serranus scriba</i>	*	*	*	*
Black scorpion fish İskorpit	<i>Scorpaena porcus</i>	*	*	*	*
Annular bream İsparoz	<i>Diplodus annularis</i>	*	*	*	*
Brown meagre İşkine	<i>Sciaena umbra</i>	*	*	*	*
Picarel İzmarit	<i>Spicara smaris</i>	*	*	*	*
Turbot Kalkan	<i>Scophthalmus maximus</i>	*	*	*	*
Two banded bream Karagöz	<i>Diplodus vulgaris</i>	*	*	*	*
Gobies Kayabalığı	<i>Gobius niger</i>	*	*	*	*
Red gurnard Kırlangıç	<i>Chelidonichthys cuculus</i>	*	*	*	*
<i>Trigla lineate</i> Kırlangıç - Mazak	<i>Chelidonichthys lastoviza</i>		*	*	*
Bogue Kupez	<i>Boops boops</i>	*	*	*	*
Waker Lahoz	<i>Epinephelus aeneus</i>			*	*
Seabass Levrek	<i>Dicentrarchus labrax</i>	*	*	*	*
Small-scaled Lipsöz	<i>Scorpaena notata</i>	*	*	*	*

Table 2 continued

Saddled seabream Melanurya	<i>Oblada melanura</i>	*	*	*	*
Striped bream Mercan	<i>Pagellus erythrinus</i>	*	*	*	*
Whiting Mezgit	<i>Merlangius merlangus euxinus</i>	*	*	*	
European conger Mıgri	<i>Conger conger</i>	*	*	*	*
Striped seabream Mırmır	<i>Lithognathus mormyrus</i>		*	*	*
Croaker Minekop	<i>Umbrina cirrosa</i>	*	*	*	*
Dusky grouper Orfoz	<i>Epinephelus marginatus</i>		*	*	*
Piper Öksüz	<i>Trigla lyra</i>		*	*	*
Large-eye dentex Patlakgöz mercan	<i>Dentex macrophthalmus</i>			*	*
Flounder Pisi	<i>Citharus linguatula</i>		*	*	*
Black sea bream Sarigöz	<i>Spondyllosoma cantharus</i>	*	*	*	*
Saupe Sarpa	<i>Sarpa salpa</i>	*	*	*	*
Dentex Sinagrit	<i>Dentex dentex</i>	*	*	*	*
Sharpsnout seabream Sivriburun karagöz	<i>Diplodus puntazzo</i>	*	*	*	*
Striped red Tekir	<i>Mullus surmuletus</i>	*	*	*	*
Blue spotted bream Trança	<i>Dentex gibbosus</i>		*	*	*
Saury Zurna	<i>Synodus saurus</i>			*	*

The present chapter attempts to evaluate the recent state of Turkey's demersal fishery resources. Based upon the official fishery statistics from 1985 to 2009, it furthermore reviews the fluctuations in the annual catches of the demersal fishes as a total resource and also for some commercially important species for each of the Turkish seas. Some of the large-scale research studies carried out on Turkey's demersal fisheries are presented as well.

2. Catch Statistics of the Major Demersal Fishery Resources

According to the catch records from the official fishery statistics from 1985 to 2009, the yields from demersal fishery resources, averaged over 25 years, constituted about 18% of the annual total marine fisheries production (Figure 1) (SIS, 1982-2003; TurkStat, 2004-2009). A similar ratio of 17% was also observed when only the most recent 2009 fishery statistics were considered (TurkStat, 2009).

A review of the data from the last 25 years' statistics (SIS, 1985-2003; TurkStat, 2004-2009) on the basis of each Turkish sea, revealed that while the demersal bony fish catches fluctuated irregularly and showed variations for each sea over the years (Figure 2), the cartilaginous fish and invertebrate production varied less and both groups were caught almost consistently more in the Black Sea (Figures 3 and 4). For instance, the demersal bony fish catches in the Mediterranean Sea began to increase from 1985 and attained a maximum of nearly 20 thousand tonnes in 1993, then in subsequent years, they declined sharply and finally reached a more or less steady plateau of 3-6 thousand tonnes starting from 2000 (Figure 2). A somewhat similar trend of increasing yields of demersal bony fishes from 1985 to 1994 was also discerned in the Aegean Sea. After two peaks of above 19 thousand tonnes in 1994 and 1998, the landings commenced to shrink and in 2003 the total production was less than 4 thousand tonnes. The last considerable rise in yield, 8.5 thousand tonnes, was recorded in

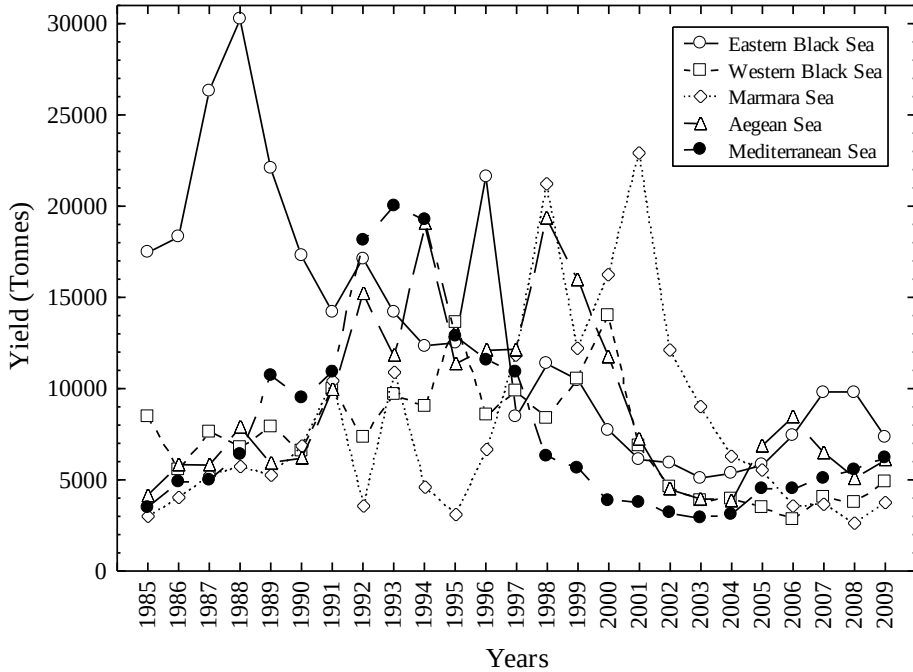


Figure 2. Annual total catch statistics of the marine demersal bony fish for each Turkish sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

2006 in the Aegean Sea. The total demersal bony fish catch was just over 6 thousand tonnes in this region in 2009 (Figure 2). The demersal bony fish production in the Eastern Black Sea was much higher than in all other seas until 1992. The last biggest yield, exceeding 21.5 thousand tonnes, was registered in 1996, thereafter a trend of decrease in catches was clearly seen (Figure 2). In the Western Black Sea, relatively small oscillations in the demersal bony fish catches were detected between 1985 and 1994. There was a peak in the production in 1995, surpassing 13.5 thousand tonnes. The largest reported yield was close to 14 thousand tonnes in 2000. In the years following, the production in this region was reduced to more or less half of that in the previous decade (Figure 2). The prevalent trend of decline in landings observed in almost every sea in the recent decade is obviously portrayed in the overall total production of demersal bony fishes in Turkey (Figures 1 and 2). After the maximum of 66.5 thousand tonnes in 1998, the annual total catch levels have fallen to below 30 thousand tonnes in the last seven years.

For the greater part of the past two decades, the major portion of the production of demersal cartilaginous fishes and invertebrates originated from

the Black Sea (Figures 3 and 4). The biggest fluctuations in yields were also documented in this region. From 1991 to 1994, a tremendous increase in demersal invertebrate catches was seen in the Western Black Sea (Figure 4). Following a peak of slightly above 30 thousand tonnes in 1994, the catches fell drastically in subsequent years to less than 4 thousand tonnes in 1999, and thereafter suddenly rose to a maximum of over 50 thousand tonnes in 2007 (Figure 4). The total demersal invertebrate catch was around 30 thousand tonnes in this region in 2009, still substantially lower than that in 2007 (Figure 4). Yet, this amount from the Western Black Sea made up just roughly $\frac{2}{3}$ of the total production of demersal invertebrates in Turkey (Figure 4).

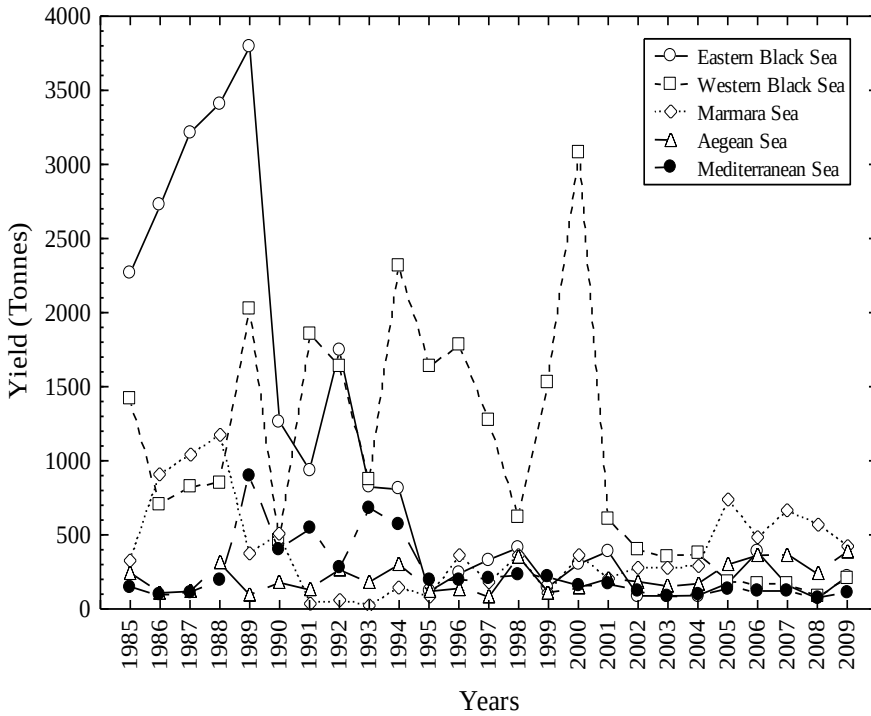


Figure 3. Annual total catch statistics of the marine demersal cartilaginous fish for each Turkish sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

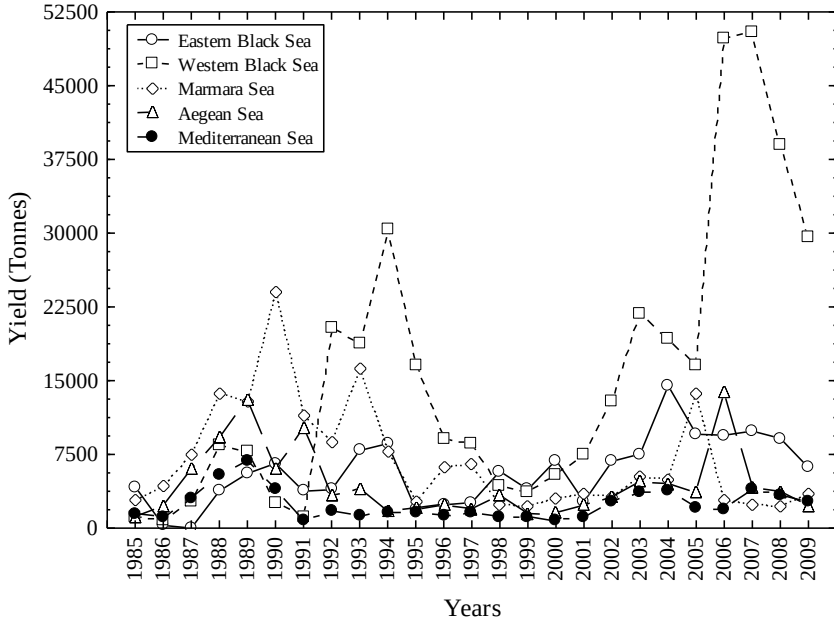


Figure 4. Annual total catch statistics of the marine demersal invertebrates for each Turkish sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

3. Regional Catch Statistics

In parallel with the changing ecological conditions in Turkish seas from north to south, the components of the demersal fishery resources naturally vary from one sea to another. Therefore, a closer and more detailed evaluation of the resources for each region is presented here.

3.1. The Eastern Black Sea

The Eastern Black Sea is the most productive fisheries region in Turkey. The last 25 years' official fishery statistics (SIS, 1985-2003; TurkStat, 2004-2009) show that over half of the country's total marine fisheries catch came from this area. According to the same statistics, the yields from demersal fishery resources in this region, averaged over 25 years, constituted 4% of Turkey's total marine fisheries production. When only the total demersal fisheries production in the country was considered, the average percentage contribution from the region was 24%. In this time period, the average share of the demersal catches in the total fisheries in the region was about 9%. The highest and lowest

percentage portions of the demersal resources in the region's total fisheries were 22% in 1990 and 4% in 2001, respectively. The total demersal landings corresponding to these years were 25.1 and 9.2 thousand tonnes, respectively (Figure 5) (SIS, 1985-2003; TurkStat, 2004-2009).

Bony fishes were the major component of the demersal fisheries in the Eastern Black Sea, and on average, they made up around 64% of the annual total catches in the past 25 years. Demersal invertebrates were also an important resource and their average proportion was 32% in the same time period. The average share of cartilaginous fishes in the total demersal fisheries was as low as 4% (Figure 5).

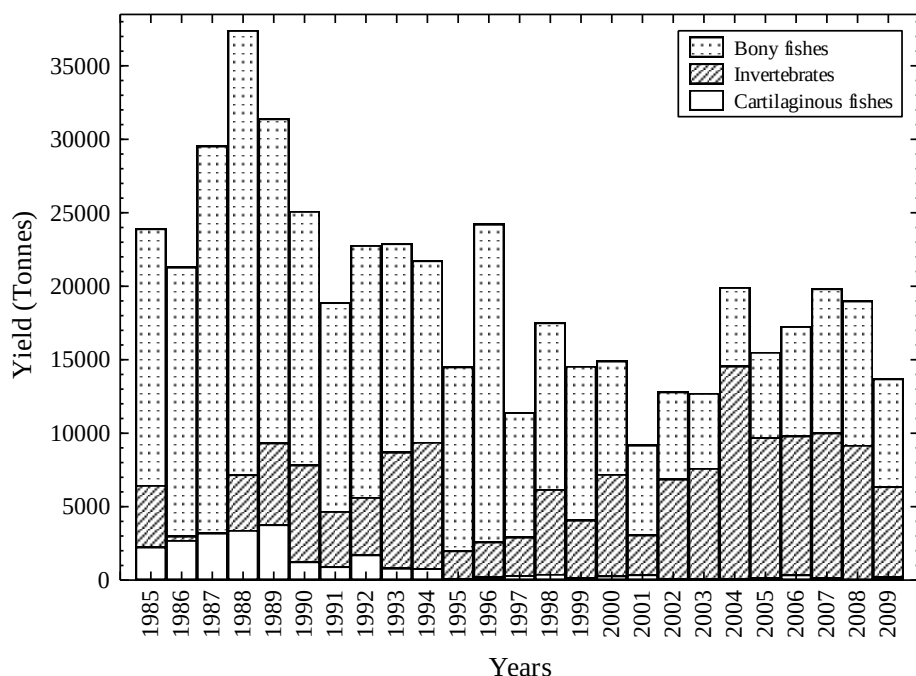


Figure 5. Annual total marine demersal fisheries production in the Eastern Black Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

The composition of the demersal fisheries production in the Eastern Black Sea varied considerably from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009). The total demersal bony fish landings were much larger than in all other seas until 1992. Then after a peak of 30.2 thousand tonnes in 1989, it began to fall. The substantial catch of 21.6 thousand tonnes in 1996 was the only strong deviation from this trend (Figure 2). The total catch of demersal bony fishes

amounted to 7.3 thousand tonnes in 2009 (Figures 2 and 5). While the yields from demersal bony fishes were decreasing, the production of demersal invertebrates in the region started to show a general trend of increase after 1987, and surpassed the total catch of demersal bony fishes in 2002 (Figures 4 and 5). The total catches from both resources attained a similar quantity of almost 10 thousand tonnes in 2007, and since then the catch levels have remained quite close to each other (Figure 5). Until 1989, the majority of demersal cartilaginous fish catches in Turkey were taken from this region (Figure 3). After a historically high yield of approximately 4 thousand tonnes in that particular year, the landings declined sharply, and since 1995 they have never exceeded 500 tonnes (Figures 3 and 5). Thus, the contribution of these fish to the region's fisheries became rather negligible.

Since 1985 one single species, whiting (*Merlangius merlangus*) conspicuously dominated the catches of demersal bony fishes (and the overall demersal fisheries till 2000) in the Eastern Black Sea (SIS, 1985-2003; TurkStat, 2004-2009). Over the course of 25 years, the average share of whiting in the total demersal bony fish production was about 78%. According to the official catch records, the quantity of whiting caught in the region rose rapidly from 11 thousand tonnes in 1985 to the historical maximum of 25 thousand tonnes in 1988. Thereafter the landings started to drop. A linear trend line fitted to these data suggested an annual decline rate of circa 550 tonnes (Figure 6). The catch amounting to nearly 16 thousand tonnes in 1996 was the only exception to this general trend (Figure 6). A close comparison of Figures 2 and 6 will also clearly illustrate the dominance of whiting in the demersal bony fish production, as the annual variations in the yields of demersal bony fishes can be primarily accounted for by the changes in the quantities of whiting catches. Based upon the fishery statistics from 1985 to 2009, whiting was by far the demersal fish species with the highest production in Turkey's fisheries, and the Eastern Black Sea was the principal region for the production of whiting in the country (SIS, 1985-2003; TurkStat, 2004-2009).

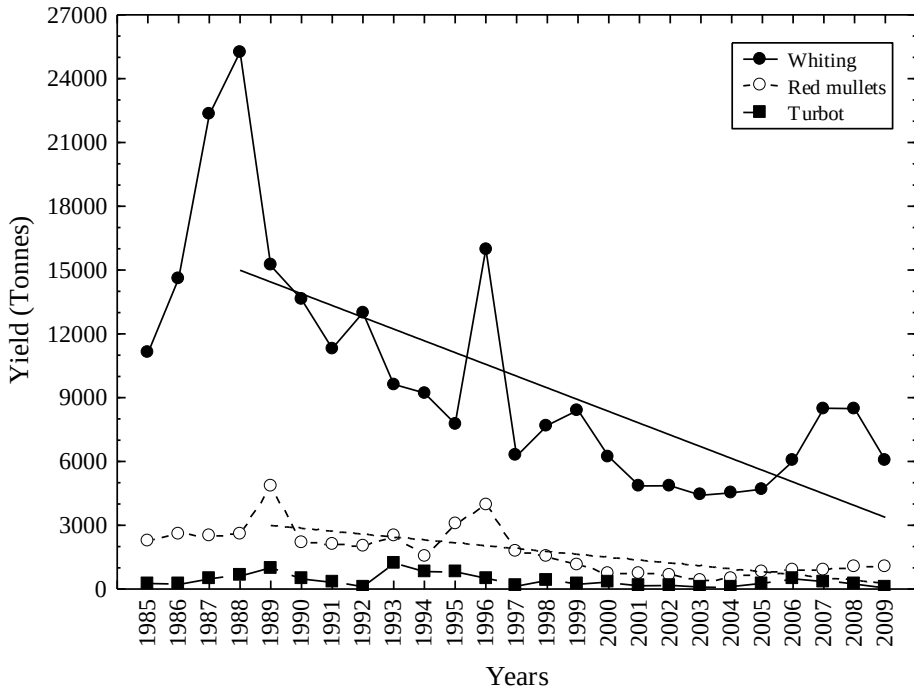


Figure 6. Annual total catch statistics of the major demersal bony fish species in the Eastern Black Sea from 1985 to 2009. These species together composed, on average, over 94% of the total demersal bony fish production in the region (SIS, 1985-2003; TurkStat, 2004-2009). The fitted linear trend lines were explained in the text.

Two closely related demersal bony fish species red mullet (*Mullus barbatus*) and striped red mullet (*M. surmuletus*) followed whiting in the catch statistics (SIS, 1985-2003; TurkStat, 2004-2009). Of these two commercially highly valued species, red mullet was more abundant in the catches and formed, on average, almost 10% of the annual total demersal fish production in the region during the last 25 years. The average contribution of striped red mullet was much lower, a little more than 3%. Since these two congener species are often mistaken for one another and since their common names are also recurrently swapped locally, their catches have been combined and presented as one in Figure 6. The catch history of red mullets fairly resembles that of whiting. The maximum recorded yield of red mullets was 4.8 thousand tonnes in 1989, after when, like for whiting the landings began to diminish (Figure 6). Again in 1996 there was an exceptional catch of approximately 4 thousand tonnes. The linear trend line fitted to the landings data indicated an annual decline rate of roughly 135 tonnes (Figure 6). In spite of the reduced landings in the last decade, the

overall total production of red mullets in the Eastern Black Sea was the biggest among all the regions.

Turbot (*Scophthalmus maximus*) was the fourth and commercially most valuable species, comprising an average of 3% of the annual total demersal bony fish catches in the Eastern Black Sea from 1985 to 2009. The turbot landings, after a peak of 1.2 thousand tonnes in 1993, commenced to decrease and since 1995 have remained at a level below 500 tonnes (Figure 6) (SIS, 1985-2003; TurkStat, 2004-2009).

Starting from 1988, the most copious species in the demersal invertebrate fisheries in the region was sea snail (*Rapana thomasiana*). This gastropod species composed, on average, over 78% of the annual total demersal invertebrate catches and the largest recorded yield was 12.1 thousand tonnes in 2004 (SIS, 1985-2003; TurkStat, 2004-2009). The landings were above 9 thousand tonnes between 2005 and 2008, but came down to 4.9 thousand tonnes in 2009. Carpet shell (*Tapes decussatus*) and black mussel (*Mytilus galloprovincialis*) were the two other notable demersal invertebrate species in the Eastern Black Sea.

3.2. The Western Black Sea

This is the second most productive fisheries region in Turkey. According to the last 25 years' fishery statistics, on average, 22% of the country's total marine fisheries catch originated from the Western Black Sea (SIS, 1985-2003; TurkStat, 2004-2009). During this time period, the average share of the yields from demersal fisheries in the Western Black Sea was 5% of Turkey's total marine fisheries production, and 25% of the total fisheries in the region. The Western Black Sea was the country's leading demersal fisheries region by biomass, and provided more than 28% of Turkey's total demersal fisheries production from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009). On the other hand, compared with other seas, the largest fluctuations in demersal landings were also seen in the Western Black Sea. They ranged from 7.1 thousand tonnes in 1986 to 54.7 thousand tonnes in 2007, corresponding to the percentage contributions of 14% and 54%, respectively, from the demersal resources into the total fisheries in the region. The production was very high particularly between 2006 and 2008 (Figure 7).

Unlike in the Eastern Black Sea, the major component of the demersal fisheries in the west in the past 25 years was demersal invertebrates with an

average proportion of 53%. However, because the mentioned big variation in the demersal landings was due to the invertebrate catches (Figure 4), the composition of the demersal fisheries production in this region altered accordingly. The percentages of demersal invertebrates in the total were as low as 9% in 1991, and as high as 94% in 2006 (Figure 7). The last total demersal invertebrate catch taken from the Western Black Sea in 2009 was around 30 thousand tonnes and made up approximately $\frac{2}{3}$ of the annual total production of demersal invertebrates in Turkey (Figure 4).

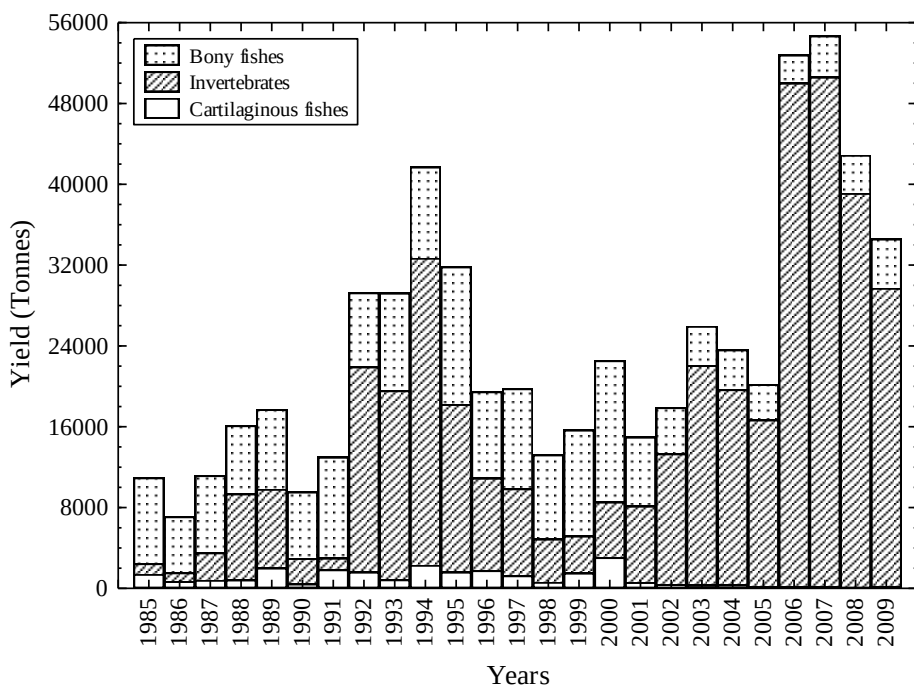


Figure 7. Annual total marine demersal fisheries production in the Western Black Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

The species composition of demersal invertebrates in the landings varied a lot throughout the years (SIS, 1985-2003; TurkStat, 2004-2009). Sea snail, the most abundant demersal invertebrate species in the Eastern Black Sea, was rather negligible in this region's fisheries except maybe in the yields of 5.1 and 6 thousand tonnes in 1988 and 1989, respectively (Figure 8). There was an immense increase in carpet shell catches in the Western Black Sea from 1.1 thousand tonnes in 1991 to 30.3 thousand tonnes in 1994 (Figure 8). After this historical maximum, the carpet shell landings dropped in subsequent years down to 2.4 thousand tonnes in 1999. Thereafter, the landings began to rise

again to the second top yield of 16.9 thousand tonnes in 2003. The last recorded catch of carpet shell was 10.9 thousand tonnes in 2005. In 2006 a new bivalve species, striped venus (*Chamelea gallina*) suddenly appeared in the official fishery statistics (TurkStat, 2006) with an outstanding amount of 48.3 thousand tonnes. Although the catches of striped venus started to fall drastically the following year, it still continued to dominate the demersal fisheries in the region until the present (Figure 8). Like in the east, black mussel was another noteworthy demersal invertebrate species in the Western Black Sea.

Bony fish catches, averaged over 25 years, formed 41% of the total demersal fisheries landings in this region (SIS, 1985-2003; TurkStat, 2004-2009). The highest catch was observed in 2000 and was close to 14 thousand tonnes. After this peak, the landings fell steeply, and the production of demersal bony fishes was as low as 2.8 thousand tonnes in 2006 (Figure 2). The catches taken in the region did not much improve since then and the latest one was merely 4.9 thousand tonnes in 2009 (Figure 2). The amounts of cartilaginous fishes caught in the Western Black Sea were low and, on average, accounted for barely 6% of the region's total demersal production (Figure 7). Yet, they constituted just about 36% of the total production of demersal cartilaginous fishes in Turkey (Figure 3).

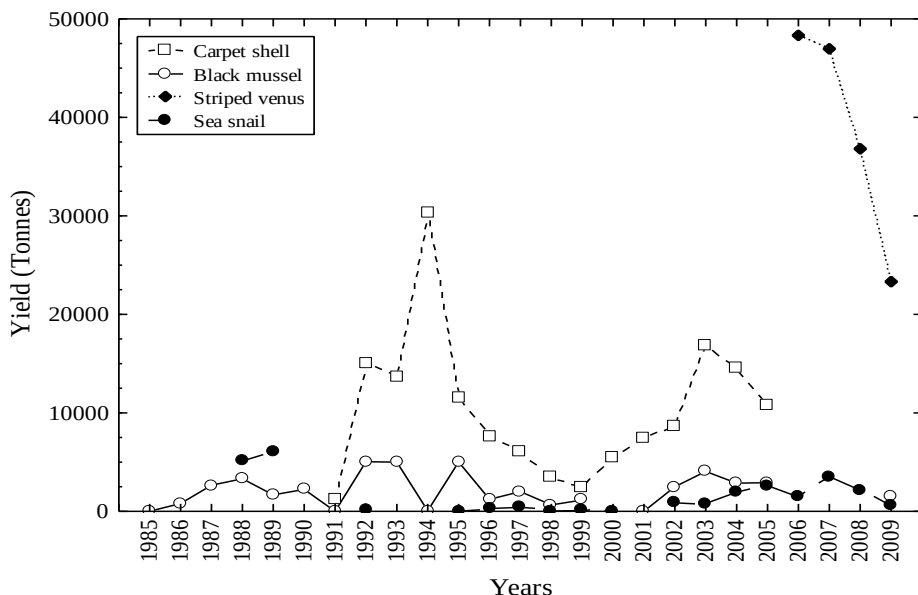


Figure 8. Annual total catch statistics of the major demersal invertebrate species in the Western Black Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Whiting was the most dominant species in the demersal bony fish catches in the Western Black Sea as well. From 1985 to 2009 the average proportion of whiting in the total demersal bony fish production was around 60% (SIS, 1985-2003; TurkStat, 2004-2009). Compared to the east, the whiting production was far more moderate in this region, only the landings in 1995 and in 2000 exceeded those from the east. In addition, these two years corresponded to the two peaks in the whiting production, 9.8 and 9.1 thousand tonnes, respectively in the west (Figure 9). Until the last peak in 2000, the whiting catches oscillated annually. Then, after a final severe fall to 2.9 thousand tonnes in 2001, the catches became more stable and have since remained within a range between 1.8 and 2.9 thousand tonnes (Figure 9). In terms of regional total whiting production, the Western Black Sea ranked second in Turkey (SIS, 1985-2003; TurkStat, 2004-2009).

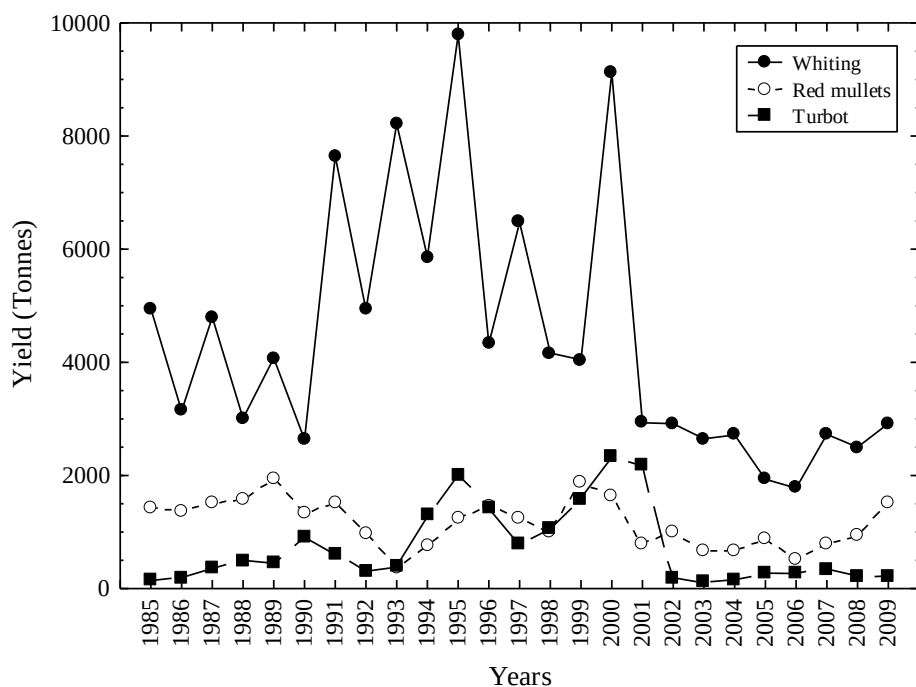


Figure 9. Annual total catch statistics of the major demersal bony fish species in the Western Black Sea from 1985 to 2009. These species together composed, on average, almost 87% of the total demersal bony fish production in the region (SIS, 1985-2003; TurkStat, 2004-2009).

Red mullets followed whiting in the catch statistics in the Western Black Sea too (SIS, 1985-2003; TurkStat, 2004-2009). Here though, according to the statistics, striped red mullet was more abundant and composed, on average, 11%

of the annual total demersal fish production in the region. The average portion of red mullet was smaller, a bit more than 6%. The catches of red mullets were substantially lower in the west than those taken in the east until 1999. The production of 1.9 thousand tonnes in that year was also the second major peak in the catch history of red mullets in the region (Figure 9). After 1999, the landings began to decline and the yield in 2006 was not more than 500 tonnes. Nevertheless, since then there seemed to be a steady increase in the landings of red mullets (Figure 9). The catch levels of red mullets were quite alike in both regions in the Black Sea in the last decade (Figures 6 and 9).

Turbot was again the fourth main species constituting an average of 9% of the annual total demersal bony fish catches in the Western Black Sea during the past 25 years. Although the turbot catch levels in both parts of the Black Sea did not differ much between 1985 and 1992, from 1994 to 2001, the landings in the west were remarkably bigger (Figure 9). Two outstanding peaks of turbot production in the region were also observed in this particular time period, the first in 1995, 2 thousand tonnes and the second in 2000, 2.3 thousand tonnes (SIS, 1985-2003; TurkStat, 2004-2009). After 2002, the annual yields in both regions were in rather similar quantities (Figure 9).

3.3. The Marmara Sea

The official fishery statistics from 1985 to 2009 ranks the Marmara Sea as Turkey's third most productive fisheries region. In this time period, the region's total fisheries production and its demersal constituent, on average, formed 12% and, a little more than 3% of the country's total marine fisheries catch, respectively (SIS, 1985-2003; TurkStat, 2004-2009). Again in the same period, the average share of the demersal fisheries in the Marmara Sea was 19% of the country's total marine demersal fisheries production, and 27% of the total fisheries in the region. The highest and lowest contributions from the demersal resources to the region's total fisheries were 47% in 1990 and 10% in 2006. Moreover, the total production of 31.4 thousand tonnes in 1990 was the historical maximum (Figure 10).

Invertebrates dominated the demersal landings in the Marmara Sea between 1986 and 1994, and made up as much as 77% of the region's total demersal fisheries in 1990 (Figure 10). In addition, demersal invertebrate production in this region was greater than all other seas between 1986 and 1991 (Figure 4). Yet, starting from 1995, and particularly between 1997 and 2003, bony fishes became more abundant in the demersal catches in the region (Figure 10). Two

exceptional peaks in the demersal bony fish landings, the first 21.2 thousand tonnes in 1998, and the second almost 23 thousand tonnes in 2001, occurred in this time period (Figures 2 and 10). After the second peak, the yields began to decline steeply and the total catch in 2009 was only 3.8 thousand tonnes. The annual total demersal fish production in the Marmara Sea was higher than in all other regions in 1998 and also between 2000 and 2004, however, after 2007 it was the lowest among all the regions (Figure 2). In the past 25 years, bony fishes and invertebrates, on average, composed around 52% and 45% of the annual total demersal catches, respectively. The average share of cartilaginous fishes in the region's total demersal fisheries was merely 3% (Figure 10) (SIS, 1985-2003; TurkStat, 2004-2009).

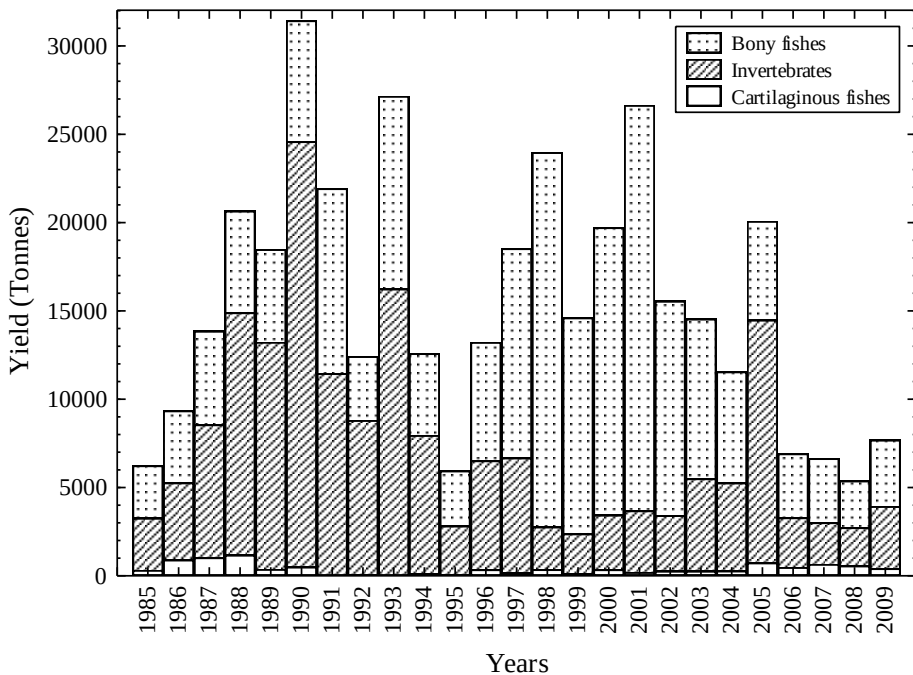


Figure 10. Annual total marine demersal fisheries production in the Marmara Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

When averaged over 25 years, with a proportion of 38%, hake (*Merluccius merluccius*) was the most abundant bony fish species in the demersal fisheries in the Marmara Sea (SIS, 1985-2003; TurkStat, 2004-2009). The hake landings in the region increased rapidly from 1.3 thousand tonnes in 1995 to 15.9 thousand tonnes in 1998 (Figure 11). After two years of relatively low catches, the historical maximum of 18.5 thousand tonnes was recorded in 2001.

Thereafter the landings started to drop severely; the last one in 2009 was no more than 780 tonnes (Figure 11). Examination of Figures 2 and 11 will further show the dominance of hake in the demersal bony fish production in the Marmara Sea, since the annual variations in the demersal bony fish landings can chiefly be accounted for by the differences in the amounts of hake catches. According to the official fishery statistics from 1985 to 2009, after whiting, hake came in as the second most caught demersal bony fish species in Turkey. The Marmara Sea was the principal region for hake production in the country (SIS, 1985-2003; TurkStat, 2004-2009).

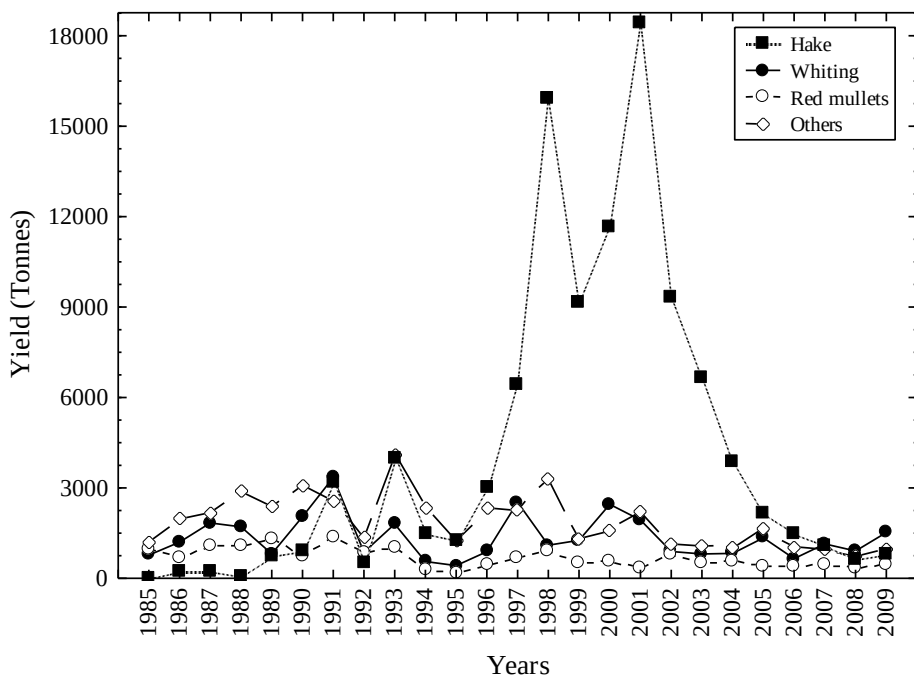


Figure 11. Annual total catch statistics of the major demersal bony fish species in the Marmara Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Whiting was the second most abundant demersal bony fish species in the Marmara Sea with an average portion of nearly 21%. However, the sizes of whiting catches in the region were quite moderate compared to those from both of the Black Sea regions. The largest catch was 3.3 thousand tonnes and taken in 1991. Two other notable landings, both about 2.5 thousand tonnes, were registered in 1997 and 2000 (Figure 11). Since 2002, the whiting catches have

remained within a range of 8 to 15 hundred tonnes (SIS, 1985-2003; TurkStat, 2004-2009).

Whiting was also followed here by red mullets in terms of abundance in the demersal bony fish catches. Like in the Western Black Sea, striped red mullet was more copious than its congener and comprised, on average, 9% of the annual total demersal fish production in the region. The average share of red mullet was much smaller, just close to 3%. During the past 25 years, the biggest yield of red mullets was observed in 1991 and amounted to 1.4 thousand tonnes. After 1991 the landings of red mullets began to diminish and in the last decade they ranged from only 200 to 400 tonnes (Figure 11). Similar to the case of whiting, the production of red mullets in this region was less than that in the Black Sea. In addition, turbot which was the fourth abundant species in both regions of the Black Sea was caught in trivial quantities in the Marmara Sea forming merely 1% of the total demersal bony fish catches (SIS, 1985-2003; TurkStat, 2004-2009).

As previously presented, the total contributions of the major fish species to the overall demersal bony fish production in both regions of the Black Sea were very high, namely 94% in the east and 87% in the west. However, in the Marmara Sea, the four major fish species mentioned so far, together on average, made up almost 71% of the region's total demersal bony fish production. This substantial remaining portion was mainly due to the increased diversity of demersal fishes in the region (Table 1). An appreciable number of demersal bony fish species, such as picarel (*Spicara smaris*) and sole (*Solea solea*), were included in the catches in the region as well, but their individual contributions were minor and varied a great deal from one year to another. These fish were collectively shown as "others" in Figure 11.

Shrimps, predominantly deep water rose shrimp (*Parapenaeus longirostris*), were the most abundant and commercially important demersal invertebrate group in the region with an average proportion of 45%. The landings of shrimps fluctuated considerably throughout the years with three major peaks in 1989, 1993 and 2003 with the corresponding amounts of 6.2, 3.5 and 4 thousand tonnes (Figure 12). During the six years after this last peak, the average annual catch of shrimps in the region was 2.2 thousand tonnes. The Marmara Sea was the principal region for the shrimp production in Turkey. Averaged over 25 years, 62% of the overall total shrimp production in the country originated here (SIS, 1985-2003; TurkStat, 2004-2009). Black mussel was the second copious

species and on average, about 19% of the demersal invertebrate catches consisted of this bivalve. The biggest catch was 9.5 thousand tonnes and taken in 2005. The other notable yields were 3.1, 3.4 and 3.3 thousand tonnes in 1987, 1990 and 1997, respectively (Figure 12) (SIS, 1985-2003; TurkStat, 2004-2009).

Carpet shell followed black mussel in the catch statistics with an average share of 17%. Like in the Western Black Sea, a sudden huge rise in carpet shell catches was also recorded in this region from 658 tonnes in 1988 to 13.2 thousand tonnes in 1990 (Figure 12). The next landing in large quantity was 11.1 thousand tonnes in 1993. After a yield of 1 thousand tonnes registered in 1999, this bivalve species more or less disappeared from the official catch statistics (SIS, 1985-2003; TurkStat, 2004-2009). Oyster (*Ostrea edulis*) was another noteworthy commercially important demersal invertebrate species in the Marmara Sea. The highest yield of oyster in the region was 2.1 thousand tonnes in 1990 (Figure 12).

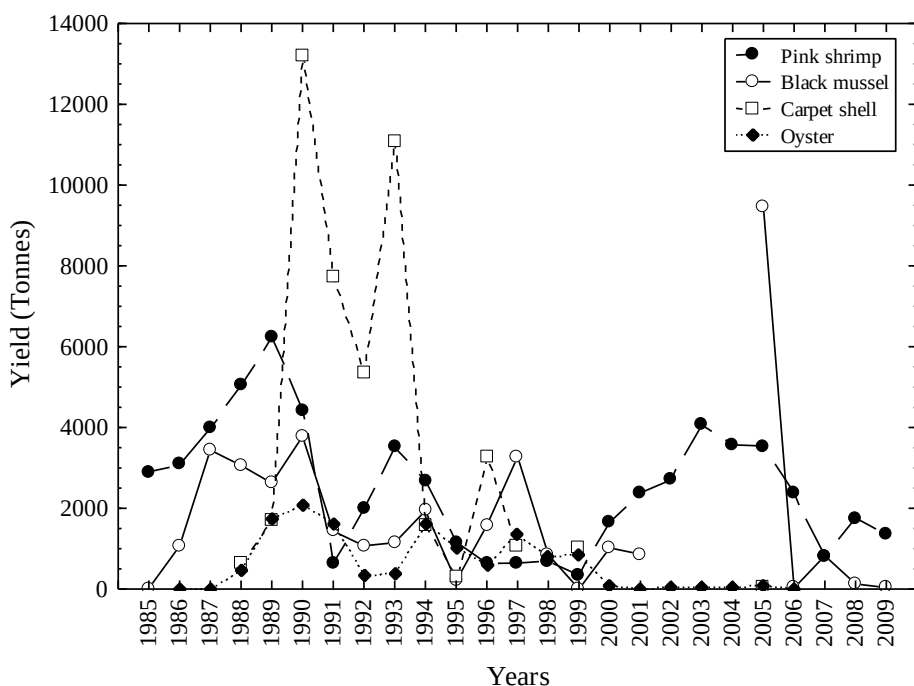


Figure 12. Annual total catch statistics of the major demersal invertebrate species in the Marmara Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

3.4. The Aegean Sea

The Aegean Sea is the fourth most productive fisheries region in Turkey. According to the last 25 years' statistics (SIS, 1985-2003; TurkStat, 2004-2009), nearly 10% of the country's total marine fisheries production originated from this region. The yields from demersal fishery resources in this region, averaged over 25 years, provided approximately 3% of Turkey's total marine fisheries production. In the same period, the average percentage contribution from the region to the total demersal fisheries production in the country was 16%. The average portion of the demersal catches in the region's total fisheries was about 31%. This ratio was bigger than those calculated for previous regions. From 1985 to 2009, the highest yield from the demersal resources in the region was 23 thousand tonnes in 1998, and the other years with landings exceeding 20 thousand tonnes were 1991, 1994 and 2006 (Figure 13) (SIS, 1985-2003; TurkStat, 2004-2009).

Bony fishes were the major component of the demersal fisheries in the Aegean Sea like in the Eastern Black Sea, and in the past 25 years, on average, they made up 65% of the annual total catches. The average proportion of demersal invertebrates in the same time period was around 33%. These ratios were also almost identical to those computed for the Eastern Black Sea. Bony fishes dominated the demersal landings in the region especially from 1992 to 2002, and formed as much as 91% of the region's total demersal fisheries in 1999 (Figure 13). There were three significant peaks in the demersal bony fish landings in this time period, the first 15.2 thousand tonnes in 1992, and the second 19.1 thousand tonnes in 2004, and the third 19.3 thousand tonnes in 2004. After this last peak, the catches started to fall and the annual total yield was only 3.8 thousand tonnes in 2004 (Figures 2 and 13). Invertebrates were more abundant in the demersal landings in 1988, 1989 and 2006. These last two years additionally corresponded to two remarkable peaks of 13 and 13.9 thousand tonnes in the demersal invertebrate production. The remaining component of the demersal fisheries, cartilaginous fishes, on average, composed barely 2% of the annual total catches in the region (Figure 13). The contribution from the Aegean Sea to the Turkey's overall total production of cartilaginous fishes was the minimum (SIS, 1985-2003; TurkStat, 2004-2009).

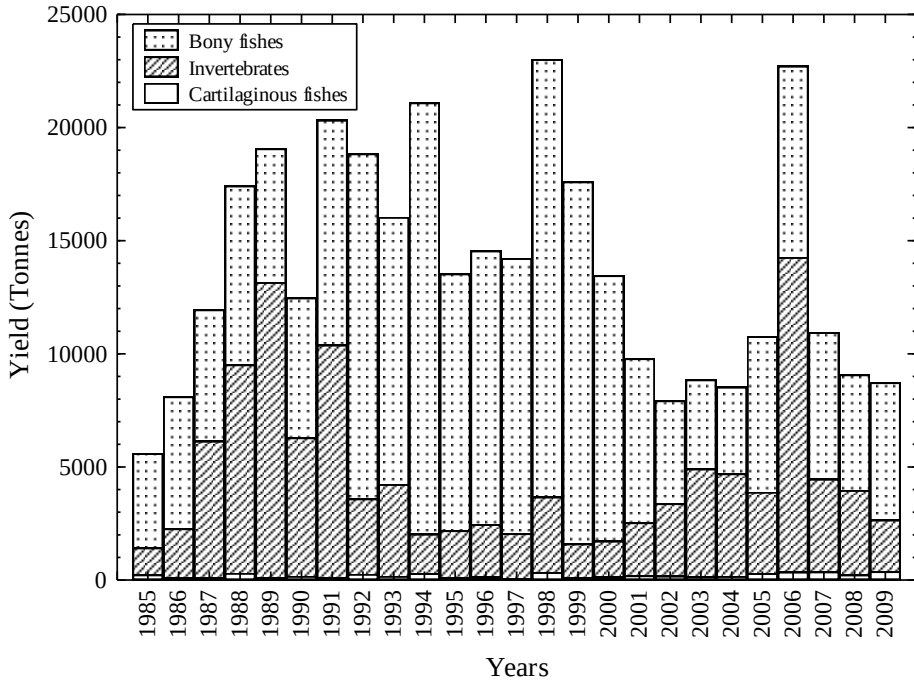


Figure 13. Annual total marine demersal fisheries production in the Aegean Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Hake was the most abundant bony fish species in the demersal fisheries in the Aegean Sea like in the Marmara Sea (SIS, 1985-2003; TurkStat, 2004-2009). However, over the course of 25 years, the average share of hake in the region's total demersal bony fish production was 22%, a figure much lower than that in the Marmara Sea. The dominance of hake in the demersal bony fish landings was more pronounced between 1992 and 2000 (Figure 14). This period contained three top years, 1992, 1994 and 1998, in hake production with the respective quantities of 5.5, 6.3 and 9.1 thousand tonnes. Following the historical maximum catch in 1998, the landings commenced to decrease. The registered amount of hake caught in 2004 was as low as 392 tonnes (Figure 14). Starting from 2005, the hake landings somewhat increased, up to above 2 thousand tonnes in 2007. Yet, the annual total yields in 2008 and 2009 were again down, just 546 and 644 tonnes, respectively (Figure 14). The second largest total production of hake in Turkey originated from the Aegean Sea (SIS, 1985-2003; TurkStat, 2004-2009).

Like in the Eastern Black Sea, red mullet was the second most abundant demersal bony fish species in the Aegean Sea. From 1985 to 2009, red mullet constituted, on average, close to 11% of the total demersal bony fish production

in the region. The average contribution of striped red mullet, on the other hand, was only slightly more than 4%. These two ratios were quite similar to those estimated for the Eastern Black Sea. Besides these two congener species, another one, a Lessepsian migrant species from the same family Mullidae, golden banded goatfish (*Upeneus moluccensis*) is also caught mainly in the southern Aegean Sea. Although it is fairly easy to distinguish this new species from the other two, separate catch information for golden banded goatfish were provided only in the last three years' official statistics (TurkStat, 2007-2009). During these years, this species formed a little more than 1% of the total demersal bony fish landings. For further evaluation, the catches of these three mullid species were pooled and referred to as red mullets. The top years for production of red mullets in the region were especially 1992, 1994 and 2001 with the corresponding yields of 2.2, 2.7 and 1.7 thousand tonnes (Figure 14). In addition, the landings of red mullets in the region in these years surpassed those registered in all other seas (SIS, 1985-2003; TurkStat, 2004-2009). After 2002, the landings diminished and fluctuated within a range of about 6 to 13 hundred tonnes (Figure 14).

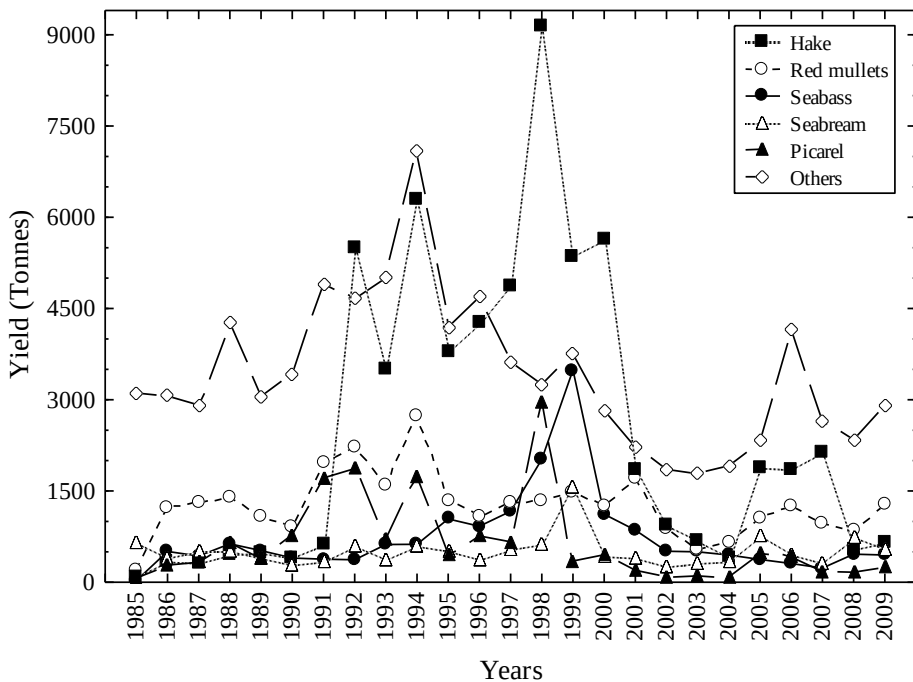


Figure 14. Annual total catch statistics of the major demersal bony fish species in the Aegean Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Seabass (*Dicentrarchus labrax*) followed red mullets in the catch statistics with an average proportion of 8% (SIS, 1985-2003; TurkStat, 2004-2009). The seabass landings ascended gradually from a trivial amount of 28 tonnes in 1985 to 1 thousand tonnes in 1995. The increase became steeper after 1996 and the catch taken in 1999 was 3.5 thousand tonnes (Figure 14). After this historical maximum, the seabass landings fell as rapidly as they had previously risen, and since 2002 they have ranged between 230 and 510 tonnes (Figure 14). The Aegean Sea was the region with the highest seabass production in the country (SIS, 1985-2003; TurkStat, 2004-2009).

Another commercially highly valued species seabream (*Sparus aurata*) was behind seabass with respect to its abundance in the demersal bony fish catches. Seabream comprised, on average, nearly 7% of the annual total demersal fish production in the region. Like in the case of seabass, the biggest seabream catch was taken in 1999 and its amount was circa 1.6 thousand tonnes (Figure 14). Picarel came after seabream with an average share of 6% in the region's total demersal bony fish landings. The largest picarel yield was roughly 3 thousand tonnes in 1998 (Figure 14) (SIS, 1985-2003; TurkStat, 2004-2009). The catches of whiting, the most dominant demersal bony fish in the Black Sea and the second in the Marmara Sea, were in trivial quantities in the Aegean Sea and on average, hardly 2% of the annual total demersal bony fish landings consisted of this species (SIS, 1985-2003; TurkStat, 2004-2009).

Even though the number of major demersal bony fish species grew in the Aegean Sea, the cumulative contribution of these six species to the region's total demersal bony fish production was down to 58%. This was in accordance with the increased diversity of demersal fishes in the region (Table 1). Consequently, compared to the previous regions, there were many more commercial demersal bony fish species, such as saupe (*Sarpa salpa*), striped bream (*Pagellus erythrinus*), sole and two banded bream (*Diplodus vulgaris*), which were included in the fisheries in the Aegean Sea albeit with relatively minor catch levels. The individual catch statistics belonging to these species were combined and shown as "others" in Figure 14.

A new group of invertebrates, cephalopods, which were caught in negligible quantities in the previous regions, were abundant in the demersal fisheries in the Aegean Sea. Averaged over 25 years, octopus (*Octopus vulgaris*) was the most dominant and commercially important cephalopod species and composed 19% of the annual total demersal invertebrate landings in the region (SIS, 1985-2003; TurkStat, 2004-2009). The octopus catches somewhat oscillated with three

notable peaks of 1.6, 1.3 and 1 thousand tonnes in 1989, 1998 and 2001, respectively. Black mussel was the second most abundant species here like in the Marmara Sea. The catch levels in this region, however, were mostly lower than those in the previous region. This bivalve made up, on average, approximately 18% of the demersal invertebrate catches in the Aegean Sea. The biggest black mussel catch in the region was 9.2 thousand tonnes in 2006, exactly one year later than 2005, the likewise record catch year for the same species in the Marmara Sea (SIS, 1985-2003; TurkStat, 2004-2009).

Shrimps were the next most copious invertebrate group in the region's demersal fisheries with an average proportion of 15%. But the sizes of the annual catches in the region were much smaller than those in the Marmara Sea. The largest recorded yield was 1.8 thousand tonnes in 2005. Deep water rose shrimp was probably the most dominating species in this group. Two other cephalopod species, cuttlefish (*Sepia officinalis*) and squid (*Loligo vulgaris*) followed shrimps in terms of abundance in the demersal invertebrate landings, both with similar average shares of around 12%. Interestingly, the highest yields for both species, 2.3 and 3.4 thousand tonnes, respectively, were registered in the same year 1989, which was again the top year in octopus production (SIS, 1985-2003; TurkStat, 2004-2009). Octopus, cuttlefish and squid collectively accounted for 55% of the total yield of demersal invertebrates in 2009 with corresponding amounts of 540, 327 and 384 tonnes (TurkStat, 2009). Carpet shell was also an important species and on average, 11% of the demersal invertebrate catches taken in the region consisted of this clam (SIS, 1985-2003; TurkStat, 2004-2009).

3.5. The Mediterranean Sea

This is the least productive fisheries region in Turkey. From 1985 to 2009, the region's total marine fisheries production and its demersal constituent, on average, formed 5% and a bit more than 2% of the country's total marine fisheries catch, respectively (SIS, 1985-2003; TurkStat, 2004-2009). Over the course of 25 years, the average percentage contribution from the Mediterranean Sea to the total demersal fisheries production in Turkey was 13%. In the same period, the average share of the demersal catches in the total fisheries landings in the region was above 45%. This was so far the biggest ratio estimated. The observed increase in this ratio from north to south was also a lucid illustration of how the fishery resources hence the characteristics of fisheries changed from a more pelagic nature to a demersal one.

The dominating component of the demersal fisheries in the Mediterranean Sea was clearly bony fishes. From 1985 to 2009, the landings of demersal bony fishes in the region exceeded those of demersal invertebrates every year except for in 2003 and 2004 (Figure 15).

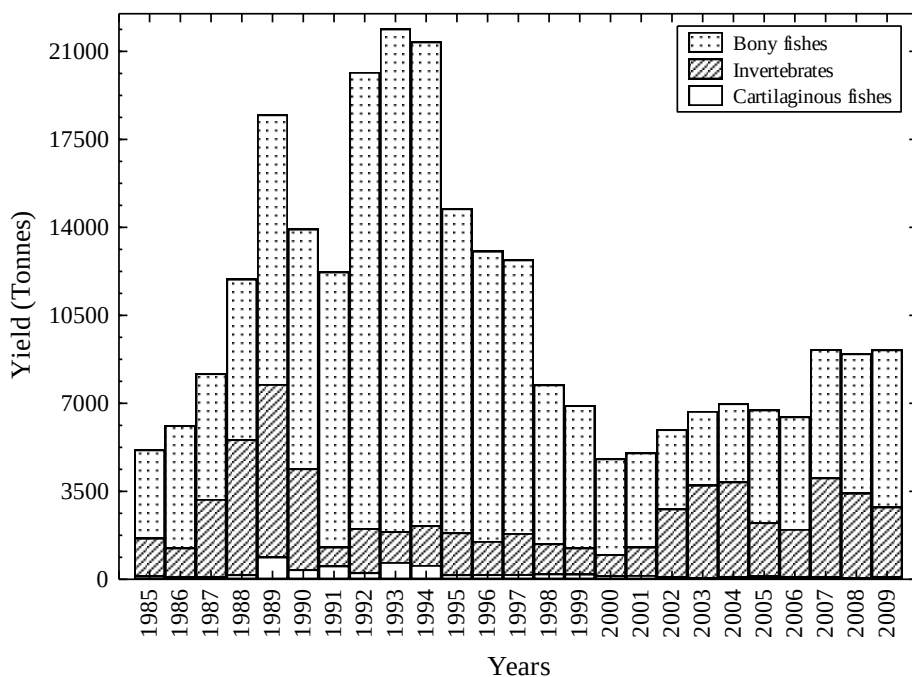


Figure 15. Annual total marine demersal fisheries production in the Mediterranean Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Bony fishes comprised, on average, 72% of the annual total demersal landings. Starting from 1985, the demersal bony fish catches showed a rapid and almost continuous rise and reached the historical maximum yield of around 20 thousand tonnes in 1993. The annual total demersal fish production in the Mediterranean Sea was higher than in all other regions between 1992 and 1994 (Figure 2). After 1994, however, the catches diminished sharply to less than 3 thousand tonnes in 2003. In subsequent years, they again began to increase but in a rather slow fashion compared with the earlier period from 1985 to 1993 (Figure 2). Between 1998 and 2004, the annual total demersal fish production was the lowest among all the regions (Figure 2) (SIS, 1985-2003; TurkStat, 2004-2009).

Red mullet was the most abundant species, composing an average of nearly 9% of the annual total demersal bony fish catches in the Mediterranean Sea from 1985 to 2009. The average portion of striped red mullet was much lower, a little more than 2%. Like in the Aegean Sea, only the last three years' statistics contained separate catch data for golden banded goatfish (TurkStat, 2007-2009). During these years, this mullid species made up close to 2% of the total demersal bony fish landings in the region. There were two peaks in the production of red mullets, the first 2.3 thousand tonnes in 1989, and the second 4 thousand tonnes in 1993 (Figure 16). After this highest recorded yield, catches of red mullets dropped drastically down to 9 hundred tonnes in 1996. The trend of decline continued gradually until 2003 when the total production was just slightly above 3 hundred tonnes. Thereafter the landings started to go up again; the last one in 2009 was over 1.2 thousand tonnes (Figure 16). The Mediterranean Sea ranked as the second region in Turkey in terms of overall total production of red mullets (SIS, 1985-2003; TurkStat, 2004-2009).

Hake was the second most abundant bony fish species in the demersal fisheries in the Mediterranean Sea with an average proportion of 7%. The landings in this region, however, were typically much smaller than those in the Marmara and the Aegean Seas. The amounts of hake caught in the region rose fast from 3 hundred tonnes in 1991 to roughly 4 thousand tonnes in 1995 (Figure 16). After this historical maximum, for a couple of more years, substantial catch levels of about 3.5 thousand tonnes were maintained. In the following years the landings commenced to shrink and the catch in 2004 was no more than 42 tonnes. The production in the region has remained small ever since (Figure 16) (SIS, 1985-2003; TurkStat, 2004-2009).

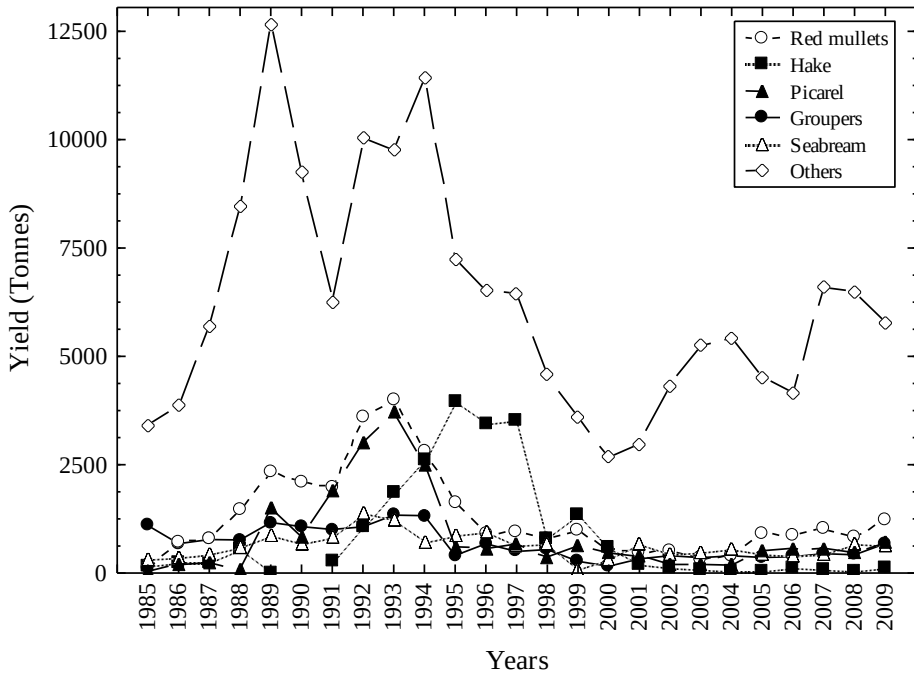


Figure 16. Annual total catch statistics of the major demersal bony fish species in the Aegean Sea from 1985 to 2009 (SIS, 1985-2003; TurkStat, 2004-2009).

Picarel followed hake constituting an average of almost 7% of the annual total demersal bony fish landings in the Mediterranean Sea during the past 25 years. The picarel production in this region was all together much greater than both in the Marmara and the Aegean Seas. The picarel catches increased from a trivial amount of 40 tonnes in 1985 to 1.5 thousand tonnes in 1989. After a slight fall in 1990, they again ascended, this time steeper, and reached to the historical maximum of 3.7 thousand tonnes in 1993. Interestingly, the largest catch of red mullets in this region was registered in the same year as well. In subsequent years, the landings declined and since 1995 they have ranged from around 2 to 7 hundred tonnes (Figure 16) (SIS, 1985-2003; TurkStat, 2004-2009).

A group of commercially highly valued demersal bony fish, containing five species from the genus *Epinephelus*, referred to as groupers were also abundant in the fisheries in the Mediterranean Sea. In this group especially two species, dusky grouper (*E. marginatus*) and waker (*E. aeneus*) were more numerous than the others. Averaged over 25 years, groupers composed nearly 7% of the annual

total demersal fish production in the region (SIS, 1985-2003; TurkStat, 2004-2009). The top years for production of groupers in the region were 1985, 1989, 1993 and 1994 with landings between 1 and 1.3 thousand tonnes (Figure 16). After 1994, the catches diminished and the lowest was 1.5 hundred tonnes in 2000. In the following years, the production of groupers in the region went up a bit and oscillated in the vicinity of 4 hundred tonnes until 2008. The yield in 2009 was approximately 7 hundred tonnes (Figure 16). Groupers were also caught in the Aegean Sea albeit in smaller quantities (SIS, 1985-2003; TurkStat, 2004-2009). Seabream came after groupers with an average share of above 6% in the region's total demersal bony fish landings. During the past 25 years, the recorded maximum and minimum catches of seabream were 1.3 thousand tonnes in 1992 and 83 tonnes in 1999 (Figure 16). From 2000 to 2009, the average annual amount of seabream caught in the region was 5 hundred tonnes. The Mediterranean Sea was the region with the highest seabream production in Turkey (SIS, 1985-2003; TurkStat, 2004-2009).

The average cumulative contribution of the bony fish species, referred as "others" in Figure 16, to the region's demersal fisheries was close to 62%. In other words, instead of a strong dominance of one or a few demersal bony fish species and more or less a very uniform catch composition like in the Black Sea and also, to a lesser extent in the Marmara Sea, there was a more diverse catch composition in the Mediterranean Sea consisting of a significant number of bony fish species contributing to the total demersal fisheries with comparatively minor amounts. Sole, striped bream, red gurnard (*Chelidonichthys cuculus*), seabass, two banded bream and striped seabream (*Lithognathus mormyrus*) were among the more notable demersal bony fish species in the Mediterranean Sea (SIS, 1985-2003; TurkStat, 2004-2009).

According to the fishery statistics (SIS, 1985-2003; TurkStat, 2004-2009), invertebrates, on average, accounted for 26% of the demersal fisheries in the Mediterranean Sea. The greatest yield was about 7 thousand tonnes in 1989 (Figures 4 and 15). Subsequently, the catches fell sharply to 7.5 hundred tonnes in 1991. From 1992 to 2001, they fluctuated within a range between 8 and 18 thousand tonnes (Figure 4). Thereafter, the production increased to 3.7 and 3.8 thousand tonnes in two consecutive years 2003 and 2004, respectively. In addition, only in these two years, the demersal invertebrate landings in the region exceeded those of demersal bony fishes (Figure 15). After 2004 the demersal invertebrate catches again began to rise and fall, and the last substantial catch was 3.9 thousand tonnes in 2007. The Mediterranean Sea was

the region with the lowest demersal invertebrate production in the country (SIS, 1985-2003; TurkStat, 2004-2009).

Like in the Aegean Sea, cephalopods were the most abundant and commercially important invertebrate group in the demersal fisheries in the region with an average combined proportion of 45%. Over the course of 25 years, cuttlefish was the most dominant cephalopod species and composed 27% of the annual total demersal invertebrate landings in the Mediterranean Sea (SIS, 1985-2003; TurkStat, 2004-2009). The cuttlefish landings ascended rapidly from a small amount of 78 tonnes in 1985 to 3 thousand tonnes in 1989. However, after this historical maximum yield, the catches dropped to 162 tonnes in 1991. From 1992 to 2003, the landings ranged from roughly 3 to 6.5 hundred tonnes. The last sizable catch was 1.1 thousand tonnes in 2004. In the subsequent five years, the average annual quantity of cuttlefish caught in the region was 850 tonnes. The other cephalopods squid and octopus made up, on average, 11% and 7% of the region's demersal invertebrate catches. The top years for production of squid and octopus in the region were 1988 and 1989, respectively, with corresponding amounts of nearly 8.5 and 4.5 hundred tonnes. The overall total yield of cephalopods in the Mediterranean Sea was less than that in the Aegean Sea (SIS, 1985-2003; TurkStat, 2004-2009).

Shrimps also followed cephalopods here like in the Aegean Sea. The average share of this invertebrate group in the demersal fisheries in the region was 32%. The shrimp production in the region was a bit bigger than that in the Aegean Sea, but much smaller than that in the Marmara Sea. There were two outstanding peaks in the catch history of shrimps in the region, the first 1.7 thousand tonnes in 1989, and the second 1.6 thousand tonnes in 2007 (SIS, 1985-2003; TurkStat, 2004-2009). Crabs, particularly blue crab (*Callinectes sapidus*), were another important and commercially highly valued species and on average, formed 5% of the demersal invertebrate production in the region. The largest recorded yield for crabs in the region was nearly 626 tonnes in 1988. Ever since, however, the crab production has been very little. Black mussel which was the second most abundant species in the Marmara and the Aegean Seas was also caught in the Mediterranean Sea, yet in lesser quantities. The average proportion of this bivalve in the region's total demersal invertebrate production was 5% (SIS, 1985-2003; TurkStat, 2004-2009).

Cartilaginous fishes, the remaining component of the demersal fisheries, on average, comprised slightly more than 2% of the annual total catches in the region (Figure 15) (SIS, 1985-2003; TurkStat, 2004-2009).

4. A Brief Review of the Previous Studies on the Demersal Fish Stocks in Turkish Seas

Although a majority of the scientific studies for the assessment of the demersal fish stocks in Turkish seas have been carried out during the last 20-25 years, investigations on fish and fisheries along the Turkish coasts have quite a long history. The first documented work on the country's marine fishes is Deveciyan's book entitled "Fish and Fishery in Turkey (Pêche et Pêcheries en Turquie)". The first edition of this book was published in 1915 and re-edited in 1926. In this book, Deveciyan presented rather detailed information on fishes that were distributed in both marine and inland waters in Turkey. The fishing methods used then to catch those fishes were also described in the book.

From 1926 to the 1930s, except for a few studies done by Russian scientists in the Black Sea there were no remarkable publications on the demersal fisheries resources in Turkey. Between 1940 and 1950, numerous inventory studies were carried out especially in the Marmara and Black Seas by various researchers from the Hydrobiology Department of Istanbul University. In the 1950s, some biological properties of several commercial fish species, the migration of some schooling pelagic fish and the pollution in fishing areas were studied in addition to other inventory studies (Bilecik, 1969). Besides these studies, between 1955 and 1960, the Meat and Fish Organization (established in 1952, and the Fish division was opened in 1955) demonstrated a special interest in the fisheries and initiated various investigations to determine trawlable areas, the potential of available demersal fishery resources and the selectivity of fishing nets in the seas surrounding Turkey. Most of the research covered larger areas compared to the studies in the previous years. Unfortunately, some of these investigations were never completed because the Fisheries Research Centre of the Meat and Fish Organization was closed down in 1961 (Bilecik, 1969).

In the early 1970s, investigations on the demersal fisheries resources were mostly focused on some commercial invertebrates such as mussels, sea snails and sea urchins in the Black Sea. In one remarkable study on the demersal fishes in the Central Black Sea between 1969 and 1973, Kutaygil & Bilecik (1976) evaluated the season and depth related variations in bottom trawl catch compositions on a percentage basis.

However, none of these studies were in fact related to the estimation of stock sizes of marine resources. The first stock assessment study was conducted in 1972 within the scope of a FAO/UNDP project and the stock sizes of small pelagics such as anchovy and horse mackerel in the Black Sea were investigated by using acoustic methods (Johannesson & Losse, 1977). Another acoustic survey was also carried out on horse mackerel in the Northern Aegean Sea around Gökçeada in 1973 (Kara et al., 1975).

Perhaps the first comprehensive attempt to assess the stock sizes of demersal fishes along the Turkish coastal area was made by the Institute of Marine Sciences of the Middle East Technical University (METU-IMS) from 1981 to 1984 using the swept area method between Anamur and İskenderun in the Eastern Mediterranean Sea. In these surveys, the depths down to 100 m in Mersin Bay were studied in detail and the biomass of commercially valuable species was estimated. The total demersal fish production was reported as ranging from 15 kg/ha to 49 kg/ha (with a mean of 29 kg/ha) in this period (Bingel et.al. 1993; Gücü & Bingel, 1994; Bingel & Gücü, 2010).

Another significant survey for the appraisal of demersal marine resources was carried out through a collaboration among the Institute of Marine Sciences and Technology of Dokuz Eylül University (DEU-IMST) and the College of Fisheries and the Faculty of Science of Ege University in the Central and Eastern Black Sea between 1985 and 1986. In this study, trawlable fishing grounds and the effects of bottom trawl fishing on the demersal resources were also investigated (DEU-IMST, 1986). Whiting was found as the dominant species and its standing biomass was reported as nearly 59 tonnes per square nautical mile in this region.

In the late 1980s, the Scientific and Technological Research Council of Turkey (TÜBİTAK) and the Ministry of Agriculture and Rural Affairs of the Republic of Turkey (MARA) focused on the assessment of fish stocks in Turkish Seas. Thus, several research projects targeting stock assessment in different Turkish seas were supported. In all of these projects, demersal fishery resources were sampled by bottom trawl and the swept area method was used to estimate available biomass of the commercial species caught.

The first of the mentioned stock assessment projects was conducted within a collaboration between METU-IMS and the Trabzon Fisheries Research Institute of MARA from 1989 to 1992 with the financial support from international and national bodies such as NATO-Science for Stability Programme, The State Planning Organization (SPO), TÜBİTAK and MARA. Bottom trawl surveys

were carried out with R/V Bilim and R/V Sürat 1. Whiting and striped mullet were the most abundant species in the surveyed areas, their biomasses showed very high spatial and temporal variations (TÜBİTAK, DEBAG 12/G, DEBAG 74/G, DEBAG 115/G & DEBÇAG 139/G, 1996).

The other stock assessment project was done again through a collaboration between the Institute of Marine Sciences and Management of Istanbul University (IU-IMSM) and the Bodrum Fisheries Research Institute of MARA in the Marmara Sea from 1990 to 1995. Bottom trawl surveys were conducted with R/V Arar. Hake was the most dominating species and made up, on average over five years, about 56% of the total available biomass in the surveyed area. Other abundant demersal fishes were whiting and red mullets (TÜBİTAK-DEBAG 75/G-116/G, 1997).

The aim of another similar research project funded by TUBİTAK and MARA was to determine and monitor the potential exploitable demersal fisheries resources in the Aegean Sea. DEU-IMST and the Bodrum Fisheries Research Institute of MARA were collaborators in this project and they divided the Aegean Sea into five subareas including both the Turkish and international waters by considering geographical, hydrographic and topographical conditions. Seasonal bottom trawl surveys started in 1990 with R/V K. Piri Reis (TÜBİTAK-DEBAG 14/G, 1991). Meanwhile in 1991 MARA and Japan International Cooperation Agency (JICA) mutually agreed to initiate a research project on the demersal fishery resources in Turkish seas. Following this agreement, large-scale research surveys were conducted in the Marmara, the Aegean and the Mediterranean Seas between 1991 and 1993 by a team of Japanese and Turkish researchers (DEU-IMST) with R/V K. Piri Reis. In order to estimate the stock sizes more accurately, each region was stratified to three depth zones as 20-100, 101-200 and 201-500 m. The stratified zones were divided into 3 square mile blocks and trawl sampling stations inside each block were selected randomly. The biomasses of about 50 demersal species were estimated. However, the major part of the total biomass was composed by a small number of taxa. Red mullet and hake were the most abundant species in most of the surveyed areas. Estimated biomasses of several other copious species, such as axillary seabream, common pandora, annular seabream, large-eye dentex, rose shrimp, octopus and squid, varied according to sampling area, depth and season (JICA, 1993).

After the completion of the JICA project, investigations on the demersal fish stocks were continued in the Aegean Sea until 1996 with the support from

TÜBİTAK. Information provided by the JICA and TÜBİTAK projects was of great importance for monitoring and management of the demersal fisheries resources in terms of multispecies and ecosystem-based approach (Benli et al., 2000).

METU-IMS carried out an important study on the Lessepsian fishes in the northeastern Mediterranean Sea in 1996. Biomasses of not only the Lessepsian fishes but also the demersal fishes along the coasts of the Turkish Republic of Northern Cyprus (TRNC), İskenderun and Mersin Bays were estimated (YDABÇAG-449/G, 1997).

The Trabzon Fisheries Research Institute of MARA conducted a research project on the demersal fisheries in the eastern Black Sea from 1997 to 2000. The stock sizes of dominant fishes such as whiting, red mullet, turbot and picarel were evaluated (TAGEM/IY/97/17/03/006, 2002).

Two projects funded by MARA evaluating the industrial fisheries in the Aegean and Mediterranean Seas were completed in 1998 and 2000, respectively (Kara & Gurbet, 1999; Kara & Aktas, 2001). In these studies, commercial trawlers were used for bottom trawl samplings and biomass estimates for various demersal resources were provided together with the comprehensive landing-site surveys.

The research on the demersal fish and fisheries during the 2000s consisted mostly of relatively small-scale studies concentrated on a particular bay or an area, like the TUBİTAK funded projects done in Saros Bay by the Faculty of Fisheries of Çanakkale 18 Mart University and in İzmir Bay by the Faculty of Fisheries of Ege University (TUBİTAK 106Y029, 2009; TUBİTAK 106Y035, 2010).

5. Conclusion

The only continuous and main source of information regarding the state of fisheries in Turkey is the official fishery statistics collected, compiled and published annually by the Turkish Statistical Institute. However, accuracy, precision, coverage and representability of these catch statistics have long been debated. Not only many fisheries scientists but also a considerable number of people involved otherwise in the fisheries sector in the country are very skeptical to the official statistics. There seems to be more or less a general consensus that the catch figures reported in these statistics are underestimates of the fish actually caught and that a substantial amount goes unreported. Yet, so far there has been no agreement upon the magnitude of the bias. Another

additional concern is the inaccuracy of the provided information particularly on the species level. The organism names given in these statistics do not always strictly correspond to the distinct biological species. Sometimes, data on several closely related species are merged and presented under only one name. Again the statistics for some similar looking species are considered somewhat doubtful because these species are often mistaken for one another and their common names are also recurrently swapped locally. Although all these concerns are duly shared, the official catch statistics are still considered here as a useful index reflecting the overall variations in the stocks of major fisheries resources. Thus, the evaluation made and the trends deduced so far on the state of demersal fisheries on the basis of the official statistics are regarded as reasonably valid.

According to the catch records from the official fishery statistics from 1985 to 2009, in terms of biomass, bony fishes were the chief component of the demersal fisheries in Turkish seas, and they composed almost 55% of the overall total demersal production in this period. Demersal invertebrates followed them with a proportion of 42%. The remaining 3% of the total demersal fisheries production in Turkey was formed by cartilaginous fishes (SIS, 1985-2003; TurkStat, 2004-2009).

Despite the appreciable richness of Turkey's demersal bony fish fauna, almost 67% of the country's overall demersal bony fish production in the past 25 years was made up of two species, whiting (36%) and hake (17%), and a combined group, red mullets (14%). On a more regional basis, whiting was dominant in the Black Sea, hake in the Marmara and the Aegean Seas and red mullets in the Mediterranean Sea (SIS, 1985-2003; TurkStat, 2004-2009).

Even though the demersal bony fish production showed temporal and regional variations, after 1998 there was an obvious trend of decline in the overall landings. This may be attributed to several reasons: fishery operations (fleet modernization, overfishing, non-selective and illegal fishing), pollution (eutrophication and chemical pollution), habitat destruction (physical changes in habitats, increased urbanization along the coastal areas) and invasion of alien species.

Organisms distributed deeper than 300-400 m should be considered as alternative demersal fishery resources. Although trawlers operating in the coastal waters occasionally shift their activity to deeper waters, their equipment is mostly not very appropriate, and furthermore there is no specific interest for deep-sea fishery in Turkey. However, various commercially valuable species,

such as hake, anglerfish, megrim, Norway lobster, deep water rose shrimp and giant red shrimp have been encountered in trawl hauls between 400 and 500 m depth (JICA, 1993). In even deeper waters, available species from myctophidae, macrouridae, gadidae and bothidae may become an important resource (Kaya, 1993). Since reliable information (catch, landings, fishing effort, area and depth) is scarce, detailed research studies need to be carried out on the deep-sea fisheries resources in Turkish Seas.

Although a great deal of effort and funds have been invested in the research activities on the demersal fishery resources in Turkey at the regional and national level over the past 25 years, the data obtained have been somewhat limited and not very dependable for a sustainable management of the demersal fisheries. For a successful and sustainable management, more comprehensive data with higher precision and accuracy must be collected on a regular basis (Tokaç et al., 2010).

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Appendix 1: The list of the Latin and common (English and Turkish) names of Turkey's marine fish species by sea and habitat selection (BS: the Black Sea, MS: the Marmara Sea, AS: the Aegean Sea, MTS: the Mediterranean Sea)

Species Name	English Name	Turkish Name	BS	MS	AS	MTS	Habitat
<i>Heptanchias perlo</i>	Sharpnose sevengill shark	Boz camgöz			*	*	Bathydemersal
<i>Hexanchus griseus</i>	Bluntnose sixgill shark	Boz camgöz	*	*	*	*	Bathydemersal
<i>Carcharias taurus</i>	Sand tiger shark	Pamuk balığı			*	*	Reef-associated
<i>Odontaspis ferox</i>	Smalltooth sand tiger	Pamuk balığı			*	*	Benthopelagic
<i>Carcharodon carcharias</i>	Great white shark	Büyük beyaz köpekbalığı		*	*	*	Pelagic
<i>Isurus oxyrinchus</i>	Shortfin mako	Dik burun canavar			*	*	Pelagic
<i>Lamna nasus</i>	Porbeagle	Dik burun karkaryas		*	*	*	Pelagic
<i>Cetorhinus maximus</i>	Basking shark	Büyük camgöz			*	*	Pelagic
<i>Alopias vulpinus</i>	Thintail thresher	Sapan balığı	*	*	*	*	Pelagic
<i>Alopias superciliosus</i>	Bigeye thresher	Sapan balığı			*		Pelagic
<i>Galeus melastomus</i>	Blackmouth catshark	Lekeli kedibalığı		*	*	*	Bathydemersal
<i>Scyliorhinus canicula</i>	Small-spotted catshark	Kedi balığı	*	*	*	*	Demersal
<i>Scyliorhinus stellaris</i>	Nursehound	Kedi balığı		*	*	*	Reef-associated
<i>Carcharhinus brevipinna</i>	Spinner shark	Sivriburun camgöz			*	*	Epipelagic
<i>Carcharhinus limbatus</i>	Blacktip shark	Köpekbalığı				*	Epipelagic
<i>Carcharhinus melanopterus</i>	Blacktip reef shark	Siyah yüzgeçli köpekbalığı				*	Reef-associated
<i>Carcharhinus altimus</i>	Bignose shark	Büyük burun köpekbalığı				*	Reef-associated

<i>Carcharhinus plumbeus</i>	Sandbar shark	Kum köpekbalığı			*	*	Benthopelagic
<i>Prionace glauca</i>	Blue shark	Pamuk balığı			*	*	Benthopelagic
<i>Galeorhinus galeus</i>	Tope shark	Camgöz			*	*	Benthopelagic
<i>Mustelus asterias</i>	Starry smooth-hound	Benekli köpekbalığı			*	*	Demersal
<i>Mustelus mustelus</i>	Smooth-hound	Adi köpekbalığı		*	*	*	Demersal
<i>Mustelus punctulatus</i>	Blackspotted smooth-hound	Benekli köpekbalığı			*	*	Demersal
<i>Sphyrna tudes</i>	Smalleye hammerhead	Çekiç balığı				*	Epipelagic
<i>Sphyrna zygaena</i>	Smooth hammerhead	Çekiç balığı			*	*	Epipelagic
<i>Oxynotus centrina</i>	Angular roughshark	Domuz balığı		*	*	*	Bathydemersal
<i>Squalus acanthias</i>	Picked dogfish	Mahmuzlu camgöz	*	*	*	*	Benthopelagic
<i>Squalus blainville</i>	Longnose spurdog	Mahmuzlu camgöz	*	*	*	*	Demersal
<i>Centrophorus granulosus</i>	Gulper shark	Köpekbalığı		*	*	*	Bathydemersal
<i>Centrophorus uyato</i>	Little gulper shark	Köpekbalığı		*			Bathydemersal
<i>Dalatias licha</i>	Kitefin shark	Küt burunlu köpekbalığı		*	*		Bathydemersal
<i>Echinorhinus brucus</i>	Bramble shark	Çivili köpekbalığı			*	*	Bathydemersal
<i>Etmopterus spinax</i>	Velvet belly	Kadife köpekbalığı		*	*	*	Bathydemersal
<i>Squatina aculeata</i>	Sawback angelshark	Keler				*	Demersal
<i>Squatina oculata</i>	Smoothback angelshark	Keler		*	*	*	Demersal
<i>Squatina squatina</i>	Angelshark	Keler			*	*	Demersal
<i>Rhinobatos cemiculus</i>	Blackchin guitarfish	Kemane balığı		*	*	*	Demersal
<i>Rhinobatos rhinobatos</i>	Common guitarfish	Kemane balığı		*	*	*	Demersal

<i>Torpedo marmorata</i>	Marbled electric ray	Elektrik balığı, Çarpan	*	*	*	*	Reef-associated
<i>Torpedo torpedo</i>	Common torpedo	Elektrik balığı, Çarpan		*	*	*	Demersal
<i>Torpedo nobiliana</i>	Electric ray	Elektrik balığı, Çarpan		*	*	*	Benthopelagic
<i>Raja batis</i>	Blue skate	Vatoz	*	*	*	*	Demersal
<i>Raja oxyrinchus</i>	Longnosed skate	Uzun burunlu vatoz		*	*	*	Bathydemersal
<i>Raja naevus</i>	Cuckoo ray	Vatoz			*	*	Demersal
<i>Raja asterias</i>	Mediterranean starry ray	Vatoz		*	*	*	Demersal
<i>Raja clavata</i>	Thornback ray	Dikenli vatoz	*	*	*	*	Demersal
<i>Raja miraletus</i>	Brown ray	Benekli vatoz		*	*	*	Demersal
<i>Raja montagui</i>	Spotted ray	Vatoz		*	*	*	Demersal
<i>Raja polystigma</i>	Speckled ray	Benekli vatoz			*		Demersal
<i>Raja radula</i>	Rough ray	Vatoz			*	*	Demersal
<i>Raja alba</i>	White skate	Beyaz vatoz			*	*	Demersal
<i>Raja undulata</i>	Undulate ray	Dalgali vatoz			*	*	Demersal
<i>Leucoraja circularis</i>	Sandy ray	Kum vatozu			*		Demersal
<i>Leucoraja fullonica</i>	Shagreen ray	Dikenli vatoz			*	*	Bathydemersal
<i>Dasyatis centroura</i>	Roughtail stingray	Rina, İğneli vatoz			*	*	Demersal
<i>Dasyatis pastinaca</i>	Common stingray	Rina, İğneli vatoz	*	*	*	*	Demersal
<i>Dasyatis tortonesei</i>	Tortonese's stingray	Rina, İğneli vatoz			*	*	Demersal
<i>Dasyatis violacea</i>	Pelagic stingray	Rina, İğneli vatoz			*	*	Pelagic
<i>Himantura uarnak</i>	Honeycomb stingray	Uzun kuyruklu rina				*	Reef-associated

<i>Taeniura grabata</i>	Round stingray	Yuvarlak rina				*	Demersal
<i>Gymnura altavela</i>	Spiny butterfly ray	Kazıkkuyruk	*	*	*	*	Demersal
<i>Myliobatis aquila</i>	Common eagle ray	Çuçuna		*	*	*	Benthopelagic
<i>Pteromylaeus bovinus</i>	Bull ray	Çuçuna			*	*	Benthopelagic
<i>Rhinoptera marginata</i>	Lusitanian cownose ray	Çuçuna			*	*	Benthopelagic
<i>Mobula mobular</i>	Devil fish	Kulaklı folya, Manta			*	*	Pelagic
<i>Chimaera monstrosa</i>	Rabbit fish	Tavşan balığı, Fare balığı			*	*	Bathydemersal
<i>Acipenser gueldenstaedtii</i>	Danube sturgeon	Rus mersini	*	*			Benthic
<i>Acipenser nudiiventris</i>	Fringebarbel sturgeon	Şip balığı, uzun burun	*	*			Benthic
<i>Acipenser stellatus</i>	Starry sturgeon	Mersin balığı	*	*			Benthic
<i>Acipenser sturio</i>	Sturgeon	Kolan balığı	*	*	*		Benthic
<i>Huso huso</i>	Beluga	Mersin morinası	*	*			Semi-pelagic
<i>Notacanthus bonaparte</i>	Shortfin spiny eel					*	Bathypelagic
<i>Facciolella oxyrhyncha</i>	Facciolella's sorcerer				*	*	Benthic
<i>Anguilla anguilla</i>	European eel	Avrupa yılan balığı	*	*	*	*	Benthic
<i>Chlopsis bicolor</i>	Bicoloured false moray	Yalancı mıgırı				*	Benthic
<i>Enchelycore anatina</i>	Fangtooth moray	Sivridişli müren				*	Benthic
<i>Gymnothorax unicolor</i>	Brown moray	Kahverengi müren			*	*	Benthic
<i>Muraena helena</i>	Mediterranean moray	Müren		*	*	*	Benthic
<i>Dalophis imberbis</i>	Armless snake eel	Mıgırı, yılanbalığı			*	*	Benthic

<i>Echelus myrus</i>	Painted eel	Mırmır yılanbalığı			*	*	Benthic
<i>Ophichthus rufus</i>	Rufus snake eel	Yılankurdu balığı			*	*	Benthic
<i>Ophisurus serpens</i>	Serpent eel	Dikenli yılanbalığı			*	*	Benthic
<i>Ariosoma balearicum</i>	Bandtooth conger	Balerik mığrısı			*	*	Benthic
<i>Conger conger</i>	European conger	Mığrı	*	*	*	*	Benthic
<i>Gnathophis mystax</i>	Thinlip conger	Mığrı			*	*	Benthic
<i>Nettastoma melanurum</i>	Blackfin sorcerer	Gagalı yılanbalığı				*	Bathydemersal
<i>Nemichthys scolopaceus</i>	Slender snipe eel				*		Bathypelagic
<i>Pisodonophis semicinctus</i>						*	Benthic
<i>Alosa fallax nilotica</i>	Twaita shad	Tirsi	*	*	*	*	Epipelagic
<i>Alosa immaculata</i>	Pontic shad	Ringa balığı	*	*			Epipelagic
<i>Alosa maeotica</i>	Blacksea shad	Ringa balığı	*	*			Epipelagic
<i>Alosa pontica</i>	Danube shad	Ringa balığı	*	*			Epipelagic
<i>Alosa tanaica</i>	Azov shad	Tirsi	*				Epipelagic
<i>Clupeonella cultriventris</i>	Blacksea sprat	Filisa	*	*			Epipelagic
<i>Chirocentrus dorab</i>	Dorab wolf-herring					*	Epipelagic
<i>Dussumieria elopsoides</i>	Slender rainbow sardine	Hint sardalyası				*	Epipelagic
<i>Etrumeus teres</i>	Red-eye round herring	Akdeniz hamsisi				*	Epipelagic
<i>Herklotsichthys punctatus</i>	Spotback herring	Benekli sardalya				*	Epipelagic
<i>Bregmaceros atlanticus</i>	Antenna codlet				*	*	Epipelagic
<i>Sardina pilchardus</i>	European pilchard	Sardalya	*	*	*	*	Epipelagic

<i>Sardinella aurita</i>	Round sardinella	Yuvarlak sardalya	*	*	*	*	Epipelagic
<i>Sardinella maderensis</i>	Madeiran sardinella	Tirsi sardalya				*	Epipelagic
<i>Sprattus sprattus</i>	European sprat	Çaça	*	*	*	*	Epipelagic
<i>Engraulis encrasicolus</i>	Anchovy	Hamsi	*	*	*	*	Epipelagic
<i>Argentina sphyraena</i>	Argentine	Derinsu gümüşbalığı			*	*	Bathydemersal
<i>Glossanodon leioglossus</i>	Smalltoothed argentine				*		Bathydemersal
<i>Microstoma microstoma</i>	Slender argentine				*	*	Bathypelagic
<i>Nansenia oblita</i>	Shining argentine				*		Epipelagic
<i>Salmo labrax</i>	Blacksea salmon	Deniz alası	*				Benthic
<i>Cyclothone braueri</i>	Garrick	Işıldak balığı			*	*	Bathypelagic
<i>Cyclothone pygmaea</i>	Pygmy garrick	Işıldak balığı				*	Bathypelagic
<i>Maurolicus muelleri</i>	Silvery lightfish	Işıldak balığı		*	*		Bathypelagic
<i>Argyropelecus hemigymnus</i>	Half-naked hatchetfish	Işıldak balığı, gümüş balta			*	*	Bathypelagic
<i>Vinciguerria attenuata</i>	Slender lightfish	Işıldak balığı			*	*	Bathypelagic
<i>Vinciguerria poweriae</i>	Power's deep-water bristle-mouth fish	Işıldak balığı			*		Bathypelagic
<i>Chauliodus sloani</i>	sloane's viperfish	Engerek balığı			*		Bathypelagic
<i>Stomias boa</i>	Scaly dragonfish	Kocaağız balığı		*	*		Bathypelagic
<i>Aulopus filamentosus</i>	Royal flagfin	Filamentli zurna balığı		*	*	*	Benthic
<i>Chlorophthalmus agassizi</i>	Shortnose greeneye	Yeşilgöz balığı			*	*	Bathydemersal
<i>Bathypterois dubius</i>	Mediterranean spiderfish	Akdeniz örümcekbalığı			*	*	Bathydemersal

<i>Saurida undosquamis</i>	Brushtooth lizardfish	Lokum balığı			*	*	Benthic
<i>Synodus saurus</i>	Atlantic lizardfish	Zurna balığı			*	*	Benthic
<i>Arctozenus risso</i>	Ribbon barracudina				*	*	Bathypelagic
<i>Lestidiops jayakari</i>	Jayakar's barracudina				*	*	Bathypelagic
<i>Lestidiops sphyrenoides</i>	Barracuda barracudina				*		Bathypelagic
<i>Sudis hyalina</i>	Longfin barracuda	Yalancı zargana			*	*	Bathypelagic
<i>Benthosema glaciale</i>	Glacier lantern fish	Işıldak balığı		*	*	*	Mesopelagic
<i>Ceratoscopelus maderensis</i>	Madeira lantern fish	Işıldak balığı			*	*	Bathypelagic
<i>Diaphus holti</i>	Small lantern fish	Işıldak balığı			*	*	Bathypelagic
<i>Diaphus metopoclampus</i>	Spothead lantern fish	Işıldak balığı			*		Bathypelagic
<i>Diaphus rafinesquii</i>	White-spotted lantern fish	Işıldak balığı			*		Bathypelagic
<i>Electrona risso</i>	Electric lantern fish	Işıldak balığı				*	Bathypelagic
<i>Gonichthys cocco</i>	Silver lanternfish	Işıldak balığı				*	Bathypelagic
<i>Hygophum benoiti</i>	Benoit's lanternfish	Işıldak balığı		*	*	*	Bathypelagic
<i>Lampanyctus crocodilus</i>	Jewel lanternfish	Işıldak balığı		*	*	*	Bathypelagic
<i>Lampanyctus pusillus</i>	Pygmy lanternfish	Işıldak balığı				*	Bathypelagic
<i>Lobianchia dofleini</i>	Dofleini's lantern fish	Işıldak balığı			*	*	Bathypelagic
<i>Lobianchia gemellarii</i>	Cocco's lantern fish	Işıldak balığı			*		Bathypelagic
<i>Myctophum punctatum</i>	Spotted lanternfish	Işıldak balığı		*	*	*	Bathypelagic
<i>Notoscopelus bolini</i>	Bolin's lanternfish	Işıldak balığı				*	Mesopelagic
<i>Notoscopelus elongatus</i>	Elongate lanternfish	Işıldak balığı		*			Mesopelagic

<i>Symbolophorus veranyi</i>	Large-scale lantern fish	Işıldak balığı				*	Bathypelagic
<i>Lampris guttatus</i>	Opah			*	*	*	Bathypelagic
<i>Lophotus lacepede</i>	Crested oarfish	Tepeli kağıt balığı			*		Bathypelagic
<i>Trachipterus trachipterus</i>	Mediterranean dealfish	Kağıt balığı		*	*	*	Bathypelagic
<i>Zu cristatus</i>	Scalloped ribbonfish	Tepeli kağıt balığı			*	*	Bathypelagic
<i>Regalecus glesne</i>	King of herrings	Büyük kurdela balığı		*	*	*	Mesopelagic
<i>Trachyrincus scabrus</i>	Roughsnout grenadier	Uzun burunlu fare balığı			*	*	Bathydemersal
<i>Caelorhynchus caelorhynchus</i>	Hollowsnout grenadier	Fare balığı			*	*	Benthopelagic
<i>Hymenocephalus italicus</i>	Glasshead grenadier	Kılkuyruk fare balığı, zarkafa			*	*	Benthopelagic
<i>Nezumia aequalis</i>	Common Atlantic grenadier	Fare balığı		*	*	*	Benthopelagic
<i>Nezumia sclerorhynchus</i>	Roughtip grenadier	Fare balığı		*	*	*	Bathypelagic
<i>Gadella maraldi</i>	Gadella	Kara mezgit			*	*	Benthopelagic
<i>Mora moro</i>	Common mora					*	Bathypelagic
<i>Benthocometes robustus</i>	Robust cusk-eel				*		Bathydemersal
<i>Gadiculus argenteus argenteus</i>	Silvery pout	Pamukçuk balığı		*	*	*	Bathypelagic
<i>Merlangius merlangus euxinus</i>	Whiting	Mezgit	*	*	*		Benthopelagic
<i>Micromesistius poutassou</i>	Blue whiting	Derinsu mezgiti		*	*	*	Bathypelagic
<i>Trisopterus minutus</i>	Poor cod	Tavuk balığı		*	*	*	Benthopelagic
<i>Gaidropsarus biscayensis</i>	Mediterranean bigeye rockling	Küçük gelincik balığı		*	*		Benthopelagic
<i>Gaidropsarus mediterraneus</i>	Shore rockling	Gelincik balığı	*	*	*	*	Benthic

<i>Gaidropsarus vulgaris</i>	Three-bearded rockling	Gelincik balığı		*	*	*	Benthic
<i>Molva macrophthalma</i>	Spanish ling	Uzun gelincik balığı			*	*	Benthic
<i>Phycis blennoides</i>	Greater forkbeard	Gelincik balığı			*	*	Benthopelagic
<i>Phycis phycis</i>	Forkbeard	Gelincik balığı			*	*	Benthopelagic
<i>Merluccius merluccius</i>	European hake	Bakalyaro, berlam	*	*	*	*	Benthic
<i>Ophidion barbatum</i>	Snake blenny	Kayış balığı	*	*	*	*	Benthic
<i>Ophidion rochei</i>	Snake blenny	Kayış balığı	*	*	*		Benthic
<i>Parophidion vassali</i>	Vassal's snake blenny	Kayış balığı	*	*			Benthic
<i>Carapus acus</i>	Pearl fish	İnci balığı		*	*	*	Benthic
<i>Bellottia apoda</i>	Footless brotula	İnci balığı			*		Bathydemersal
<i>Lophius budegassa</i>	Blackbellied angler	Fener balığı	*	*	*	*	Bathydemersal
<i>Lophius piscatorius</i>	Angler	Fener balığı	*	*	*	*	Bathydemersal
<i>Apletodon dentatus</i>	Small-headed clingfish	Ördek balığı		*			Benthic
<i>Apletodon incognitus</i>		Ördek balığı				*	Benthic
<i>Diplecogaster bimaculata</i>	Two-spotted clingfish	Çift benekli ördek balığı	*	*	*	*	Benthic
<i>Gouania willdenowi</i>	Blunt-snouted clingfish	Küt burunlu ördek balığı			*	*	Benthic
<i>Lepadogaster candollei</i>	Connemarra clingfish	Ördek balığı	*	*	*	*	Benthic
<i>Lepadogaster lepadogaster</i> <i>lepadogaster</i>	Shore clingfish	Ördek balığı	*	*	*	*	Benthic
<i>Atherina boyeri</i>	Big-scale sand smelt	Gümüş balığı, Çamuka	*	*	*	*	Epipelagic
<i>Atherina hepsetus</i>	Mediterranean sand smelt	Gümüş balığı	*	*	*	*	Epipelagic

<i>Atherinomorus forskalii</i>	Hardyhead silverside	Gümüş balığı			*	*	Epipelagic
<i>Lebias fasciatus</i>	Mediterranean banded killifish	Dişli sazancık		*	*	*	Benthic
<i>Scomberesox saurus</i>	Atlantic saury	Pinnüllü zargana		*	*	*	Epipelagic
<i>Belone belone</i>	Garfish	Zargana	*	*	*	*	Epipelagic
<i>Belone svetovidovi</i>	Garfish	Zargana			*		Epipelagic
<i>Tylosurus acus imperialis</i>	Garfish	Zargana			*	*	Epipelagic
<i>Hemiramphus far</i>	Blackbarred halfbeak	Çomak balığı			*	*	Epipelagic
<i>Hyporhamphus affinis</i>	Tropical halfbeak	Çomak balığı				*	Epipelagic
<i>Hyporhamphus picarti</i>	African halfbeak	Çomak balığı			*	*	Epipelagic
<i>Cheilopogon heterurus</i>	Mediterranean flyingfish	Uçan balığı				*	Epipelagic
<i>Hirundichthys rondeletii</i>	Black-wing flyingfish	Uçan balığı		*	*	*	Epipelagic
<i>Parexocoetus mento</i>	African flyingfish	Uçan balığı			*	*	Epipelagic
<i>Hoplostethus mediterraneus</i>	Mediterranean slimehead	Kütük balığı			*	*	Benthopelagic
<i>Sargocentron rubrum</i>	Redcoat	Hindistan balığı			*	*	Benthic
<i>Zeus faber</i>	John dory	Peygamber balığı, Dülger	*	*	*	*	Benthopelagic
<i>Capros aper</i>	Boarfish	Peri balığı		*	*	*	Benthic
<i>Gasterosteus aculeatus</i>	Three-spined stickleback	Dikence balığı	*	*	*	*	Benthopelagic
<i>Pungitius platygaster</i>	Southern ninespine stickleback	Dikence balığı	*				Benthopelagic
<i>Fistularia commersonii</i>	Bluespotted cornetfish	Külâh balığı				*	Epipelagic
<i>Macroramphosus scolopax</i>	Longspine snipefish	Trompet balığı, boru balığı			*	*	Benthic
<i>Macroramphosus gracilis</i>	Slender snipefish	Trompet balığı, boru balığı				*	Benthic

<i>Nerophis maculatus</i>	Spotted worm pipefish	Deniz iğnesi		*			Benthic
<i>Nerophis ophidion</i>	Straightnose pipefish	Deniz iğnesi	*	*	*	*	Benthic
<i>Syngnathus abaster</i>	Black-striped pipefish	Deniz iğnesi	*	*	*	*	Benthic
<i>Syngnathus acus</i>	Greater pipefish	Deniz iğnesi	*	*	*	*	Benthic
<i>Syngnathus phlegon</i>	Phlegon pipefish	Deniz iğnesi			*	*	Epipelagic
<i>Syngnathus schmidtii</i>	Schmidt's pipefish	Deniz iğnesi	*	*			Epipelagic
<i>Syngnathus tenuirostris</i>	Narrow-snouted pipefish	Deniz iğnesi	*	*	*	*	Benthic
<i>Syngnathus typhle</i>	Broadnosed pipefish	Geniş burunlu deniz iğnesi	*	*	*	*	Benthic
<i>Syngnathus variegatus</i>	Pipefish	Deniz iğnesi	*				Benthic
<i>Syngnathus rostellatus</i>	Nilsson's pipefish	Deniz iğnesi					Benthic
<i>Hippocampus hippocampus</i>	Short snouted seahorse	Deniz atı	*	*	*	*	Benthic
<i>Hippocampus guttulatus</i>	Long-snouted seahorse	Deniz atı	*	*	*	*	Benthic
<i>Hippocampus fuscus</i>	Sea pony	Deniz atı				*	Benthic
<i>Helicolenus dactylopterus</i>	Blackbelly rosefish	Derinsu iskorpiti		*	*	*	Bathydemersal
<i>Scorpaena elongata</i>	Slender rockfish	Kırmızı iskorpit			*	*	Benthic
<i>Scorpaena maderensis</i>	Madeira rockfish	İskorpit			*	*	Benthic
<i>Scorpaena notata</i>	Small red scorpionfish	Benekli iskorpit	*	*	*	*	Benthic
<i>Scorpaena porcus</i>	Black scorpionfish	Lipsoz	*	*	*	*	Benthic
<i>Scorpaena scrofa</i>	Red scorpionfish	Adabeyi	*	*	*	*	Benthic
<i>Scorpaena loppei</i>	Cadenat's rockfish						Benthic
<i>Dactylopterus volitans</i>	Flying gurnard	Uçan kırlangıç		*	*	*	Benthic

<i>Chelidonichthys cuculus</i>	Red gurnard	Dikenli kırlangıç	*	*	*	*	Benthic
<i>Chelidonichthys gurnardus</i>	Grey gurnard	Benekli kırlangıç	*	*	*	*	Benthic
<i>Chelidonichthys lastoviza</i>	Streaked gurnard	Mazak		*	*	*	Benthic
<i>Chelidonichthys lucerna</i>	Tub gurnard	Kırlangıç	*	*	*	*	Benthic
<i>Chelidonichthys obscurus</i>	Longfin gurnard	Antenli kırlangıç			*	*	Benthic
<i>Lepidotrigla cavillone</i>	Large-scaled gurnard	Kırlangıç		*	*	*	Benthic
<i>Lepidotrigla dieuzeidei</i>	Spiny gurnard	Dikenli kırlangıç			*		Benthic
<i>Trigla lyra</i>	Piper gurnard	Öksüz		*	*	*	Benthic
<i>Peristedion cataphractum</i>	African armoured searobin	Dikenli öksüz		*	*	*	Benthic
<i>Dicentrarchus labrax</i>	European seabass	Levrek	*	*	*	*	Benthic
<i>Dicentrarchus punctatus</i>	Spotted seabass	Levrek			*	*	Benthic
<i>Champsodon nudivittis</i>	Gaper					*	Epipelagic
<i>Polyprion americanus</i>	Wreckfish	İskorpit hanisi, kaya lagosu		*	*	*	Benthic
<i>Serranus cabrilla</i>	Comber	Asıl hani, hanoz	*	*	*	*	Benthic
<i>Serranus hepatus</i>	Brown comber	Benekli hani	*	*	*	*	Benthic
<i>Serranus scriba</i>	Painted comber	Yazılı hani, Ali bereket	*	*	*	*	Benthic
<i>Anthias anthias</i>	Swallowtail seaperch	Berber balığı		*	*	*	Benthic
<i>Epinephelus aeneus</i>	White grouper	Lagod, Grida			*	*	Benthic
<i>Epinephelus caninus</i>	Dogtooth grouper	Çizgili taş hanisi			*	*	Benthic
<i>Epinephelus costae</i>	Goldblotch grouper	Çizgili taş hanisi			*	*	Benthic
<i>Ephinephelus haifensis</i>	Haifa grouper	Taş hanisi, Pörtlek				*	Benthic

<i>Epinephelus marginatus</i>	Dusky grouper	Orfoz		*	*	*	Benthic
<i>Mycteroperca rubra</i>	Mottled grouper	Dudaklı zuber			*	*	Benthic
<i>Callanthis ruber</i>	Parrot seaperch	Kırmızı berber balığı			*	*	Benthic
<i>Pelates quadrilineatus</i>	Fourlined terapon	İspinoz				*	Benthic
<i>Apogon imberbis</i>	Cardinal fish	Kardinal balığı		*	*	*	Benthic
<i>Apogon nigripinnis</i>	Bullseye	Kardinal balığı				*	Benthic
<i>Apogon pharaonis</i>	Pharao cardinalfish	Kardinal balığı			*	*	Benthic
<i>Apogon fasciatus</i>	Broadbanded cardinalfish	Kardinal balığı				*	Benthic
<i>Apogon queketti</i>	Spotfin cardinal	Kardinal balığı			*	*	Benthopelagic
<i>Apogon smithi</i>	Smith's cardinalfish	Kardinal balığı				*	Benthic
<i>Epigonus denticulatus</i>	Pencil cardinal	Küçük kardinal balığı			*		Bathydemersal
<i>Epigonus telescopus</i>	Black cardinal fish	Küçük kardinal balığı			*		Bathydemersal
<i>Epigonus constanciae</i>	Deepwater cardinalfish	Derinsu kardinal balığı			*		Bathydemersal
<i>Microichthys coccoi</i>	Cocco's bulls-eye	Derinsu kardinal balığı			*		Benthopelagic
<i>Sillago sihama</i>	Silver sillago	Deniz sudağı			*	*	Benthic
<i>Pomatomus saltatrix</i>	Bluefish	Lüfer	*	*	*	*	Epipelagic
<i>Echeneis naucratis</i>	Live sharksucker	Vantuz balığı		*	*	*	Epipelagic
<i>Remora australis</i>	Whalesucker	Vantuz balığı			*	*	Epipelagic
<i>Remora remora</i>	Common remora	Vantuz balığı		*	*	*	Epipelagic
<i>Alectis alexandrinus</i>	African threadfish	İskender balığı			*	*	Epipelagic
<i>Alepes djedaba</i>	Shrimp scad	Çatal balığı			*	*	Epipelagic

<i>Campogramma glaycos</i>	Vadigo	Çıplak			*	*	Epipelagic
<i>Caranx crysos</i>	Blue runner	Kral balığı			*	*	Epipelagic
<i>Caranx hippos</i>	Crevalle jack	İstavritbozması balığı			*	*	Epipelagic
<i>Caranx rhonchus</i>	False scad	Kral balığı			*	*	Epipelagic
<i>Lichia amia</i>	Leerfish	Akya, avcı	*	*	*	*	Epipelagic
<i>Naucrates ductor</i>	Pilotfish	Malta palamudu, kılavuz balığı	*	*	*	*	Epipelagic
<i>Pseudocaranx dentex</i>	White trevally	Kral balığı			*	*	Semi-pelagic
<i>Seriola dumerili</i>	Greater amberjack	Sarıkuyruk, kuzu balığı			*	*	Semi-pelagic
<i>Trachinotus ovatus</i>	Derbio	Çıplak, yaladerma		*	*	*	Semi-pelagic
<i>Trachurus mediterraneus</i>	Mediterranean horse mackerel	Sarıkuyruk istavrit	*	*	*	*	Semi-pelagic
<i>Trachurus picturatus</i>	Blue jack mackerel	Derinsu istavridi			*	*	Semi-pelagic
<i>Trachurus trachurus</i>	Atlantic horse mackerel	Karagöz istavrit	*	*	*	*	Semi-pelagic
<i>Trachurus indicus</i>	Arabian scad					*	Epipelagic
<i>Decapterus russelli</i>	Indian scad					*	Benthopelagic
<i>Coryphaena hippurus</i>	Common dolphinfish	Lambuga		*	*	*	Epipelagic
<i>Equulites klunzingeri</i>	Klunzinger's pony fish	Pul balığı, Itsi balığı			*	*	Benthic
<i>Brama brama</i>	Atlantic pomfret	Baltabaş balığı			*	*	Epipelagic
<i>Lobotes surinamensis</i>	Tripletail	Üçkuyruk			*	*	Benthopelagic
<i>Pomadasys incisus</i>	Bastard grunt	Gargur			*	*	Benthic
<i>Pomadasys stridens</i>	Striped piggy					*	Benthic

<i>Boops boops</i>	Bogue	Kupes	*	*	*	*	Benthopelagic
<i>Dentex dentex</i>	Common dentex	Sinagrit	*	*	*	*	Benthopelagic
<i>Dentex gibbosus</i>	Pink dentex	Trana		*	*	*	Benthopelagic
<i>Dentex macrophthalmus</i>	Large-eye dentex	Patlakgöz mercan			*	*	Benthopelagic
<i>Dentex maroccanus</i>	Morocco dentex	Fas mercanı			*	*	Benthic
<i>Diplodus annularis</i>	Annular seabream	İsparoz	*	*	*	*	Benthopelagic
<i>Diplodus cervinus cervinus</i>	Zebra seabream	Çizgili isparoz			*	*	Benthic
<i>Diplodus puntazzo</i>	Sharpsnout seabream	Sivriburun karagöz	*	*	*	*	Benthopelagic
<i>Diplodus sargus sargus</i>	White seabream	Sargoz	*	*	*	*	Benthic
<i>Diplodus vulgaris</i>	Common two-banded seabream	Karagöz	*	*	*	*	Benthopelagic
<i>Lithognathus mormyrus</i>	Sand steenbras	Mırmır		*	*	*	Benthic
<i>Oblada melanura</i>	Saddled seabream	Melanur	*	*	*	*	Benthopelagic
<i>Pagellus acarne</i>	Axillary seabream	Yabani mercan		*	*	*	Benthopelagic
<i>Pagellus bogaraveo</i>	Blackspot seabream	Mandagöz mercan		*	*	*	Benthopelagic
<i>Pagellus erythrinus</i>	Common pandora	Kırma mercan	*	*	*	*	Benthopelagic
<i>Pagrus auriga</i>	Redbanded seabream	Kınalı mercan			*	*	Benthopelagic
<i>Pagrus caeruleostictus</i>	Bluespotted seabream	Antenli mercan			*	*	Benthopelagic
<i>Pagrus pagrus</i>	Red porgy	Fangri		*	*	*	Benthopelagic
<i>Sarpa salpa</i>	Salema	Salpa	*	*	*	*	Benthopelagic
<i>Sparus aurata</i>	Gilthead seabream	Çipura	*	*	*	*	Benthic
<i>Spondyllosoma cantharus</i>	Black seabream	İskatari	*	*	*	*	Benthopelagic

<i>Monotaxis grandoculis</i>	Humpnose big-eye bream					*	Benthic
<i>Nemipterus randalli</i>	Randall's threadfin bream					*	Benthic
<i>Centracanthus cirrus</i>	Curled picarel	İstrangiloz			*	*	Benthopelagic
<i>Spicara maena</i>	Blotched picarel	Beyazgöz izmarit	*	*	*	*	Benthopelagic
<i>Spicara smaris</i>	Picarel	İzmarit	*	*	*	*	Benthopelagic
<i>Argyrosomus regius</i>	Meagre	Sarıağız	*	*	*	*	Benthopelagic
<i>Sciaena umbra</i>	Brown meagre	Eşkine, Mağruşkil	*	*	*	*	Benthic
<i>Umbrina cirrosa</i>	Shi drum	Minakop, Kötek	*	*	*	*	Benthic
<i>Mullus barbatus</i>	Red mullet	Barbun	*	*	*	*	Benthic
<i>Mullus surmuletus</i>	Striped red mullet	Tekir	*	*	*	*	Benthic
<i>Upeneus moluccensis</i>	Goldband goatfish	Paşa barbunu			*	*	Benthic
<i>Upeneus pori</i>	Por's goatfish	Nil barbunu				*	Benthic
<i>Parupeneus forsskali</i>	Red Sea goatfish	Kızıldeniz barbunu				*	Benthic
<i>Pempheris vanicolensis</i>	Vanikoro sweeper	Üçgen balığı, Gölge balığı			*	*	Benthic
<i>Heniochus intermedius</i>	Red Sea bannerfish					*	Benthic
<i>Platax teira</i>	Teira batfish					*	Benthic
<i>Cepola rubescens</i>	Red bandfish	Kurdela balığı		*	*	*	Benthic
<i>Chelon labrosus</i>	Thicklip grey mullet	Kefal balığı, mavraki	*	*	*	*	Epipelagic
<i>Liza aurata</i>	Golden grey mullet	Altınbaşkefal balığı	*	*	*	*	Epipelagic
<i>Liza carinata</i>	Keeled mullet	Kefal balığı, bıldırcın kefal			*	*	Epipelagic
<i>Liza ramada</i>	Thinlip mullet	Pulatarina balığı, ceran	*	*	*	*	Epipelagic

<i>Liza saliens</i>	Leaping mullet	Kefal balığı, kobar, kastros	*	*	*	*	Epipelagic
<i>Mugil cephalus</i>	Flathead mullet	Haskefal balığı, topan kefal	*	*	*	*	Epipelagic
<i>Mugil soiyuy</i>	So-iuy mullet	Rus kefali, pelingas	*	*	*		Epipelagic
<i>Oedalechilus labeo</i>	Boxlip mullet	Dudaklı kefal balığı		*	*	*	Epipelagic
<i>Chromis chromis</i>	Damselfish	Papaz balığı	*	*	*	*	Benthic
<i>Acantholabrus palloni</i>	Scale-rayed wrasse	Derinsu lapini			*	*	Benthic
<i>Coris julis</i>	Mediterranean rainbow wrasse	Güneş balığı, Gelin balığı	*	*	*	*	Benthic
<i>Ctenolabrus rupestris</i>	Goldsinny-wrasse	Çırçır, Ot balığı	*	*	*	*	Benthic
<i>Labrus bergylta</i>	Ballan wrasse	Çırçır, Ot balığı	*	*	*	*	Benthic
<i>Labrus mixtus</i>	Cuckoo wrasse	Lapin, Ot balığı	*	*	*	*	Benthic
<i>Labrus viridis</i>	Green wrasse	Lapin	*	*	*	*	Benthic
<i>Pteragogus pelycus</i>	Sideburn wrasse	Filamentli çırçır			*	*	Benthic
<i>Symphodus cinereus</i>	Grey wrasse	Gri çırçır	*	*	*	*	Benthic
<i>Symphodus doderleini</i>	Doderlein's wrasse	Çırçır, Ot balığı		*	*	*	Benthic
<i>Symphodus mediterraneus</i>	Axillary wrasse	Çırçır, Ot balığı	*	*	*	*	Benthic
<i>Symphodus melanocercus</i>	Black-tailed wrasse	Siyah kuyruklu çırçır		*	*	*	Benthic
<i>Symphodus melops</i>	Corkwing wrasse	Çırçır, Ot balığı			*		Benthic
<i>Symphodus ocellatus</i>	Ocellated wrasse	Benekli çırçır	*	*	*	*	Benthic
<i>Symphodus roissali</i>	Five-spotted wrasse	Çırçır	*	*	*	*	Benthic
<i>Symphodus rostratus</i>	Long snout wrasse	Sivriburunlu çırçır	*	*	*	*	Benthic
<i>Symphodus tinca</i>	Peacock wrasse	Lekeli çırçır	*	*	*	*	Benthic

<i>Thalassoma pavo</i>	Ornate wrasse	Gün balığı, Aykuyruk		*	*	*	Benthic
<i>Xyrichtys novacula</i>	Pearly razorfish	Ustura balığı		*	*	*	Benthic
<i>Sparisoma cretense</i>	Parrotfish	Papağan balığı			*	*	Benthic
<i>Gymnammodytes cicereus</i>	Mediterranean sand eel	Kum balığı	*	*	*	*	Benthic
<i>Echiichthys vipera</i>	Lesser weever	Varsam		*	*	*	Benthic
<i>Trachinus araneus</i>	Spotted weever	Kum trakonyası		*	*	*	Benthic
<i>Trachinus draco</i>	Greater weever	Trakonya	*	*	*	*	Benthic
<i>Trachinus radiatus</i>	Starry weever	Çarpan		*	*	*	Benthic
<i>Uranoscopus scaber</i>	Stargazer	Tiryaki, kurbağa balığı	*	*	*	*	Benthic
<i>Tripterygion delaisi</i>	Black-faced blenny	Karabaş balığı			*	*	Benthic
<i>Tripterygion melanurus</i>	Small triplefin	Karabaş balığı			*	*	Benthic
<i>Tripterygion tripteronotus</i>	Red triplefin	Karabaş balığı	*	*	*	*	Benthic
<i>Clinitrachus argentatus</i>	Cline	Arı balığı, Pullu horozbina		*	*	*	Benthic
<i>Aidablennius sphynx</i>	Sphynx blenny	Horozbina	*	*	*	*	Benthic
<i>Blennius ocellaris</i>	Butterfly blenny	Benekli horozbina	*	*	*	*	Benthic
<i>Coryphoblennius galerita</i>	Montagu's blenny	Horozbina	*	*	*	*	Benthic
<i>Lipophrys adriaticus</i>	Blenny	Horozbina	*	*	*	*	Benthic
<i>Lipophrys dalmatinus</i>	Dalmation blenny	Horozbina			*	*	Benthic
<i>Lipophrys nigriceps nigriceps</i>	Black-headed blenny	Horozbina			*		Benthic
<i>Parablennius gattorugine</i>	Tompot blenny	Horozbina	*	*	*	*	Benthic
<i>Parablennius incognitus</i>	Pygmy blenny	Horozbina	*	*	*	*	Benthic

<i>Parablennius rouxi</i>	Stripped blenny	Şeritli horozbina			*	*	Benthic
<i>Parablennius sanguinolentus</i>	Rusty blenny	Horozbina	*	*	*	*	Benthic
<i>Parablennius zvonimiri</i>	Red blenny	Horozbina	*	*	*	*	Benthic
<i>Paralipophrys trigloides</i>	Bullhead blenny	Horozbina		*	*	*	Benthic
<i>Petroscirtes ancyllodon</i>	Arabian fangblenny	Horozbina				*	Benthic
<i>Salaria basilisca</i>	Basilisk blenny	Horozbina			*	*	Benthic
<i>Salaria pavo</i>	Peacock blenny	İbikli horozbina	*	*	*	*	Benthic
<i>Scartella cristata</i>	Molly miller	Horozbina			*	*	Benthic
<i>Callionymus fasciatus</i>	Barred dragonet	Üzgün balığı	*	*	*	*	Benthic
<i>Callionymus filamentosus</i>	Blotchfin dragonet	Üzgün balığı				*	Benthic
<i>Callionymus lyra</i>	Dragonet	Üzgün balığı	*	*	*	*	Benthic
<i>Callionymus maculatus</i>	Spotted dragonet	Üzgün balığı		*	*	*	Benthic
<i>Callionymus pusillus</i>	Festive dragonet	Üzgün balığı	*	*	*	*	Benthic
<i>Callionymus risso</i>	Risso's dragonet	Üzgün balığı	*	*	*	*	Benthic
<i>Synchiropus phaeton</i>	Deepwater dragonet	Üzgün balığı			*	*	Benthic
<i>Aphia minuta</i>	Transparent goby	Beyaz kayabalgı	*	*	*	*	Epipelagic
<i>Chromogobius quadrivittatus</i>	Chestnut goby	Kahverengi kayabalgı		*	*	*	Benthic
<i>Crystallogobius linearis</i>	Crystal goby	Kristal kayabalgı			*		Benthic
<i>Deltentosteus collonianus</i>	Toothed goby	Dişli kayabalgı				*	Benthic
<i>Deltentosteus quadrimaculatus</i>	Four-spotted goby	Dört benekli kayabalgı		*	*	*	Benthic
<i>Gobius auratus</i>	Golden goby	Altın kayabalgı		*	*	*	Benthic

<i>Gobius bucchichi</i>	Bucchich's goby	Kayabalığı	*	*	*	*	Benthic
<i>Gobius cobitis</i>	Giant goby	Büyük kayabalığı	*	*	*	*	Benthic
<i>Gobius cruentatus</i>	Red-mouthed goby	Kırmızı dudaklı kayabalığı		*	*	*	Benthic
<i>Gobius geniporus</i>	Slender goby	İnce kayabalığı		*	*	*	Benthic
<i>Gobius niger</i>	Black goby	Kömürcü kayabalığı	*	*	*	*	Benthic
<i>Gobius paganellus</i>	Rock goby	Kayabalığı	*	*	*	*	Benthic
<i>Gobius vittatus</i>	Striped goby	Çizgili kayabalığı			*	*	Benthic
<i>Gobius couchi</i>	Couch's goby				*		Benthic
<i>Trypauchen vagina</i>	Burrowing goby					*	Benthic
<i>Vanderhorstia mertensi</i>	Mertens' prawn-goby						Benthic
<i>Knipowitschia caucasica</i>	Caucasian dwarf goby	Kayabalığı	*	*	*	*	Benthic
<i>Lesueurigobius friesii</i>	Fries's goby	Kayabalığı		*	*	*	Benthic
<i>Lesueurigobius suerii</i>	Lesueur's goby	Kayabalığı			*	*	Benthic
<i>Mesogobius batrachocephalus</i>	Knout goby	Yassıkafalı kayabalığı	*	*	*	*	Benthic
<i>Ponticola eurycephalus</i>	Mushroom goby	Kayabalığı	*				Benthic
<i>Neogobius melanostomus</i>	Round goby	Kum kayabalığı	*	*	*		Benthic
<i>Neogobius ratan</i>	Ratan goby	Kayabalığı	*				Benthic
<i>Ponticola kessleri</i>	Bighead goby	Büyükbaşlı kayabalığı	*				Benthic
<i>Ponticola syrman</i>	Syrman goby	Kayabalığı	*	*			Benthic
<i>Oxyurichthys papuensis</i>	Frogface goby	Sivrikuyruk kayabalığı			*	*	Benthic
<i>Pomatoschistus bathi</i>	Bath's goby	Küçük kayabalığı		*	*		Benthic

<i>Pomatoschistus marmoratus</i>	Marbled goby	Küçük kayabalığı	*	*	*	*	Benthic
<i>Pomatoschistus minutus</i>	Sand goby	Küçük kayabalığı	*	*	*	*	Benthic
<i>Pomatoschistus pictus adriaticus</i>	Painted goby	Küçük kayabalığı		*			Benthic
<i>Thorogobius ephippiatus</i>	Leopard-spotted goby	Leopar kayabalığı			*	*	Benthic
<i>Zebrus zebrus</i>	Zebra goby	Kayabalığı			*	*	Benthic
<i>Millerigobius macrocephalus</i>					*	*	Benthic
<i>Zosterisessor ophiocephalus</i>	Grass goby	Saz kayabalığı	*	*	*	*	Benthic
<i>Siganus luridus</i>	Dusky spinefoot	Esmer sokar			*	*	Benthic
<i>Siganus rivulatus</i>	Marbled spinefoot	Beyaz sokar, Sokkan			*	*	Benthic
<i>Luvarus imperialis</i>	Luvar	İmparator balığı			*	*	Mesopelagic
<i>Sphyræna chrysotaenia</i>	Yellowstripe barracuda	Iskarmoz			*	*	Epipelagic
<i>Sphyræna flavicauda</i>	Yellowtail barracuda	Iskarmoz				*	Epipelagic
<i>Sphyræna sphyræna</i>	European barracuda	Iskarmoz	*	*	*	*	Epipelagic
<i>Sphyræna viridensis</i>	Yellowmouth barracuda	Iskarmoz			*	*	Epipelagic
<i>Ruvettus pretiosus</i>	Oilfish	Kalas balığı			*	*	Benthopelagic
<i>Lepidopus caudatus</i>	Silver scabbardfish	Palaska balığı, Kayış balığı			*	*	Benthopelagic
<i>Trichiurus lepturus</i>	Largehead hairtail	Kılkuyrak balığı			*	*	Benthopelagic
<i>Xiphias gladius</i>	Swordfish	Kılıç balığı	*	*	*	*	Epipelagic
<i>Istiophorus albicans</i>	Atlantic sailfish				*	*	Epipelagic
<i>Tetrapturus belone</i>	Mediterranean spearfish	Kılıç balığı			*	*	Epipelagic
<i>Auxis rochei</i>	Bullet tuna	Gobene, tombik, tulina	*	*	*	*	Epipelagic

<i>Euthynnus alletteratus</i>	Little tunny	Yazılı orkinoz	*	*	*	*	Epipelagic
<i>Katsuwonus pelamis</i>	Skipjack tuna	Çizgili orkinoz		*	*	*	Epipelagic
<i>Orcynopsis unicolor</i>	Plain bonito	Akpalamut		*	*	*	Epipelagic
<i>Sarda sarda</i>	Atlantic bonito	Palamut	*	*	*	*	Epipelagic
<i>Scomber japonicus</i>	Mediterranean chub mackerel	Kolyoz	*	*	*	*	Epipelagic
<i>Scomber scombrus</i>	Atlantic mackerel	Uskumru	*	*	*	*	Epipelagic
<i>Scomberomorus commerson</i>	Narrow-barred Spanish mackerel	Ceylan balığı, tombak			*	*	Epipelagic
<i>Thunnus alalunga</i>	Albacore	Orkinoz	*	*	*	*	Epipelagic
<i>Thunnus thynnus</i>	Northern bluefin tuna	Orkinoz, ton balığı	*	*	*	*	Epipelagic
<i>Centrolophus niger</i>	Rudderfish	Karabalık			*	*	Bathypelagic
<i>Schedophilus ovalis</i>	Imperial blackfish	Karabalık			*	*	Benthopelagic
<i>Stromateus fiatola</i>	Blue butterfish	Mavi yağ balığı, Yıldız balığı			*	*	Benthopelagic
<i>Citharus linguatula</i>	Spotted flounder	Kancaağız pisi balığı		*	*	*	Benthic
<i>Lepidorhombus boscii</i>	Four-spot megrim	Benekli pisi		*	*	*	Benthic
<i>Lepidorhombus whiffiagonis</i>	Megrim	Pisi balığı		*	*	*	Bathydemersal
<i>Zeugopterus regius</i>	Eckström's topknot	Küçük pisi balığı		*	*	*	Benthic
<i>Scophthalmus maximus</i>	Turbot	Kalkan	*	*	*	*	Benthic
<i>Scophthalmus rhombus</i>	Brill	Dişi kalkan, Çivisiz kalkan	*	*	*	*	Benthic
<i>Arnoglossus grohmanni</i>	Grohmann's scaldfish	Küçük pisibalığı		*	*	*	Benthic
<i>Arnoglossus imperialis</i>	Imperial scaldfish	Küçük pisi balığı		*	*	*	Benthic

<i>Arnoglossus kessleri</i>	Scaldback	Küçük pisi balığı	*	*	*	*	Benthic
<i>Arnoglossus laterna</i>	Mediterranean scaldfish	Şeffaf pisi balığı	*	*	*	*	Benthic
<i>Arnoglossus rueppelii</i>	Rüppell's scaldback	Küçük pisi balığı			*	*	Benthic
<i>Arnoglossus thori</i>	Thor's scaldfish	Küçük pisi balığı	*	*	*	*	Benthic
<i>Bothus podas</i>	Wide-eyed flounder	Pisi balığı			*	*	Benthic
<i>Platichthys flesus luscus</i>	European flounder	Pisi balığı	*	*	*	*	Benthic
<i>Buglossidium luteum</i>	Solenette	Küçük dil balığı	*	*	*	*	Benthic
<i>Dicologlossa cuneata</i>	Wedge sole	Dil balığı		*	*	*	Benthic
<i>Microchirus azevia</i>	Azevia sole	Dil balığı		*	*	*	Benthic
<i>Microchirus ocellatus</i>	Foureyed sole	Dört benekli dil balığı		*	*	*	Benthic
<i>Microchirus variegatus</i>	Thickback sole	Lekeli dil balığı	*	*	*	*	Benthic
<i>Monochirus hispidus</i>	Whiskered sole	Küçük dil balığı		*	*	*	Benthic
<i>Pegusa lascaris</i>	Sand sole	Dil balığı	*	*	*	*	Benthic
<i>Solea senegalensis</i>	Senegalese sole	Dil balığı		*	*	*	Benthic
<i>Solea solea</i>	Common sole	Dil balığı	*	*	*	*	Benthic
<i>Synapturichthys kleini</i>	Klein's sole	Dil balığı		*	*	*	Benthic
<i>Cynoglossus sinusarabici</i>	Red Sea tonguesole	Sivrikuyruklu dil balığı				*	Benthic
<i>Symphurus nigrescens</i>	Tonguesole	Sivrikuyruklu dil balığı			*	*	Benthic
<i>Balistes caprisus</i>	Grey triggerfish	Çütre, Domuz balığı	*	*	*	*	Benthic
<i>Stephanolepis diaspros</i>	Reticulated leatherjacket	Dikenli çütre			*	*	Benthic
<i>Lagocephalus lagocephalus</i>	Oceanic puffer	Mavi balon balığı			*	*	Benthopelagic

<i>Lagocephalus spadiceus</i>	Half-smooth golden pufferfish	Balon balığı		*	*	*	Benthic
<i>Lagocephalus suezensis</i>	Suez puffer	Balon balığı			*	*	Benthic
<i>Lagocephalus sceleratus</i>	Silver-cheeked toadfish	Balon balığı			*	*	Benthic
<i>Sphoeroides pachygaster</i>	Blunthead puffer	Balon balığı			*	*	Benthopelagic
<i>Torquigener flavimaculosus</i>	Yellow spotted puffer	Cüce balon balığı				*	Benthic
<i>Tylerius spinosissimus</i>	Spiny blaasop	İğneli balon balığı				*	Bathydemersal
<i>Mola mola</i>	Ocean sunfish	Aybalığı		*	*	*	Epipelagic
<i>Ranzania laevis</i>	Slender sunfish	Pervane balığı		*	*	*	Epipelagic

ALIEN SPECIES IN THE TURKISH SEAS

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1. Introduction

The phenomenon of alien or exotic species in the the Black Sea and Mediterranean Sea have been recorded for several decades. It has speeded up in recent years, with many examples of negative impacts on marine ecosystems, on the local marine fauna and flora, and on socio-economic activities, such as fisheries and tourism. The Black Sea and Mediterranean Sea are interconnected by the Turkish Straits System. These narrow straits act as a biological corridor, a barrier or an acclimatization zone for some marine species. Since the Suez Canal opening, the Mediterranean Sea has been connected also to the Red Sea, thus the Indian Ocean. Some Indo-Pacific species have entered and started to colonize in the Black, Marmara, Aegean and Mediterranean Seas via ship-mediated transport or the Suez Canal. Besides, ship-transported species, such as *Rapana venosa*, or introduced species, such as *Mugil souyi* to the Black Sea, dispersed to the Mediterranean Sea. In recent years, the fish composition and fish catch amount have changed due to the alien species. Moreover, some venomous fish and invertebrate species also established themselves mostly in the eastern Mediterranean Sea and started causing problems for fishery, biodiversity and human health. As it happened in the Black Sea, some intentionally or unintentionally introduced species are found in the Mediterranean Sea. It is predicted that alien species may affect fisheries more seriously on the Black and Mediterranean basin in the coming years. In this report, the Black and Mediterranean Seas are examined separately to be more concise, although they are interconnected each other. Recent information indicated that total 400 alien species assessed from the entire Turkish Seas Çınar *et al.* (2011).

2. Status of Alien Species in the Black Sea

The Black Sea is one of the world's most isolated seas from the major ocean and the largest anoxic body of water on planet (87 % of its volume is

anoxic). The total surface area of the Black Sea is 423,000 km² and its catchment area is over 2 million m². It is surrounded by Turkey, Bulgaria, Romania, Ukraine, Russia and Georgia. On the north-eastern corner, the Black Sea is connected to the Sea of Azov through the Kerch Strait, and on the south-western corner, to the Sea of Marmara through the Istanbul Strait (Bosphorus). The maximum depth is 2212 m.

The changes in the Black Sea ecosystem since the 1960s due to the concurrent impacts of eutrophication, overfishing, climatic fluctuation and alien species invasions have been studied extensively. A synthesis provided recently by the “State of the Environment Report” (BSC, 2008) documents the changes in pelagic and benthic ecosystems.

The Black Sea’s biodiversity clearly reflects its geological history. Brackish water fauna known as ‘Caspian relics’ originated from the Neoeuxinian Lake, and the components of this fauna are found only in waters with low salinity. Some bivalves such as *Dressenia* and fishes such as many species of goby and sturgeons are good examples. Another group of species is called ‘cold water relics’ and includes ctenophores (Pleurobrachia), copepods (Calanus), and fishes such as spiny dog fish, sprat, flounder and whiting. (Zaitsev and Mamaev, 1997), (Öztürk and Öztürk, 2005). This group is the second oldest inhabitants of the Black Sea, entering the sea sometime between the Neoeuxine Lake Period and the early stage of the formation of the Istanbul Strait (Bosphorus). After the Istanbul Strait (Bosphorus) established a connection with the Mediterranean Sea about 7,000-10,000 years ago, the salinity of the Black Sea rose gradually and soon the Mediterranean species were established in the Black Sea. Today, 80% of total fauna in the Black Sea are Mediterranean origin. According to Slastenenko (1959), the Black Sea received more than 1/3 and about 1/5 of its fauna from the Aegean Sea and the Mediterranean Sea, respectively. The last group of species is called ‘alien species’, which includes those introduced either intentionally or unintentionally by human activities from the various seas and oceans of the world.

2.1. Vectors for the alien species in the Black Sea

In recent years, the Black Sea has become home for a large number of alien plants and animals. There are three main vectors for alien species to reach the Black Sea. These are: a) shipping activities, which is the most common way; b) intentional or unintentional introduction by humans; c) Mediterraneanization,

which means that Mediterranean originated species pass all ecological barriers in the Turkish Straits and penetrate to the Black Sea, probably due to the effect of climate (Öztürk, 2010)

2.1.1. Shipping Activities

The most common way of invasion of alien species is via ocean-going ships. Marine organisms usually travel either as a part of the fouling attached to ship hulls or in tank sediment or in ballast water. (Zaitsev and Mamaev, 1997; Zaitsev and Öztürk, 2001; Öztürk, 2002; Gomiou *et al.*, 2002) Shipping activities are intense in the Black Sea mainly due to the Caspian petrol transportation from Novorossisk, Russia, to the Mediterranean countries via Turkish Straits. Its also known that the largest unintentional pathway for the transport of marine organisms is the ballast water of commercial vessels (See fig 1) a typical commercial bulk vessel may carry over 30.000 metric ton (MT) of ballast water to provide stability and trim adjustment during a voyage (cited, Wonham *et al.*, 2000).

Hundreds of algal and animal species, both microorganisms and even smaller organisms, are known to travel by attaching themselves to the hulls of the ship. Most of them are attached to the living substrate such as algae, clams and barnacles. But active non-sessile forms can also be found, such as amphipods, shrimps, crabs and fishes. When the ship is in motion they hide in barnacles and other similar shelters, so as not to be swept away by the current.

Ballast water pumped to tanks to stabilize a ship when it is not carrying any cargo. When ships fill their ballast tanks in ports or sometimes in certain areas, suspended matter and various planktonic organisms are also pumped into the tanks with the water. Many organisms survive the trip in the ballast water or sediment, sometimes as spores and eggs. Upon arrival at the ship's destination, the ballast water is discharged into the sea and the organisms find themselves in a new environment. If the conditions are favorable to their particular needs, the organisms may survive and even become naturalized. The huge number of ocean-going ships means that many new species are introduced into new environment constantly.

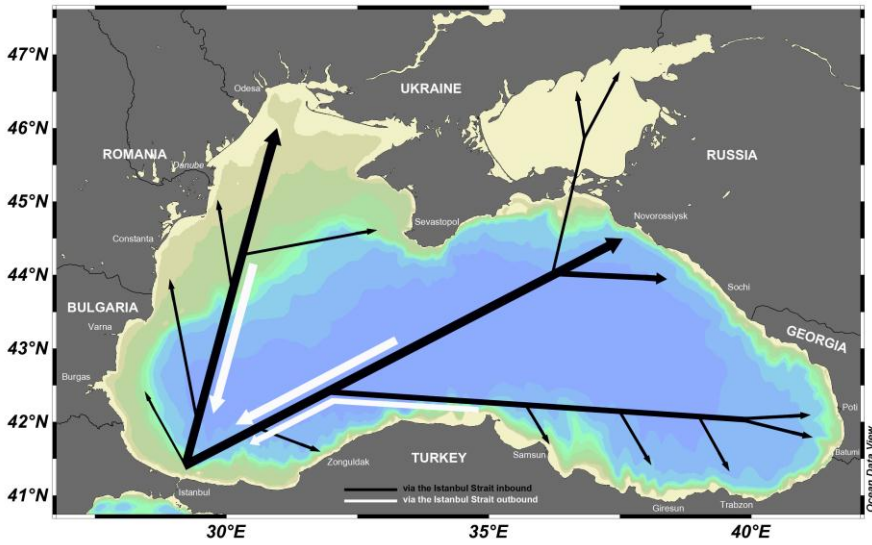


Figure 1. Main shipping routes for oil transportation in the Black Sea (Öztürk, 2010)

2.1.2. Intentional or Unintentional Introduction by Humans

Several alien species have been introduced to the Black Sea for aquaculture or other reasons. The mosquito fish *Gambusia affinis* is a good example for this type of introduction. This fish is well known for its ability to feed on neuston larvae and mosquito eggs, including those species which transmit malaria. It was, thus, introduced to the wetlands to combat malaria in the entire Black Sea basin. After the fish was adapted and reproduced, *Gambusia* turned to euryhaline species. Today *Gambusia* is widespread in the Black Sea basin. There are several other examples in the Black Sea for intentional introduction to the Black Sea.

2.1.3. Mediterraneanization Effects

This is a relatively new phenomenon and the reason for the invasion of the Mediterranean originated species to the Black Sea seems to be related with climate change. Even though the Turkish Straits (Istanbul and Çanakkale Straits) serve as an ecological barrier for these species due to totally different oceanographic peculiarities of the Black Sea from the Mediterranean Sea, some species penetrate to the Black Sea (Georgieva ,1993, Kovalev, 2006; Selifinova *et al.*, 2008). Because of climate change impact, some Mediterranean fish species also penetrated to the Black Sea, such as sardine, bouge and wrasse, in

recent years. Öztürk *et al.* (2011) also reported *Balinopsis vitrea* from the Black Sea.

2.2. The Alien Species in the Black Sea

Twenty six alien species have been described from the Black Sea by Zaitsev and Mamaev (1997). According to Zaitsev and Öztürk (2001), there are 59 species of alien marine organisms in the Black Sea and only a few species have been investigated, such as whelk *Rapana* and a ctenophore *Mnemiopsis leidyi*, in terms of the impacts on fisheries. Çınar *et al.* (2005) reported 20 alien species from the Turkish part of the Black Sea. Alexandrov *et al.* (2007) reported 240 alien species from the Ukrainian fresh, brackish and marine waters. Shiganova and Öztürk (2009) reported 161 alien species from the Black Sea and most of alien species came from the Mediterranean Sea.

2.2.1. Alien Invertebrates in the Black Sea and Their Impacts on the Biodiversity

Among several alien invasive species, a mollusc species *Rapana venosa*, bivalve species *Mya arenaria* and *Anadara inaequalis*, gelatinous carnivores *Mnemiopsis leidyi* and *Boreo ovata* have developed mass populations and gave rise to considerable impacts on the pelagic and/or benthic food webs of the Black Sea during the last several decades of severe ecosystem transformations.

2.2.1.1. *Mnemiopsis leidyi*

Mnemiopsis leidyi is a carnivorous ctenophore. It is characterized by the presence of two big lobes referred to as lateral or oral lobes. The oral lobes are derivated of the ctenophore body (Spherosome). Four smaller lobes are situated under the two principal oral lobes. The size of the animal varies from 40 to 180 mm in length in the Black Sea. The adult animal is about 100 mm in length, specimens larger than this being rare.

The first record of *Mnemiopsis* appearance in the coastal water of the Black Sea goes back to 1982 (Pereladov, 1988). The first registration of this species in open water was made in winter 1986-1987 (Zaitsev *et al.*, 1988). The massive growth of the Black Sea population started in 1988 and at first covered only bays, gulfs and coastal waters. Its abundance reached $10\text{--}12\text{ kg}\cdot\text{m}^{-2}$ at several coastal areas (e.g., Anapa, the southwestern Bulgarian coast), but did not exceed $1.5\text{--}3\text{ kg}\cdot\text{m}^{-2}$ in the open sea (Shushkina and Vinogradov, 1991). Maximal development of this species was registered in 1989 and 1990 (about $1200\text{ g}\cdot\text{m}^{-3}$), but then the abundance of *Mnemiopsis* started to decrease

(Vinogradov et al., 2000. Average biomass of *Mnemiopsis* during 1993-1997 there was $3.2\text{--}5.1 \text{ g}\cdot\text{m}^{-3}$. Its population density during these years stabilized at 300 to $800 \text{ g}\cdot\text{m}^{-2}$ in the Black Sea and at 500 to $600 \text{ g}\cdot\text{m}^{-2}$ in the Sea of Azov (GESAMP, 1997).

The annual loss of the fish catch attributed to the *Mnemiopsis* plague was calculated to be approximately 200 million USD in the Black Sea and 30-40 million USD in the Sea of Azov (GESAMP, 1997).

2.2.1.2. *Beroe ovata*

Another alien ctenophore species *Beroe ovata* needs to be examined as it is the competitor of *M.leidy*. This species is miter-shaped and the lateral compression is very marked, the broad lateral diameter being fully twice the width of the narrow one. Eight rows of cilia extend about three-quarters the distance from the apical sense-organ to the mouth and each is composed of about 100 combs. The side branches do not begin to develop until the animal is 19 mm long. When about 23 mm long, it begins to lose its transparency and assume the translucent milky hue of an adult, (Zaitsev, Öztürk, 2001, Volovik, 2004).

The appearance of *Beroe ovata* during 1998 in the Black Sea, a predator of the ctenophore *M. leidy*, led to a partial recovery of the planktonic food web structure by compensating its negative impacts *M. leidy* made. *B. ovata* predominantly inhabits 30 mile-width of the coastal zone of the Black Sea. Most probably the reproduction of this species takes place in open waters.

2.2.1.3. Sea snail (*Rapana venosa*)

Rapana venosa is known as a sea snail or a whelk. *Rapana thomasi* is its synonym. It is assumed that this sea snail was brought to the Black Sea with ballast water from its home sea of the Indian-Pacific Oceans (Sorokin, 1982).

Turkey has been conducting large-scale harvesting of sea snail since the mid-1990s. The other Black Sea countries, except Romania, joined to its fisheries (see Fig. 1.6). The Turkish catch remained, however, much higher than other countries, followed by Bulgaria. It also became a commercially important resource in Bulgaria after 1994.

In Turkey, the catch of sea snail has been greatly increasing for the recent years. Analysis of fisheries along the eastern coast of Turkey (Samsun Province) showed that the number of vessels using dredges for sea snail harvesting in 2000-2005 increased by large rates, especially in the vessel group

33-149 HP. These are typical boats that combine sea snail dredging, bottom trawling and net fishing (Knudsen and Zengin, 2006). Although the resource of this mollusc is still withstanding such high intensity of fisheries, a large-scale implementation of dredges has a destructive effect on the bottom biocenoses and the ecosystems as a whole Düzgüneş *et al.* (1997). In recent years, some studies have been initiated for new catching methods, such as pots and surface supplied diving system in the Black Sea (Kideys, 2002, Kideys *et al.*, 2007, Sağlam *et al.*, 2007). The operational costs of new environmentally friendly system, however, are not preferred by fishermen. Culha *et al.* (2009) reported that the highest number of *Rapana* was found at 15 m depth in the sandy-muddy biotopes in the Sinop Peninsula on the Turkish coast. According to the data collected by the fisheries cooperatives, a total of 65 boats actively catch *Rapana* in the Turkish part of the Black and Marmara Seas.

2.3. Other Alien Invertebrate Species and Impacts on the Biodiversity

The bivalve *Mya arenaria*, a native of the Northern Atlantic, was first detected in 1966 and became very abundant in a short time in the northwestern and western part of the Black Sea, reaching its peak abundance in 1972. It was later affected adversely by regular hypoxia-anoxia crisis that destroyed the entire benthos in the 1980s. But it still retains considerable abundance in the western coastal waters. This species is a competitor for habitats with small local bivalve, *Lentidium mediterraneum*, which avoids sandy bottoms siltated by *M. arenaria*. Large amounts of washed mollusks on the beach attract their consumers, such as gulls and crows. Another bivalve of Indo-Pacific fauna, *Anadara inaequalis*, was found in the Black Sea in 1968, and has spread to the whole basin. This species seem to be commercialized soon (Sahin *et al.*, 2006). One of the oldest alien bivalve species has been found in the Black Sea Shipworm, *Teredo navalis* is small numbers and impacts can not be significant at present because of replacement of wood by concrete or metallic underwater construction and ship worm become rare. Other alien species such as ivory barnacle, *Balanus eburneus*, and acorn barnacle, *Balanus improvises*, are typical organisms of fouling communities, which may have a significant role for the sea bass aquaculture net cages in Trabzon in the Turkish Black Sea coasts.

A Mediterranean jellyfish is a threat for humans in the Marmara and Black Sea. Compass jellyfish *Chrysaora hysoscella* (Linnaeus, 1767), a temperate planktophagous species, was firstly reported from the Sea of Marmara by Inanmaz *et al.* (2002). However, this species made a large bloom in the Marmara Sea, Istanbul Strait and Turkish part of the Black Sea in July 2009

Öztürk and Topaloglu, (2009). Most of beach bathers used fishing nets to protect themselves from this stinging jellyfish. While this species is venomous, this needs to be monitored in the Black Sea in terms of the impact on human health and interrelation with the entire Black Sea biota. *C. hysoscella* will establish its population in the Black Sea shortly. Finally, in November 2009, a few individuals of *Cassiopea andromeda* were found on the shore of Kilyos, just off the Istanbul Strait.

2.3.1. The Impacts of Alien Species on the Pelagic Fisheries in the Black Sea

Alien species in the Black Sea have been examined in several studies. There is, however, no accurate data to explain their impacts on the fisheries of some commercial pelagic fishes, such as bluefish, mackerel, and bonito, and commercial demersal fishes, such as whiting, turbot, red mullet, and striped mullet. On the other hand, the impacts by *M. leidy* and *B.ovata* on small pelagic fish, such as anchovy and sprat, have been studied intensively as described below.

2.3.1.2. Black Sea Anchovy

The Black Sea anchovy, *Engraulis encrasicolus*, is the most important commercial pelagic fish species distributed over the whole Black Sea. In October-November, it migrates to the wintering grounds along the Anatolian and Caucasian coasts and forms dense wintering concentrations until March and becomes subject to intensive commercial fishery. Anchovy competes for food with *M. leidy* (Grishin *et al.*, 1994) and this competition probably further affected the anchovy population growth (Oguz *et al.*, 2008). It is noteworthy that the sharp decline in anchovy catch happened after the outburst of *M.leidy* at the end of 1980s and the early 1990s. In addition, Kideys (2002) mentioned that as *Mnemiopsis* feeds on the eggs and larvae of the anchovy, it was responsible for the collapse of the anchovy fisheries. The catch increased after the outburst of competitor species *Beroe ovata* at the end of the 1990s. In a way, *B. ovata* helped the ecosystem to recover by feeding almost exclusively on *Mnemiopsis*. Catch of anchovy by Turkish fishermen was also stabilized after the 1990s to 2000s in the Black Sea. The total loss of the anchovy catch over the years between 1989 and 1992 due to the *M. leidy* outbreak can be only roughly estimated. According to Campbell (1993), total annual loss of fish processing factories was estimated to be USD 11 million and the total annual loss in fishing itself was very roughly about USD 330 million in 1992. The

economic damage to the Turkish fishery alone is conservatively estimated at several hundred million dollars.

Damage by *M. leidy* to the anchovy population was most likely done through food competition, as unusual low level of zooplankton was observed in the top 50 m layer in summer of the early 1990s (Oguz *et al.*, 2008). Oguz *et al.* (2008) reported that the switch of a large marine ecosystem to a totally gelatinous invader-dominated state requires extremely strong environmental perturbation. More often, environmental disturbance creates a suitable niche for an alien gelatinous invader to become a member of the food web structure, and to share food resources with the native small pelagic fish community.

2.4. Alien Fish Species and Their Impacts

Total number of fish species found in the Black Sea is 189 according to Slestenenko (1955-1956), among which 34 species live in the estuary and lagoon areas in the Black Sea. In recent years, however, some fish species which are ecologically tolerant to temperature and salinity have settled in the Black Sea. An intentionally introduced fish, haarder, *Mugil soiuy*, has become an important commercial species and distributed in the coastal waters of the Black Sea, Azov Sea, Sea of Marmara and Mediterranean Sea, even in the Algerian coasts. Its annual catch in the Black Sea exceeds 10,000 tons (Zaitsev and Öztürk, 2001). Okumus and Bascinar (1997) reported that this fish appears to have established a population in the Black Sea, the growth rates seem to be much better and the age at first sexual maturity is earlier than that of the native mullet species. Age at first maturity was estimated as 3-4 years for males and 4-5 years for females and the spawning period extends from the end of May to the beginning of July. Its pelagic eggs are 0.8-0.9 mm in diameter, have large oil droplets, which constitute up to 23% of the egg volume. This is the reason of high floatability of haarder's eggs, which can develop in low saline water in some coastal wetlands. The fries of the haarder are feeding on zooplankton and therefore can compete with local plankton-eating fish. This species feeds on small bottom living organisms mostly of meiobenthos, thus, compete with plaice and turbot juveniles in the coastal areas. Some specific parasites (Trematoda, Monogenea) associated with the haarder were introduced in the Black Sea and were found in the body of local grey mullets as well. This consequence needs to be further investigated for human health and biota of the Black Sea. It is expected that this species will be more commercialized in next years in the Black and Mediterranean Seas. Among intentionally introduced species, rainbow trout, *Onchorhynchus mykiss*, and salmon, *Salmo salar*, are

also commercially produced mostly in the Turkish part of the Black Sea. Sea trout production is about 2,000 tons yearly and salmon production is 1,500 tons (Okumuş and Deniz, 2007). The problem of the intentionally introduced species is the risk of the genetic contamination when they escape from cages at sea. The risk of hybridization also needs to be investigated in a long term scale.

2.4.1. Conclusion and Recommendations for the Black Sea

The introduction process of alien species is still continuing in the Black Sea and needs to be monitored at the national level. A special monitoring programme is requested for key areas, such as Istanbul and Canakkale for the better understanding of dispersion patterns of alien species. The impact of the alien species is complex and most of time unpredictable due to lack of monitoring and poor scientific knowledge about those species. Initiatives for the database management on *Mnemiopsis* and other jellyfish should be continued by Black Sea Commision. Legal measures for intentional introduction to the Black Sea should be taken by national authorities and international conventions, such as Bucharest and Bern Conventions. Public awareness and sensibilization programmes for local people, fishermen, boat crew, harbor masters and coast guards are needed to explain alien species and their impacts on nature, human health and fisheries. Special education programmes should be given to the fisheries cooperatives to inform local fishermen for the impacts of alien species.

Fishery statistics should be harmonized in the Turkish part of the Black Sea for better understanding the impacts on the local fishery and native species by intentionally introduced alien species. Separate alien species catch and fleet statistics should be established with the guidance of GFCM and its relevant subcommittee. For that purpose, an informative booklet in native languages should be prepared for the national fisheries authorities. It should be reminded that alien species may carry several parasites or fungi which may threaten native fauna and flora, thus may cause harm to local fisheries. Thus they should be monitored by the riparian governments with national capacity as well as relevant international agencies.

Because of climate change, some Mediterranean species also penetrate to the Black Sea, such as sardine, bouge and wrasse, in recent years and it is expected that the fishing catch amount change in a certain period. Mediterranean originated species need to be monitored in the Black Sea. General trends show that a miniature Mediterranean Sea is going to be established within the Black Sea since several species penetrate to the Blak Sea with various vectors. Besides, alien species penetration into the Black Sea puts

pressure on the autochthonous Black Sea endemic. According to the general rule “*Natura abhoret vacuum*” they were occupied by invader planktophagous *M.leidy*. Overfishing, therefore, should be avoided for all fish species to minimize the risk of alien species invasion. *M.leidy* has already penetrated to the Mediterranean Sea and the lesson learned in the Black Sea should be applied to the Mediterranean Sea case in terms of impacts on the fisheries and whole biota. International cooperation is essential to combat for the alien invasive species in the entire ecosystem. Impacts of climate change and Mediterraneanization should also be taken into account for the Black Sea.

3. Status of Alien Species in the Marmara Sea

3.1. The main characteristics of the Marmara Sea

The Marmara Sea, including the Istanbul Strait (Bosphorus) and Canakkale Strait (Dardanelles), which constitute the Turkish Straits System, situated between 40°00’ and 41°10’ N and 26°15’ and 29°55’ E. The surface area of the sea is 11,500 km² and the volume is 3,378 km³. The length of the coastline is 927 km. It is one of the busiest water ways in the world because of shipping activities between the Mediterranean and the Black Sea basins; about 55,000 ships pass every year (Ozturk *et al.*, 2006). Shipping traffic trend is growing in the Istanbul Strait and thus poses new risks for the Black Sea while shipping is the main vector for alien species in this region.

3.2. Alien species of the Marmara Sea

There has been increasing trend of alien species in the Marmara Sea. Zaitsev and Ozturk (2001) reported 14 alien species and Cinar *et al.* (2005) reported 48 alien species and Çınar *et al.* (2011) reported 69 alien species in the Marmara Sea. However, these numbers do not include Mediterranean species although there are several species found in the Marmara Sea which are originally from the Mediterranean Sea. This factor is mostly related with climate change and the cause of Mediterraneanization, which is not discussed in this paper. Alien fauna and flora of the Marmara Sea have been introduced with various vectors: Mainly by ships in ballast water, sediment tank or on ship’s hull, e.g. *Mnemiopsis leidy*, or through man-made introduction, e.g. *Gambusia affinis*. Lessepsian species, which enter the Mediterranean Sea from the Red Sea through the Suez Canal, are only a few yet in the Marmara Sea as it serves as a barrier for many thermophilic fish species. However, the Marmara Sea is likely to act as a major transitional acclimatization and colonization zone prior to settlement in the Black Sea. For example, Katagan *et al.* (2004) and Tuncer *et*

al. (2008) reported for the first time the settlement of a lessepsian migrant stomatopod shrimp *Erugosquilla massavensis* and fish *Lagocephalus spadiceus*, in the Sea of Marmara whereas they have not been reported yet in the Black Sea. *Solea senegaelensis* is the only example of the Atlantic alien species in the Marmara Sea. Besides these, only three intentionally introduced species are found in the Marmara Sea, namely *Gambusia affinis*, *Mugil soiuy*, and *Marsupenaues japonicus*.

3.2.1. Ctenophore, *Mnemiopsis leidyi*, and Its Impacts on the Fisheries and Fish Stocks in the Marmara Sea

M. leidyi made severe negative impacts on the fisheries and this needs to be evaluated in terms of fisheries and fishery stocks in the Marmara Sea. This species was first introduced to the Black Sea and via the surface current to the Marmara, Aegean and Mediterranean Seas. It was first recorded in the Marmara Sea by Artuz (1991). In October 1992, an extremely vigorous outbreak was recorded in the Marmara Sea (GESAMP 1997). The abundance of *M. leidyi* was as high as 4.3 kg m⁻² near the Istanbul Strait and 9.7 kg m⁻² near the Canakkale Strait, mostly in 10-30 m deep water (Shiganova *et al.*, 1995).

The pelagic fish stocks in the Marmara Sea declined since the pelagic fish feed mainly on copepods and cladocerans, which are also foraged by *M. leidyi*. Furthermore, *M. leidyi* feeds on fish eggs and larvae, seriously affecting the economically important fishes, such as *Scomber scombrus*, *Sardina pilchardus*, *Sprattus sprattus*, *Engraulis encrasicolus*, *Trachurus trachurus* and *Pomatomus saltator*, which use the Marmara Sea as spawning grounds. Isinibilir (2007) reported that the abundance of the *M. leidyi* become limited in summer, when *Beroe ovata* is present in Izmit Bay. It means that like in the Black Sea *B. ovata* managed to control the *M. leidyi* stocks. After the outburst of *Mnemiopsis* during 1989 in the Black Sea (which could be assumed for the Marmara Sea as well), the fish catch was increasing steadily until 1999 (up to almost 55,000 tons). As clearly seen in Figure 2, the catch of the main pelagic commercial fish species declined in 1989. While the Sea of Marmara represents about 15 % of total catch amount of Turkey, any alien species which is substantially harmful for fisheries stocks and resilient community.

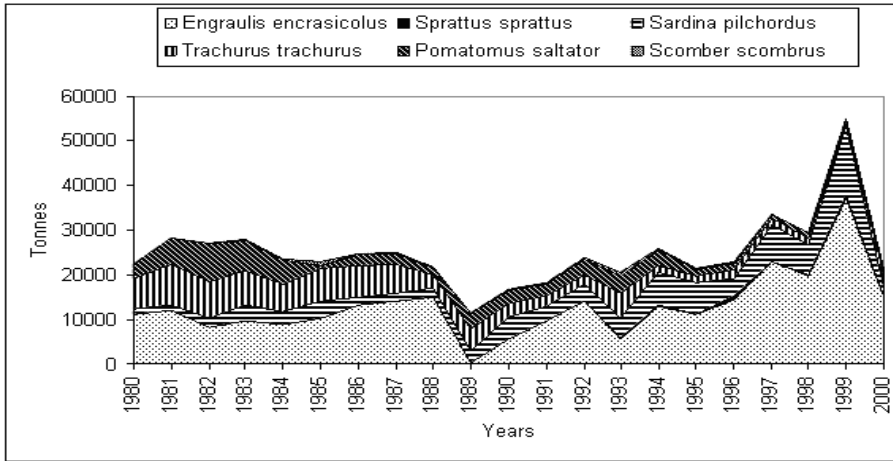


Figure 2. Catches of some pelagic fish species in the Marmara Sea (1980-2000)
Source: Isinibilir *et al.* (2001)

Nevertheless, between 1991 to 2000 period, the decline of the fish stocks and economic loss of fisheries was estimated at 400,000 USD for Turkey only (Ozturk and Ozturk, 2000).

Another economic impacts made by *M. leidy* was also important. The fresh water reservoir of the Istanbul City was invaded by this species and it caused a serious economic loss due to the damage of the pipeline (Ozturk *et al.*, 2001).

3.2.2. Sea snail, *Rapana venosa*, and its impacts on the fisheries in the Marmara Sea

Rapana venosa is a whelk shell and native to the Sea of Japan. Its possible way of introduction into the Black Sea, is by ballast water and eggs attached to ship hulls. *R.venosa* penetrated the Marmara Sea in the 1960s and later in the Aegean Sea as well.

R. venosa feeds mainly on mussels and oysters on rocky bottoms. In the Marmara Sea, it is quite abundant at 5-25 m depth (maximum density is 15-20 ind m⁻²). Total distribution area of *R. venosa* had increased to 170 km² (Ozturk, 1999). Due to the high population density of *R.venosa* along the Marmara coasts, oysters and mussels have been exterminated from these areas where the bivalve harvesting used to be commercially important. This gastropod is

harvested by diving and by dredging. The dredging method is harmful to benthic ecosystem, as it is a non-selective method, unlike diving. For the first time in 1982, this speices gained an economic importance and was exported as *Rapana* meat to Japan. Then it became beneficial to the Turkish fisheries economy; about 2 million USD profit was estimated from the export and about 600 persons were directly involved in this business (Ozturk, 2002). Eighteen boats operate for *Rapana* in the Marmara Sea in 2009 See fig 1.1. Between 1999 and 2007, a total of 1,444 tons of *Rapana* were caught in the Marmara Sea (see Figure 3).

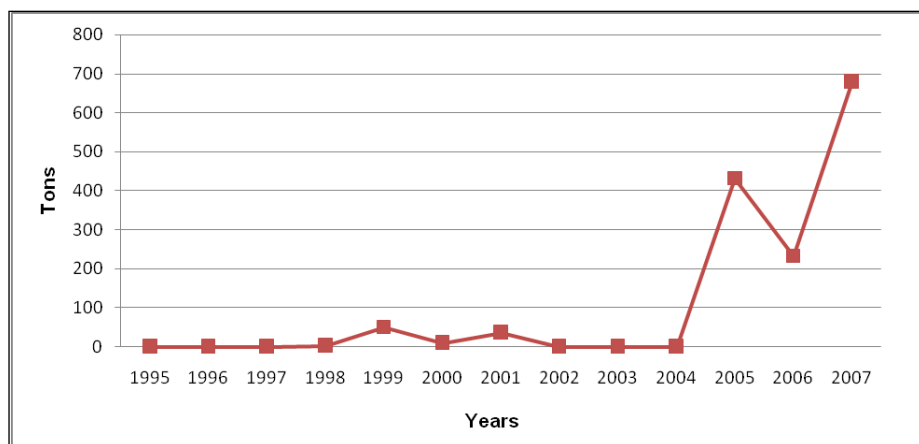


Figure 3. Catch of *Rapana venosa* in the Marmara Sea from 1995 to 2007 (Referans).

3.2.3. Other alien species and impacts on the fisheries in the Marmara Sea

The Indo-Pacific prawn *Marsupenaeus japonicus* was intentionally introduced to the Marmara Sea in the late 1960s from Iskenderun Bay on the Turkish coast of the Mediterranean Sea (M. Demir, pers. comm.). However, its population did not increase as much as expected. Another Indo-Pacific crustacean, *Erugosquilla massavensis* (Kossmann, 1880), a mantis shrimp, was found in the central Marmara Sea in 2004 (Katagan *et al.*, 2004). This is the second Indo-Pacific crustacean species reported from the Marmara Sea. Manthis shrimps do have commercial value in Turkish part of the Mediterranean Sea but no fishing has been made yet in the Marmara Sea due to its small stock size.

An intentionally inroduced fish, haarder, *Mugil soiuy*, native to the Amu Darya River basin, reached the Turkish Black Sea coast from the Sea of Azov, migrated to the west, reaching the Marmara Sea and later the coasts of the

Aegean Sea. This species has potential commercial importance. The Indo-Pacific originated *Lagocephalus spadiceus* (Richardson, 1845) is one of the most abundant non-indigenous pufferfishes of the eastern Mediterranean Sea, distributing along the entire Levantine basin coasts from Port Said to the southern Aegean Sea (Golani *et al.*, 2002). It is known to be poisonous to eat. Colonization of this species needs monitoring in terms of fisheries and human health and impacts of native fish fauna in the Marmara Sea. Bivalves, *Anadara inaequalis* and *Mya arenaria*, are also remarkable alien mollusc species in the Marmara Sea. These bivalves are found between 3-15 m depth dominantly. *M. arenaria* is preyed on by *Rapana venosa* and demersal fishes, such as turbot, goby and mullet, in the Marmara Sea. Around the Prince Islands, its average biomass was 1kg.m⁻² in 1999. The alien starfish species *Asterias rubens* was observed in the Marmara Sea – Istanbul Strait in 1996 (Albayrak, 1996). But the interaction with mussel community seems to be slow in the Marmara Sea. A Mediterranean originated Compass jellyfish *Chrysaora hysoscella* (Linnaeus, 1767) were reported from the Sea of Marmara (Inanmaz *et al.*, 2002). Blooms of this species were observed in the Marmara Sea, Istanbul Strait and the Black Sea in July 2009 (Ozturk and Topaloglu, 2009). Due to this jellyfish bloom, beach bathers used fishing nets to protect themselves from these animals in 2009. As this species is venomous, it needs to be monitored in the Marmara Sea in terms of impacts on human health and interrelation with fishing. Seasonal blooms of *C. hysoscella* damage fishing nets, mostly purse-seines and gill nets thus affect fishing yields and cause socio-economical problems for mostly artisanal fishermen.

3.3. Conclusion and Recommendations for the Marmara Sea

The Marmara Sea is a link between the Mediterranean and Black Sea, which is the reason why alien species, originally introduced to either of the two seas, are found here. However, for certain species, the Marmara Sea serves as a barrier which limits their distribution, while for others, it serves as a corridor for enlarging their distribution ranges. The Istanbul Strait (Bosphorus) plays a crucial role for dispersion of marine organisms. A permanent plankton runoff from the Black Sea to the Sea of Marmara takes place in the Istanbul Strait due to surface water current, and the Black Sea origin organisms are common in the northern part of the Sea of Marmara, some of them reaching the Aegean Sea. On the other hand, the bottom saline water in the Istanbul Strait transport Mediterranean organisms to the Black Sea. Few of them can survive in low salinity water. Hence, the Black and Marmara Sea interactions should always be

considered. The Marmara Sea is also a small acclimatization area for alien species. Consequently, more detailed investigations and monitoring studies are needed for the alien species and impacts to the biota and fisheries.

Interestingly, some alien species have turned out to be highly valuable resources, such as *Rapana venosa* and *Mugil soiuy*. On the contrary, some species, such as *Mnemiopsis leidyi*, have turned out to be extremely harmful to the native fauna and flora, creating a considerable economic loss.

It is predicted that more alien species will be observed in the near future due to heavy shipping activities between the Mediterranean and Black Sea.. Although the vectors for most species are ships, some species were intentionally introduced in the Black Sea and subsequently settled in the Marmara Sea: *Gambusia affinis* and *Marsupenaeus japonicus*. *M. soiuy* needs to be monitored due to the possibility of displacement with other native mullet species. A pufferfish species, *Lagocephalus spadicus*, and a jellyfish, *C. hysoscella*, are poisonous and need special attention for public health, biota and impact of fisheries. Special monitoring programs are needed for the toxic phytoplankton species, jellyfish, such as *B.ovata*, and *M. leidyi*, due to their important impacts on the fisheries not only in the Marmara Sea but also in the Mediterranean and Black Seas. The Marmara Sea is a kind of “test laboratory” for alien species and monitoring of these alien species in this sea may help prediction on the Black and Aegean Seas.

3. Status of Alien Species in The Turkish Part of The Mediterranean Sea

3.1. Main vectors for alien species in the Mediterranean Sea

In the Mediterranean Sea including Aegean Sea, alien species can be distributed with a) shipping, ship's ballast waters, tank sediments and hull fouling, b) the straits, the Kerch and the Turkish Straits System for the Black Sea species and the Gibraltar Strait for the Atlantic species. These straits also play an important role for the introduction of the Black Sea originated alien species, such as, *Mugil soiuy*, *Mnemiopsis leidyi* and *Rapana venosa*, and the Atlantic originated alien species, respectively. c) the Suez Canal: one of the major vectors for the Indo-Pacific originated species or lessepsian species, d) intentional or unintentional introduction by humans: this introduction is generally for aquaculture or aquarium, and e) besides these main vectors, aquarium, fish baits and other minor vectors should also be considered. According to the Streftaris *et al.* (2005) in the Mediterranean shipping, although it contributed more than aquaculture as a vector, appears to have had a less

significant role (20 %) over all as it is surpassed by the introduction of species via the Suez Canal (52 %). Galil *et al.* (2008) also reported 558 species from the Mediterranean Sea.

3.1.1. Shipping

Ship-transported species spread over many parts of the world ocean. The routes of the access of alien species by ship transportation may be categorized such as transportation with ballast water or sediment, sessile (fouling) and vagile (clinging) form on ship hulls, or even drilling platforms. In the Mediterranean Sea shipping is the biggest factor for the introduction of alien species. It is estimated that Mediterranean Sea carry 30 % of the international cargo volume, and 20 % of petroleum (Dobler, 2002) (Fig. 3.3). With some 2000 merchant ships sailing in the Mediterranean at all times, the transfer of biota stemming from the regular operation of these ships is significant. Inter Mediterranean and North/South (Black Sea-Mediterranean Sea via Turkish Straits, Mediterranean Sea - Indian Ocean via Suez Canal) marine traffic is increasing due to the expansion of global trades.

3.1.2. Straits

International straits used for navigation in the Mediterranean and Black Sea are biological corridors at the same time from the biogeographical point of view. For example, one of the intentionally introduced fish species, *Mugil soiuy* was first introduced to the Azov Sea and after the successful colonization there, entered to the Black Sea via the Kerch Strait. Later it entered the Turkish Straits (Istanbul and Çanakkale) and is presently found in Mediterranean Sea. There are some other examples such as *Rapana venosa* and *Mnemiopsis leidyi*. Their first record was in the Black Sea and after the successful migration through the Turkish Straits, they penetrated to the Aegean and Mediterranean Seas.

On the other end of the Mediterranean, the Gibraltar Strait is also a long biological corridor for alien species from the Atlantic Ocean. The Atlantic-Mediterranean faunistic connection had an impact to the Mediterranean biogeography, similar to the Mediterranean - Red Sea connection.

3.1.3. The Suez Canal

The Suez Canal was opened in 1869 in order to shorten the trade route between the Mediterranean and Indian Ocean. Ferdinand de Lesseps (1805-

1894) who was a French engineer in charge of the construction of the Suez Canal which joined the Mediterranean and Red Seas for the first time in 1869 and substantially reduced sailing distances and time between the West and the East. The opening of the Suez Canal in 1869 created the first salt-water passage between the Mediterranean and Red Seas. The Red Sea is generally saltier and more nutrient-poor than the Atlantic, so the Red Sea species have advantages over the Atlantic species in the less salty and nutrient-rich Levant Basin.

The construction of the Aswan High Dam across the Nile River in the 1960s reduced the inflow of freshwater and nutrient-rich silt from the Nile into the eastern Mediterranean, making conditions there even more similar to the Red Sea, thus increasing the impact of invasions and facilitating the occurrence of new ones. The Red Sea and the Mediterranean removed a geographic barrier between them, then the migration began from the Red Sea to the Mediterranean, and many Red Sea species (Lessepsian) have penetrated to the Mediterranean. As a result, various changes have occurred in the biota of the Mediterranean.

Accordingly, most invasions are of Red Sea species into the Mediterranean, and only few in the opposite way (Ben-tuvia, 1966; Avsar, 1999).

Enlargement of the Suez Canal is also a facilitating factor for Lessepsian migrants to settle or pass to the Mediterranean Sea. The Suez Canal was deepened and widened several times, and now has a navigational depth of 14.5 m and width of 365 m (see Table 1). Dimension of the Suez Canal through the years (Halim, 1990).

Table 1. Dimension of the Suez Canal through the years

Years	1869	1956	1981
Width at sea surface (m)	52	160	365
Width of navigable channel (m)	44	110	190
Total depth (m)	7.8	12	14.5
Cross-sectional area (m ²)	304	1200	3600

The term “Lessepsian“ was first used by Por (1964) to characterize the new phase into which the Eastern Mediterranean had entered with the opening of the Suez Canal. Por (1969, 1971) coined the term ‘Lessepsian migrant’ for the Red Sea species which have passed through the Suez Canal and settled in

the Eastern Mediterranean (Por, 1978). Lessepsian migration (also called Erythrean migration) is the ongoing unidirectional migration of marine species through the Suez Canal, from the Red Sea to the Mediterranean Sea.

Through the Suez Canal, several marine species migrate to the Mediterranean Sea such as marine phanerogams, macrophytes, coelenterates, molluscs, crustaceans and echinoderms as well. Rate of this migration is growing and the eastern Mediterranean may be called as “Lessepsian Province” in terms of biodiversity or due to various Red Sea originated species: a new geographic region has appeared. Direction of the migration is also another important matter. Even a large number of marine species have migrated to the Mediterranean Sea since the opening of the Suez Canal, only a few species migrated to the Red Sea side, which is called anti-Lessepsian migration. The possible reason for this can be suggested that the Indo-Pacific origin species may be more adaptable to different ecological conditions than Atlanto-Mediterranean origin ones and the dominant current and wind system may facilitate carrying eggs and larvae from the Red Sea to the Mediterranean and later to the Levantine Sea with the local gyre of the region. Mavruka and Avsar (2008) reported that establishment of the Lessepsian fish populations in the Levantine Basin (eastern Mediterranean Sea) is facilitated by similar conditions such as Iskenderun and Mersin Bay and Red Sea in terms of salinity and temperature. All of these conditions have formed an ecosystem which is similar to that of a tropical ecosystem. With higher salinity, temperature and as an oligotrophic sea, the Levantine Basin has poor species diversity compared to other parts of the Mediterranean Sea. Most of the researches have been carried out on fish species because fish has much more economic value than other species. Other species need to be more deeply investigated.

3.2. Lessepsian Migration and Species

The colonization of the Mediterranean Sea by Red Sea marine species has been reviewed by several authors, such as Ben-Tuvia (1978) who listed 36 Red Sea immigrants. Interestingly in that time, Red Sea immigrants constitute 12% of the population in the Levant Basin and 7 % for the Mediterranean as a whole, but only 1% of the population in the central part of the sea. None of the Red Sea immigrants had reached the western basin. Por (1978, 1990) reported that, as far as the fauna was concerned, Lessepsian alien species represented about 4 % of the Mediterranean specific diversity and 10% of the Levantine Basin. These percentages, however, have changed in the last ten years.

Beside fish, the number of Lessepsian mollusc species also has been increasing although Por (1978) listed 25 species as high-probability and 13 species as low-probability Lessepsian migrants. Cevik *et al.* (2001) reported *Crasostrea gigas* and *Saccostrea commercialis* from Iskenderun Bay which are both alien commercial species. Another commercial mollusc species, *Strombus persicus* is also reported from Turkish waters. Ozgur and Ozturk (2007) stated that in rocky reefs in Oludeniz/Fethiye this species is found in dense colonies. Çevik *et al.* (2007) reported that in Iskenderun Bay, 67 of the 181 mollusc species are exotic, which consists 37% of total fauna, a percentage by far higher than those reported elsewhere. Concerning alien crustacean species in the Mediterranean Sea have been also reported by several experts. Kocatas and Katagan (1994) reported 20 Lessepsian alien species recorded from the Turkish coasts. Cinar *et al.* (2005) reported 45 alien crustacean species.

3.2.1. Lessepsian Fish Species

Alien fish species entered the Mediterranean Sea via four pathways: a) via the Strait of Gibraltar, b) via the Suez Canal, c) via the Çanakkale Strait (Dardanelles) and d) via human activities such as ship-mediated transportation, mariculture and others. First studies have been made by Koswigg (1953) for Lessepsian fish migrant species and he reported that *Mulloidichtys auriflamma* has economic importance in Iskenderun region Bilecenoglu (2010).

Dispersion of the Lessepsian fish in the Mediterranean Sea depends on several factors such as cyclonic Mediterranean shore currents to the Levantine Sea, and similar temperature conditions. Most of the successful species are euryterm and euryhaline species and they can adapt to other ecological conditions such as feeding and habitat type (Mavruk and Avsar, 2008). Gucu and Gucu (2002) reported that low native species diversity was effecting the rate and the success of immigrant colonization. Furthermore, the absence of *Posidonia oceanica* meadows was found to be another important factor, affecting the success of Lessepsian invasion. *P. oceanica*, the endemic seagrass that is the key species of the Mediterranean coastal ecosystem, was found responsible for defending the Levant Sea's ecological integrity and its native characteristics against invasion. Its absence has resulted in successful invasion of Lessepsian species. Vertical distribution of Lessepsian fish species has also been examined by several authors. Bilecenoglu and Taskavak (2002) reported that a few specimens of *Upeneus moluccensis* were found at the depth of 180-190 m in the Turkish coasts and this species seems to be very adaptive to the

low temperatures prevailing in such depths throughout the eastern Levantine Basin. Moreover some Lessepsian species are very abundant in Antalya Bay and rare in Mersin and Iskenderun Bay in Eastern Mediterranean part of Turkey. Silverstripe blaasop *L. sceleratus* are highly abundant in Antalya bay and rarely fished in Iskenderun Bay, and this is opposite for the broad-banded cardinal fish *Apogon fasciatus* (Turan 2010). Antenna codlet *Bregmaceros atlanticus* first recorded from Antalya Bay (Yılmaz *et al.* 2004), and later Aegean Sea Filiz *et al.* (2007), and lately reported from Iskenderun Bay (Turan *et al.*, 2011).

3.2.2. Evaluation of the Catch of Lessepsian Fish Migrants

Many alien fish species are fished for the economical purpose in the Eastern Mediterranean. Gucu and Bingel (1994) summarized that there is no specific catch statistics to evaluate the contribution of the Red Sea species in the total landing. However, their importance in the total demersal fish biomass as 62% in the Gulf of Iskenderun, 34% in Mersin Bay and 27% in the coastal strip between Incekum and Anamur. Torcu and Mater (2000) reported that *Upeneus moluccensis* and *Saurida undosquamis* have economical values in the eastern Mediterranean trawl fisheries. Can and Demirci (2003) reported that the lizard fish *Saurida* spp. have provided approximately 50% of the total economic catch in Iskenderun Bay. Cicek and Avsar (2003) reported that 17 species were Lessepsian among 90 fish species collected by trawl samplings during 2002-2003 in the northeastern Mediterranean Sea. They found that Catch Per Unit Effort (CPUE) for Lessepsian fishes ranged from 3.39 kg/h in November to 11.73 kg/h in September 2002, and its mean value was calculated as 5.28 ± 3.32 kg/h, most of the Lessepsian biomass was obtained the near shore, which is located in 0-20 m depth ranges, the number of Lessepsian fish species constituted 18.9% in total number of fish species, while 26.66 % of total biomass was shared by Lessepsian fishes. Among them the most abundant Lessepsian fish was *S. undosquamis* with the value of 47.16%, followed by *Upeneus pori* (29.92 %), and *Leiognathus kluzengeri* (13.25%). Basusta *et al.* (1997) found 22 Indo-Pacific origin fish in Iskenderun Bay, which is one of the important fishing grounds for Turkey in the eastern Mediterranean Sea. Ismen (2006) stated that in the eastern Mediterranean 98% of the total biomass of *U. pori* was trawled in less than 50 m deep water and its market increased in the recent years.

Yılmaz and Hoşsucu (2003) reported that 360 tons of the round herring, *Etrumeus teres*, has been caught in Antalya Bay, according to the unofficial fish market record in Turkey. Yesilcimen and Kusat (2007) reported that a Lessepsian fish *S. undosquamis* is one of the commercial fish species in Antalya Bay in Turkey. Yılmaz and Hossucu (2007) compared length-weight relationship and relative condition factor of Lessepsian *S. undosquamis* and native *S. saurus* and found that environmental conditions are suitable for both species in Antalya Bay.

Özgür-Özbek *et al.* (2010) reported that abundance and biomass of the 18 exotic fish species caught during the bottom trawl survey carried out in the Gulf of Antalya in the summer period of 2009. Among 76 teleost species identified, alien constituted 11.6% of the average abundance and 12.08% of the average biomass of the teleosteans. Spanish mackerel was one of the commercial alien species in the Turkish part of the Mediterranean Sea.

3.2.3. Evaluation of the Catch of Lessepsian Crustaceans

Dogan *et al.* (2008) reported that among crustaceans, *Fenneropenaeus merguensis*, *Marsupenaeus japonicus*, *Melicertus hathor*, *Metapenaeus monoceros*, *Metapenaeus stebbingi*, *Penaeus semisulcatus*, *Callinectes sapidus* and *Portunus pelagicus* have commercial importance in the Turkish Aegean and Mediterranean Seas. Geldiay and Kocatas (1972) reported that in Iskenderun Bay *Penaeus kerathurus* was substantially caught by fisherman but it replaced by *M. japonicus*. Similarly the blue crab is common in Turkey, Greece, Syria, Lebanon, Israel and Egypt. Off the southeastern coast of Turkey, the alien shrimps *M. japonicus* and *P. semisulcatus* are the most important species in the landings (Duruer *et al.*, 2008). Lessepsian penaeid shrimps make up most of the shrimp catches along the southeastern Levantine coasts. The manthis shrimp, *Erugosquilla massavensis*, has commercial importance in Turkey. Blue crab, *Callinectes sapidus*, has an important market value in Turkey. It was caught as 22 tons in 2007 and 17 tons in 2008 between Antalya and Iskenderun Gulf. Commercialized alien crustacean species are listed in Table 2. A total 9 species are sold in the markets.

Table 2. Commercialized alien crustacean species in the Turkish part of the Mediterranean Sea

Species name
<i>Calinectes sapidus</i>
<i>Portunus (Portunus) pelagicus</i>
<i>Marsupenaeus japonicus</i>
<i>Trachysalambria palaestinensis</i>
<i>Metapenaeus monoceros</i>
<i>Erugosquilla massavensis</i>
<i>Metapenaeus stebbingi</i>
<i>Penaeus semiculcatus</i>
<i>Melicertus hathor</i>

4. Harmful Alien Species and Impacts

4.1. Venomous Alien Fish Species

The issue concerning the venomous fish species is one of the important matters and needs to be deeply investigated in many aspects such as public health and damage to fishermen. Venomous alien fish species are known from the eastern Mediterranean countries, such as Greece (Kasapidis *et al.*, 2007), Israel (Golani, 1996), Syria (Saad, 2005), and Turkey (Akyol *et al.*, 2005; Bilecenoglu, 2003; Bilecenoglu *et al.*, 2006).(Bilecenoğlu,2012).

4.2. Harmful Alien Jellyfish and Its Impacts

In recent years, more alien jellyfish species has been observed in several coasts of the Mediterranean Sea. Jellyfish expansion caused severe anxiety among fishermen and tourists in many countries. Even some of the jellyfish species are not harmful and native to the Mediterranean Sea, their distribution has been enlarged. For example, *Cassiopea hysoscella* has never made big blooms in the northern Aegean, but in recent years the situation has changed. Jellyfish of Indo-Pacific origin like *Rhopilema nomadica* and *Cassiopea andromeda* established themselves in the eastern Mediterranean Sea and cause damage to local economies to some extent when entangled in fishing nets or

stranded on beaches, frightening visitors. Upside-down jellyfish, *Cassiopea andromeda*, is frequently encountered in the eastern Mediterranean Sea (Bilecenoğlu, 2002). Özgür and Öztürk (2008) reported that the distribution of this stinging species extended its distribution from south to further north, up to Fethiye on the Turkish Mediterranean coast. Çevik *et al.* (2011) reported the Australian spotted jellyfish *Phyllorhiza punctata* from Iskenderun Bay, northeastern Mediterranean Sea, for the first time for Turkish Seas. Turan. *et al.* (2011) reported a new alien jellyfish species *Aequorea globosa* Eschscholtz 1829 (Cnidaria: Hydrozoa) in the Mediterranean Sea. Up to date there have been four indo-Pacific jellyfish species in Turkish Seas.

4.3. Impacts on Fisheries

Mostly in the eastern Mediterranean Sea, several alien species cause damages to fisheries. *Caulerpa taxifolia* cause considerable fouling on fishing nets. *Calinectes sapidus* also damages nets with entangling and cutting, In Turkey and Cyprus, the fishermen complain about *Logocephalus scalaratus* because they cut hooks of longlines and bite off the captured fish in the nets or on the lines, which cause economical damage for the fishermen.

Synaptula reciprocans is found in all detritic bottoms, mostly around fish cages, in the Aegean Sea and feeds on some baits, detritus or organic particles and mostly stick to the nets. This species extends its range to the northern Aegean Sea. Fire worms *Hermodice carunculata* have very painful cilia and give pain and extra labor to fishermen during collection of fishes on the nets. Table 4.1 summarizes the harmful effects on the fishing nets mostly in the eastern Mediterranean Sea. Kideys and Gucu (1995) and Avsar (1996) reported that the proliferation of *R. nomadica* off the eastern Mediterranean coast of Turkey has a potential risk to human health, tourism and fisheries. During August 1995, many swimmers were stung and sought medical treatment. Turan *et al.* (2011) reported that jelly fish can adversely affect commercial fisheries by clogging nets, by feeding on the young age classes of fish. Local fishermen claimed that the catch from the gill net fisheries decreased and that the jellyfish entangled in their nets were a major nuisance. In Iskenderun, due to mass jellyfish blooms, the fish farmers could not lift their nets to the surface when they wanted to take the fish from the cages. *R. nomadica* do not move actively, thus penetrates the Levant Sea with current system. Firstly they reached Lebanon and Syria, then Turkish eastern Mediterranean coasts, clinging to fishing nets and cause economic damage, also reported by Bingel *et al.*, (1993),

Avsar (1999). Turan *et al.* (2011) reported that *R. nomadica* represent 60% of the total catch for all fishing gears in the eastern Mediterranean coast of Turkey when its blooming in March-April 2011.

Impacts of the alien species should be considered also for the fisheries management, because the traditional mesh size of the fishing nets may need to be changed due to new commercial species mostly in the eastern Mediterranean countries. This requires extra costs for fishermen or fishing communities, which is difficult for traditional fishermen who have limited financial source. Another issue is that fish inspectors can easily confuse native and alien fishes when they examine control the size limitation of the fish on the deck of fishing boats, e.g. native mullet *Mullus barbatus*, *Mullus surmelatus* vs *U. moluccensis*. Some of the Turkish fishermen complain about discards of alien fish species such as *Logocephalus spp.* and *Sargocentron rubrum* which have no commercial value in the Mediterranean part of Turkey.

4.4. Impacts on tourism, human health and other socio-economic activities

Alien jellyfish species is a threat also for tourism and some hospitalized events occurred in the eastern Mediterranean Sea countries. Jellyfish can be dangerous for people in case that allergic impacts are made. Death rarely occurs, but minor effects can be seen on all people. These can be itching, severe poisoning, muscle cramps, abdominal rigidity, and decrease in touch sensation, nausea, vomiting, serious back pain, speech difficulties, involuntary muscle contractions, and breathing difficulty. Summarizes the impacts of the alien species to the tourism and human health. Ozturk and Isinibilir (2010) reported that due to jellyfish 815 hospitalized cases were recorded in 2009 in Antalya, Mersin, Iskenderun and Adana Provinces in the Turkish part of the Mediterranean Sea

White stinger, Hydrozoa, Cnidaria, *Macrorhynchia philippina*, is a common circumtropical species (Watson, 2002) and this Lessepsian migrant found along the coast Mersin and Iskenderun. Colonies of 10-15 cm height were frequently found at 1- 2 m depth, on rocks. Dense populations of this species in shallow water may pose a risk for tourism, as it causes a painful, itching sting (Çınar *et al.*, 2005). White stinger is harmful for bathers, skin divers and sponge divers.

Alien echinoderm species, the needle-spined urchin *Diadema setosum*, poses a threat for bathers due to its spines. This species is found in shallow water. Another Indo-Pacific alien echinoderm, a holothuroid, Kocak et al. (1999) and Ergen *et al.* (2002) reported that fouling serpulid worms are known as nuisance in ports and harbours in the Mediterranean Sea, as they cause economic losses.

4.5. Impacts on the Biodiversity

M. leidyi is reported in several parts of the Mediterranean Sea from Turkey to Italy (Uysal and Mutlu 1993; Kideys and Niermann, 1994; Shiganova, 1997, 2001, 2004; Boreo, 2009; Galil *et al.*, 2009; Shiganova and Malej, 2009). This species is also known as one of the '100 world's worst' invaders by IUCN. While this species was the cause of the hypoxia and the collapse of the fisheries in the Black Sea fisheries, major questions are how *Mnemiopsis leidyi* will impact on the Mediterranean fisheries, If the same thing will happen in the Mediterranean as in the Black Sea, or to what extent it will impact on or threat the fisheries in the Mediterranean Sea. Since both *Mnemiopsis* and anchovies inhabit mainly the upper mixed layer and the peak of spawning of the anchovy and ctenophore coincide in time and space, both being correlated with high water temperatures and both consume mainly the same prey organisms. This is also important for the Mediterranean Sea. Some of the alien combjelly like *M. leidyi* also spread to the northern Aegean Sea (Isinibilir and Tarkan, 2002), further to the Adriatic Sea and up to the Sicily Island (Faris, 2009). While *M. leidyi* and *B. ovata* invaded up to the Central Mediterranean Sea, it should be reminded that since 1992 this species was found in the eastern Mediterranean Sea (Uysal and Mutlu, 1993) and has not made any major impact on the pelagic fisheries, such as anchovy, horse mackerel and sardine fisheries, at least in the Turkish part of the Aegean and Mediterranean coasts so far. In addition, the Mediterranean ecosystem is totally different from the Black Sea in terms of the number of species, biodiversity, competition, current systems, etc. Moreover, there are combjelly *Beroe forskalii*, *B. cucumis* and *Balinopsis vitrea* which are native to the Mediterranean Sea and predators of *M. leidyi*. Besides, *Beroe ovata* is also a competitor for *M. leidyi* in the Mediterranean Sea and is found in several Mediterranean countries. Most of the fish suffer overfishing in the Mediterranean and the alien species can easily find empty niches to establish themselves in the new environment. Certainly more researches are needed to better understand impacts of *M. leidyi* on the fisheries, local communities and Mediterranean biota.

Meric *et al.* (2002) reported that proliferation of the foraminifer *Amphistegina* spp., Lessepsian foraminifer, change habitat type as the density becomes high around Antalya in the Turkish coast.

Doğan *et al.* (2007) reported that the Red Sea mussel does not form dense populations in the Aegean Sea because the water of the Aegean Sea is less saline and colder. Occhipinti-Ambrogi (2000, 2002) observed that *Anadara inaequalis* replaced native *Cerastoderma glaucum* in the northern Adriatic Sea. Çınar *et al.* (2005) reported that an alien tunicate *Phallusia nigra* found in Alanya harbour may cause fouling and economic loss if they foul ship hulls or pipes for water intake. Some ship-transported species gain economic importance like swimming (blue) crab, *Callinectes sapidus*. Besides, some species like serpulid worms cause nuisance in ports and marinas. *Halophila stipulacea* is the only successful colonizer from the Red Sea among sea grasses in the eastern Mediterranean Sea.

Özcan *et al.* (2008) reported that native mantis shrimp, *Squilla manthis*, has been displaced by an alien mantis species, *Erugosquilla massavensis*, along the Levantine coast of Turkey. *Synaptula reciprocans* was reported in several regions, such as in the Turkish coast of the Mediterranean and Aegean Sea in Ayvalık. Sea water temperature rise due to climate change is likely to have a significant influence on the Lessepsian alien species distribution. It has been said already that Mediterranean Sea is in the tropicalization process and extension of the warm water species to the western part has already occurred. Some Atlantic originated species also migrated to the Mediterranean Sea with the Atlantic influx.

5. Intentionally Introduced Alien Species in the Mediterranean Sea and Their Impacts

Some accidental introduction is seen with the species like *Caulerpa taxifolia* which escaped from aquaria (Boudouresque, 1996). This species is introduced in 1984, and later dispersed in France, Italy, Monaco, and Croatia, and finally reported from Turkey, in the Gulf of Iskenderun (Cevik *et al.*, 2007). Impacts of *C. taxifolia* are the impoverishment of the Mediterranean algal communities which may reach 75%; most of autochthonous algae tend to disappear dramatically (Verlaque and Fritayre, 1994).

Besides *C. taxifolia*, *C. racemosa* is also important in terms of dispersion. This species has been already colonized in several Mediterranean countries,

such as France, Italy, Spain, Greece, Albania, Malta, Croatia, Montenegro, Turkey, Cyprus, Lebanon, Libya, and Syria (Cirik and Öztürk, 1991; Verlaque *et al.*, 2003; Macic and Kscelan, 2007; Lakkis and Novel-Lakkis, 2001). *C. racemosa* impacted on the benthic communities of macroalgal assemblages by causing impoverishment in the number of species. Sponges, sea urchins and some other benthic species are also covered by *C. racemosa* and die after a certain period at the bottom. Okutan *et al.* (2002), Akcali and Cirik (2007) reported that *C. racemosa* and *Halophia stipulacea* affect the biota in the Turkish coasts. Aquaculture is a main reason of intentional introduction of alien species. In Turkey, mostly in the Aegean Sea, several fish cages were also broken and several times tons of fish escaped from the cages. Genetic impacts of these escaped or released fish is a concern mostly for the genetic hybridization. To stop Lessepsian aliens species from the Suez Canal is not seems to be possible. However, slowing down of the alien species passage to the Mediterranean Sea should be urgently studied in terms of biodiversity, human health and to protect natural heritage of the entire Mediterranean and Black Seas. Further modification of the physical structure of the Canal, such as deepening of the Canal, may be one of the catastrophes for the Mediterranean Sea. Rivers and Lagoon of the Black and Mediterranean part of Turkey are sensitive to alien species and easier to the introduced species.. Due to oil transportation from the eastern Mediterranean Sea mostly from the Ceyhan Terminal in Turkey, the number of ship-transported alien species will be increased parallel to the intensity of oil transportation.

A working group should be established in Turkey to monitor impacts on the fisheries and biodiversity. A warning system or an alarming system is needed for toxic phytoplankton species, in case that they are transferred with ship ballast water to the Mediterranean or Black Sea, to mitigate negative impacts on fish, mussel and oyster farming and human health. Eradication or completely removal of the alien species from the ecosystem is almost impossible but the control or containment may be possible for some species like *Caulerpa taxifolia* or *C. racemosa*. Public awareness campaigns and educational materials are important to recognize, identify or disseminate information for alien species' distribution or harm for all stakeholders like fishermen, harbour authorities, divers, tour operators, and fisheries cooperatives in Turkey.

To collect new and accurate information on the occurrence of alien species, a reporting and monitoring system is required. In this system, fishermen must report to fisheries cooperatives or relevant fisheries authorities whenever

they find unusual organisms in their catch. Regarding the introduction and transfer of alien species, new regulation, legislation and guidelines is needed in Turkey.

A healthy pristine ecosystem may defend the native fauna and flora of the Mediterranean and Black Seas. Stress on marine environment favors the spreading and facilitating of alien species. Key species and key habitats, for example, *Posidonia* meadows, should be protected for maintaining such healthy ecosystems to combat alien species invasion.

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INLAND WATERS FISHERY IN TURKEY

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1. Introduction

Although seas stand more in the forefront in terms of fishing around the globe, inland waters are in fact the lifeblood of sea fishery. Marine ecosystem is largely based on land with respect to the supply of nutrient elements, and such a relationship can only be established through inland waters connecting land to sea. Rivers carry nutrients during their journey from high mountains they are born towards seas they pour into. So, in a sense, sea fishery is also closely related to inland waters.

Whenever fishing in Turkey is discussed, people would say that “we are somehow unable to generate sufficient income from fishing in a country surrounded by water on three sides”. And, they tend to ignore fishing in inland waters in general. However, the productivity of the seas depends on nutrients carried by rivers in Turkey as anywhere else in the world. And, surrounding the entire country just like capillaries in the human body, the network of inland waters is crucially important source of food and livelihood for poor rural population.

Although it's located in a semi-arid climate zone, Turkey has still some substantial inland water resources, but not as much as Europe with its rainy climate (Figure 1). Turkey's inland water assets consist of 177000 km river network, more than 300 large and small lakes, 673 dam lakes and approximately 2000 ponds (The State Hydraulic Works, *Devlet Su İşleri or DSI in Turkish*, 2010). Our freshwaters have a high potential in terms of species diversity. According to Kuru (2004), 236 species and subspecies belonging to 26 families live in Turkish inland waters. Küçük (2006) notes that 42 species and 28 subspecies from 8 families in these 236 taxsons are considered as endemic for our country. These taxonomic species include 58.5% Cyprinidae, 14.3% Cobitidae, 10% Cyprinodontidae, 8.6% Balitoridae, 2.8% Salmonidae, 2.8% Gobiidae, 1.5% Clupeidae and 1.5% Petromyzontidae. Families with the highest level of endemism are Cyprinodontidae (78%), Cobitidae (62%) and Cyprinidae

(32%) respectively. Endemic taxons are observed to be concentrated in Beyşehir Lake basin (10 taxons), Büyük Menderes basin (8 taxons), Antalya basin (7 taxons), Burdur basin (6 taxons), Eber, Akşehir and Çavuşçu Lakes (5 taxons), Kızılırmak and Sakarya riverine systems (5 taxons), Gediz River and Lake of Marmara (5 taxons), Küçük Menderes and its surroundings (4 taxons), Eğirdir Lake (3 taxons), Salt Lake basin (3 taxons), Hazar Lake basin (3 taxons), Seyhan and Ceyhan Rivers (3 taxons) and Lake Van basin (2 taxons) (Küçük, 2006).

The high diversity of species and endemism in Turkey is due to its location at the intersection of various biogeography regions. According to Demirsoy (1996), the distribution of fish species in Turkish inland waters can be grouped into two main categories as follows: The first group migrates from sea to freshwaters, and the second comes to Anatolia from foreign freshwaters through a variety of ways. Those migrating from sea are called as secondary freshwater fish, and others coming to Anatolia through many ways are called as primary freshwater fish (Demirsoy, 1996).

Some secondary fish species currently living in Turkish inland waters have migrated to freshwaters from seas earlier. Those migrated from the Mediterranean Sea are called “Tethys originated” referring to “Tethys” - the name of the ancient Mediterranean. Some others migrated from the Sarmatic Sea as formerly called, covering today’s Black Sea, Caspian Sea and Aral Lake partly. It’s assumed that cold water fish of different origins such as trout reached Anatolia in the glacial period. On the other hand, it’s assumed that such species as *Atherina mochon*, *Arius cous* and *Mugil abu* migrated from sea to freshwaters in the near past (Demirsoy, 1996).

Demirsoy (1996) divides primary freshwater fish in Anatolia into five main groups based on their origins:

1. Pangea origin
2. West Palearctic and Europe origin
3. West and Central Asia origin
4. Sarmatic inland sea origin
5. Mesopotamia origin

In fact, if we take a look at the differences between primary and secondary freshwater fishes based on their origins, the reason for Turkey being considerably rich in terms of species diversity in inland can be easily understood.

Although there is a high diversity of species in inland waters of Turkey, the relative share of inland water fisheries in total fishing practices would fall between 5-10% by year. Considering the total added value of fishery products, it's observed that this ratio in total turnover would decrease even further. Actually, this gives us a quick idea about the overall state of inland waters fishery in Turkey. Such a small ratio stems from a set of problematic areas including an unprofessional, almost entirely amateur approach towards inland waters fishery in particular.

On one hand, this study presents a snapshot of inland water fishery in Turkey from the past to the present and makes an assessment on where it stands now in the fishery sector. And on the other, it examines major problems related to inland waters fishery within the context of water resources management and develops suggestions for sustainable fisheries in Turkey.

2. Inland Waters Potential of Turkey and Regional Dispersi

Turkey cannot be considered as a rich country with respect to the availability of its inland water resources. It's located in the semi-arid climatic zone. The semi-arid climate zone is characterized by low river flow rates and oscillation in lake water levels due to precipitation fluctuations. Except for small streams in the Black Sea Region, Turkey fully reflects this characteristic feature. Especially in hinterlands with prevailing continental climate, the irregularity of river flow rates reaches peak. As for the Eastern Anatolia Region, the birthplace of large rivers such as Euphrates and Tigris, flow rates are less variable than hinterlands but still irregular. For instance, Kura River, which emerges from the Northeastern Anatolia and pours into the Caspian Sea, has a flow rate of $300\text{m}^3/\text{s}$ during the spring months whereas it decreases to $15\text{-}20\text{m}^3/\text{s}$ in the fall (Sarı, 2005). If we look at the nation's network of rivers (Figure 1) without taking flow rate irregularities into account, Turkey might be perceived as rich in terms of its water resources. If we consider the number of lakes on Figure 1 as well, we would see that the entire country is enriched by a considerable network of rivers and lakes except for Central Anatolia Region. However, flow irregularities and improper water use policies led to the

weakening of many small rivers and lakes as seen on the map below to the extent that they cannot be counted as aquatic ecosystems anymore.

Although Turkey has numerically high potential for inland water resources (Table 1), its sustainability level is weak due to climate and regional conditions as defined above. Hence, the ratio of inland fisheries to total fish catch has never exceeded 10%.

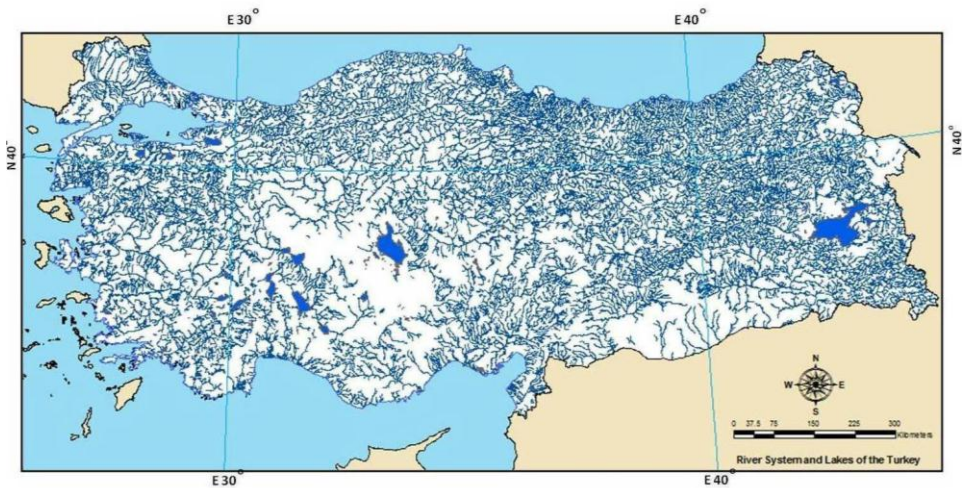


Figure 1. River System and Lakes of Turkey

Table 1. Turkey’s Inland Waters Potential (Sari *et al.*, 2001)

Inland Water Resources	Potential
River systems	177,714 km
Natural lakes	200 number
Dams	678 number
Small reservoir	1,000 number
Total inland surface area	1,500,000 ha

If Table 1 and Figure 1 are taken together, it's seen that the distribution of inland water resources varies by region. For instance, Figure 1 shows a large number of rivers in the Black Sea region. Analyzing Figure 2, however, we would see that the same region has a 6% share out of inland fisheries in total. Rivers in this region are not major aquatic ecosystems due their extremely small flow rates and short river lengths from steep slopes they are born towards the sea they pour into. Despite being born in Turkey, Turkey's largest rivers are also transboundary water resources such as Euphrates, Tigris, Kura, Aras, and Çoruh. Considering their long network and abundance of dams on them, they are very significant aquatic ecosystems for inland waters fishery. Looking at the distribution of inland fisheries by regions, we can clearly see this situation on Figure 2.

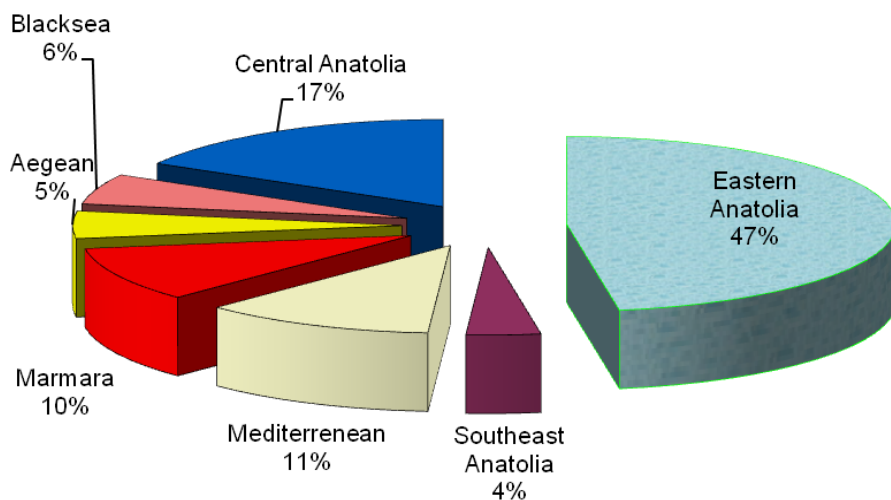


Figure 2. Distribution of Inland Fisheries by Geographic Region (TUIK, 2009)

As seen on Figure 2, the East Anatolia Region has the largest share of inland fisheries in Turkey with 47%. Two greatest rivers of the country, namely Euphrates and Tigris, are fed by rich water sources in this region. The Central Anatolia ranks second with a 17% share in terms of inland fisheries by geographic region. Actually, the Central Anatolia is one of the poorest regions in the country with respect to the availability of its internal water resources (see Figure 1). It ranks second because of our largest river, Kızılırmak (Red River),

which is born and pours into the sea within the boundaries of our country. Kızılırmak has an irregular flow rate varying from 20 m³/sn to 1700 m³/sn with an average of 184 m³/s. Eight dam lakes built on Kızılırmak are very important habitats for inland waters fishery (Polat *et al.*, 2009).

Another point to be noted in Figure 2 is that with only a 4% share today, the South Eastern Anatolia Region will gradually increase its share in total inland fish catch after several dams built on the Euphrates and Tigris. Because even the Ataturk Dam Lake alone is one of the largest freshwater reserves in our country with its more than 800 km² surface area. Looking at catch of freshwater fish by province (Figure 3), we would see that Van, Ankara and Bursa are three top ranking ones in terms of inland water fisheries. As seen in Figure 3, these three provinces are followed by Bitlis, Konya, Adana, Adıyaman, Şanlıurfa and Elazığ (TUIK, 2009).

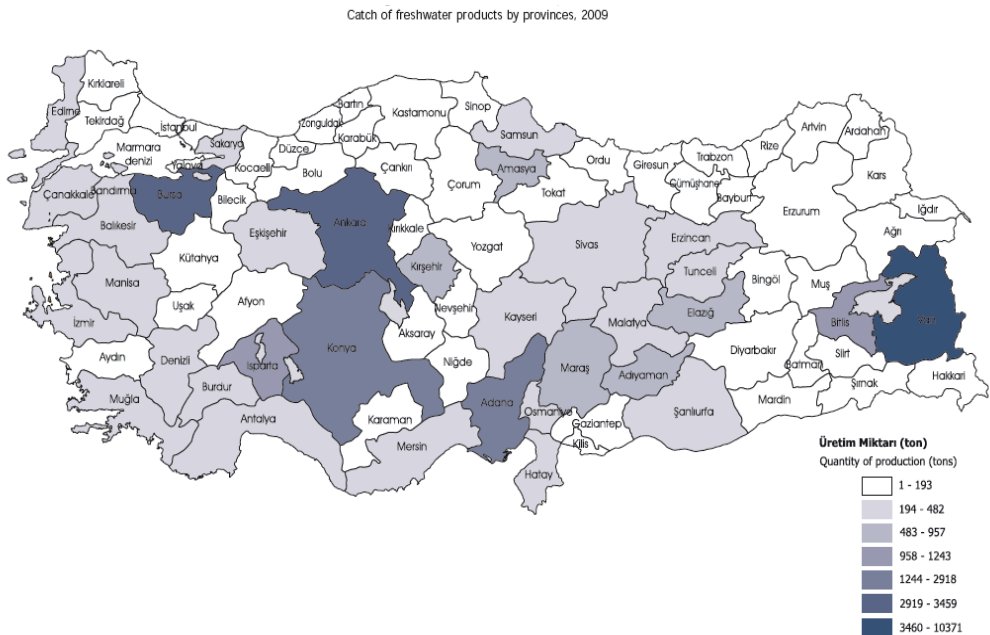


Figure 3. Catch of Freshwater Fish by Province (TUIK, 2009)

3. Past and Present of Inland Waters Fishery in Turkey

Examining inland waters fishery in Turkey both in the past and present, we should in fact take fisheries management into account through a historical perspective. Fisheries management in our country has gone through two phases

so far: The first phase covers the period from 1876 to 1971 followed by the second phase from 1971 to present. During the first phase, the old fisheries law *Zabita-i Saydiye* was in effect. The most prominent features of this period were the ineffective management of natural resources, poor fishing fleet, and lack of investment in fishery infrastructure. With the enactment of Fisheries Act (no.1380) in 1971, however, the Ministry of Agriculture and Rural Affairs became the sole authority to enforce the fisheries law and the General Directorate of Fisheries was established, which further led to a predominantly centralized structure of fisheries management at national level during the second phase (Atay, 1993).

In both phases mentioned above, due to geographic characteristics of our country, seas and marine fish have taken priority while inland waters remained in the background. Moreover, scientific fisheries management practices (closed season, size limits, etc.) were first applied in catching sea fish; and they were much later applied to inland waters for some species like trout.

Inland water resources have been exploited without being subjected to any control for many years. Protecting inland water resources has become a serious issue in parallel with the increasing awareness on environmental conservation recently. However, most of our inland water sources (rivers in particular) have undergone a myriad of biological changes so far. Floods caused by erosion; pesticides; domestic and industrial wastes; use of improper fishing techniques with dynamite, electric current and various toxic substances; a vast number of dams without fish ladders (*fish passes*); and increasing number of run-of-the-river hydropower plants in recent years are all contributing factors which caused fish species in our rivers to be much reduced or completely disappear. Almost all of inland water fisheries are practiced through fishing in natural lakes, dam lakes, lagoons and ponds. Ratios of inland fishery by species according to 1980-2000 statistics are given in Table 2 below.

The ratio of freshwater fish to total fish catch has changed over the years. In years of 1967, 1970, 1975 and 1979; this ratio was 3.15%, 7.39%, 15.39% and 6.40% respectively. Due to an unexpected decrease in marine fisheries from 1989 onwards, the ratio which was around 7-8% in 1980s increased up to 10% in 1991. But, it decreased as low as it was before in 1980s in later years (Sarı, 2001).

As seen in Table 2, 80% of inland fish species and the ratios of these species changed significantly in 2000. Carp and pearl mullet fishing increased up to 3.38% and 14.88% while crayfish, catfish and freshwater mullet decreased

to 14.03%, 2.86% and 3.9% respectively. The most important change is seen in perch and pike. These two had species constituted 5% of total inland fisheries in 1980 statistics, but they did not even exist in 2000 statistics.

Table 2. Inland fishing quantities between years 1980-2000 (tones), ratios of species in inland fishery (%) and changes in ratios from 1980 to 2000 (%)

Catches	Years						Change
	1980		1990		2000		
Total Catch of Fish in Turkey	424,451		385,114		582,376		37.2
Total Catch of Freshwater Fish	32,255		37,315		43,385		34.5
Ratio of Freshwater Fish to Total Catch %	7.6		9.7		7.43		-0.17
Important Species	Catch	Ratio	Catch	Ratio	Catch	Ratio	Change
Common Carp	9,413	29.2	16,001	43	14,137	32.58	3.38
Pearl Mullet (Tarek)	6,954	21.2	11,100	30	15,654	36.08	14.88
Cray Fish	5,767	17.9	542	1.45	1,681	3.87	-14.03
Mullet	1,767	5.5	606	1.62	698	1.6	-3.9
Wels	1,663	5.2	480	1.28	1,019	2.34	-2.86
Pike perch	1,590	4.9	1,563	4.19	0	0	-4.9
Total	27,154	84.2	30,290	81.5	33,189	76.5	-7.7

Moreover, total catch of heavenly fish (*Gökçe balığı* in Turkish), which is not included in the table above, was 665 tons in 1980 whereas it did not appear in 1996 statistics at all. As clearly seen here, species biodiversity has decreased in terms of inland fisheries with a focus on current catch of two species only: The ratio of carp and pearl mullet catch to total catch was around 50% in 1980 while it was 68% later in 2000. In other words, the total catch of these two species in particular has increased by approximately 18% over 20 years. And, carp fishing declined by 20% in 2000 from the previous year. The total catch of carp fishing was 17,396 tons according to 1999 statistics while it was 14.137 tons in 2000 figures. On the other hand, pearl mullet fishing rose to first rank by a 15% increase over 20 years. But, crayfish fishing almost collapsed due to disease and decreased to 14%.

Reviewing data on Table 2, we see that the ratio of carp and pearl mullet constitutes more than $\frac{3}{4}$ of total inland waters fishery which is another significant point to consider here. These figures indicate that when speaking of inland waters fishery in Turkey, we should focus on carp and pearl mullet in particular. Actually, looking at statistical data collected over the last 10 years as shown in Table 3 below, we can see more clearly that carp and pearl mullet are both driving forces of inland waters fishery.

Carp is an omnivore species that exists in all inland waters throughout our country from the east-west or south-north, and is not very selective in terms of water quality criteria. Carp fishing is quite common due to its high reproduction and growth performance in natural ways in our inland waters. There are several fish hatcheries at various spots around the country, and carp has gradually become one of the species introduced from hatcheries to inland waters for breeding purposes. Millions of juvenile carps are being introduced every year to almost all the dam lakes, especially to newly built ones.

Table 3. Quantity (tons) of freshwater fish caught between the years of 1994-2009 and the ratio (%) of species in total fishery in Turkey

Species	1999	Ratio	2000	Ratio	2001	Ratio	2002	Ratio	2003	Ratio	2004	Ratio	2005	Ratio	2006	Ratio	2007	Ratio	2008	Ratio	2009	Ratio
Chub	176	0.35	104	0.24	91	0.21	73	0.17	82	0.18	93	0.20	87	0.19	85	0.19	82	0.19	71	0.17	63	0.16
Trout	263	0.52	277	0.65	364	0.84	352	0.80	393	0.88	352	0.77	376	0.82	374	0.85	550	1.27	630	1.54	557	1.42
Bream	259	0.52	200	0.47	151	0.35	198	0.45	221	0.49	213	0.47	234	0.51	259	0.59	225	0.52	170	0.41	148	0.38
Gökçe	9	0.02	11	0.03	37	0.09	39	0.09	43	0.10	37	0.08	41	0.09	49	0.11	45	0.10	47	0.11	42	0.11
Sand smelt	1455	2.90	1583	3.70	1685	3.89	1733	3.94	1826	4.09	2107	4.62	5248	11.38	6677	15.15	6540	15.10	6630	16.17	6184	15.78
Pearl Mullet (Tarek)	20000	39.85	15654	36.55	15848	36.58	14930	33.98	14215	31.80	14259	31.28	14103	30.58	11978	27.17	11623	26.83	11758	28.67	10685	27.27
Tench	-	-	690	1.61	778	1.80	800	1.82	785	1.76	1875	4.11	1792	3.89	1953	4.43	1884	4.35	1632	3.98	1482	3.78
Catfish	516	1.03	576	1.35	520	1.20	495	1.13	507	1.13	487	1.07	480	1.04	478	1.08	486	1.12	339	0.83	310	0.79
Bighand goby	118	0.24	107	0.25	116	0.27	85	0.19	73	0.16	79	0.17	105	0.23	101	0.23	70	0.16	57	0.14	51	0.13
Mullet	752	1.50	698	1.63	710	1.64	659	1.50	738	1.65	820	1.80	830	1.80	948	2.15	927	2.14	1023	2.49	970	2.48
Rudd	449	0.89	323	0.75	257	0.59	240	0.55	247	0.55	267	0.59	281	0.61	285	0.65	258	0.60	261	0.64	239	0.61

Table 3 continued

Frog	-	-	-	-	-	-	-	-	-	-	-	-	803	1.74	833	1.89	895	2.07	668	1.63	622	1.59
Pike perch	1906	3.80	1633	3.81	1644	3.79	1850	4.21	1751	3.92	1852	4.06	1768	3.83	1656	3.76	1586	3.66	1346	3.28	1234	3.15
Snail	1585	3.16	1592	3.72	1601	3.70	1937	4.41	1850	4.14	1879	4.12	1873	4.06	1462	3.32	1397	3.22	1007	2.46	2227	5.68
Common carp	17396	34.66	14137	33.01	12265	28.31	12965	29.51	13820	30.92	13451	29.51	13718	29.75	12116	27.49	12286	28.36	11625	28.35	10964	27.98
Transcaucasian barb	1489	2.97	1124	2.62	1009	2.33	918	2.09	1013	2.27	1027	2.25	971	2.11	967	2.19	985	2.27	993	2.42	891	2.27
Wels	958	1.91	1019	2.38	813	1.88	987	2.25	912	2.04	897	1.97	804	1.74	1245	2.82	1293	2.98	1275	3.11	1193	3.04
Eel	-	-	-	-	-	-	-	-	-	-	-	-	176	0.38	162	0.37	179	0.41	171	0.42	158	0.40
Pike	276	0.55	224	0.52	192	0.44	217	0.49	237	0.53	4	0.01	249	0.54	279	0.63	242	0.56	213	0.52	197	0.50
Cray fish	1372	2.73	1681	3.93	1634	3.77	1864	4.24	2183	4.88	2317	5.08	809	1.75	797	1.81	816	1.88	783	1.91	734	1.87
Other	902	1.80	1639	3.83	2613	6.03	2551	5.81	2852	6.38	2352	5.16	1367	2.96	1378	3.13	952	2.20	312	0.76	236	0.60
Total	50190		42824		43323		43938		44698		45585		46115		44082		43321		41011		39187	
Change (%)	17.16		-14.68		1.17		1.42		1.73		1.98		1.16		-4.41		-1.73		-5.33		-4.45	

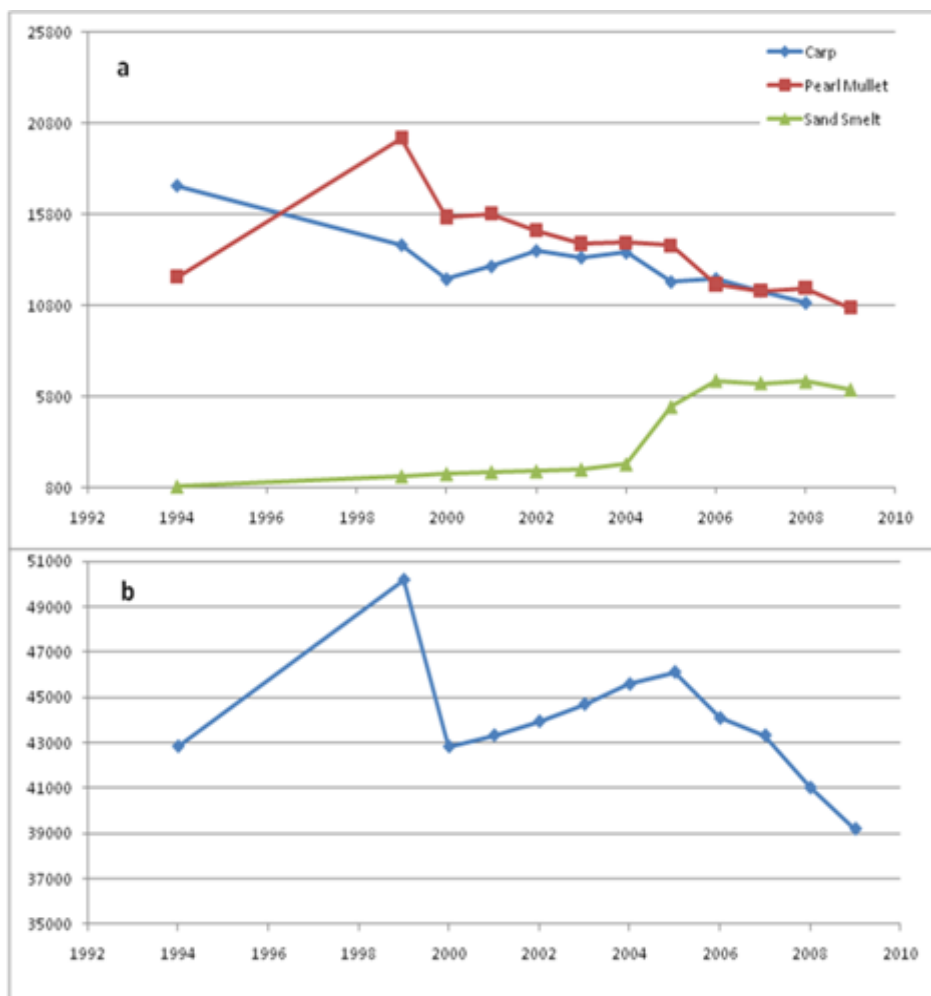


Figure 4. Total catch of carp, pearl mullet and sand smelt **(a)** and the catch of total inland fish **(b)** by years

In other words, introduction to dam lakes for breeding purposes can be considered as the main factor that led pearl mullet to become competitive with carp in terms of inland waters fishery. If millions of carps had not been introduced to inland waters for breeding purposes every year, carp fishery would have already collapsed just like some other species did in the past. This means that as an endemic species of Lake Van, pearl mullet is the only species with a high share in inland waters fishery. In fact, the main reason for pearl mullet fishing to be practiced in a relatively sustainable way is the ongoing conservation efforts since 1992. Without these conservation efforts, pearl mullet

which was included in the list of endangered species in 1996 - would have already lost its statistical ranking for fishing like many other inland water fish species in Turkey (Sarı 1997, Sarı 2008a). An alternative model of fisheries management, developed by Sarı (1997) and implemented by a university-civil society cooperation which was later extended to include all public institutions as well, has rescued pearl mullet from negative influences of overfishing (Sarı, 2008a). Various international projects on sustainable pearl mullet fishing were implemented (UNDP, 2006), and many scientific research studies have focused on the ongoing conservation efforts so far (Sarı 2008b, Nalçaoğlu and Sarı 2008).

If Figures 4a and b are taken together, we see that changes in total inland waters fishery are in parallel with carp and pearl mullet fishing over years. In other words, it can be observed that whenever carp and pearl mullet fishing increase, total inland waters fishery also increases or vice versa.

Sand smelt appears to be the most caught fish in recent years following carp and pearl mullet fishery (Figure 4a). The reason for an increase in total catch of sand smelt is not because these reserves have been discovered newly, but rather the fact that it has been introduced and adapted well into certain environments through breeding.

Despite having a small ratio in inland fishery, natural trout (*Salmo trutta*) is significantly important because it has high economic value and stands at the top of food chain in the aquatic ecosystem. Although trout fishing varies by years, it generally has a ratio between 0.5 and 1.5% to total inland waters fishery as seen in Table 3. Trout in Turkey mostly exists in the Eastern Black Sea Region, secondly in the northern parts of East Anatolia Region, and also in the Taurus Mountains, Aegean Region and Thrace rivers in small quantities. However, increasing deforestation, floods, pollution, and climate change in recent years would threaten aquatic life habitat for trout and narrow its ecological living space gradually. Especially dams without fish ladders or fish ladders and run-of-the-river hydropower plants (HPPs) can be evaluated as indicators of even further narrowing of aquatic life habitat for trout in the coming years.

3. Fishing Gears and Techniques Used in Inland Waters Fishery

Gears and techniques used in inland waters fishery are too limited because the current fishing practice is amateurish rather than being professional. Almost all the fishing gears used in catching fish in inland waters are passive fishing equipment. The use of such fishing equipment as trawl nets and seine nets are banned due to their large size and high catch per unit of effort. Fishing techniques used in inland waters can be grouped into 6 categories as below:

- Drift nets
- Fyke nets
- Fishing tackles
- Cast nets
- Beach seine nets
- Ghost nets (*Tırvırı*)

Drift nets are the most commonly used fishing gears in inland waters in the professional manner. Depending on the type of fish species to catch, simple or trammel nets are used with mesh sizes ranging from 28 to 90 mm. Fishnets used in catching small fish such as silver have their mesh size around 28 mm while that of fishnets used in catching carp can reach up to 90 mm. Mesh sizes for pearl mullet in Lake Van, which ranks second in terms of total catch in inland waters, vary between 40-48 mm. Trammel nets are used for pearl mullet fishing in general. Monofilament nets hold a significant place among drift nets, which have become widespread for the last 15 years. The Ministry of Agriculture and Rural Affairs, however, banned their use in 2011.

Fyke nets are mostly used for crayfish, eel and carp fishing. The size of fyke nets, availability of guiding nets, overall length of guiding nets, and mesh sizes of these nets would vary depending on fish species to catch.

Fishing tackles are used to catch for almost all species in inland waters, including catfish in particular. Hook sizes and fishing line thickness may vary according to the availability of fish species to catch. Hook size and thread thickness are bigger for such species as catfish while they are both smaller for trout fishing. Beyond professional fishing, hand-line fishing for sporting purposes is highly popular in Turkey. Although amateur fishers prefer more valuable species like brown trout; they can easily adapt their fishing tackles into whatever fish species is available to catch in their environment.

Although cast nets are more commonly used than drift nets for inland waters fishery, they don't have much value in terms of professional fishing practice since they are mostly used in the amateurish manner. Cast nets usually weigh around 4 to 6 kilograms with highly variable mesh sizes. Since easy to find and use, they are the most commonly used fishing equipment in inland waters fishery. They cannot be used in stony, rapid flowing creeks though.

Beach seine nets are among those fishnets the use of which has been completely banned in inland waters lately. Except for those used for sand smelt fishing with special permission by the Ministry of Agriculture and Rural Affairs, beach seine nets in inland waters fishery is strictly prohibited. Although illegal use of beach seine nets in some natural and dam lakes can still be seen to catch pearl mullet in Lake Van particularly, it diminishes day by day. In Van Lake and its vicinity, the wing length of beach seine nets used to catch pearl

mullet during their reproduction period vary from 50 to 300 m, pocket length from 8 to 16 m, and wing depth from 2 to 6 m. Mesh sizes both for wings and pockets do not vary dramatically, which are usually around 32-36 mm (Sarı, 2001).

The amateur use of ghost net fishing equipment has been gradually increasing in recent years. As a matter of fact, whether ghost nets should be considered as one of the fishing gears or not is still highly controversial. This hybrid fishing equipment is used like fishing lines, but the way it catches fish is similar to that of drift nets. A ghost net is made of 50-100 cm long monofilament net with varying mesh sizes tied to a body and lead sinker one side in general. Despite being illegal, it is very commonly used throughout the country. It is cheap; easy to find, use and store; and not too selective. This makes the equipment very advantageous, and there seems to be too hard to stop the current practice. Although illegal, it is widely used and difficult to control. Therefore, new legal measures need to be taken to prevent the use of such equipment.

4. Problems Related to Freshwater Fisheries and Some Suggestions

Inland waters are relatively small ecological systems compared to seas and oceans, and therefore, they can easily be affected from natural and anthropogenic changes. Such variable characteristics of inland waters lead them to be considered as “sensitive habitats”. In this case, rapid vulnerability of inland water resources will naturally have an impact on fauna in these water resources. Hence, major problems in Turkey’s inland waters fishery are evaluated in three groups as follows:

- Problems arising from natural reasons
- Anthropogenic problems
- Administrative problems

4.1. Problems Arising from Natural Reasons

Turkey is located in the semi-arid climate zone by its geographic location. The semi-arid climate zone is characterized by irregular flow rates due to precipitation fluctuations and high oscillation in lake water levels due to precipitation fluctuations in stagnant waters like natural and dam lakes. Therefore, seasonal changes in river flow rates can be observed to a great extent in Turkey. 60% of inland water species available in Turkey belongs to Cyprinidae family, so how fish in reproduction process in floodplains during high flow rate periods or their reproductive success during non-flood periods are negatively affected from sudden changes in flow rate can be easily understood. For instance, the reproductive success of Cyprinidae family will significantly fall in a river where the flow rate increases to 600 m³/h during

rainy springs, but drops to 200 m³/s in relatively dry spring months. Therefore, as a country in the semi-arid climate zone, the major problem arising from natural reasons in Turkey's inland waters fishery is the irregularity of flow rates. Such irregularity causes rivers with lower flow rates to dry completely in some years, which will further lead us to observe fish deaths in the region. Some rivers do not completely dry, but their decreasing water level will also lead to fish deaths due to increases in water temperature or lack of oxygen.

Flow rate irregularity should be evaluated as a major problem in terms of inland waters fishery. Considering that fish can hardly find areas to reproduce or hide during dry seasons, fishing will become easier and this may lead to over-fishing without any adequate control mechanisms.

Another important natural reason to consider is the lack of vegetation in uplands of East and Southeast Anatolia Regions due to their altitude and climate conditions. It causes sudden and strong floods when strong precipitations occur in steep hillsides. Floods destroy natural habitats of inland water fishes, damage fish spawns and larval fish populations.

4.2. Anthropogenic Problems

There is a wide range of anthropogenic problems in Turkey in terms of inland waters fishery. When combined with natural and administrative problems, some of these problems may create a negative multiplier effect, which leads even more difficult dilemmas to be solved. Anthropogenic problems can be grouped into subject headings as below. Each and every anthropogenic problem affecting inland waters fishery is significant enough to be discussed in a separate article. Since it's not possible to discuss all such problems within the limits of this article, only the most striking issues will be discussed below: Problems caused by introducing fish species to dams, ponds, or run-of-the-river hydropower plants or by breeding.

Anthropogenic problems can be listed as below:

- Draining of Wetlands and Some Shallow Lakes
- Dams, Ponds, and Run-of-the-River Hydropower Plants
- Introducing, Breeding and Exotic Species
- Road & Bridge Constructions and Various Water Collectors
- Sand Mining
- Flood Mitigation and Stream Rehabilitation
- Pollution and Eutrophication
- Agricultural Irrigation
- Illegal Fishing Techniques
- Overfishing
- Flood Erosion

Dams are macrostructures, which are built on rivers for energy production, irrigation and flood mitigation. Dams, which are actually the key elements of hydroelectricity and agricultural irrigation, also have a potential for a positive impact on increasing inland waters fishery. Because dam lakes – reservoirs created as artificial lakes – are ideal habitats for such inland water fish species as carp. However, dams are built on rivers without fish passes during construction phase, and they become a nightmare for inland water fish species. According to a study conducted on Magpie River in Canada between the years of 2002-2007, fish population in areas downstream of the dam decreased by 2-3 times when compared to the period during the construction (Murchie *et al.*, 2008). Dams built without any consideration of ecological approaches will lead to negative impacts on the river bed as listed below (Hack, 2004)

- Flow rate, width of the river bed and aquatic habitat decreases
- Hiding places for fish and small ponds disappear
- Water flow, regime, and speed change
- Dams hold silt in water and river bed under dams deteriorates
- Temperature rises in summer while river bed freezes in winter
- Concentration of dissolved oxygen decreases
- Species diversity of aquatic organisms decreases, fish in particular
- Water level drops at underground waters in the region
- Vegetation in river bed and along river edges decreases

For instance, after the construction of Atatürk Dam - the largest dam of Turkey, eight inland water fish species existed in that particular region before are no longer seen today (Şevik, 1998). Fish escaping to natural environment due to breeding activities for carnivorous species at dams will put a predation pressure on fish population in the region they moved to. Dams without fish passes (almost none of the dams built in Turkey has fish passes) prevent fish migration towards upstream during their spawning period. And therefore, reproduction and life habitat for fish species would disappear over time.

According to statistical data released by the State Hydraulic Works (2011), there are currently 673 dams and around 2000 dam ponds in Turkey. These figures do not include dams which are planned, projected, and already in construction phase. According to 2010 statistics released by the Ministry of Environment and Forestry, construction has already started in 136 out of more than 1700 planned run-of-the-river hydropower plants in Turkey and 45 dams are currently in operation. This shows us that dams, dam ponds, and hydropower plants are the most critical issues to consider within the scope of anthropogenic problems for inland waters fishery in Turkey. In other words, if these planned dams and power plants are built without proper fish passes as required, inland water fish species will be facing a major disaster in the near future. A large part of fish species with such destroyed natural habitats will also

lose their ecological living spaces and optimum population size in time, leaving us with no need to even discuss other related issues.

We're experiencing major problems with the amount of water released from dams and hydropower plants to river beds. This amount has been determined by taking human needs into account in the past. As a result of bad experiences so far, it is now planned by taking "ecological needs" into account. In other words, instead of asking "How much water should remain in the river bed?" as we did in the past, we now tend to ask the following question: "What should be the minimum ecological flow rate?" (Bovee *et al.*, 1998; Stalnaker *et al.*, 1995).

The term "minimum ecological flow rate" is used to define the flow rate at which aquatic life (invertebrates, fish, aquatic flies, plants, etc.) can continue to exist without any damage, and there is no single measure for numerical optimization. Aquatic life may vary due to many biological and environmental factors such as river flow rate, speed, riverbed geometry, and climate. Aquatic life shaped in each river bed is a dynamic structure which has adapted itself into environmental conditions for centuries. So, for such a general question of "how much water should remain in the river bed?" above, a general answer can be given as "it varies for each river". In other words, the minimum ecological flow rate for each river must be determined by taking unique aquatic life in that river plus some environmental, climatic and physical conditions into account. Early studies on how to determine this flow rate have begun in 1970s, and become increasingly diverse in 1990s. Researchers developed various methods to determine the minimum ecological flow rate (Richter *et al.*, 2003). All of these methods are based on flow rate values collected for many years, hydrologic or habitat approaches in this respect. In determining the minimum ecological flow rate, all methods consider the needs of indicator species such as trout in the upper ring of food pyramid with selective habitat demand. Unfortunately, the number of rivers with "the minimum ecological flow rate" (or "life-line support" as more commonly called in our country) calculated according to these approaches is only a handful in Turkey (Sari *et al.*, 2003). As noted in earlier sections of this article, Turkey is in the semi-arid climate zone and has too many natural disadvantages in terms of inland fisheries. The amount of life-line support for each river should be calculated by considering its sensitivities towards seasonal changes and vulnerability of unique aquatic ecosystem. And, all intervention efforts to be conducted on these rivers should take the end results of such calculations into account.

Introducing fish to freshwater is usually carried out by government for economic purposes. In spite of innocent intentions at the very start, it usually turns into a disaster due to lack of ecological approaches in time. Two main purposes of introducing of fish to freshwaters are to increase fishermen's profit

through breeding fish species with “higher economic value”, and to support inland waters fishery in that particular habitat after a new dam lake is built. However, the term "higher economic value" is a subjective approach in the ecological sense. These well-meaning interventions would result in the loss of fish fauna, mostly due to the introduction of carnivore and sometimes even predator fish species. Lake Eğirdir is a frequently given example of such imperiled habitats. Including but not limited to Lake Eğirdir, such interventions has led to severe damages and economic losses in almost all in the Region of Lakes and also in the Mediterranean and Central Anatolia (Gündoğdu, 2010). Being transferred to unfamiliar inland water resources as a prey for pike perch with rapidly increasing total catch figures in recent years, sand smelts must serve as another example of ignoring lessons learned from pike perch. Çetinkaya (2006) reported that 25 exotic fish species were introduced to freshwater in Turkey, 5 species out of them are now extinct. He also added that 15 fish species living in inland waters of Turkey earlier were transferred from their natural habitats to some others.

Although trout breeding in inland waters is not a fish introduction process, it has similar effects considering the end results. Rainbow trout escaping from hatchery to natural habitat would put pressure on both omnivore and herbivore species in terms of nutrition, and compete with natural trout in that particular habitat. In both cases, it threatens fish species diversity in the natural habitat where rainbow trout joined later. So, when planning rainbow trout breeding facilities, systems to prevent escapes to any natural habitat must be also taken into account.

Furthermore, *Carassius sp.* (goldfish as more commonly known) has been transferred from Kura River to such unsuitable places as Lake Nazik during introduction process carried out by various institutions in Turkey without any control at all. Known as a warm water fish, goldfish cannot grow fast enough in the East Anatolia Region where winters last for 7 months or more. For this reason, local people do not prefer to consume it. But, since it's fed by similar nutrients in the same habitat with carp, it would disturb carp population in the region.

4.3. Administrative Problems

It's difficult to differentiate administrative problems affecting inland waters fishery in Turkey from fishery management decisions at national level. In this section, we will especially focus on issues that directly affect inland waters fishery. Administrative problems would arise due to current lack of efficient legal arrangements for the management of fisheries, poor implementation of laws, and bureaucratic processes. Most of the problems in this context are more related to bureaucracy and lack of legal regulations rather than law enforcement. On the other hand, inland fishery is considered to be

independent of river basin management as a whole. Therefore, fisheries management would be based on local decisions instead of overall basin management efforts. Inland waters fishery cannot be considered independent of construction of roads, dams, run-of-river hydropower plants and the lack of waste treatment facilities in human settlements though.

Inland water resources are directly related to many fields of activity ranging from agricultural irrigation to drinking water, or from construction sector to energy production. Therefore, even if the problem itself seems to be related to inland waters fishery, it's in fact a water distribution problem. With the enactment of Fisheries Act (no. 1380), new legal arrangements were introduced to avoid administrative problems mentioned above. For instance, according to the Articles 7th and 9th of Fisheries Act, a special permission by the Ministry of Agriculture and Rural Affairs is required for any beneficial use of inland water sources. Measures to protect fishery products from damage are expected to be taken in planning any beneficial use of inland water sources. However, it's true that permissions for many destructive activities are taken from the Ministry every day - such as for heavy duty machines sand mining in rivers or for reservoirs and dams constructed without fish passes. In other words, everything may seem perfect legally, but there are still some serious problems in terms of law enforcement.

Almost all of the anthropogenic problems discussed in the previous section are actually caused by the lack of law enforcement. After all, discharge of untreated municipal waste to freshwaters can not be legally permitted in Turkey or elsewhere in the world. It's indeed banned by our laws, and there are severe penal sanctions for those who violate the discharge ban. However, almost all of the country's domestic waste is discharged into natural water resources without any treatment, but only a handful of people/institutions are punished nation-wide for violating the ban within a year.

Fishery management in Turkey is carried out by the Ministry of Agriculture and Rural Affairs under the Fisheries Act (no.1380), various regulations based on this law, and notices issued every two years. If we examine these notices through a historical perspective for the last 20 years, we would be faced with quite interesting results. If Table 2 and Table 3 are taken together as given above, it can be seen that the total catch of some inland fish species decreases on a regular basis each year. Our fishery management authority is highly developed today in terms of experience, tools & equipment and personnel when compared to 20 years ago. There were no personnel who had completed undergraduate education on aquaculture back then, but the number of aquaculture engineers reached up to tens of thousands today. Aquaculture Notices that regulate fishing in seas and inland waters are now regularly issued. If we examine records kept by the Ministry of Agriculture and Rural Affairs,

there seems to be no control and inspection deficiency observed on their part. How to explain the continuous decline in total catch of some inland fish species over the years then? In 1980s, fishing was either partly or entirely prohibited, or there were some species-specific restrictions in 1300 natural lakes, ponds, dam lakes and rivers listed in the Fisheries Circular. We don't have such a big number today, but considerable restrictions still continue. From this perspective, we get the wrong impression that fishing sector is well-controlled in Turkey. Statistics released by Turkish Statistical Institute tells us just the opposite though. Some species lose their statistical ranking, and many of them would never go back where they were before. What is the reason for that? People become more educated, the number of experts on fishery products increases, and control tools develop a little more each year. So, how to explain the reason for our inland water resources – small enough to be controlled easily with the largest of which is 3712 km² - to diminish then?

Finding the answers to these questions will lead to a new era in Turkey with respect to inland waters fishery. Of course, we will not be able to find a single answer to such complex issues which have been ongoing for several decades. But in this article we can easily put forward that current legal regulations are not properly enforced. We have to accept the fact that no control over inland fisheries management is done efficiently. The majority of the requested permissions for all kinds of interventions to be conducted in freshwaters are not based on-site inspections and assessments.

There is no centralized fisheries management authority in Turkey, which is the main source of administrative problems related to fisheries management - an open secret that everyone knows about. However, even if the Directorate General of Fisheries was established as of today as a sole regulatory authority, a sudden break from current practices in general within a short period of time would be unrealistic. So, fisheries management in fact must be seen as part of a whole in order to solve administrative problems related to inland fisheries. If we can improve our overall fisheries management policies, we will be able to make a progress in terms of inland waters fishery. One thing to remember here is the fact that inland waters are sensitive aquatic systems and there is a risk of total collapse for inland waters fishery today due to the above-mentioned reasons. For the time being, the only way to avoid this risk seems to be the effective enforcement of current laws and adoption of basin-oriented approaches regarding inland fishery problems.

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CLASSIFICATION OF COMMERCIAL FISHING GEARS AND METHODS IN TURKISH FISHERIES

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1. Introduction

A foremost difficulty facing fisheries management in Turkey is the fact that fishing gears have not yet been classified in line with scientific basis and international standards. It is known that a gear may have a different name in different areas or in some areas only those gears specific to the region are being used. This situation significantly obstructs the desire to set general regulations in fisheries. Therefore this study seeks to make a classification of basic fishing gears used throughout Turkey in order to overcome these difficulties at least to some extent.

Various classification methods are used in the classification of fishing gears for type, shape, materials and methods that may be mutable, even statistically for data collection purposes. Therefore it is essential to mark the objective of the classification when separating groups of fishing gears.

Although there are many studies in Turkey as to how marine products are caught and which gears are used, these studies are mostly populated with the general structures of the gears and methods of usage. Often the information is denoted with local nomenclature, and sometimes a single gear may be referred to in different local names which especially complicates the management of fisheries and causes multiple confusions and hardships in the administration of decisions taken or required for management. Indeed, in the 2002 second stated meeting of National Fisheries Advisory Board, which TAGEM¹ is also a member, held on 9th July 2002, some concepts used in fisheries proved to be controversial and it was agreed that the definitions thereof should be clarified.

Turkish fisheries display characteristics of coastal fisheries that depend on small-scale fisheries. The fishing fleet mainly consists of boats 6.5 to 7 meters or smaller in length. However there are larger boats with 45 to 50, or even 60 meters of length for industrial fishing such as purse seines and trawls.

This article tries to make a systematic classification of some of the primary fishing gears according to FAO and EU standards (von Brandt, A.,

¹ General Directorate of Agricultural Research

Gartenbach, L.P.D. Classification, Definition and Codification of Fishing Gear Statistics, FAO Fisheries Circular) with technical drawings for some of these important gears.

There are also some publications in the form of textbooks for fishery faculties where fishing gears are discussed in a number of ways. Some include “Balıkçılık Tekniği/Fishing Technique” (T. Mengi, 1977), “Su Ürünleri Avcılığı ve Av Teknolojisi/ Fisheries and Fishing Technology” (S. Sarıkaya, 1980), “Balıkçılık (Av Araçları ve Avlanma Yöntemleri)/Fishing (Fishing Gear and Methods)” (H. Hoşsucu, 1991), “Av Araçları ve Avlanma Teknolojisi/Fishing Gear and Technology” (S. Çelikkale, E. Düzgüneş, F. Candeğer, 1993), Av Araçları ve Yapım Tekniği/Fishing Gear and Construction Technique (O. Taşdemir and C.E. Özyurt, 2004), Türkiye’de Balık ve Balıkçılık/Fish and Fishery in Turkey (Deveciyan, K, 2006) and “Ağ Yapım ve Donam Tekniği/Fishing Gear Design and Construction Technique” (A. Tokaç, 2010). Nonetheless, in “Ege Denizi Balıkçılığı”/ first published in 2010, contains in-depth information on the classification and technical schemes of fishing gears used in the western coast of Turkey (Tokaç *et al.*, 2010).

Among other noteworthy publications in which technical data and classification of fishing gears are provided are Fish Catching Methods of the World (A. vBrandt., 1984), Catalogue of Small-Scale Fishing Gear (C. Nedelec, 1975), Definition and Classification of Fishing Gear Categories (C. Nedelec., J. Prado, 1982), Outline of Fishing Gear and Method (M, Nomura, 1978), Fisheries of Australia (P, Pownall, 1979) and Commercial Fishing Methods (C.J. Sainsbury , 1995).

The article focuses on fishing gears used in Turkish fisheries. For this purpose fieldworks were done on different dates for in situ identification, gears identified are classified systematically and technical drawings of the gear groups that fall into each category are provided along with some gears belonging to their respective sub-groups if any. Technical data referred to in composing these technical drawings were derived from interviews with local fishermen or through hands-on inspections on the gears.

2. Findings

International Standard Statistical Classification of Fishing Gear (ISSCFG) (29th July 1980) and identification and grouping regarding fishing gears used in Turkey based on FAO/ICES Fishing gears classification have been detailed below. Details of these findings have been supported with technical drawings of some gears widely used in Turkish seas for each group.

Table 1. Main Fishing Gear Categories Used in Turkish Fishery

SURROUNDING NETS

Surrounding nets with purse line (one-boat operated purse seine)

1. Operated by mechanically
 - Anchovy-sardine, gray mullet, bonito, mackerel, tuna purse seiner
2. Operated by hand

SEINE NETS

1. Beach seines (hauling by fishermen via manpower to the coast)
2. Boat seines (hauling by mechanize to the boat)

TRAWLS

Bottom trawls

- Beam trawls
- Single bottom otter trawls

Midwater trawls

- Single boat mid-water trawl
- Mid-water pair trawl

DREDGES

- **Hand dredges**
- **Boat dredges**
- **Towed dredges**
- **Mechanized dredges**

LIFT NETS

Stationary lift nets (shore or shallow water)

FALLING GEARS

Manual cast nets

GILL NETS AND ENTANGLING NETS

Set gill nets

Entangling/Trammel nets

- Single trammel nets
- Double trammel nets
- Triple trammel nets

Combined (gillnets-trammel nets) nets

Encircling gill nets

Drift nets

TRAPS

Pots

Fyke nets

Stow nets

Barriers

Aerial traps

HOOKS AND LINES

1. Hooks

- **Single hook lines**
- **Multiple hook lines**
 - Vertical set lines
 - Set longlines
 - Drifting longlines
- **Trolling lines**

FISHING BY GRAPPLING AND WOUNDING

- Harpooning
- Speargun fishing

HARVESTING MACHINERY

- Fish pumps
- Mechanized dredges
- Mechanized hydraulic dredges

OTHER FISHING GEARS

RECREATIONAL GEARS

OTHER UNKNOWN OR UNCODED GEARS

2.1. Surrounding Nets

Surrounding nets mainly divide into two groups as with purse line (one boat and mechanically operated purse seine) and without purse line (operated by hand).

Purse seines in Turkey are used along with a boat mostly for anchovy-sardine purse seines (Figure 1), gray mullet purse seines, bonito purse seines, mackerel purse seines, tuna purse seines and *voli* purse seine. Purse seines are extremely large nets that are used first to surround the pelagic schools by the sides and later at the bottom. Construction of a purse seine net require many days of work and manpower (Figure 2).

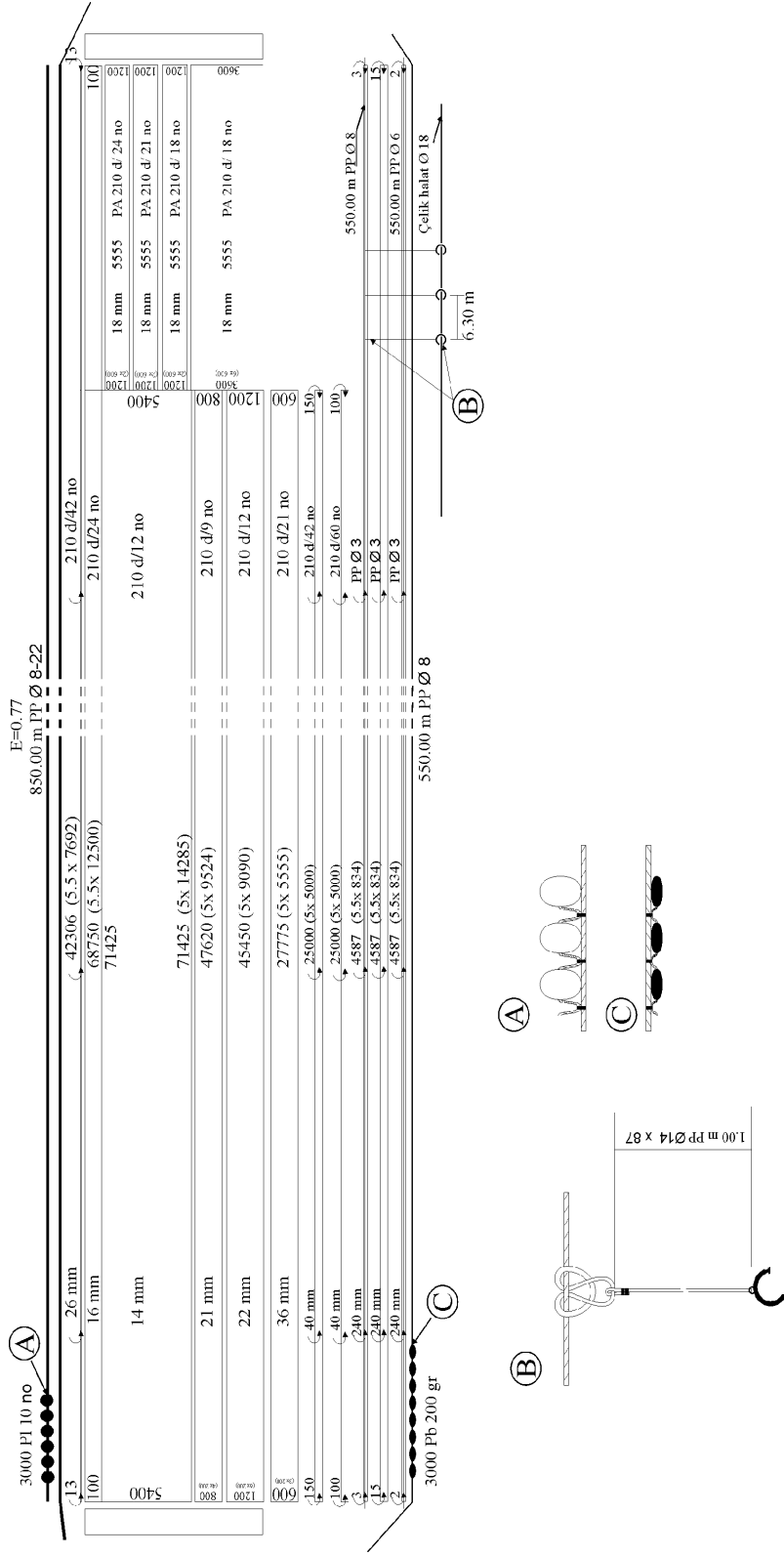


Figure 1. Typical Turkish Anchovy-Sardine Purse Seine (Tokaç *et al.*, 2007)



Figure 2. Fisherman who are working in the construction and rigging of purse seine net

2.2. Seine Nets

Seine nets are fishing gears often fillets made by connecting long ropes, wings and a bag. Usage is through casting and hauling and collecting marine creatures, especially fish captured in the net. Seine nets can be either hauled in by fishermen via manpower to the coast or by mechanized pulleys to the boat. They are named according to their sizes and structures respectively as *manyat* (middle seine net), *tarlakoz* (small seine net), *trata* (Figure 3) and *ıgırp* (seine netting) in Turkish.

Although *trata* and similar seine nets are banned throughout all Turkish coasts as of 2001, such traditional nets have been used in some endemic regions with special provisional permits until recently. However the ban was extended to cover these regions in 2009 and fishing with all type of seine nets is now entirely banned (Tokaç *et al.*, 2010).

2.3. Trawls

Trawls by a loose definition are fillet-shaped nets dragged behind a boat. Active fishery is performed by filtering or towing the area. They divide into two main groups as bottom and midwater trawl nets with also respective subgroups. Trawl nets used in Turkey are usually bottom trawls, with exceptions of midwater especially in Black Sea, generally using high opening nets towed by two trawler boats for this purpose. Among bottom trawls is the beam trawl, widely used for shrimp in Marmara and Çanakkale regions.

In recent years there have been significant changes in the trawl nets used in Turkish seas. Besides traditional otter trawl nets with 600 or 900 meshes (Figure 4) known as the “Ottoman trawls” by the fishermen and used for years, other trawl nets are becoming widespread such as some bottom nets modified from traditional trawls and those of Atlantic style.

2.4. Dredges

Dredges, especially used for mussel fishing are divided into two; those hauled behind the boat (towed dredges and mechanized dredges) or manually (hand dredges).

2.5. Kaldırma Ağları (Lift Nets)

The most widely used gear in Turkey within this group is the stationary lift net subgroup used in shallow waters and shores (Figure 5).

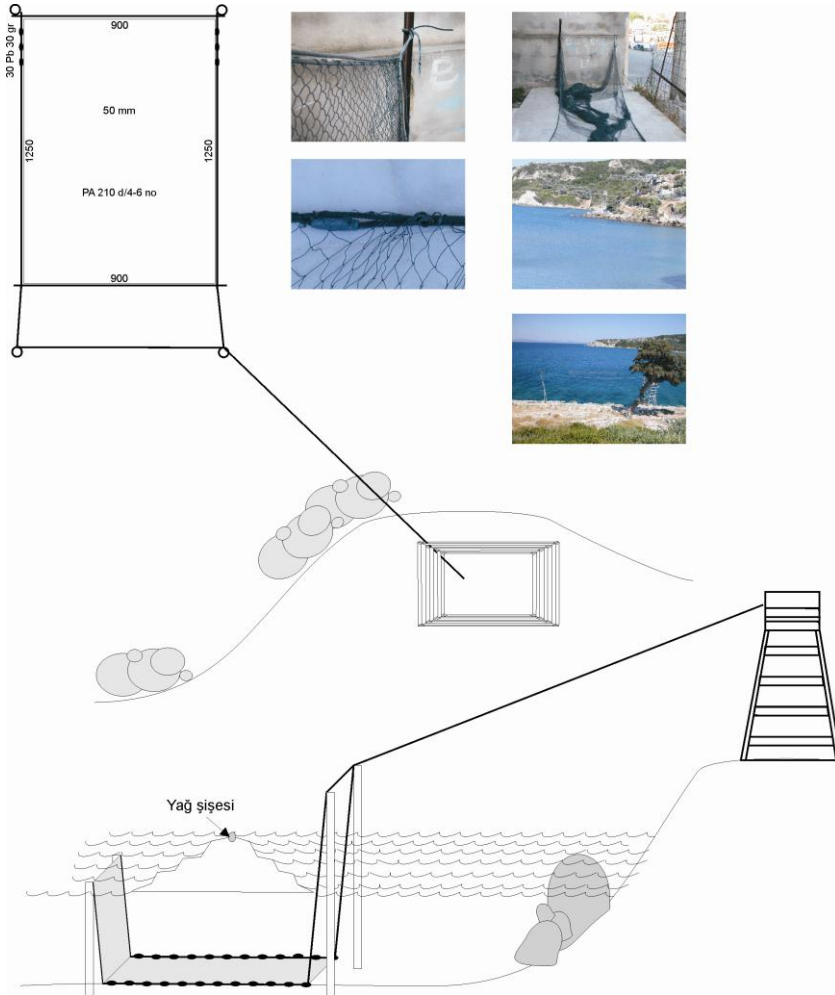


Figure 5. Illustration and drawing of traditional Turkish stationary lift net (Tokaç *et al.*, 2010)

2.6. Falling Gears

Falling gears divide into manual cast nets and falling nets. As of yet there's no evidence as to the usage of falling nets in Turkey, however cast nets are widely used especially in lakes and rivers (Figure 6).



Figure 6. Manuel cast net (Photo: Dr. M. Sürer/aris)

2.7. Gill Nets And Entangling Nets

Gillnets have the most variety among fishing gears. Studies reveal 39 variations of gillnets under 5 main subgroups customized for targeted species. Classifications of these nets are shown in Table 2.

Table 2. Types of nets identified for Gill nets and Entangling nets

GROUPS OF GILL NETS AND ENTANGLING NETS	NET EXAMPLES IDENTIFIED
SET GILL NETS	1. Red mullet set gill net 2. Redmullet (monofilament netting) 3. White shark set gill net 4. Chup mackerel set gill net 5. Shark set gill net 6. Bogue set gill net 7. Bluefish set gill net 8. Saddled bream set gill net
—Set gill nets are stationary nets on stakes, also known as “fixed gill nets” generally cast in the evening and hauled in the morning by “ <i>dönek</i> ” method. However sometimes these may be used by	

Table 2. Continued

fishermen in some small inlets and inner bays by casting them and later scaring the fish towards the net by making noise. Nets utilized for this purpose are called “ <i>voli</i> ” gill nets, and the procedure, “ <i>voli</i> ” fishing.			9. Red sea bream set gill net
			10. Bonito set gill net
			11. Sardine set gill net (Figure 7)
			12. Twaite shad set gill net
			13. Frigate tuna set gill net
			14. Sea bream set gill net
			15. “ <i>Voli</i> ” set gill net (Figure 8)
			16. Garfish set gill net
ENTANGLING NETS			Single Trammel Nets
— Entangling nets have 3 subgroups which are single, double and triple netting walls, also known as trammel nets. Of these, trammel nets have the most variety and widest usage. Trammel nets also divide into two as single framework netting and multi-framework netting			1. Lobster trammel net
			2. Turbot trammel net
			3. Albacore tuna trammel net
			4. Sturgeon trammel net
			Double Trammel Nets
			-
			Triple Trammel Nets
			<i>Single Framework Trammel Nets</i>
			1. Octopus-squid trammel net
			2. Red mullet trammel net
			3. Lobster trammel net
			4. Sole trammel net
			5. “ <i>Dönek</i> ” trammel Net
			6. Thick Net
			7. Shrimp trammel net (Figure 9)
			8. Gray mullet trammel net
			9. Gray mullet- sea bream-sea bass
			10. Sea bass
			11. “ <i>Marya</i> ” Net
			12. Sea bream, red sea bream-shark trammel net
			13. Sea bream trammel net
			14. Squid-cuttle fish trammel net
			15. “ <i>Stone</i> ” Net
			16. “ <i>Voli</i> ” trammel net
			<i>Multi-Framework Trammel Nets</i>
			1. Bluefish trammel net (Figure 10)
			2. Shrimp trammel net
			3. “ <i>Voli</i> ” trammel net
COMBINED (GILL NET-TRAMMEL NET) NETS			1. Bogue combined net (Figure 11)
			2. Bluefish combined net

Table 2. Continued

ENCIRCLING GILLNETS	1. “ <i>Alamana</i> ” nets (Figure 12)
— “ <i>Alamana</i> ” nets are used mainly for bluefish and small bluefish but are also used for big-scale sand smelt, sardine and garfish.	2. Bluefish “ <i>Alamana</i> ” net
DRIFTNETS	1. Sword fish drift net
	2. Bonito (drift) net

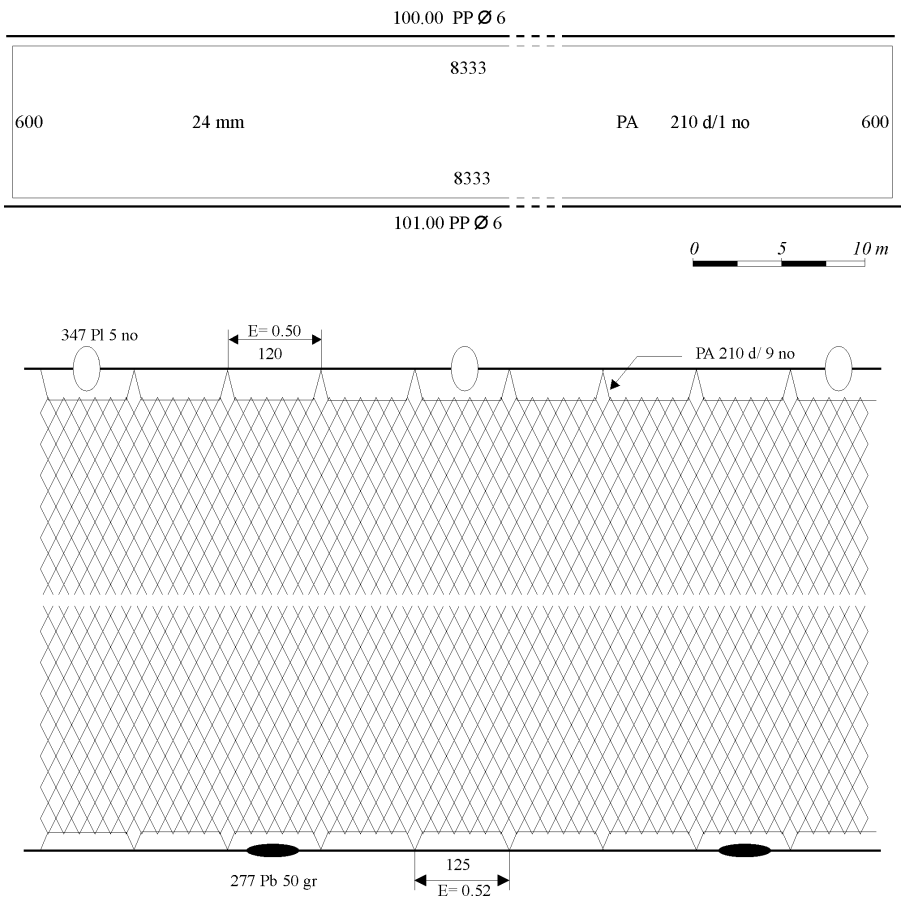


Figure 7. Drawing of sardine set gill net (Tokaç *et al.*, 2010)

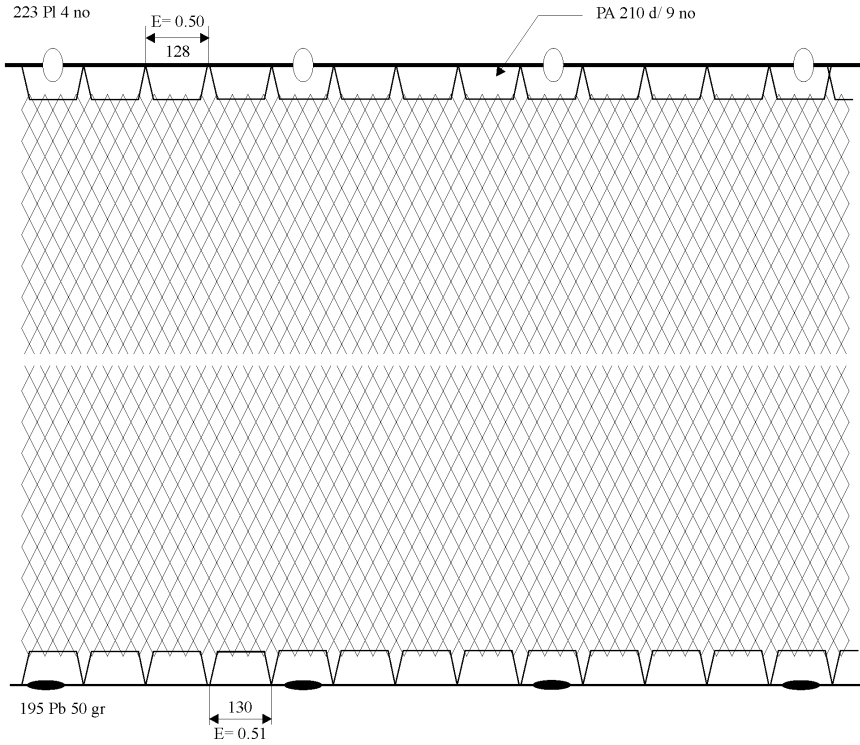
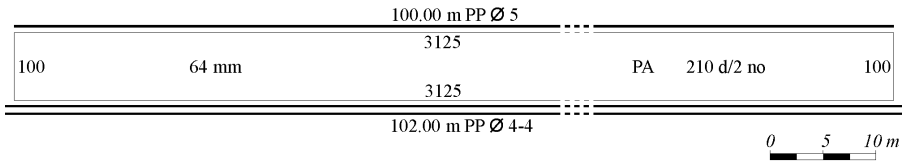


Figure 8. “Voli” Set gill net (Tokaç *et al.*, 2010)

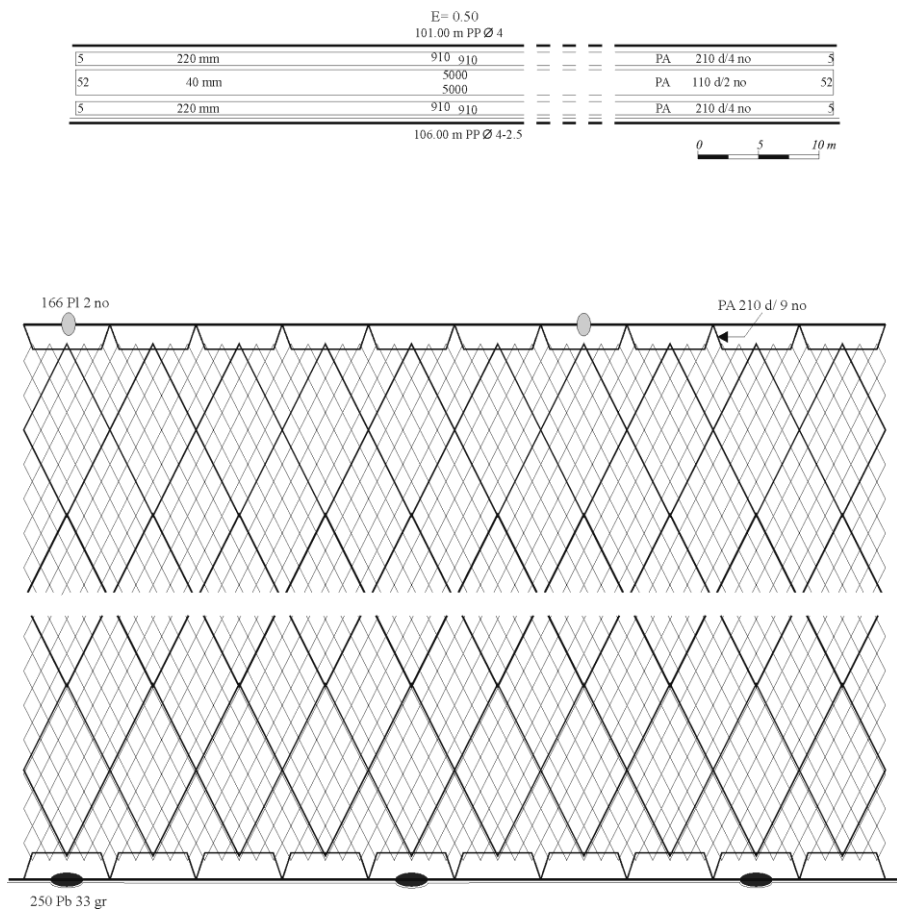


Figure 9. Shrimp trammel net (Tokaç *et al.*, 2010)

Figure 10. Bluefish trammel net (Tokaç *et al.*, 2010)

		100.00 PP Ø 5			
120	40 mm	5000	==	PA 210 d/2 no	120
		5000	==		
13	280 mm	714	==	PA 210 d/6 no	13
		714	==		
120	40 mm	5000	==	PA 210 d/2 no	120
		5000	==		
13	280 mm	714	==	PA 210 d/6 no	13
		714	==		
		100.00 PP Ø 4			

0 5 10 m

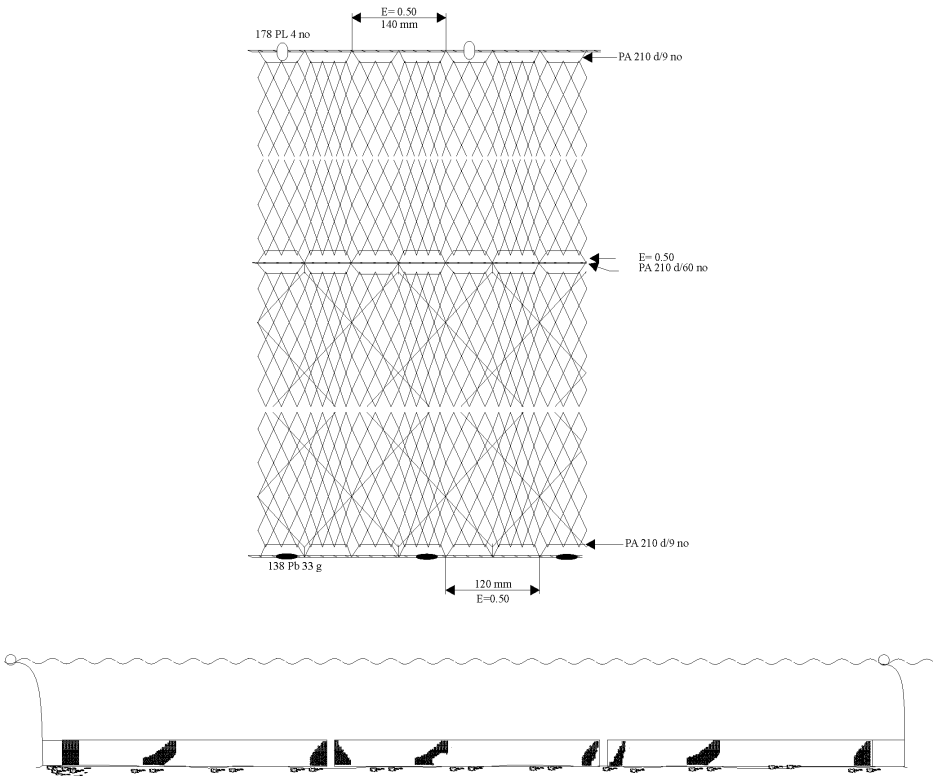


Figure 11. Bogue combine (gill net-trammel net) net (Tokaç *et al.*, 2010)

2.8. Traps

Traps are passive fishing gears with or without bait designed to work by making use of fish behaviour. Primary types are pots, fykes, bush stows, barriers and aerial traps. All traps have various materials depending on the locale they are used. They are convenient both for commercial and recreational fishing. Pots (Figure 13) are generally used for recreational fishing activities while fyke nets (Figure 14) are preferred for commercial fishing.



Figure 13. Pot used for generally amateur fishing activities (Ayaz ve diğ., 2006)



Figure 14. Fyke nets used for generally commercial fishing activities (Tokaç *et al.*, 2010)

2.9. Hooks and Lines

Hooks and lines fishing is a traditional and important fishing method with a great variety of usage. Respective classification of prevailing gears is given below.

1. Hooks
 - 1.1. Single hook lines
 - 1.1.1. Mackerel line with fish shaped lure
 - 1.2. Multiple hook lines
 - 1.2.1. Hanging line
 - 1.2.2. Squid line
 - 1.2.3. “*Cyprus*” line (Figure 15)
 - 1.2.4. “*Kateti*” line
 - 1.2.5. Vertical set lines
 - 1.2.5.1. Throwing vertical set lines
 - 1.2.5.1.1. Horse mackerel vertical set lines (Figure 16)
 - 1.2.5.1.2. Bonito vertical set lines
 - 1.2.5.1.3. Chup mackerel-mackerel vertical set lines
 - 1.2.5.2. Pelagic vertical set lines
 - 1.2.5.2.1. Bluefish vertical set lines (Figure 17)
 - 1.2.5.3. “*Parangula*” (Octopus vertical set line)
 - 1.2.6. Set Longlines
 - 1.2.6.1. Thick set longline
 - 1.2.6.2. Sea bream set longline
 - 1.2.6.3. Thin set longline
 - 1.2.6.4. Thin set longline with cork
 - 1.2.6.5. Swordfish set longline (Figure 18)
 - 1.2.6.6. Red sea bream set long line
 - 1.2.6.7. Gilt head sea bream set longline
 - 1.3. Trolling lines
 - 1.3.1. Spoon line
 - 1.3.2. Spinner line
 - 1.3.3. Plug line
 - 1.3.4. Minnow spoon, twister, shad, spinnerbait, dead-bait spinnig tackle etc.

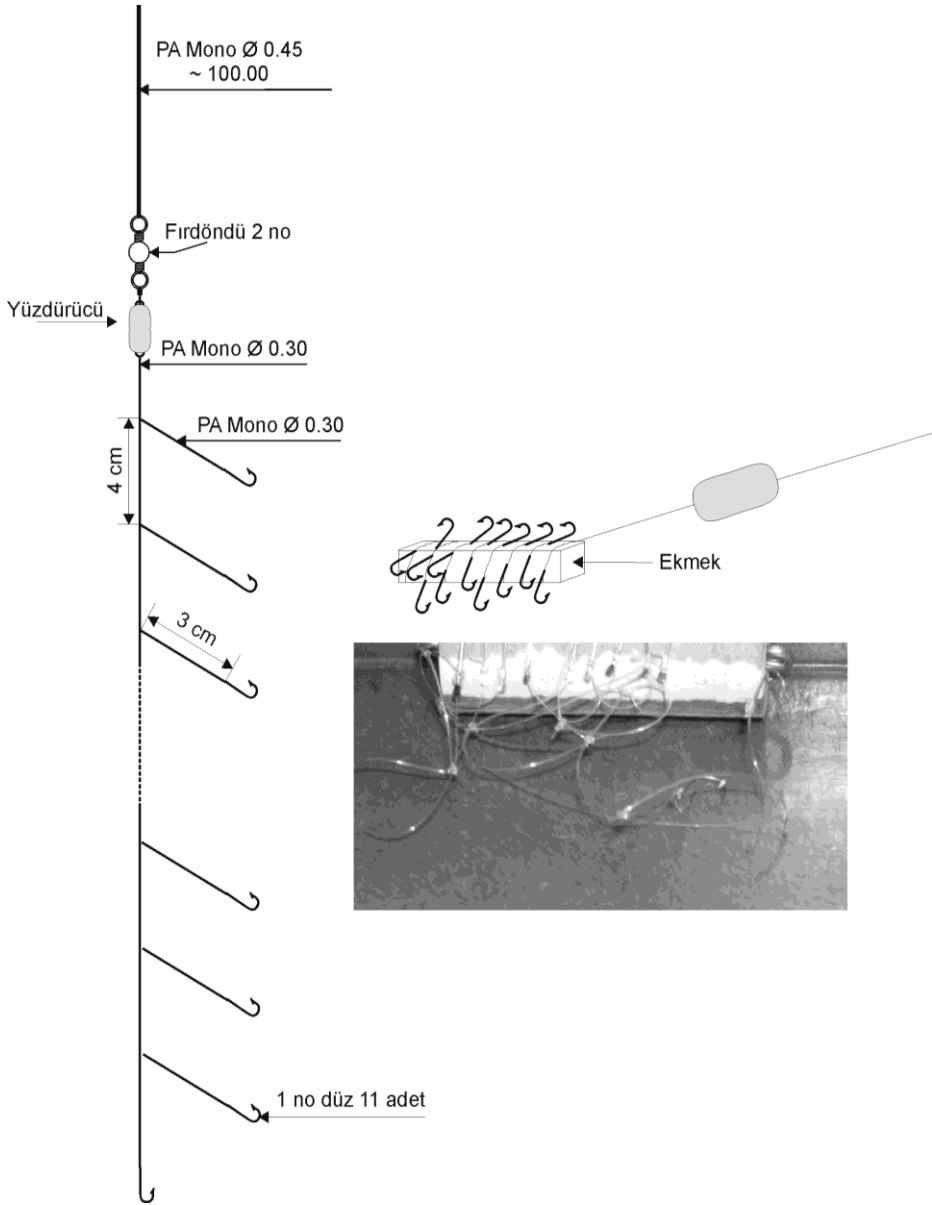


Figure 15. “Cyprus” hand line (Tokaç *et al.*, 2007)

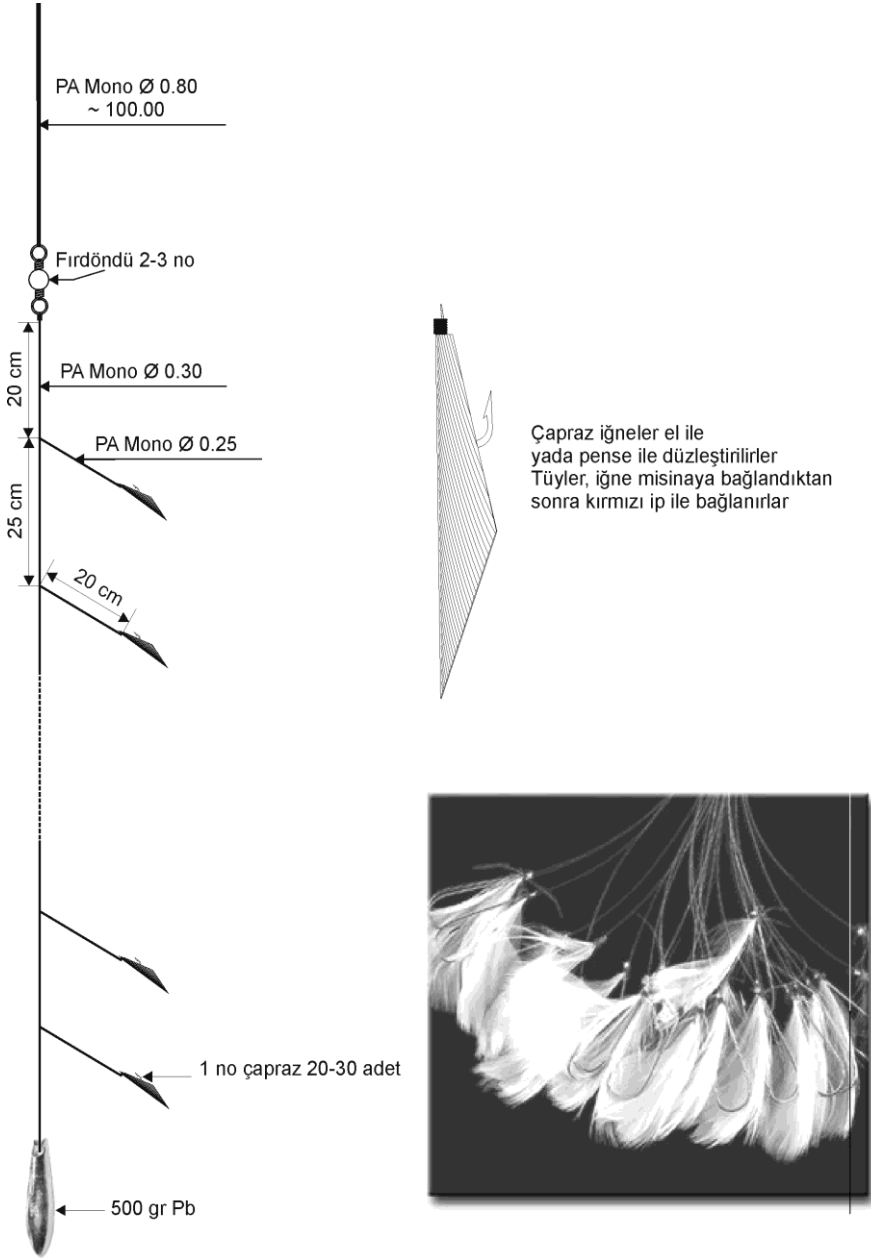


Figure 16. Horse mackerel vertical set line (Tokaç *et al.*, 2010)

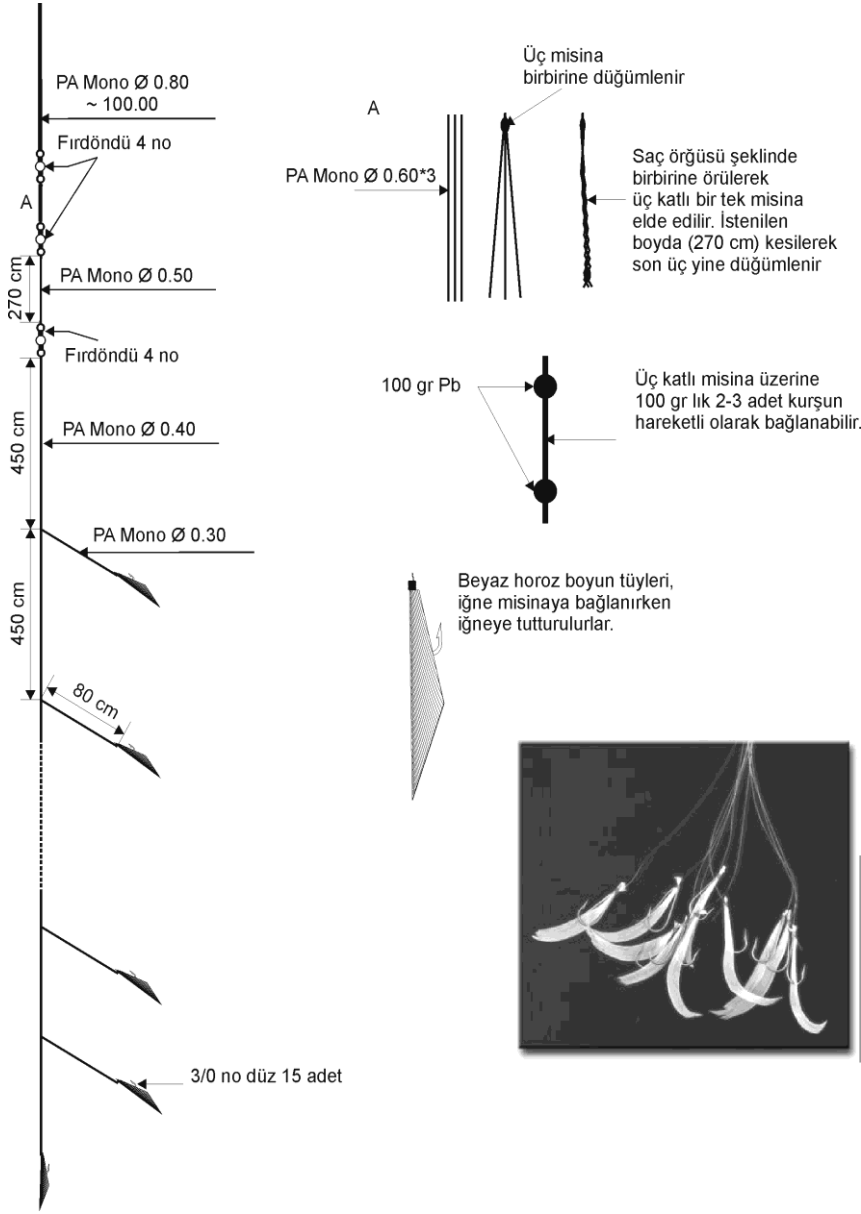


Figure 17. Bluefish pelagic vertical set line (Tokaç *et al.*, 2010)

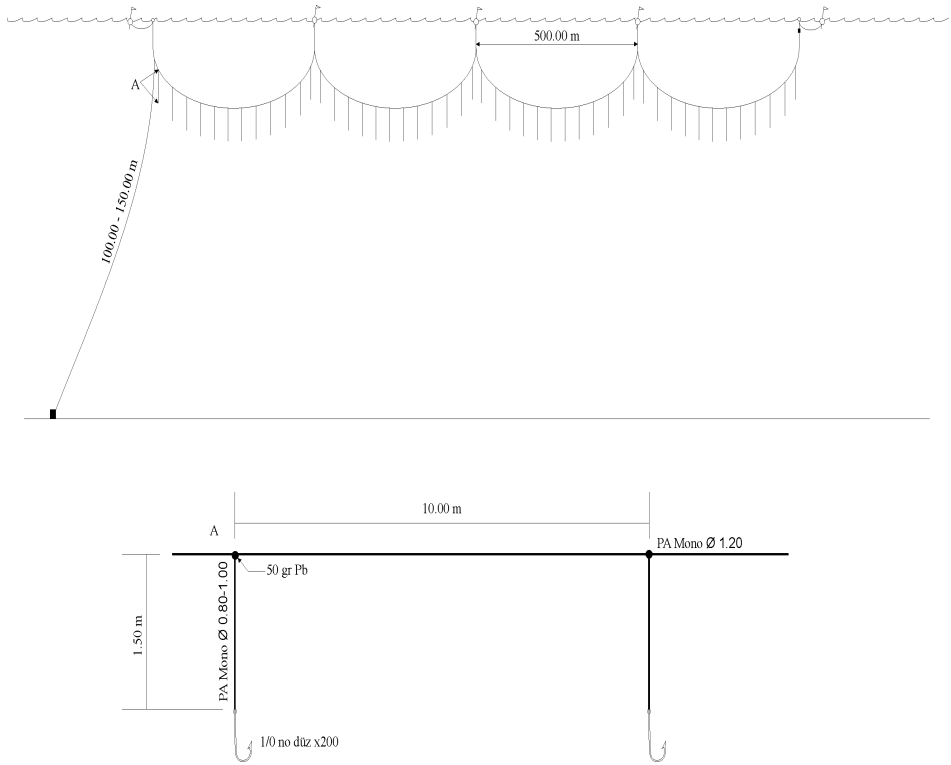


Figure 18. Swordfish set longline (Tokaç *et al.*, 2010)

2.10. Fishing by Grappling and Wounding

Harpoon and speargun fishing are included in this group. They are more frequently used for recreational fishing in the seas. With the 2006-2008 hunting season circular no.37/2 regulating recreational fishing in seas and inland waters, some restrictions and regulations have been introduced in regard to the usage of harpoon and speargun fishing. According to this, all harpoon and speargun fishing activities at night are prohibited. All equipment except a light source and snorkel are prohibited such as all kinds of artificial respiratory source, tube, hookah, all kinds of respiratory devices and spare air source. Harpoon and speargun fishing for groupers is prohibited as well.

Spearfishing for swordfish is also common, however the harpoon used for swordfish is different in design. It consists of two parts; a steel, sharp and barbed spearhead and a pole with a long handle. The barbs on the harpoon are closed while penetrating the body of the fish and open when pulled back, allowing the harpoon to remain where it is thrust. As the speared fish struggles

to run away, the rope attached to the harpoon should be released a little to prevent resistance. Tired fish is then pulled to the boat.

2.11. Harvesting Machinery

Fish pumps, mechanized dredges and the likes are classified in under this group. Fish pumps are gears designed to drive the surrounded fish from the net to the boat or from boat to harbor with water via the suction created by a motor. Evidently, however, they are used indirectly in industrial fisheries, by purse seiners in particular, to land the fish packed between the net aboard conveniently. Nonetheless, there are also pumps used in farming facilities designed accurately to transport live fish between tanks. Mechanized hydraulic dredges are generally used for mussel fishing in Dardanelles and Western Marmara regions.

2.12. Other Fishing Gears

Methods used in this group are hand-picking, scooping, manually operated shore seines, hand fishing with simple tools with or without diving gear, fishing with explosives or poisons with anesthetizing or pestilent effect, fishing with some trained animals and electric fishing.

2.13. Recreational Gears

Gears such as handlines and pots used in recreational (sport/hobby) fishing fall into this group.

2.14. Other Unknown or Uncoded Gears

It is a known fact that gears used for fishing come in great variety. Sometimes there are local gears that have not yet been spread. Therefore this group consists of gears that are unknown or have yet to be identified according to the International Standard Statistical Classification of Fishing Gear (ISSCFG) (29th July 1980).

3. Discussion, Conclusion and Recommendations

Turkish fisheries generally display coastal fishing characteristics and the fishing activities are on daily basis by leaving the home port, fishing throughout the day and returning back to the home port. Nonetheless, some long range fishing activities require longer periods in the sea such as turbot fishing with turbot trammel nets, trawling and purse seine fishing in the open sea and international waters, and tuna fishing. Turkish fisheries constitute an important industry with production quantities, production values and contribution to employment. This article provides an assessment of fishing gears used in Turkish seas according to the International Standard Statistical Classification of Fishing Gear (ISSCFG) (29th July 1980) and exemplifies some of the gears used in Turkey that fall into these classifications. Also drawings of some fishing gears widely used in Turkish have been included in order to provide tangible

information on the technical specifications of these gears which will prove helpful in the process of standardization or labeling of these gears.

As stated above, there are two main groups in Turkish fisheries. The first group is small scale fisheries performed daily around the home port with fishing lines and longlines and the second is large scale fisheries, mobile with trawls and purse seines in a larger area. Additionally recreational fishing activities are intensively carried, generally with jig lines either at the shore or by boat. Equally important are diving activities with harpoons and spearguns. Part of these recreational activities has in time become semi-commercial, adversely affecting real fishermen. A new regulation is required for recreational fisheries to protect the commercial fisherman who is already facing many problems.

Technical drawings of fishing gears reveal a great deal of the fishing activities in a region. These schemes have also been a first step for the standardization of fishing gears. In general, fishing gears have similar properties; however sometimes significant varieties of a gear have also been observed in different regions. Gears with traditional equipment and structure have maintained their features for long periods of time. In particular, gill nets and long lines have not been diversified from the traditional form except for materials which may bring some limited changes due to the newly introduced monofilament nets, knotless nets, floating ropes or lead lines. Despite the stagnancy in the small scale fisheries, noteworthy structural improvements are observed in the nets used for gill nets and purse seines in recent years. Especially in trawl fishing, traditional Ottoman trawls are replaced with those with specially modified nets. Also the use of knotless polyamide or polyethylene nets has surpassed multifilament (10 or 15 filaments) knotted lines. Buoys used in purse seiners and the way they are equipped are also changing. Along with those occurring in trawl and purse seine nets, the vessels are also undergoing significant changes. These renovations such as notable increase in the length of the vessel and the capacity of upper deck mechanization systems need to be observed closely since each development in the fishing gears and vessels suggests an increase in both fishing efforts and pressure on fishery.

Lastly, the primary need is an inventory to assess how much and how diverse the gears used in the Turkish fishing fleet are, and later, standardization and labeling steps should then be taken gradually.

Acknowledgement

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THE BLACK SEA FISHERY

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1. Introduction

The Black Sea is an inland sea surrounded by Bulgaria, Georgia, Romania, Russian Federation, Ukraine, and Turkey, and its fishing sources are shared by these countries. The lengths of the Black Sea coast of these countries are as follows: Bulgaria 354 km, Georgia 315 km, Romania 225 km, Russian Federation 475 km (including the sea of Azov), Turkey 1329 km, and Ukraine 2782 km (including the sea of Azov).

Of all the Black Sea coastal countries, Turkey had the highest share in the amounts of the products gathered only from the Black Sea fishing and farming in 2008 (FAO, 2010). While the total product obtained from the Black Sea by fishing is 48.13 % in Turkey, it is 32.70 % in Ukraine, 10.08 % in Russia, 4.14 % in Georgia, 2.78 % in Romania, and 2.17 % in Bulgaria.

In the Black Sea which is among the shared stocks, there are 1261 Bulgarian fishing boats, 7308 Turkish, 880 Romanian, 2912 Russian (including high sea fisheries), 324 Georgian, and 2300 Ukrainian fishing boats (FAO, 2010). According to the number of the ships in the Black Sea, Turkey seems to have the most powerful fishing fleet.

16% of the total length of the coast of Turkey and 65 % of the total fisheries production are covered in the Black Sea. As for the fishing fleet capacity, 35.45% of 16,815 fishing boats (except for those > 5 m) in Turkish seas and inland waters are in the Black Sea. Considering the length of the coastal area, the amount of the fish caught, and the fishing fleet capacity, the Black Sea is the most important fishing area of Turkey and surrounding countries.

2. Fishery Production

Turkey also has the diversity of fish species in four surrounding seas with different characteristics. There are 240 fish species in the Black Sea, 200 in the Marmara Sea, 300 in the Aegean Sea, and 500 in the Mediterranean Sea. However, the number of the seafood species with economic value is about 100. In addition to the pelagic and demersal fish, crustaceans, molluscs, and other species are fished in our seas as well (Çelikkale *et al.*, 1999).

The amount of aquatic products from the Black Sea is in direct proportion to the amount of the total aquatic products of Turkey. Because about

65 % of Turkey’s total aquatic products output is provided from The Black Sea (Figure 1).

The distribution of some fishing activities in the Black Sea by the region and species is given in Table 1. The high economic value of aquatic products from the Black Sea include anchovy, sprat, horse mackerel, bonito, bluefish of pelagic species; red mullet, whiting, turbot of demersal species; and marine snails and sand mussels of crustaceans, respectively

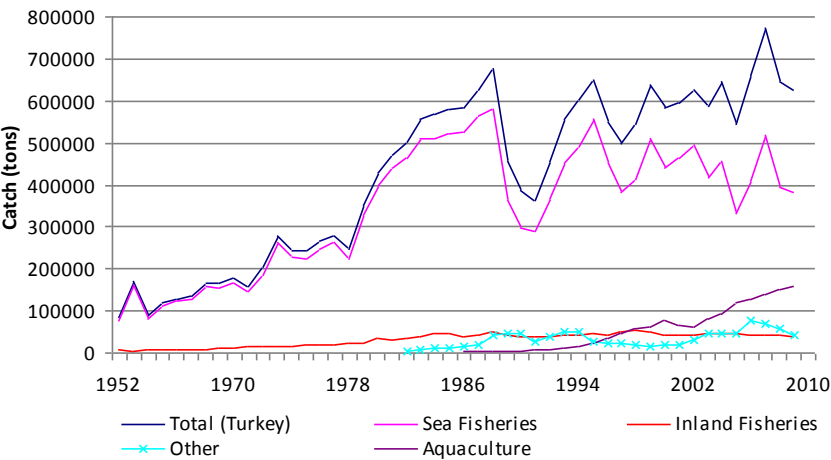


Figure 1. Turkey’s total aquatic products (1952 – 2010)

Table 1. According to region and species distribution, some of the fishing activities in the Black Sea

Fisheries	Area	Species
Purse seine	Especially Eastern Black Sea, All Black Sea	Anchovy Horse mackerel Bonito Sprat Garfish Mullet Twait shad
Bottom Trawl	Western and Middle Black Sea	Red mullet Whiting Turbot Picarel
Middle Trawl	Middle Black Sea	Anchovy Sprat Horse mackerel

Table 1 continued

Long line	All Black Sea	Bonito Garfish Twait shad
Trammel nets	All Black Sea	Whiting Red mullet Turbot
Manual cast nets	All Black Sea	Whiting
Mechanized dredges	Western Black Sea	Striped venus
Dredge	Eastern Black Sea	Sea snail
Hand line	All Black Sea	Horse mackerel Blue fish Garfish Mullet
Spears	All Black Sea	Mullet Brown meagre Sea bass

2.1. Pelagic Species

Most of the production of marine products in Turkey, especially anchovy, bonito, mackerel, sardines, and bluefish, are provided from pelagic species. In 2009, pelagic species constituted 71 % of the total fisheries production.

2.1.1. Anchovy

Engraulis (anchovy) type of species usually live in all tropical and sub-tropical seas. They form schools mainly in coastal parts and sometimes get into the river mouths. Anchovy is a small-sized 3-4 years of life pelagic fish which is abundant in the Black Sea and Azov Sea but rare in the Mediterranean Sea. Anchovy is claimed to be represented with two sub-types of fish in the Black Sea. These are *Engraulis encrasicolus ponticus* and *Engraulis encrasicolus maeticus*. Besides these two sub-types, a hybrid of them is mentioned (Bingel, 2010). The Black Sea anchovy is named as *Engraulis encrasicolus ponticus* and it is about 18-20 cm (Slastenenko, 1955/56 and Fischer, 1973). The second type, *Engraulis encrasicolus maeticus*, is known as Azov anchovy and it grows up to 15 cm (Slastenenko, 1955/56).

Azov anchovy (*Engraulis encrasicolus maeticus*) feeds in the Azov Sea and goes to the Crimean coast and to the south through the Caucasian coast, usually to Suchumi and sometimes to Turkish coast for wintering (Tchashchin, 1990).

According to Ivanov and Beverton (1985), the Black Sea anchovy migrates to the northern part of the Black Sea, especially to the north-west shelf

area, for spawning and feeding. With the start of cold weather, the anchovy fed and spawned in the north move down to the South to Turkish coasts. Depending on the temperature, migrations are to the South from October to November or December, and to the north in February, March, and April. Depending on the speed of the water temperature rise and fall, the migration of the anchovy is either along the coast (slow change in temperature) or directly across the sea (rapid change in temperature). Moving to Turkey's Black Sea coast (especially to the Eastern Black Sea) to overwinter, anchovy forms schools with the cooling of water and its fishing is mostly done there. Anchovy fishing is made with purse seine and mid-water trawls. Generally consumed fresh, anchovy is also processed in large amounts at fish meal oil factories. It is processed and exported to European countries in recent years.

According to TUIK (2010) data, Turkey's total aquaculture production from marine fisheries was 380.865 tons in 2009. 239.703 tons of this production from Eastern Black Sea, 38.000 tons from Western Black Sea, 277.703 tons in total were obtained from the Black Sea. Anchovy constitutes 67% of the Black Sea fisheries and 49% of Turkish fisheries. Anchovy provides 73% of total fisheries production of sea through fishing (Figure 2). Therefore, any change in the distribution of anchovy and the quantity of fishing in any fishing season has an important effect on total annual fishing amount.

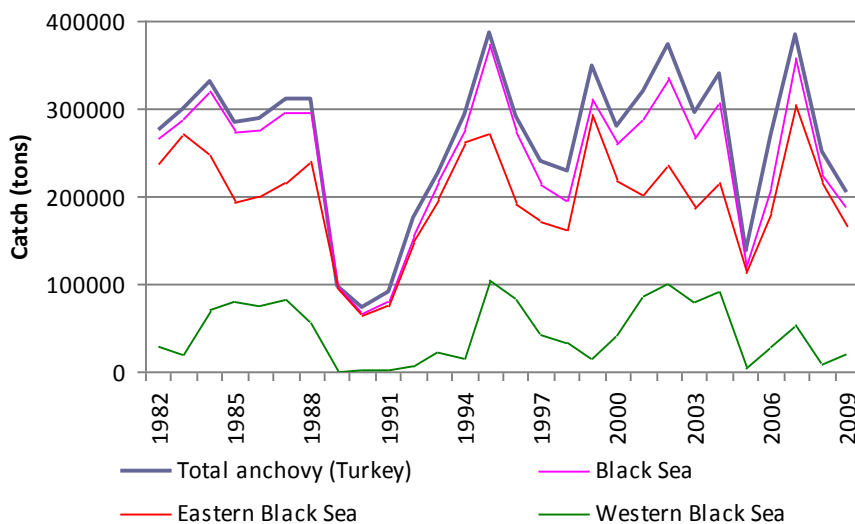


Figure 2. Quantity of caught anchovy (1982-2010)

Oğuz (2010) has reported that the increase in small-sized pelagic fishing in the Black Sea from 100 thousand tones to 300 thousand tones in 1970s was due to the collapse of demersal species, dolphins, and some large fish stocks in top of the food chain because of overfishing, and due to the relative reduction

of feeding pressure on sub-pelagic groups, which caused some fish such as anchovy and sprat fed with smaller and less valuable plankton to become dominant predator species in the ecosystem. It is seen that small pelagic fishing amount increased from 300 thousand to 600 thousand tones in the period of 1979- 1982 following the first increase and this fishing level was protected until 1988 despite increasing fishing pressure (Figure 3).

As small pelagic fish became the target of industrial fishing towards the end of 1980s, fish size became increasingly smaller, stocks decreased, and annual production could not meet the consumption. As a result, the amount of small pelagic prey levels decreased from 600 thousand to 300 thousand tones in 1989 and to about 100 thousand tones in the period of 1990-1991 (Figure 1). The collapse of small pelagics with excessive increase in fishing pressure led the fishing values of medium-sized pelagics to decrease from 125 thousand tones to 25 thousand tones again in the period of 1991-1993 (Figure 3).

That the collapse of small and medium-sized pelagic fish stocks emerged at the same time and in all regions of the Black Sea suggests that other factors such as eutrophication, climatic effects, *Mnemiopsis* population explosion as well as overfishing have been effective in that case. (Oğuz *et al.*, 2008).

According to long-term changes in the value of fishing in Figure 3, medium-sized pelagic fish did not get into the recovery process in the Black Sea following the collapse in the period of 1990-1992, and the amount of total catch remained consistently below 25 thousand tones as in the period before 1970. In addition, there was not any increase in demersal species after the collapse in 1970s and the total amount of fishing was consistently below the limit of 25 thousand tones. Besides, there were not any positive changes in the fishing of pelagic species longer than 90 cm, and their fishing amount was between 5000-35000 tones in the period of 1950-2006. As can be seen in Figure 1, only smaller pelagics were in a relative recovery process following the collapse and the fishing amount reached half of the values of 1980 period (250.000–400.000 tones).

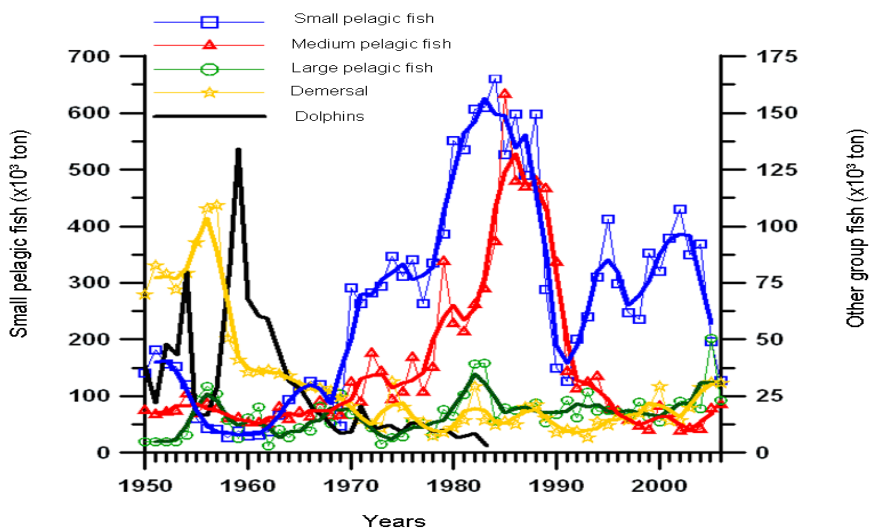


Figure 3. Changes in fishing in 1950-2006 period over dolphins, demersals, small, medium, and large size groups of pelagic fish. Thick lines indicate filtered changes based on triple moving average. Small pelagic prey values are shown on the left axis and the values for other groups are given on the right axis (from Oguz, 2010).

When looked at regional variations in the amount of small pelagic prey, it is seen that a very big part of it occurs along the southern coast in Turkey-Georgia sector and it is realized that the total amount of small pelagic prey in the remaining regions of the Black Sea could not get better after a period of decline in the early 1990s. (Figure 4). That is, only anchovy fishing could be performed in the southern shores of the Black Sea alone in the period of 1993–2006. At all times of 1950-2006 period in Bulgaria, Romania and Russia coasts, Anchovy fishing in private sector and the total amount of fishing in general remained very low. Fishing in coastal waters of both sides of the Crimean Peninsula and the north west continental shelf including Ukranian sector reached approximately one third of the fishing in the South in 1980s, but there was not any recovery in this region after the collapse in 1990, either. (Oğuz, 2010).

Anchovy flocks migrate to Georgian side after January. During this period, Turkish fishing boats wait in the port of Hopa, leave it for fishing and usually anchovy fishing is done in the area up to the border of Georgia. With the agreement done between the two countries, 3 or 4 boats leave for fishing every day and the others wait at the port. However, some fishing boats go fishing in Georgian waters with the special permission of the Georgian government, any they pay in return. In addition, there are some boats fishing in Abhazia region.

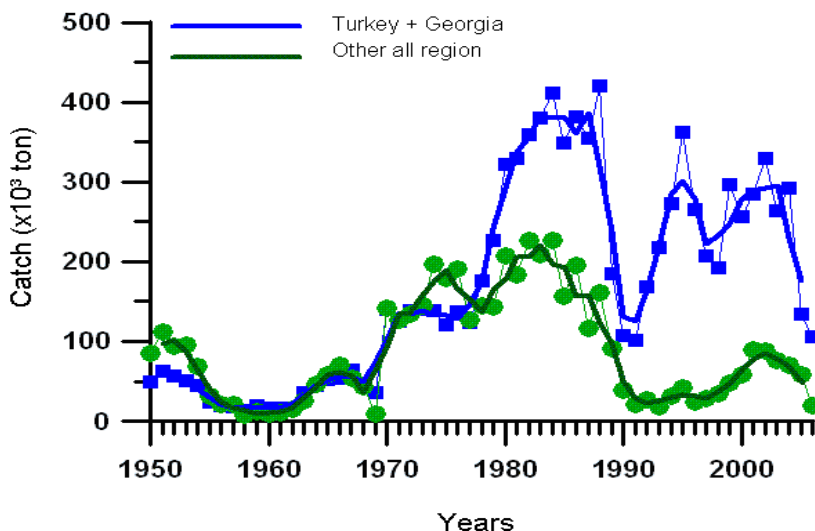


Figure 4. Total changes in the amount of small sized pelagic fish in the southern sector (Turkey+Georgia) (■) and in other parts of the Black Sea (●) by the years in 1950-2006 period. Thick lines indicate values based on triple moving average (from Oguz, 2010)

To sum up, more than 80 % of the total fishing in the Black Sea in 1993-2009 period was done only in the southern sector as small pelagic fishing aloe (anchovy in particular). The amount mentioned is about 50-60% of 1980 period and about 250000–300000 tones of production is done. Although there was a decline in fishing amount in 2005-2006 period similar to 1990-1991 period, according to the data from Turkish Statistical Institute, fishing was able to recover in 2007-2008 period.

2.1.1.1. Anchovy Fishing Regulations

According to Fisheries Law No.1380, the Ministry of Agriculture and Rural Affairs has the authority to audit and take any decision concerning fisheries. The ministry had no ban on the size of anchovy which forms 65 % of total fishing amount in our country until 1988. The bans on the size of anchovy after that year are mentioned in the circulars. With the regulations, the size was determined as 7 cm in 1988, 9 cm in 1989 and 1991, 7 cm in 1992 (25 % exceptions), and current application is 9 cm. (Kürüm, 2010).

A series of meetings on anchovy were held by the Ministry of Agriculture and Rural Affairs on 2 August, 2007 (2007-2008 fishing season), 18 July, 2008 (2008-2009 fishing season)and on 4 August, 2009 (2009-2010 fishing season), and the fishermen and the ministerial members participated in them. General decisions taken at these meetings are as follows:

- Fishing Permit is required for the fishing boats using purse seine to fish anchovy.

- Anchovy fishing is to be done between 4 pm and 6 am. (Official Paper, 19 October 2007). In addition, in the General Directorate of Protection and Control (GDPC)’s letter dated 31 October, 2007, it was reported that fishing in Georgia would not be permitted in 2007-2008 fishing season.

- Anchovies, sardines, and mackerel fish are to be carried in cases or boxes with net weight of 12 kg (+ 10%)

- A document of transport is to be prepared for all the fish to be transported at landing points

- Fisheries cooperatives are to be authorized for the editing of a transport document

- The amount of fishing will be limited for the anchovy to be marketed depending on the size of fishing boats

- Except for the ones to be marketed, annual quota will be applied for the amount to be sent to cold storage and processing facilities (Table 2)

- Size standards for the boxes to carry anchovy have been set. (Table 3)

Table 2. Quota for anchovy fishing

Wessel Lenght (m)	<15m	15– 19.99	20– 24.99	25– 29.99	30– 34.99	35– 39.99	40– 44.99	45– 49.99	>50m
Daily quota	250	300	500	600	700	750	800	850	900
Middle trawl fishing vessels engaged in fishing with each team (two boats), a total of 900 boxes or safe									
Year quota	12.500	15.000	25.000	30.000	35.000	37.500	40.000	42.500	45.000

Table 3. Size standards for the boxes for anchovy carrying

Type of Safe/Box	Lenght (cm)	Width (cm)	Depth (cm)	Feet tall (cm)
Wooden safe	52	37	7	11
Plastic safe	52	37	7	
Strafor box	54	34	11	
Note: Dimensions teeming inside. Leg length is from the ground.				

2.1.2. Horse Mackerel

A member of Carangidae family, *Trachurus* species has two types in the Black Sea; these are *T. mediterraneus* (Mediterranean horse mackerel) and *T. trachurus* (Atlantic horse mackerel) (Mater et al., 2002). Due to its taste, high fishing capacity and long fishing time, *Trachurus* is very important for fishery economics (Akşıray, 1987). As for production amount, among pelagic fish, horse mackerel is the second after anchovy in our country's fisheries. Because horse mackerel is a school forming species, it is caught with seine nets and midwater trawl of active fishing gear. However, it is reported to be fished with bottom trawls as well (Erdem, 2000). Özdemir (2006) has reported that horse mackerel is the most common economical type of prey in the Eastern Black Sea after whiting and red mullet which are the targets of bottom trawling. Horse mackerel is also caught with angles by amateur fishers. With minimum fishing size of 13 cm, horse mackerel is consumed fresh in our country (Anonymous, 2010).

Despite its importance in marine fish production, there have been great variations in the fishing amount of horse mackerel over the years (Figure 5). Although the average amount of horse mackerel catch was 102,146 tones between 1983 and 1990, it decreased to 33,848 tones in 1991, and to 29,334 tones in 1992. Despite the small variations until 1999, it was recorded as the lowest in that year with 13,220 tones (Figure 5). The sudden decrease in the amount of horse mackerel production in 1990 was in parallel with the amount of anchovy fishing (Anonymous, 1982–2010). The amount of horse mackerel caught in all our seas in 2009 was 28268 tones, 10,493 tones of which were from the Eastern Black Sea, 4,212 tones of which were from the Western Black Sea, 14,705 tones in total from the Black Sea. That is, 56 % of total horse mackerel production was done in the Black Sea. Because the amount of fishing has decreased, in recent years fishermen have started to catch the small fish of little value which have not reached to legal fishing size, and they have formed fishing pressure on horse mackerel (Dinçer *et al.*, 2007).

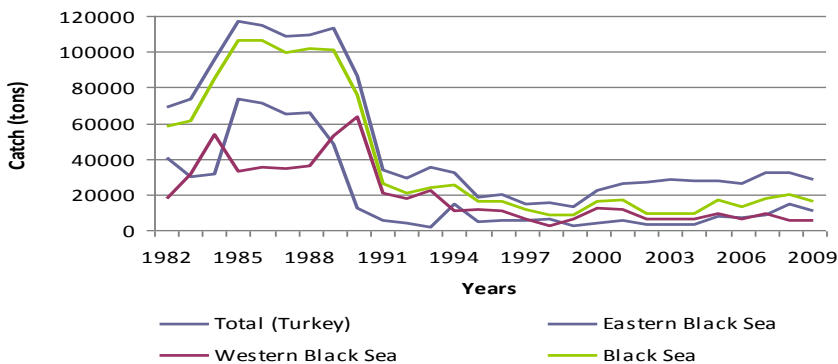


Figure 5. Quantity of caught horse mackerel (1982-2010)

2.1.3. Sprat

Sprat, which is abundant and shows a wide distribution in European shores of the Mediterranean, in Adriatic and Black Sea region in particular (Avşar, 1994), has gained great economical value in the Black Sea in the last 20 years. The sprat in the Black Sea is of smaller size and has shorter life span than the individuals of the same species living in the Adriatic and Mediterranean (Prodanov and others., 1997).

Almost all the sprat caught with midwater trawl, especially in April and May, is sent to fish meal and oil factories as raw materials (Samsun et al., 2006). The need for raw material a great amount of which was met with anchovy until 1997 has shifted onto sprat through popular midwater trawl fishing with two boats. Free sprat fishing with midwater trawl has allowed fish meal and oil factories to work even in May when fishing season finishes (Kalaycı *et al.*, 2006). When the sprat forms schools with anchovy, fishing is done with seine, as well. The sprat whose fishing is the most intense in Samsun region is not a species consumed directly in our country.

In fisheries statistics of our country, though it was not present before 1993, the fishing amount of sprat varies by the years, and it was 6025 tones in 2009 (Figure 6). 95 % of the sprats have been caught in the Black Sea. (TUIK, 2010).

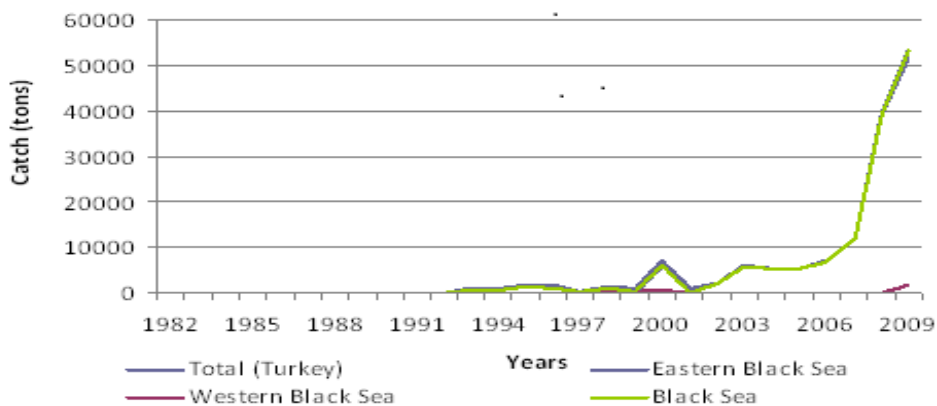


Figure 6. Quantity of caught sprat (1982-2010)

2.1.4. Atlantic Bonito

Atlantic Bonito is a species living in temperate and tropical regions such as Atlantic Ocean, Gulf of Mexico, the Mediterranean and Black Sea (Collette and Chao, 1975). Bonito has been a commercially consumed species in the Mediterranean basin since ancient times. (Demir, 1963). One of the important commercial fish, bonito migrates from the Black Sea to Marmara and the Aegean Sea through the straits in great masses of schools in early autumn every

year. Migration for reproduction is in the opposite direction in spring months. During these reproduction and alimental migrations, they provide a great amount of production. Bonito fishing is done with seine and extension nets.

The length of bonito nets used in Istanbul region and the western Black Sea ranges from 1200 to 1530 m and the depth of the nets vary between 36-7 m. These nets are used by the local fishermen between September and December in coastal waters and where the water is of 300 m depth. The nets are set after sunset and retreated every 3 to 4 hours by observing the fish schools and set again, which continues until sunrise (Okan *et al.*, 2008).

Bonito is an economically important fish and a fish of 700-750 g costs 8-10 TL in 2010-2011 fishing season. Bonito is usually consumed fresh and as salted fish.

The total amount of bonito fishing in all our seas in 2009 was 7,036 tones, 2,535 tones of which were from the Eastern Black Sea, 1681 tones from the Western Black Sea, 4216 tones in total from the Black Sea. Namely, 60% of total bonito fishing was of the Back Sea. The lowest bonito fishing was 2602 tones in 1982 and the highest was 63,896 tones in all the Black Sea in 2005 (Figure 7).

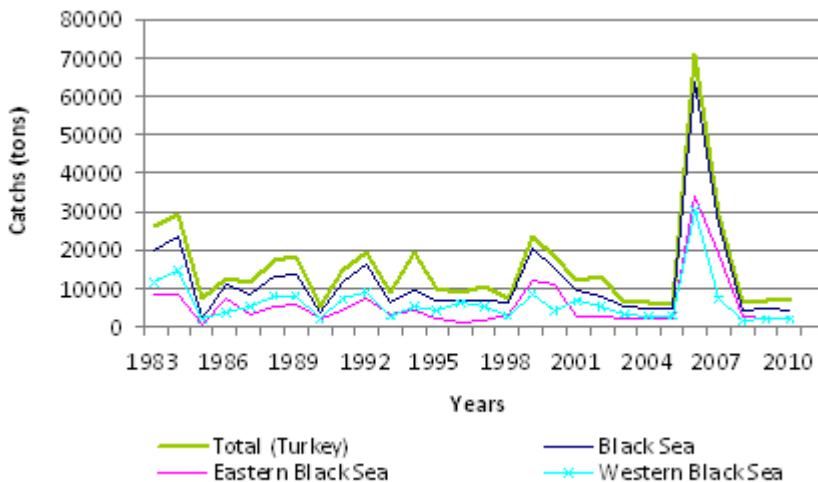


Figure 7. Quantity of caught Atlantic bonito (1982-2010)

2.1.5. Bluefish

Bluefish which is a member of *Pomatomidae* family in our seas is fished with angles, seine, and trawl nets. Although it is not the target of the Black Sea bottom trawling but caught as by-catch product as and in less amounts than blue whiting, red mullet, and horse mackerel, it has the highest market value (Özdemir *et al.*, 2006). According to their sizes, those which are smaller than 10

cm are called defneyaprağı, 10-15 cm are çinekop, 15-20 cm are Sarıkanat, 20-25 cm are lüfer, and those bigger are bluefish kofana. The present catch size for the blue fish is 14 cm in our country. (Anonymous, 2008). Bluefish is consumed fresh in our country.

During its seasonal migration for nutrition-reproduction between the Black Sea and the Aegean Sea, the bluefish is fished intensely, especially in the Western Black Sea and the Marmara sea. (Akşıray, 1987). Its fishing reaches to maximum level as 25,000 tones in some years (Anonymous, 2000).

When the amount of bluefish fishing in Turkey is examined, it is seen that the highest production was achieved with 32,184 tones in 1982. It was recorded that the catch amount was 25,000 tones in 2002 when there was intense bluefish move. (TÜİK, 1982-2010). The most intense fishing is done in the Black Sea with 57%. (Figure 8). Seine sets are mostly used for bluefish catch in this area. It is followed by the Marmara Sea with 34%. In general, Bluefish catch is done with angles, seines, and trawls.

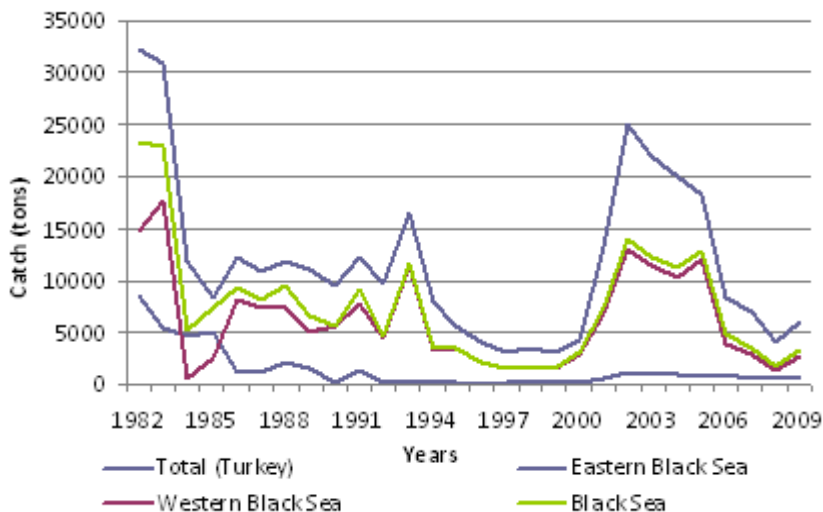


Figure 8. Quantity of caught blue fish (1982-2010)

2.2. Demersal Species

Demersal species have high commercial value both in our country and in the world though they are caught less than other pelagic stocks. With the decrease in pelagic fish, fishermen have started demersal fishing (Zengin and Düzgüneş, 2003). The whiting (*Merlangius merlangus euxinus*) makes up 70-80% of demersal stock in the eastern Black Sea, and it is followed by such other species as red mullet (*Mullus barbatus*), bream fish (*Spicara smaris*), turbot (*Psetta maxima*), flounder (*Platichthys flesus luscus*), respectively (Kutaygil

and Bilecik, 1973 and 1976; Samsun, 1990; Kara, 1980 and 1989; Samsun and Özdamar, 1995; Bingel *et al.*, 1996; Genç *et al.*, 1994; Genç, 2000; Ak, 2009).

Demersal fish is caught with bottom trawl nets where trawl fishing is available and with bottom nets (gill nets) along the coast in the Black Sea. Fishing with bottom trawling is available where continental shelf enlarges (in Samsun and Sinop bays and from the western part of Sinop to the border of Bulgaria). While trawl bags with legal total mesh size of 40 mm are used in trawl fishing, gill nets with 18-20-22 mm of mesh size are used for whiting and red mullet fishing. Fishing with extension nets is usually done in coastal waters. The extension (gill) nets used for whiting fishing vary from 3-4 pieces to 15 pieces. However, nets of 2 to 4 pieces are used for red mullet fishing. A complete net has a length of 100 m and a depth of 1-1.5 m (Çelikkale *et al.*, 1993). The nets for whiting and red mullet fishing are set in the sea and taken back in almost one or a half day. The mesh size of the fixed nets used for turbot fishing varies as 140, 160, 180 mm. In general, the nets set towards the evening are taken back in the early morning. A set of net used for turbot fishing is made up of 8 or 10 pieces of nets. These nets are left in the water for about 4 to 7 days.

In the Black Sea, aquatic products fishing with any kind of trawl nets is forbidden in our territorial waters from Ordu province, Ünye district, and Cape Taşkana to the border of Georgia, between Sinop Province, İnceburun and Samsun province, Yakakent district, Cape Cayağzı, and between Zonguldak province, Ereğli Fishing shelter and Bartın province, Amasra district, Tarlaağzı Fishing shelter (Anonym, 2000-2010). The reason for this is the reduction of the territorial waters of 100-120 m depth in these areas where demersal fish can survive. However, demersal fauna in this region which is closed to trawl fishing leaves the environment as seine fishing has been decreased from 18 fathom to 10 fathom in recent years (Anonymous 2008). In 2010 report of “Seine Fisheries Monitoring Project in the Eastern Black Sea” by Central Fisheries Research Institute since 2005, some demersal species, red mullet and whiting in particular, have been reported in anchovy and horse mackerel fishing with seine nets as non-target species (Genç *et al.*, 2010). A great majority of non-target species of red mullet and whiting are made up of 0+ individuals. When the amount of anchovy fishing is considered, this amount should not be underestimated (Ak, 2009).

2.2.1. Whiting

It is a species which is caught abundantly in every season in the Black Sea. It lives in the waters deeper than 40-60 m. It is fished intensely in the waters of 60-80 m in the Eastern Black Sea coasts (Çiloğlu *et al.*, 2002). Breeding takes place throughout the year and the maximum occurs between the months September and March (Ak, 2009; Genç, 2000).

Whiting is fished commercially with bottom trawls, bottom extension nets, deep water trawl nets, and with hand line by the amateurs. Because bottom trawl fishing is forbidden in the South East Black Sea, fishing is extensively done with extension nets. Fishing is done with bottom trawl nets in particular in Samsun region. Caught at minimum level in summer, whiting is consumed fresh in our country.

In the circulars of Ministry of Agriculture and Rural Affairs General Directorate of Protection and Control, regulating commercial fishery, the minimum size for the fishery of whiting is defined as 13 cm (Anonymous 2008). Ak (2009) reports that the first breeding size of the whiting is 15 cm. He adds that in a non-selective study with bottom trawling in the Eastern Black Sea where trawl fishing is not permitted, only 30 % of the whiting caught were 13 cm and bigger, which indicates intense fishing pressure on the whiting (Figure 9).

Under intense pressure throughout the year, whiting is in the first place among demersal fisheries caught in Turkey. The reasons for this are its ability to use the big area under the thermocline layer formed in summer, its high fecundity, and its breeding capacity throughout a year. According to the data of the year 2010, the amount of the whiting caught in the Black Sea coasts was 8,979 tones (Figure 10) (TUIK, 2010).

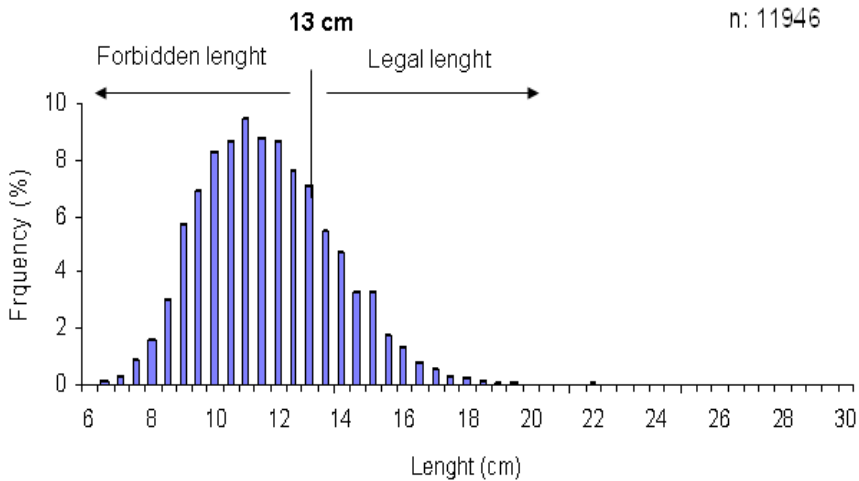


Figure 9. Catch and forbidden length frequency, whiting *Merlangius merlangus euxinus*, in the Eastern Black Sea (from Ak, 2009)

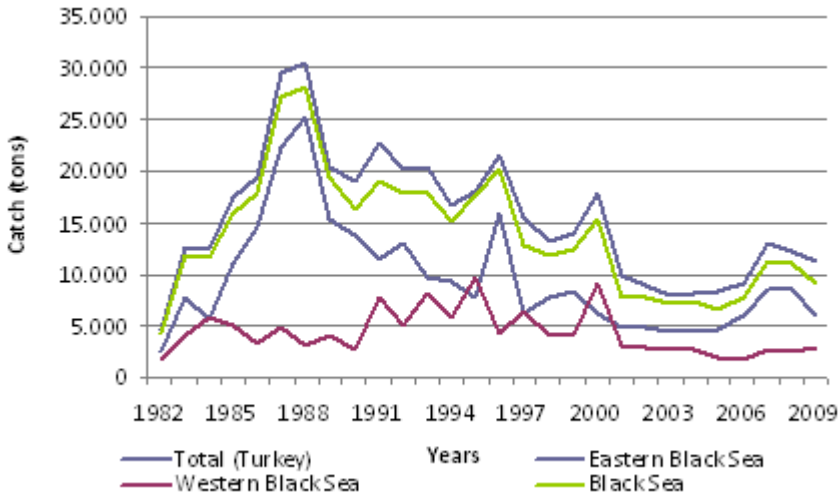


Figure 10. Quantity of caught whiting (1982-2010)

2.2.2. Red Mullet

Red mullet is the most intensively caught demersal species after whiting. The breeding of the red mullet which is caught less in recent years continues in summer as well. Spawning from the end of May, this species continues this activity until mid-August. Its female individuals start the first breeding in one year old of about 11 cm, and the temperature in the breeding environment varies between 18-25 °C (Genç *et al.*, 1999; Ak, 2009).

Red mullet is fished commercially with bottom trawl nets, bottom extension nets, and deep throw nets. As South Eastern Black Sea region is closed to bottom trawl fishery, fishing is usually done with extension nets. It is caught in Samsun region especially with bottom trawls. Fishery with extension nets is done intensely in spring and summer months. Red mullet is consumed fresh in our country. A kilo of red mullet is sold at 10-15 TL in the market.

In the circulars of Ministry of Agriculture and Rural Affairs General Directorate of Protection and Control, regulating commercial fishery, the minimum size for the fishery of red mullet is specified as 13 cm (Anonymous 2008). Ak (2009) reports that in his non-selective study with bottom trawling in South Eastern Black Sea, 55 % of the red mullet caught were 13 cm and bigger. It is known that there is intense fishery pressure on red mullet as on other species (Figure 11).

According to the data of the year 2010, the amount of the red mullet caught in the Black Sea coasts was 1531 tones (Figure 12) (TÜİK, 2010).

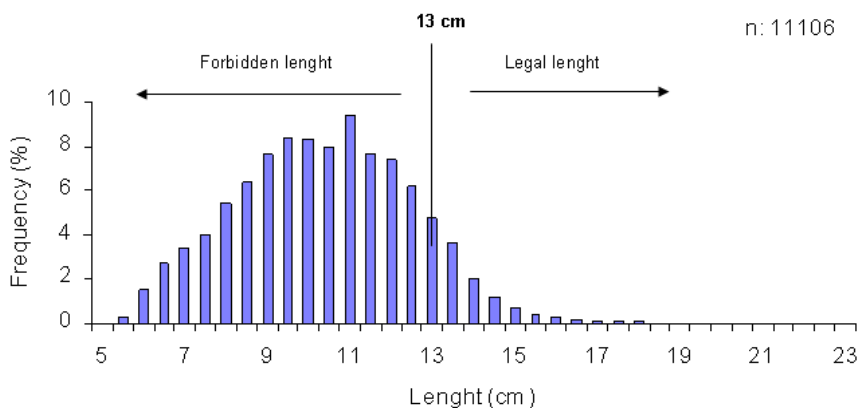


Figure 11. Catch and forbidden length frequency, red mullet *Mullus barbatus*, in the Eastern Black Sea (from Ak, 2009)

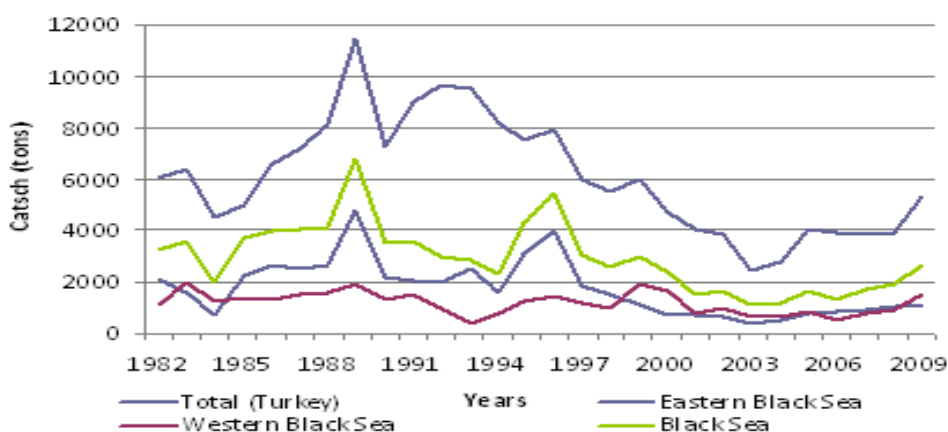


Figure 12. Quantity of caught red mullet (1982-2010)

2.2.3. Turbot

Turbot which is the third in demersal fish species as for production amount in the Black Sea has the highest economical value. Turbot fishery is done with either extension nets or bottom trawls in the Black Sea. While fishery with extension nets is done in neritic waters of Turkey, bottom trawling and turbot fishery are done in the places where the continental shelf enlarges in the Black Sea coasts of Turkey, in Samsun and Sinop bays and in the west of Sinop, and in parts close to the border of Bulgaria. The main turbot fishery is done in Bulgaria, Romania, and in the neritic waters of Ukraine.

Most of the turbot sold in our country used to come from traditional fishery areas off Kerch Strait and the Danuba delta. In the same period in our coasts, turbot fishery was usually done only in spring months. According to “the Black Sea Economic Area Agreement” signed by the countries bordering the Back Sea in 1982, every country enlarged its fishing ground up to 200 miles including offshore waters of the Black Sea, which put our traditional turbot fishing ground under the economy of Russia, Ukraine, Romania, and Bulgaria. (Acara, 1985). As turbot fishery was confined to our coasts and the pressure of fishing increased in the later periods, the production gradually decreased, and Turkey’s fishing amount has varied between 399 and 5250 tones in the last 25 years. (Figure 13) (TÜİK, 2010).

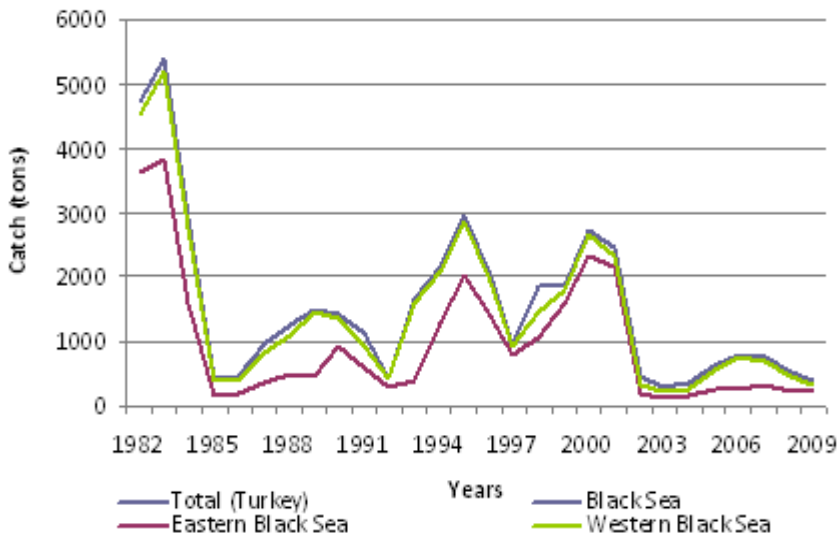


Figure 13. Quantity of caught turbot (1982-2010)

According to the data of the year 2010, the amount of the turbot caught in the Black Sea was about 300 tones, and despite its low fishing amount, it has quite high economic value. It is ranked first in the retail market selling prices of important commercial fish caught in the Black Sea. Its rate in the amount of total fishery including the commercial species caught most often in the Black Sea such as anchovy, horse mackerel, Atlantic bonito, mullet, whiting, and red mullet is recorded as 0.61 %. However, its value in the domestic market is quite high compared with other commercial species. According to the data of the year 2010, the average retail selling price of turbot changed between 10 to 12 Euros. (TUIK, 2010).

2.3. Other Aquatic Products

Other aquatic products are caught in our seas as well as fish, but they are considered to be only for foreign markets. In 2009, among other aquatic products, 44,410 tones in total, the main ones are the striped venus (24,642 tones) which is especially important for EU markets, and the sea snail (6,085 tones) is exported to Japan.

2.3.1. Striped Venus

An important shellfish in our country, striped venus (*Chamelea gallina* L., 1758) fishing has been done in Turkish coasts since 1986. Striped venus is present in large populations in many places with sandy floor and up to 20 m depth around the Black Sea and the Marmara Sea. According to the Ministry of Agriculture and Rural Affairs circulars numbered 34/1 regulating commercial fishery in marine and inland waterways, white striped venus fishery is not allowed in the Marmara Sea but only in the Black Sea. Its fishery is done in the fishing places in the west of the Black Sea (in Kastamonu-Sinop region, Sakarya region and İstanbul region). Ministry of Agriculture opens these areas for fishery in turns. After landing the fish with boats equipped with hydraulic dredges, it is sent to the processing factories alive. Factories whose capacities range from 55 to 200 tone/day, 680 tone/day in total, export the product they have processed during the fishery season to other EU countries, including Italy, and Japan before the next fishing season starts. (Dalgiç *et al.*, 2006).

There are eight factories in total processing white striped venus in our country. Six of these factories are in Marmara region, one in the Central Anatolia, and one in the Black Sea region. Depending on their sizes and business volumes to process pure white striped venuses, these factories employ 27 to 150 employees and 2 to 24 technical staff.

The fishing of striped venus with the smallest fishing size of 17 mm is forbidden in shallow waters less than 5 m. Fishery is forbidden from 1 May to 31 August. Striped venus fishing vessels are required to take Fishery Permit organized on Fisheries Information System (FIS) from Provincial Directorate where permit licenses are issued. In 2010-2011 fishery season, a total of 30,000 tones of white striped venuses are allowed for fishing. Half of this amount (15,000 tones) were caught until 31 December 2010 and the rest will be caught after the New Year. In addition to annual total quota, fishing boats with Fishing Permit are given 15 tones of quota per day. The landing and transport of white striped venus more than 15 tones is not permitted and a document is not issued.

Caught with hydraulic dredges, striped venus ranks the first among the shellfish catch in Turkey. According to the data of the year 2010, the amount of striped venus caught in the coasts of the Black Sea was 24574 tones (Figure 14) (TUIK, 2010).

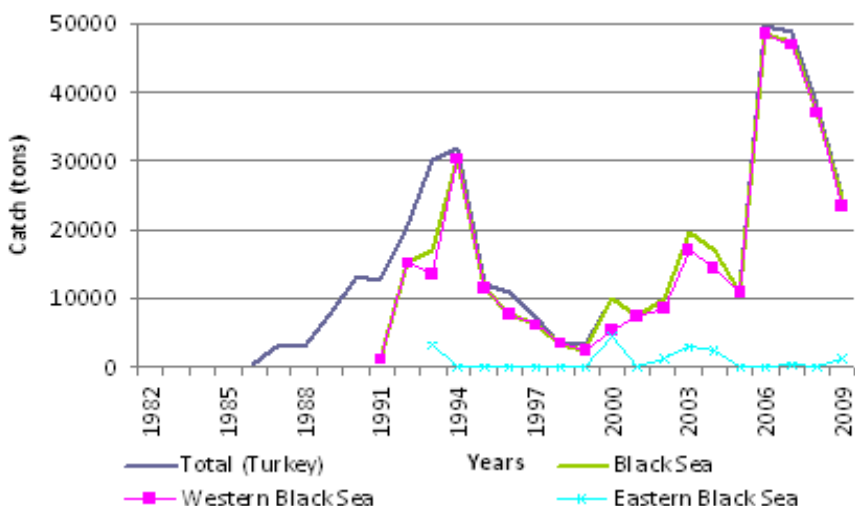


Figure 14. Quantity of caught turbot (1982-2010)

2.3.2. Sea Snail

Sea snail *Rapana venosa* Valenciennes is a species of 1846 East Asian origin. This creature of Prosobranchia sub-group is estimated to have been carried to the Black Sea with ballast waters of commercial ships. It was reported in the Black Sea for the first time in the Gulf of Novoroski in 1946. Then, it spread to all the Black Sea and Azov Sea, and to the Aegean Sea and the Mediterranean Sea in 1984 (Pastorino *et al.*, 2000).

Its fishery is directed by the circulars regulating Aquatic Fisheries published every year by the Ministry of Agriculture and Rural Affairs (MARA). There have been many changes in the decisions on sea snail fisheries in the last 20 years. The size of the dredge pocket was decreased from 2,5 m to 1 m in 1988, and the ban on fishery with dredge within a distance of 200 m from the beach was changed to 500 m in 1996. Since 2000, more than one algarna taken on board has been prohibited. “Sea Snail Fishery Permit” from the provincial directorate where vessel license permit is given for the vessels doing fishery with algarna or diving has been made compulsory since 1 September 2001. Sea snail fishery with diving, basket, and all kinds of traps has been permitted since 2005. Sea snail fishery with any kind of fishing equipment is forbidden between 1 May and 31 August.

The highest snail production is in Bulgaria, Turkey, Georgia, Ukraine, and Russia, respectively, among the Black Sea countries (BSEP, 2003). About 90 % of the sea snail production is from the Black Sea (TUIK, 2010). Sea snail

gained commercial value in Turkey after 1985. Depending on the export facilities, its production exceeded 10 thousand tones in 1989 and gradually decreased in later years to the level of 2000 tones. However, it has been 10 thousand tones again in recent years. Total sea snail production was 12600 tones in 2009 (Figure 15) (TUIK, 2010). Although not consumed in our country, it is an important export item. There is a significant demand from Far Eastern countries.

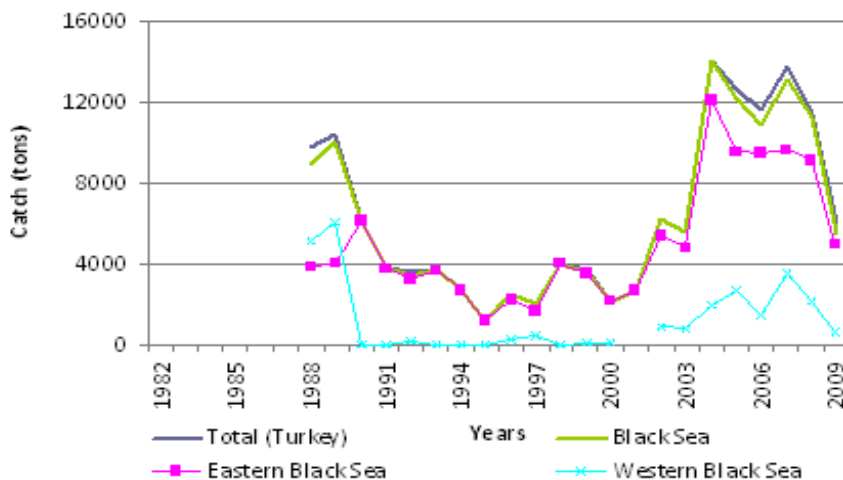


Figure 15. Quantity of caught turbot (1982-2010)

3. Fishing Fleet

There are 16,815 licensed fishing boats in Turkey (except for small boats of <5 m). When the distribution of fishing boats by region is considered, it is seen that there are 5,973 fishing boats in the Black Sea (35.45%) including 3,413 fishing boats in the Eastern Black Sea region and 2,560 in the Western Black Sea, 2,963 fishing boats (17.58%) in the Marmara Sea, 5,713 fishing boats (33.91%) in the Aegean Sea, and 2,196 fishing boats (13.03%) in the Mediterranean Sea (TUIK, 2010).

Fishing boats are divided into five groups as for main fishing activities: seine, trawl, trawler-seine, carrier, and others (TUIK, 2010). Approximately 85% of the Turkish fleet and 78 % of the Black Sea fishing fleet consist of boats under 10 m (TUIK, 2010). Small fishing boats under 10 m are usually defined as small fishing and they usually do demersal (whiting, red mullet, turbot, sea bream, scorpion fish, etc.) and pelagic (horse mackerel, shad, bluefish, bonito, etc.) fishery with trammel and non-trammel nets. In addition, they sometimes do sea snail fishery with beam trawl or diving, and sand mussel fishery with water pipe and dredges. 3 or 5 people work in these fishing boats depending on the type of fishery and the season.

Fishing boats larger than 10 m are used as trawlers (bottom and mid-water) and purse. Bottom trawling is used for whiting, red mullet, turbot, rock, sharks and rays, etc. fishery, and seine and mid-water trawl is used for anchovy, horse mackerel, sprat, bluefish and bonito, etc. fishery. 5 people in average work in the trawlers in Samsun region and 30 people work in seine boats.

With the adoption of Fisheries Law No. 1380 and with the establishment of the General Directorate of Fisheries in 1971, the fisheries sector has started to develop. Exemption from customs duty and tax relief were applied to the purchase of fishing equipment import for Fisheries cooperatives in 1972. Fishing fleet has grown in number and equipment with the incentives and exemptions from customs applied. Technological equipment has been used in fishing boats. The amount of fishery and the number of fishing boats have increased in the region with the operation of fish meal and oil factories since 1980 (Üstündağ, 2010). As a result of this, excessive capacity had negative impact on fish stocks and the regulation of fishing licenses was suspended in 1991. However, the fishing boats were given a limited number of additional license permits in 1994, 1997, and 2001. Any new fishing boats have not been given license permit since 2002.

The number of fishing fleet remained stable in recent years after significant increases until the early 2000s. While the number of fishing boats remained stable, the fishing capacity of the boats, especially those larger than 12 m (length, engine power and tonnage), increased. As any new fishing boats were not taken into the fleet after 2002, the change in the boat numbers of the same size was in the form of either the boat pass to a top group with the increases in the boat size or the removal of the boat out of the fleet with the revocation of their licenses (Üstündağ, 2010).

There was an increase in the capacity of the engine powers of the fishing in time. The number of small boats with engine power smaller than 10 kW in Turkey was 7571 in 2002, but it declined to 6490 in 2009. It decreased from 850 to 604 in the Western Black Sea and from 2251 to 1451 in the Eastern Black Sea. These two examples indicate that Turkish fishing fleet has increased in both engine power (kW) and fishing capacity. This increase, as a result, will be reflected in fish stocks as fishing pressure. Fishing boats bigger than 20 m are usually seine boats, trawlers, trawl-seine boats, and most of them are bigger than their original sizes. Their numbers increased until 2005 but remained stable after that date.

Similarly, when the changes in the engine powers of the boats in recent years are considered, it is seen that boats pass into upper engine groups with the increase in their engine powers, therefore, the number of the boats with low engine power decreases but the number of the boats with high engine power increases from year to year. It is reduced 500-1000 HP in Turkey.

However, the number of boats in 500-1000 HP and higher than 1000 HP engine power group was 216 in 2004 but increased to 280 in 2007, and those higher than 1000 HP were 111 in 2004 but increased to 198 in 2007. The number of boats in 500-1000 HP group in the Black Sea region was 125 in 2004 but increased to 140 in 2007, and the boats with engine power higher than 1000 HP were 87 in 2004 but increased to 137 in 2007.

As a result of incentives, support and subsidies, the fishing industry has achieved world standards in terms of fishery and fishing equipment. Due to the lack of research on fishing resources and continuous research, our fishing fleet has overgrown (Oray *et al.*, 1997).

The increase in fishing fleet has led the fishermen to overfishing to reach the amount of catch per boat in previous years, and, as a result, there have been fluctuations in production in case of several-year periods. This situation indicates that when maximum sustainable yield level (MSY) from our fishing resources is reached with our present fishing fleet, there will not be any more possibilities of increasing the production of fishery in Turkey as in the world (Atay and Korkmaz, 2001).

4. Fisheries Union and Cooperatives

Central Union of Fisheries Cooperatives was established by the Eastern Black Sea, Istanbul, Canakkale, Balıkesir, Izmir, Mugla and Mersin Regional Union of Fisheries Cooperatives in 2004. The general objectives of the union are to protect the common interests of common unions and their related cooperatives on the fishery, production, processing and marketing of aquatic products, to provide education and training activities, and to do industry-related investment activities.

There are Regional Associations of the Eastern Black Sea Fisheries, Sinop Fisheries, and Istanbul Fisheries Cooperatives in the Black Sea Region. There are 2379 members in 24 cooperatives of Eastern Black Sea Regional Union, 394 members in 9 cooperatives of Sinop Fisheries Union, and 1976 members in 32 cooperatives of Istanbul Fisheries Cooperatives Union.

4.1. Fishing Shelters and Landing Points

The most important infrastructure in fisheries production is fishing shelters. They are vital and of great significance for the fulfillment of both our fishing activities and the activities of the ministry. These places meet the requirements of the protection, accommodation and maintenance of fishing vessels, and they are the landing points of the fish caught by the fishing boats as well. Constructions of fishing shelters and major repairs after construction are carried out with the grant from annual agricultural sector investment programs by the Ministry of Transport General Directorate of DLH Construction. Rental operations are based on the positive views of our Ministry and the Ministry of

Transport in accordance with Fisheries Act and Regulations of Fishing Shelters, and carried out by the Ministry of Finance. (KKGM, 2004).

There are 290 pieces, in the seas surrounding Turkey, and, along the Black Sea coast, 130 pieces of fishing shelters, housing locations, slip locations, and landing points. 58 of the facilities in the Black Sea are major fishing ports, 15 of them are small fishing ports, and the rest are coastal plants. There are 165 big and 39 small fishing ports in Turkey. (KKGM, 2004). With the construction of the Black Sea coast road, a lot of fishing shelters, especially in the Eastern Black Sea, have been rebuilt in a modern way and put into operation.

The lack of monitoring of fish stocks has been obvious especially in the process of EU integration, and the necessity for immediate stock assessment studies has been realized in order to eliminate the problems resulting from not being able to organize Turkish fisheries according to reliable data. In 2005, 30 major landing points “port offices” were established in order to prepare a healthy infrastructure that will allow the collection of data at fisheries landing points to carry out stock assessment studies based on fisheries data. 15 of the landing points were established in the provinces along the Black Sea coast (Figure 16).

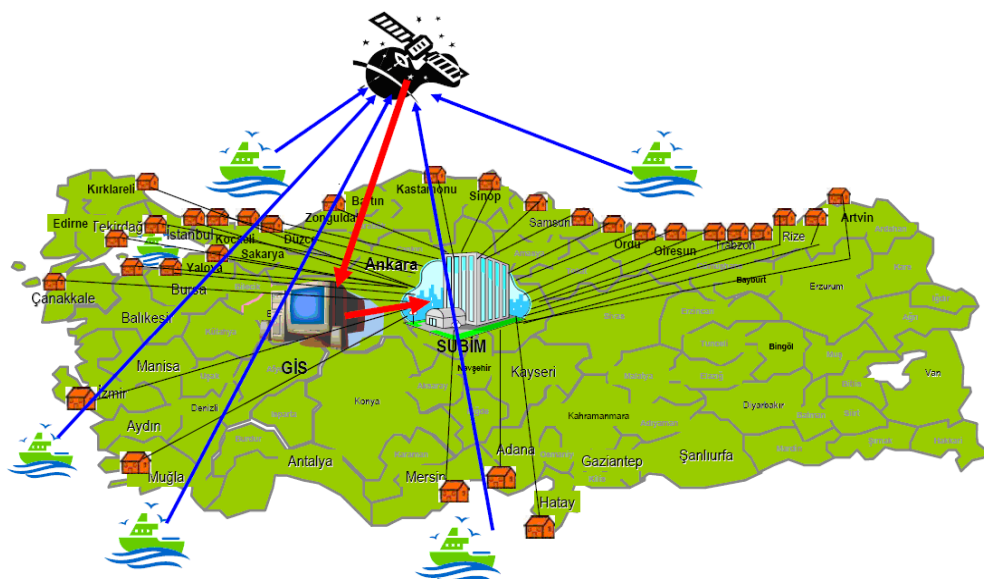


Figure 16. The landing points in Turkey (from Kutlu, 2009)

5. Marketing, Processing, and Consumption

5.1. Marketing

Water products are marketed in three ways in our country in general. These are daily markets, fish meal and oil factories and water products processing plants, and cold storages. That these places meet and supply the demands depends on sustainable operation of stocks. Therefore, the supply should be monitored absolutely and this monitoring should be recorded at each stage (from fishing to consumption).

Demand for fishery products on the market, especially for anchovies, may occur in very low market price due to supply. Sometimes the marketing expenses (boxes, shipping, etc.) may exceed product sales price. It is necessary to control the supply to the market in order to make the price meet the cost of the fishermen and make money. When anchovy is rare, a 12 or 13 kg of anchovy box is 50 or 60 TL, while it is 10 TL in abundant times. The serious drop in price makes the consumer glad but adversely affects the fishermen. Therefore, the amount to be consumed daily and to enable the fishermen earn some money should be estimated accurately and reported to the fishing boats, and it should be followed regularly. (Ak and Dağtekin, 2010).

The most important consumption channel for the anchovy and sprat fish over the market need is fish meal and oil factories. In Turkey, they were established in the Black Sea region on the basis of anchovy fishery potential (Zengin, 2001). Depending on the amount of the increase in the production of fishery products in Turkey in the 1980s, the evaluation of surplus fisheries, especially anchovies, other than fresh consumption was taken on the agenda and 25 pieces of fish meal and oil factories started to operate with the incentives for this purpose between the years 1983 and 1995 (Özdamar and Aral, 1995). As a result of anchovy crisis in 1987-88 fishing season, the number of the factories has decreased by half. The capacity of the factories has never been over 25 % (Çelikkale *et al.*, 1999). There were 9 active fish meal and oil factories in 2009 and 2010, 6 of which are in Sinop province. Sinop is among the priority provinces for development and incentives are given to it. That's why; there are a lot of fish meal and oil factories in Sinop.

The amount of anchovy processed in the factories is almost half of the total anchovy production especially after 2002. Shortness of anchovy fishing season and not being able to find almost any anchovies especially after the new year period has led the fishermen to fishing in Georgia with bilateral trade agreements. That the amount anchovy processed has increased despite the shortness of the fishing season is due to the increase in the capacity of present factories. In order to process the most fish in short fishing season, factories have started gradual capacity application. In this system, factories have more than one machine and depending on the raw material, they start to use new machines

as additional capacity, so they can process a maximum raw material. This has two negative impacts and its sustainability is not possible (DPT, 2007).

These factories meet the fishermen's need for cash and costs of pre-season with the money they give to the fishing boats before the season. No matter how much anchovy is caught, it is processed at fish meal and oil factories, which contains a contradiction negatively affecting the supply of raw materials for the following years. It is necessary that annual amount of fish to be sent to fish meal and oil factories should be determined in order not to have raw material problems in the following years, to prevent limited working hours for factories, and to reduce the pressure of fishing on stocks.

The fish caught in the Black Sea is sent to the market by loading it into the transport vehicles at landing points. In this way, the fish is sold from the boat by the first-hand. The fish to be sold is marketed to fish markets, especially, in Istanbul and Ankara, in Trabzon and Samsun, and to fish meal and oil factories in operation and fish processing factories. There are many problems in the marketing of the fish. These problems sometimes prevent the fish caught be used in the best way and cause the fishing boats large financial losses. This is already a very negative situation for the fishermen who barely recover their costs.

Fish prices vary during the day depending on weather conditions and amount of fishing. Because of the change in fish prices, marketing strategies vary as well. As a result of falling fish prices due to excessive fish amount caught, the fish is usually sold to fish processing plants at very modest prices. In fact, as the fish price does not recover the cost of the fishermen, the fish is sometimes put into the sea again instead of sending it to the market. On the other hand, the height of the periodic fish prices decreases fresh consumption of water products and limits fish processing. In such an irregular marketing system, the most important problems are the assessment of the product and the variability of the marketing margin obtained from the product. This problem can be resolved with fixed base price for fish sale by the unions and the government. In this way, fishing industry can survive and develop with the efficient utilization of the fish caught and by keeping the profit margin of the fishing boats.

5.2. Processing

Fishery products processing and evaluation facilities process raw material fishery products and provide them for consumption as fresh cooled, frozen, fillets, canned food, marinating (oily brine), salted, smoked, and processed frozen food. In addition, fish meal and oil is produced from anchovies, sprat, and other fish. (Öğretmen and Öğretmen, 2010). To support the activities of

value-add by processing the fisheries caught will provide our people consume this product throughout the year.

Present facilities produce and market a variety of products in the standards of EU and other countries to sell their products. Processed products as fresh, cooled or frozen in complete or without internal organs are canned food (tuna fish, two crustaceans, crayfish), fillet (fresh chilled or frozen), salted fish (anchovy, sardinella), marinating, anchovies, processed frozen sand mussel, processed frozen sea snail, and dried beche-de-mer.

The demand for canned products has increased in recent years. The canned food has five years of shelf life and does not cause additional costs on the shelves, the business enterprises have established a wide network of distribution and marketing, and there is a great advertising support for the canned food, which may have caused the increase in consumption (DPT, 2007). Despite the positive sides of the canned food industry, the import of a large part of the fish causes external dependence. External market price changes affect the sector. In recent years, fresh, chilled and frozen fish exports have increased. The demand for cleaned or fillet frozen fish mainly from Germany, France, and Belgium has increased. Italy and Spain demand for shellfish products and Far Eastern countries demand for sea snail which is not consumed much in our country.

The demand for fish products in EU countries is more than the supply, so, 60% of fish products are imported. The demand of EU countries is mostly for the raw material necessary for processing industry. Two third of EU fish import is beyond the scope of import duty. Such applications as tax exemption, independent tariff quotas, and suspending customs duty temporarily by EU are important opportunities to be considered for our fishermen as well.

5.3. Consumption

The habit of eating fish is low in our country compared to other countries. Average annual per capita fish consumption is 16 kg in the world, 22 kg in EU countries, but about 7 kg in our country. Compared with EU countries, Turkey is the 7th in production but the last in consumption (TUIK, 2010). Turkey needs to increase its current production 2-fold to reach the world average consumption, and 3-fold to reach the EU level. While fish consumption is very high in the Black Sea coastal areas, it is very low in the interior such as the Eastern Anatolia, South East Anatolia, and Central Anatolia, as people in these regions do not have the habit of eating fish and they lack the culture of fish eating. Because fish which is vital for human health is abundant and its price is reasonable for everybody, the advertising of anchovy is important to increase the habit of fish consumption.

6. Aquaculture

Aquaculture farming started in Turkey with the establishment of first trout farm in 1970s and the total number of fish farms increased to 1,659 in 2009. The share of farming in total aquatic products cultivation has increased rapidly and reached approximately to 10 % of the total production (TUIK, 2010). Interest has centered on such species as trout and salmon.

Turbot is included in the marine fish farming group due to its commercial value and its adequate growth performance in aquaculture environment. Its high rate of growth and food conversion, its easy adaptation to the artificial environment, and its resistance to diseases increases the interest to its farming. Aquaculture activities have been successfully applied by Western European countries (Atlantic turbot; *Scophthalmus maximus*) and Ukraine (The Black Sea turbot, and Azov turbot) (Zengin, 2000).

Turbot aquaculture activities in our country were started in 1997, and continue in Trabzon Central Fisheries Research Institute with technical cooperation between the governments of Japan (Japan International Cooperation Agency-JICA) and Turkey (The General Directorate of Agricultural Production Development-GDAPD) under the name of “the Black Sea Fish Culture Development Project”. The aim of this project is to research flatfish fries production and cultivation techniques, to make its production widespread in the Black Sea coasts of Turkey, and to develop Turbot stocks in the Black Sea. Studies on turbot focus on larval period and hatchery techniques (Şahin, 2001). In order to enhance the stocks, 30,000 turbots in 2002 and 15,000 turbots in 2009 were left to the Black Sea. A private fish farm has completed its infrastructure for turbot cultivation and started production in the Aegean region.

Black Sea trout (*Salmo trutta labrax* PALLAS, 1811) is the only trout species found naturally in our country (Geldiay and Balık, 1996). It has been reported to be living in the rivers of Northern and North-Eastern Anatolia Region in Turkey and in the rivers flowing into the Black Sea (Geldiay and Balık, 1996). At the institute, by examining the bio-ecological characteristics and culture potential of the Black Sea trout, some parts of the fries taken from sampled spawners are aimed to be left to the nature in order to present an alternative culture form to trout businesses operating in the region and to enrich the natural stocks of the species. In order to increase fish number, 4500 marked fish were left to the Yanbolu Creek in Trabzon borders. In addition, this endemic species is given to the private sector for farming. Today, Black Sea trout farming continues in 7 present land facilities.

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FISHERIES OF THE SEA OF MARMARA

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1. Introduction

The Sea of Marmara, which has the surface area of 11500 km² and the volume of 3378 km³, is connected to the Black Sea on the north by the İstanbul Strait (32 km length, average of 1,6 km width and 35 m depth) and to the Aegean Sea on the south by Çanakkale Strait 62 km length, average of 4 km width and 55 m depth). The basin of the Marmara Sea is occupied by two distinctly different water masses throughout the year: one is the brackish waters (22-26 p.s.u.) of Black Sea origin, forming a relatively thin surface layer (10-15 m thick) with a mean residence time of 4-5 months, and the other is the subhalocline waters of Mediterranean origin (38.5-38.6 p.s.u.) separated from the former by a sharp interface 10-20 m thick (Ünlüata *et al.*, 1990; Tuğrul and Polat, 1995; Balkis, 2003). Because of the large volume of water inflow from the adjacent Black Sea (600 km³) into the relatively small upper layer volume (225 km³) of the Sea of Marmara, the upper layer ecosystem of the latter has been influenced to a large extent (Balkis, 2003). The mean flow of the surface waters is controlled by basin-scale anti-cyclonic circulation under the influence of Coriolis force, Bosphorus outflow, wind stress, and coastline geometry (Besiktepe, 1991). As a result of its permanently stratified character and the bacterially mediated oxidation of sinking organic matter, sub-halocline water masses (below 20-30 m water depths) of the Sea of Marmara are permanently depleted in dissolved oxygen (Basturk *et al.*, 1990).The oxygen-rich waters entering from the Aegean Sea through the Dardanelles underflow lose a considerable proportion of their oxygen content immediately upon entering the Marmara Basin (Unluata and Ozsoy, 1986). Dissolved oxygen concentrations of the sub-halocline Marmara waters, which can practically be regarded as aerobic (more than 1 ml l⁻¹ O₂) to dysaerobic (0.1-1.0 ml l⁻¹ O₂), according to the classification by Savrda and Bottjer (1987). A further distinguishing feature of the Sea of Marmara is that it occupies, in terms of primary production, an intermediate position between Black Sea and the Mediterranean Sea. In general, the chlorophyll-a values are found to be relatively high in the Black Sea and decrease gradually across the Sea of Marmara, the Aegean Sea, and the NE Mediterranean (Ergin *et al.*, 1993). Previously reported estimates of the primary productivity (in g Cm⁻²year⁻¹) range from 52 to 250 in the Black Sea (Sorokin, 1983; Gocmen, 1988), from 60 to 100 in the Sea of Marmara (Yilmaz, 1986; Unluata and Ozsoy, 1986), around 36 in the Aegean Sea (Yilmaz, 1986), and

from 16 to 25 in the NE Mediterranean Sea (Murdoch and Onuf, 1974; Gocmen, 1988). Thus, a considerable amount of organic matter is expected to be transported from the Black Sea to the Marmara Sea (Unluata and Ozsoy, 1986; Polat, 1989). Primary production in the Sea of Marmara appears to be highly controlled by the diatom and dinoflagellate blooms during the winter-spring and summer-late summer periods (Unsal and Uysal, 1988). These results are in good agreement with the distribution of nutrients (Basturk *et al.*, 1988) and chlorophyll-a concentrations (Gocmen, 1988) determined in the Sea of Marmara. The chemical oceanography of the Sea of Marmara is significantly influenced by the Black Sea and Aegean Sea. In the upper euphotic zone, concentrations of nutrients are relatively low and show seasonal fluctuations that reflect the photosynthetic activity (Baştürk *et al.*, 1986). Since primary production is always limited to the less saline upper layer (15-20 m) of the Sea of Marmara, the subhalocline waters of Mediterranean origin are always rich in nutrients (Polat *et al.*, 1998).

During the last three decades, dramatic changes have occurred in the Black Sea ecosystem as a result of both human and natural pressures (Bologa *et al.*, 1995). Since the Marmara upper layer water is renewed at least twice a year by the Black Sea inflow, similar modifications have been observed in the ecosystem of the former (Kocataş *et al.*, 1993). It contains living species from both the Black Sea and the Mediterranean Sea and it is the feeding and breeding ground for the Atlantic originated pelagic fishes during the migrations from the Black Sea to the Sea of Marmara or vice versa. Additionally, the Turkish Straits form an "acclimatization zone" for transiting species, allowing those from the Mediterranean to adjust to the different environmental conditions in the Black Sea, and vice versa (Birpınar *et al.*, 2006). 118 different species belonging to 10 taxonomic groups were observed in the Marmara Sea (Zengin *et al.*, 2004). This situation causes to be gained at a satisfactory level of income for many fishery families and sustainable of their lives. Instead of forbidden fishing period (May to August), there are several species and high quality and valuable of fish landings could be caught such as Horse mackerel, Atlantic bonito, Blue fish and etc., and its fisheries are given very important input regional and national economy (Güngör *et al.*, 2007).

2. The Structure of Marmara Sea Fishery in Turkey

2.1. Fishery Production of the Marmara Sea

According to 2009 TUIK statistics, total fishery production was 623.191 ton in Turkey, comprising marine fisheries 61.1%, aquaculture 25.5%, inland fisheries 7.1% and the remaining 6.3% from other marine organisms. The 8.3% of total production is obtained from the Sea of Marmara (Figure 1) (TUIK, 2009). The production of marine fish in the Marmara Sea between 2000-2009 is shown in Figure 2.

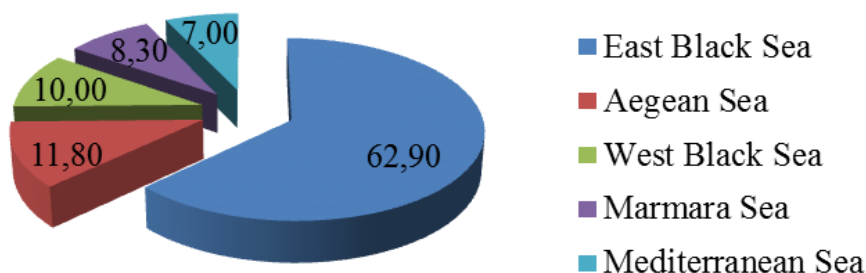


Figure 1. The distribution of total marine fish production



Figure 2. Marine fish production by years (2000-2009)

As it clear from the statistics about the production of sea fish from 2000 to 2009, the values which increased by 2006 had decreased from that years. Fishes in the sea of Marmara provide good fishing during migrations for feeding, spawning and wintering between the Aegean Sea and the Black Sea through system of straits. After 1980, a substantial increase is observed in fishing, the numbers of fishing boats and their capacities (Kocataş *et. al.*, 1993; Eryılmaz, 2001). Pelagic species dominate marine landings in the Marmara Sea, particularly anchovy, pilchard, horse mackerel, scad, bluefish and whiting. Around 60-70% of the total landings are anchovy so any change in the distribution and catches of anchovy in any one year or season has a significant impact on the total annual catches (Table 1).

Table 1. Landings of important fish species in Marmara Sea: 2000-2009 (ton)

Species	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Anchovy	14986	21988	25641	20279	23372	15178	43238	19362	20786	10984
Horse mackerel	2231	4279	10500	8831	9729	2272	5096	6449	5304	4374
Pilchard	2159	1690	2666	3684	3955	4638	3663	4928	3407	5371
Scad	2784	2793	4523	7514	6048	3890	2733	3650	1675	2600
Blue fish	967	4470	8557	7530	6812	4592	2636	2438	1381	1906
Whiting	2455	1935	890	808	829	1342	654	1141	907	1519
Atlantic bonito	1249	3345	479	457	434	4878	2208	731	1006	983
European hake	-	18459	9314	6654	3886	2164	1507	1100	650	783
Striped red	365	291	304	220	202	306	319	331	304	406
Thornback ray	81	56	127	186	183	437	269	628	391	337

Currently any port or small quay may be a potential discharge point (although there are reportedly some designated landing sites during the closed season in the pelagic fishery) so with the large number of ports nationwide it is nearly impossible to monitor the quantity of fish been caught in a season. As a result there may be big differences between official data and actual landings.

The reported catch of shellfish, cephalopods and non fin-fish was 44.410 ton in Turkey, its 8% belongs to the Marmara Sea (Table 2) (TUIK, 2009). Mussel and prawn are the dominant catches in the Sea of Marmara. Because of having rich sea benthic fauna, it could be giving opportunity of living source, mainly of deep water pink shrimp fisheries. For the shrimp fishing are generally used dredge, beam trawl, bottom trawl, traditional seine net. In spite of forbidden deep trawl also used all around year since along time in the Marmara Sea. Deep trawl are used much more than other in this area (Zengin *et al.*, 2004). The production and export potential of Turkey is still very low level comparatively to other countries. According to the statistics about the past decade, the amount of exports have been realized is about 300-600 tons and exporting value is about 15-20 million dollars per year averagely. The main exporting countries are primarily Italy and then Lubeneon, France, Spain respectively (Çelikkale *et al.*, 1999). The shrimps are generally marketing into five different categories such as jumbo, sub grand, medium, small and fracture. There are noticeable price differentiations among these quality classes (Güngör *et al.*, 2007).

Table 2. Production of shellfish and other species in Marmara Sea (ton) (TUIK, 2009)

Species	Production (ton)
Octopus	10
Mediterranean mussel	36
Bearded horse mussel	480
Spiny lobster	6
Norway lobster	6
Sea snail	532
Common lobster	2
Squid	1
Green tiger prawn	5
Caramote prawn	85
Giant gamba prawn	995
Deepwater rose prawn	1349
Speckled shrimp	1
Cuttle fish	5
Common shore crab	1
Total	3514

2.2. Fishing Fleet Profile of the Marmara Sea

The fishery in the Marmara Sea waters encircling can be categorized into two main groups as inshore fishery and coastal fishery. The inshore fishery is a daily fishery and performed by the boats of 5-12 m length and 10-70 HP. These smaller boats are operated by a mixture of professional (full-time), subsistence (part-time) and recreational fishermen. It is not clear how many of these vessels are active. Part time fishers are also less likely to report their catches and hence their impact of the sector and status of fish stocks is probably underestimated in official statistics. Conversely, if a large proportion of these small vessels are inactive and catch estimates are based on a sample aggregated simply according to the number of boats, this would in fact exaggerate landings (Final Report, 2007). Number of fishing vessels reached to 2963 in 2009 in the Marmara Sea, more doubling in last 15 years (TUIK, 2009). Of these vessels, 87% is made of wood, 12% sheetiron and 1% is fiberglass.

Fishing vessels in the Marmara Sea are classified into five categories based on their principle fishing activity: There are 2578 (87%) inshore fishery boats, 177 purseseiners (6%), 15 carrier vessels (0.5%), 109 trawler (4%) and 84 trawler-purseseiner (3%) (Table 3).

There are no crew in 86% of the vessels, 10% has 1-4 crew and 4% has over 5 and more crews. Since 1980 there has clearly been a significant increase in the number, size and engine powers of Turkish fishing vessels. However, the majority of even newer fishing vessels lack cold storage, freezing units or processing capability. Most vessels have cramped living conditions and are used

for daily fishing trips for single species (Final Report, 2007). Mean capacity, engine power and net tonnage of the fishing vessels above 10 m are 40 ± 1.8 GT, 141 ± 7.0 KW and 16 ± 0.7 NT and fishing vessels over 20 m 160 ± 6.1 GT, 627 ± 29 KW, and 60 ± 2.5 NT respectively (Sağlam and Düzgüneş, 2010).

Table 3. Fishing fleet characteristics of the Marmara Sea (TUIK, 2000-2009)

	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Operation type										
Inshore Fishery Boats	2755	2456	2828	2673	2640	2606	2580	2570	2697	2578
Purseseiner	191	142	194	137	153	131	187	164	194	177
Carrier vessels	31	34	22	20	19	40	51	39	14	15
Trawler	29	69	88	71	72	190	134	137	105	109
Trawler-Purseseiner	-	32	106	106	67	123	98	72	67	84
Total	3006	2733	3238	3007	2951	3090	3050	2982	3077	2963
Material of construction										
Wood	2859	2593	3019	2790	2727	2733	2697	2623	2688	2584
Sheetiron	146	139	199	207	224	351	318	342	362	352
Fiberglass	1	1	20	10	-	6	35	17	27	27
Total	3006	2733	3238	3007	2951	3090	3050	2982	3077	2963
Tonnage (gross ton)										
1-4	1822	2054	2144	2015	2084	1798	1691	1815	1910	1871
5-9	604	271	427	464	419	590	678	500	440	507
10-49	375	254	516	369	299	428	409	389	461	359
50+	205	154	151	159	149	274	272	278	266	226
Total	3006	2733	3238	3007	2951	3090	3050	2982	3077	2963
Engine power (kW)										
1-9	510	440	950	1273	1401	941	688	1028	757	906
10-19	630	720	641	460	351	427	499	390	307	328
20-49	660	751	774	553	402	689	608	555	650	624
50-99	327	321	268	230	283	346	426	284	501	435
100+	879	501	565	455	463	683	829	725	862	670
Without engine	-	-	40	36	51	4	-	-	-	-
Total	3006	2733	3238	3007	2951	3090	3050	2982	3077	2963

Table 3 continued

Length range(m)										
1-4.9	40	10	41	20	30	44	2	2	3	-
5-9.9	2161	1992	2390	2310	2334	2222	2270	2203	2249	2191
10-19.9	646	561	639	513	414	597	494	480	544	513
20+	159	170	168	164	173	267	284	297	281	259
Total	3006	2733	3238	3007	2951	3090	3050	2982	259	2963
Number of crew employed										
Owner/Skipper	1790	1323	1229	1703	1847	1656	1500	1507	1735	2543
1-4	1056	1232	1299	1162	954	1215	1348	1244	1077	290
5-9	51	56	234	43	53	86	80	67	81	53
10-19	65	63	226	48	47	63	57	81	109	38
20-29	39	45	223	37	32	47	52	67	67	29
30+	5	14	27	14	18	23	13	16	8	10
Total	3006	2733	3238	3007	2951	3090	3050	2982	3077	2963

The 87% of total fishing vessels are the inshore fishing boats. But the portion of this fishery in total production is just 10% (TUIK, 2009). Evaluation of fisheries by species in Table 4 was made in the Marmara Sea.

Table 4. The Sea of Marmara Fisheries by Species (Source: Sector Study Final Report: Fisheries&Aquaculture, 2007)

Name of fishery	Region	Species
Pelagic species	Marmara	Anchovy, Atlantic bonito, Sprat, Scad, Blue fish, Sardine
Artisanal Fisheries (gill net, trammel net, longline, traps)	Black Sea, Marmara, Mediterranean and Aegean	Mixed (whiting, turbot, red mullet, grey mullet, shrimp, sparids, sole and dab, squids, octopus and cuttlefish, swordfish)
Sea snail fisheries (Dredging)	Eastern Black Sea, Sea of Marmara	Sea snail
Shrimp/Prawn fisheries	Marmara, Aegean and Mediterranean	Shrimp
Lagoon fisheries	Mediterranean, Aegean Sea and Marmara	Mixed (Sea bass, sea bream, eel, mullets)

The main fish species caught by the inshore fishing boats are red mullet (*Mullus barbatus*), Striped red mullet (*Mullus surmuletus*), Gilt-head sea bream (*Sparus aurata*), Pandora (*Pagellus erythrinus*), Grey mullet (*Mugil cephalus* and *Liza spp*), European sea bass (*Dicentrarchus labrax*), Saddled bream (*Oblada melanura*), Dogs-teeth dentex (*Dentex dentex*), Sea bream (*Pagrus pagrus*), Blue spotted sea bream (*Sparus ehtenbergi*), Salema (*Salpa sarpa*), Two-banded sea bream (*Diplodus vulgaris*) (Kınacıgil and İlkyaz, 1997).

The catching duration of coastal fishery vessels are longer and the catching areas are changing due to the behaviours of fish groups. This kind of fishing is industrial and performed by trawlers and purseseiner. The main pelagic fish species caught by coastal fishery vessels are Atlantic horse-mackerel (*Trachurus trachurus*), Mediterranean horse-mackerel (*Trachurus mediterraneus*), European anchovy (*Engraulis encrasicolus*), European pilchard (*Sardina pilchardus*), Atlantic bonito (*Sarda sarda*), Bluefish (*Pomatomus saltator*), Chup mackerel (*Scomber japonicus*), Mackerel (*Scomber scombrus*), Bogue (*Boopsboops*), Atlantic bluefish tuna (*Thunnus thynnus*), Grey mullet (*Mugil cephalus* and *Liza spp.*) and the main demersal fishes are, Red mullet (*Mullus surmuletus*), Pandora (*Pagellus erythrinus*), Dover sole (*Solea vulgaris*), Flounder (*Platichthys flesus*), Turbot (*Psetta maxima*), Poor-cod (*Trisopterus minutus capelanus*) Hake (*Merluccius merluccius*) and Prawn (*Penaeus spp.*) (Kınacıgil and İlkyaz, 1997).

More than 90% of pelagic fish production in Turkish sea waters is performed by purseseiner fishery. The purseseiner fishery is especially concentrated in Black Sea and Marmara Sea. Each of the purseseiner catching in Black Sea and Marmara Sea has at least one carrier vessels. The lengths of purseseiner are between 18-32 m and the powers between 250-850 HP. The purseseiner nets loaded by these vessels have the dimensions of 600-1200 m, length and 100-150 m depth. Most of the purseseiner catching in West Black Sea and Marmara have the special nets for European anchovy and European pilchard beside the nets for Atlantic bonito, Atlantic bluefish tuna. The purseseiner of 23-22 m length can be caught continuously for 3-7 days. The carrier vessels transport the caught fish to the marketing port. The loading capacity of these fishing vessels is between 20-40 ton/fish. The lengths are between 15-24 m and the powers are between 150-300 HP. More than 90% of demersal fish production in Turkish sea waters is obtained from trawl fishery which is concentrated especially in Black Sea, Aegean Sea and Mediterranean in order. All sorts of trawl fishery are forbidden in Marmara Sea as stipulated in the Article 24 of the Fisheries Law no. 1380.

3. Problems of the Marmara Sea Fishery

The Marmara Sea is an important sea in terms of affecting the human health and many ecosystems. The importance of the sea is clear because an inner sea and having an important part of population, industry and trade centers of Turkey around it. It is fact that concentrations of the organic and inorganic toxic substances in the sea water and sediment are high due to municipal and industrial wastes. The fish and natural life exposed to these compounds are affected negatively (Taşdemir, 2002).

The Sea of Marmara is a small (size $\sim 70 \times 250$ km) intercontinental basin connecting the Black Sea and the Mediterranean Sea. The oceanographic feature of the basin are influenced by the Black Sea and the Aegean Sea via the Bosphorus Strait and the Dardanelles, respectively. The Marmara Sea is now the recipient of a large number of wastewater discharges from land-based sources. The basin receives a total of 1.9×10^6 tons of total organic carbon and 2.7×10^5 tons of total nitrogen per year from the Black Sea inflow. Pollution loading from Istanbul alone, the biggest city of Turkey in population and industry, makes up the major portion (40-65%) of the total anthropogenic discharges (Tuğrul and Polat, 1995; Albayrak *et al.*, 2006). Anthropogenic activities in the coastal area of the north Marmara Sea include, urban effluent, summer resorts (untreated effluent discharged into the sea), agricultural run off, sunflower oil factories, a big cement factory, fishing and shipping (Öztürk *et al.*, 2000). In addition tanker traffic of several thousand oil carrying vessels per day, via the Bosphorus Strait are a constant threat to the marine ecosystem (Albayrak *et al.*, 2006). Indeed, the Volgoneft-248 tanker accident in December 1999, led to a serious oil spill in the Marmara Sea with significant impacts (Otay and Yenigun, 2000). Other negative impact of shipping on the coastal benthic ecosystem seems to be the recent appearance of exotic species such as the manila clam *Tapes philippinarum* (Albayrak *et al.*, 2006).

Mucilage formation in seas is the aggregation of organic substances that are produced by various marine organisms under special seasonal and trophic conditions (Innamorati *et al.*, 2001; Mecozzi *et al.*, 2001; Balkıs *et al.*, 2010). Having serious effects on such human activities as fisheries, tourism and aquaculture, mucilage formation was reported to occur in the Adriatic Sea since 17th Century (Totti *et al.*, 2005). In Turkish territorial waters, mucilage formation began to be observed firstly in Izmit Bay in the Marmara Sea in October 2007 and mainly fisheries and tourism have been damaged seriously (Tüfekçi *et al.*, in press; Balkıs *et al.*, 2010). The jellyfish or algal blooms may be resulted in gelatinous masses affected the fishery areas of all the different levels which are inshore, offshore, surface, pelagic and benthic in the Sea of Marmara and a significant depletion occurred in fishery economics. It is certain that the following proposals are worth to consider, in order for reducing the effects of gelatinous organisms on fish stocks and fisheries. Firstly, it is required

to decrease the fishing effort in the Sea of Marmara. On the other hand, the uncontrolled and unconscious fishery should be taken under control. The depletion in fish stocks creates a negative feeding competition between small pelagic fishes and gelatinous organisms that shares the same trophic food chain in the ecosystem. In order to come over this case, it is necessary to develop a long-term fishing strategy for small pelagic stocks and firstly; the fishery of small pelagic stocks should be completely banned for a certain period, a quota system which designs a reduction in the negative effect of over-exploitation should be applied after the stocks renewed and reached a significant biomass (Zengin *et al.*, 2010).

In the Marmara Sea, shrimp fishery activities have been getting satisfactory revenue to the fishermen. However, many problems have been faced still on a noticeable levels due to variable factors. This problems are listed: the revenue is low level because of higher fishery costs, unharmoniesness of forbiddens, uncertainties of fishery areas, limitation of shrimp fishery, blockaging of troll kind fishery, gradually decreasing fishing amount, obligatoriness of fishing deeper sea levels (100-150 fathoms), manyat method causes to be decreasing shrimp fishing amount, increasing amount of shrimp fishing, decreasing prices and income, shrimp fishing gradually decreasing up to 100 fathoms, jumbo type shrimp has not been noticeable amount in Marmara sea, forbiddens have been applied without noticeable the specialities of regions, manyat method causes to be destroyed shrimps and lowered prices, forbiddens are applied during december-february period although intensive fishing opportunity, algarna method causes to be destroyed shrimps shelters, the number of vessels engaged with shrimp fishing are too much out of necessity, the price balance is very low with in shrimps and fuel oil prices, technical levels of vessels cause to be unfair competition, shrimp prices and income level are relatively low according to life standards, trawl and lamb usage in shrimps fishing cause to be lowered catching amount (Güngör *et al.*, 2007).

4. Fisheries Regulations in the Marmara Sea

The prohibitions, limitations and liabilities for the Marmara Sea below are implemented by the Ministry of Agriculture and Rural Affairs fort he 1st September 2006-31st August 2008 (www.kkgm.gov.tr).

4.1. Trawl Prohibitions

All sorts of trawling are prohibited in inland waters, Marmara Sea, the İstanbul Strait, the south of the line between Kelağra (Galere) Cape and Dalyan(Kilyos) Cape, and in the Çanakkale Strait, as stipulated in the Article 24 of the Fisheries Law no. 1380. It is obligatory that the trawl vessels to pass through Marmara Sea have their nets and doors sealed during their passage from İstanbul and Çanakkale straits to the Marmara Sea, as per the principles to be specified by Çanakkale and Istanbul Provincial Administrations. The nets shall

be kept in the hold, and doors on the deck or in the hold. The trawl ships departing from Marmara Sea and sailing to other territorial waters of our country for trawling shall apply the nearest provincial or district administration for having their nets and doors sealed. Midwater trawling is prohibited in Marmara Sea, Aegean Sea and Mediterranean Sea, and in areas where all sorts of trawling are prohibited in the Black Sea.

4.2. Shrimp Fisheries

Shrimping with all types of gears is prohibited in Marmara Sea and Bosphorus and Dardanelles Straits in 15th April - 31st August and 1st - 31st January. However, caramote prawn (*P. kerathurus*) shrimping with gillnets is permitted in 1st June – 15th July. During the periods when landing activities are permitted in Marmara Sea, in areas specified in table 5 and figure 3. Deep water pink shrimp landing is permitted in waters deeper than 50 m. with 2 double-bunt shrimp trawls whose total beam length is no higher than 15m or 3 single-bunt shear legs each of whose total beam length is no higher than 5 m, having a mouth of 50 cm high, shoulder mesh size and bunt mesh size of 32 mm. at minimum, and a bunt length of 6 fathom (11 m) at maximum. Use of steel rope is prohibited in shrimp landing with shear legs. The diameter of the ropes to be used can not be ticker than 16 mm. Bunt mesh size of *manyats* to be used in prawns landing can not be smaller than 28 mm. On the other hand, use of *manyat* with a bunt mesh size smaller than 32 mm shall be prohibited as of 1st September 2007.

Table 5. Permitted Areas in Marmara Sea for Shrimping with Manyat

	Coordinate	Permitted areas for Fishing
A	40° 33' 15" N-27° 00' 00" E	East of the line connecting Şarköy İnceburun lighthouse to Çanakkale Şevketiye Bozburun Bank.
B	40° 24' 15" N-26° 55' 00" E	
C	40° 28' 30" N-27° 17' 00" E	North of the line connecting Karabiga Karaburun lighthouse to Ekinlik Island and Erdek İlhan köyü
D	40° 33' 15" N-27° 30' 00" E	
E	40° 30' 30" N-27° 41' 30" E	Northeast of the line connecting Erdek Kapsül Cape lighthouse to Mara cape
F	40° 29' 00" N-28° 02' 00" E	
G	40° 24' 00" N-28° 20' 15" E	West of the line connecting Kurşunlu to Narlı
H	40° 21' 30" N-29° 01' 00" E	
I	40° 29' 00" N-29° 02' 00" E	West of the line connecting Dil Cape lighthouse and Dil Wharf lighthouse
J	40° 44' 30" N-29° 31' 00" E	
K	40° 46' 00" N-29° 31' 00" E	South of the line connecting İstanbul Maltepe to Büyükçekmece Değirmen Cape lighthouse.
L	40° 55' 00" N-29° 08' 00" E	
M	40° 57' 30" N-28° 37' 00" E	South of the line connecting Marmara Ereğlisi lighthouse to Barbaros.
N	40° 58' 15" N-27° 52' 00" E	
O	40° 55' 00" N-27° 28' 30" E	

Table 6. Areas where Shrimping with Shear Legs in Waters Deeper than 50 m. is Permitted

	Coordinate	Permitted areas for Fishing
1	40° 57' 35" N-28° 48' 53"E	South-west of the line connecting Yeşilköy to Armutlu Bozburun lighthouse
2	40° 32' 00" N-28° 47' 00" E	
2	40° 32' 00" N-28° 47' 00" E	North-west of the line connecting Armutlu Bozburun lighthouse to Mudanya Buruncu Cape lighthouse.
3	40° 22' 30" N-28° 40' 30" E	
3	40° 22' 30" N-28° 40' 30" E	North-east of the line connecting Mudanya Buruncu cape to Kapsül Cape lighthouse
4	40° 29' 00" N-28° 02' 00" E	
5	40° 30' 30" N-27° 41' 30" E	North of the line connecting Erdek İlhanlıköy to Ekinlik Island and Karabiga Karaburun lighthouse
6	40° 33' 15" N-27° 30' 00" E	
7	40° 28' 30" N-27° 17' 00" E	
8	40° 24' 15" N-26° 55' 00" E	East of the line connecting Çanakkale Şevketiye Bozburun Bank to Şarköy İnceburun lighthouse.
9	40° 33' 15" N-27° 00' 00" E	

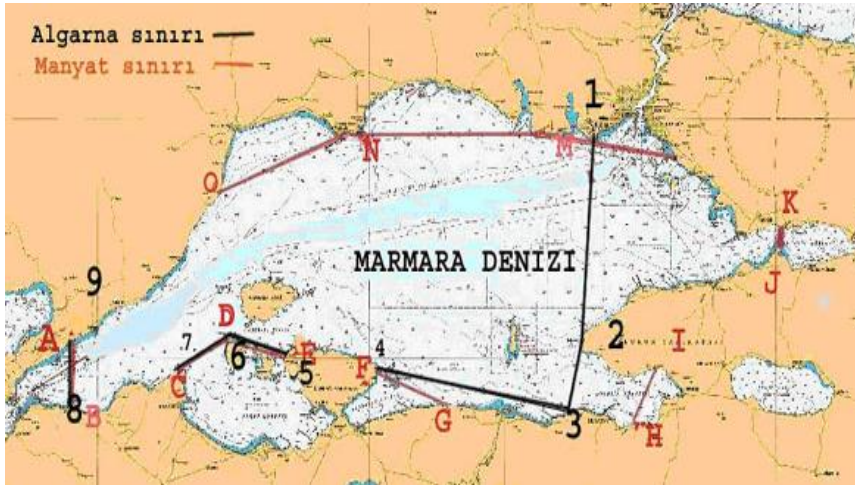


Figure 3. Shear Leg Border

4.3. Sea Shell and Sea Cucumber Landing

Seashell harvesting with shear legs is prohibited in Marmara Sea and İstanbul and Çanakkale Straits during the fishing year, and in other territorial waters between 1st May-31st August. In all territorial waters, sea cucumber harvesting with shear legs is prohibited during the fishing year. On the other hand, sea cucumber harvesting may be performed in Marmara Sea during the period and under the conditions which the shrimping with shear legs is permitted. Diving for sea cucumber is permitted outside the period of 1st August-15th September on condition that the authorization is granted by the provincial administration.

4.4. Crawfish, Lobster, Octopus and Blue Crab Harvesting

Harvesting of crawfish and lobster is permitted in all territorial waters only in the term between 15th April-15th June.

4.5. Bivalve Mollusks Harvesting

All methods of striped venus harvesting with any gears are prohibited in Marmara Sea and Bosphorus and Dardanelles Straits. And, between 1st May - 31st August in areas other than the prohibited areas. However, in case catch quota for the cockle has been fulfilled, the Ministry has the authority to extend the period of the ban. All methods of golden carpet-shell and warty venus harvesting with any gears are prohibited in all territorial waters in 15th May-15th September. All methods of oyster and great scallop harvesting with gears are prohibited in all territorial waters in 15th May-15th September. Tellina harvesting is prohibited in the Black Sea and Marmara Sea during the fishing year.

4.6. Turbot, Swordfish, Grouper, Golden Grouper, Sole and Sand Dab Landing

All methods of turbot landing in the territorial waters are prohibited in 1st May-30th June. All methods of swordfish landing is prohibited in 1st October-31st January. All methods of sole and sand dab landing are prohibited in 15th February-15th March. All methods of grouper and golden grouper landing is prohibited in 15th June-31st July. However, golden grouper catch with set longline is permitted during the said period on condition that the used fishhook is smaller than no: 9 (larger in size). Grouper and golden grouper landing through diving, with fish spear or underwater rifle, and traps like basket, *pinter* (some kind of basket) etc. is prohibited.

4.7. Bonito, Large Bonito, Tuna Fish, Little Tunny, Albacore, Plain Bonito, Leer Fish, Greater Amberjack and Pilchard Landing

Bonito and large bonito fishing by all kinds of gears including stake nets is banned between 1 April-31 August throughout all our territorial waters. However, longlining for bonito is permitted between 15-31 August. Tuna fishing by purse seine between 1 July-31 December, by longline vessels whose length is 24 m and over between 1 June-31 December, and by feeding method between 15 November-15 May is prohibited throughout all our territorial waters. However, in case the catch quota allocated for our country by the International Commission for the conservation of Atlantic Tunas (ICCAT) has been fulfilled, the Ministry has the authority to extend the subject periods of ban.

4.8. Little tunny, Plain bonito, Leer fish, Greater Amberjack and Albacore

Fishing little tunny, albacore, plain bonito, leer fish and greater amberjack by entangling net is permitted during the season throughout our territorial waters and by purse seine from 15 April to 15 May in the territorial waters between Mihli creek (39°33'209"N-26°39'472"E) and Syrian border. Pilchard gillnetting is permitted during the term.

4.9. Algae Harvesting

Collecting, harvesting and selling of *Caulerpa* species of alga are prohibited in all territorial waters. Harvesting of *Gracilaria* species of alga is prohibited in all territorial waters in 1st April-15th July. Harvesting within the permitted period shall be performed, upon the permission from provincial administrations, in turn so that at least 1/3 will be able to sporulate.

4.10. Sponge Harvesting

Sponge harvesting is prohibited during the fishing year in all territorial waters.

4.11. Gear Prohibitions

4.11.1. Harvesting with Surrounding Nets

Harvesting of fisheries by purse seines is prohibited in all seas in the term 15th April-31st August. Unless a prohibition is implemented in all territorial waters as the tuna landing quota offered to Turkey by ICCAT (International Commission for the Conservation of Atlantic Tunas) reaches the top in the term between 15th April-15th July and 16th-31st August, harvesting of tuna fish by purse seines is permitted. In all territorial waters purse seining is prohibited in waters shallower than 10 fathom (18 m). However, purse seining in waters up to 6 fathom deep (11 m) is permitted in the territorial waters in Black Sea between Köpekkaya Cape in Cide District of Kastamonu Province and Bulgarian border, and in the Marmara Sea in 1st September-1st December. In Mediterranean, purse seining in waters up to 6 fathom deep (11 m) is permitted in the territorial waters between the mouth of Seyhan River and Susanoğlu-Atakent.

4.11.2. Light Fishing

Using light for fishing is prohibited in following areas: In the Marmara Sea, the Bosphorus and Dardanelles Straits, for the vessels to pass through Marmara Sea, Bosphorus and Dardanelles Straits with the aim of light fishing in other territorial waters, it shall be obligatory to obtain "Transit Pass" given in Annex-4 from the Provincial or District Administration closest to the ship, as long as transit pass route is notified, and the transit pass from concerned locations shall be performed in 3 days, at the latest.

4.11.3. Seine nets, Gillnets and Other Fishing Nets

All sorts of seining with *ıĝrip*, *trata*, *tarlakoz*, *manyat* and other beach seines are prohibited in all territorial waters. These seine nets and the equipment enabling their usage are prohibited in fishing vessels. In Marmara Sea, shrimping with the type of *manyat* specifically employed for such purpose is permitted on condition of full compliance with the regulations on shrimping.

4.12. Region and Area Prohibitions

4.12.1. Followings are the area prohibitions in Marmara Sea

a) On the coordinate point (40°32'50" N-27°16'00"E) where Australian submarine (A-E 2) sank,

b) In 1st May – 30th September within 3 miles off the coast line between the mouth of Gönen Stream (40°19'38"N-27°38'00"E), and Denizkent (40°18'15"N-27°30'45"E) in Balıkesir Province,

c) in the area to the coast-side of the line between the Doĝu Cape of Çınar Port in Erdek and the coordinates (40°23'02"N-27°48'30"E) and Seyitgazi Cape,

d) Within the sea area inside the line between Erdek Port, Seyitgazi Cape, Tavşanlı Island Cape, southern Cape of Zeytin Island and the port mole,

e) In the area connecting the following coordinates around İmralı Island: (40°37'00"N-28°27'00"E), (40°37'00"N-28°37'00"E), (40°28'00"N-28°37'00"E), (40°28'00"N-28°27'00"E),

f) In the 50 m. long sea area around Mudanya Municipality Port,

g) with shear legs, dredges, rakes and hydraulic systems in the territorial waters between Kelağra (Galere) Cape and Dalyan Cape (Kilyos opening) in Istanbul Province,

h) In the area up to the mouths of Alibeyköy and Kağıthane Streams from New Galata Bridge, in Haliç of Istanbul Province,

ı) In the area within the lines connecting the coordinates; (41°03'58"N 28°15'05"E), (41°03'30"N-28°11'28"E), (41°03'13"N-28°11'27"E), (41°02'59"N-28°11'25" 41°02'51"N-28°10'57"E), (41°03'12"N-28°10'51"E), where TPAO Northern Marmara Natural Gas Production Platform and related sea floor pipelines are located in Silivri District of Istanbul Province,

j) In Yalova District, within 200 m. off the sea at the right and left side of the municipality sewerage system,

k) within 500 m. off the coast in the area between Yalova Province, Altınova District, Hersek Cape and Kocaeli Province, Karamürsel District, Büyükdere Cape,

l) Within 500 m. off the sea at the right and left sides of the sewerage system of the municipality in Altınova offings in Tekirdağ Province,

m) In the area within the lines connecting the coordinates (40°58'00"N – 27°58'06"E), (40°58'00"N-28°00'24"E), (41°01'12"N-28°00'24"E), where BOTAŞ natural gas terminal operational zone in Marmara Ereğli of Tekirdağ Province, Trakya Un-Mar natural gas cycle plants and sea floor pipelines and buoys of Bütangaz A.Ş. are located, harvesting of fisheries are prohibited.

n) In Marmara Sea (in İstanbul), anchor dropping is prohibited within 200 m to the right and left side of the oil – natural gas pipeline in Pendik – Ambarlı.

4.12.2. Other Prohibitions

Use of sonars with a frequency output of 20 Khz (included) and lower is prohibited in harvesting of fisheries in Marmara Sea. Boats to pass through the Bosphorus and Dardanelles Straits to Marmara Sea, with sonars of 20 Khz (included) and lower, shall have their sonars sealed by provincial administrations and apply to the administrations to unseal them for exit. I (a) group mine extraction is prohibited in Marmara Sea so as to protect fisheries and their natural environment.

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AEGEAN SEA FISHERIES

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1. Introduction

Turkey is of crucial importance to the capacity of marine fisheries resources and productivity in the Mediterranean system, including the Black Sea. Turkey, most of the eastern Mediterranean waters are harbored, %34 of the marine capture fishery in the Mediterranean has been provided by Turkey among 26 Mediterranean countries (FAO, 2009) and therefore this fact renders Turkey very important for the area.

The marine capture fishery of Turkey is approximately 423,000 tons (Turkstat 2006, 2007a, 2007b, 2008, 2009) and is produced from the Black Sea, Sea of Marmara, Aegean Sea and Mediterranean. These all have different conditions of climate, hydrography and productivity, with a cumulative total of 8333 km of shoreline and 154,080 km² magnitude of continental shelves. Three fourths of the marine capture production has been obtained from the Black Sea, followed by the Sea of Marmara, the Aegean and Mediterranean Seas respectively (Figure 1).

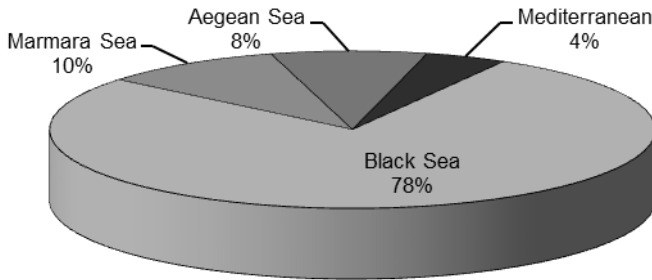


Figure 1. Distribution of marine capture fishery production of Turkey according to sea areas (%) (Turkstat 2009).

The Black Sea is the most productive in terms of nutrients and provides approximately 78% of the marine production of Turkey. The Sea of Marmara, located between the Black Sea and Aegean Sea, is more diverse in terms of demersal and pelagic fish species as compared to the Black Sea and provides 10% of the total production. The Mediterranean is the least productive sea of all those surrounding Turkey and 4% of the total production comes its waters. Although the Aegean Sea has many gulfs and bays, fisheries activities are limited because of hilly and bumpy deep structures and a narrow continental shelf, 8% of the total production comes from the Aegean Sea and it has high species richness (Turkstat 2009).

2. Aegean Sea Fisheries Zones

Fisheries are carried out in fishing centers which are set up on bays, gulfs and headlands. Important fishing areas from north to south are: Saros Bay, Gökçeada and Bozcaada, Edremit Bay, Çandarlı Bay, İzmir Bay, Sığacık and Kuşadası Bay, Kovela port, Güllük (Mandalya) Bay and Gökova (Kerme) Bay (Figure 2) (Kınacıgil and İlkyaz 1997; Mara 2004). Not only shore fisheries but also offshore fisheries are carried out in the Aegean Sea. Over 300 fish boats, 118 purse seiners and 188 trawlers, were certificate for fishing in international water of the Aegean Sea, in 2010.

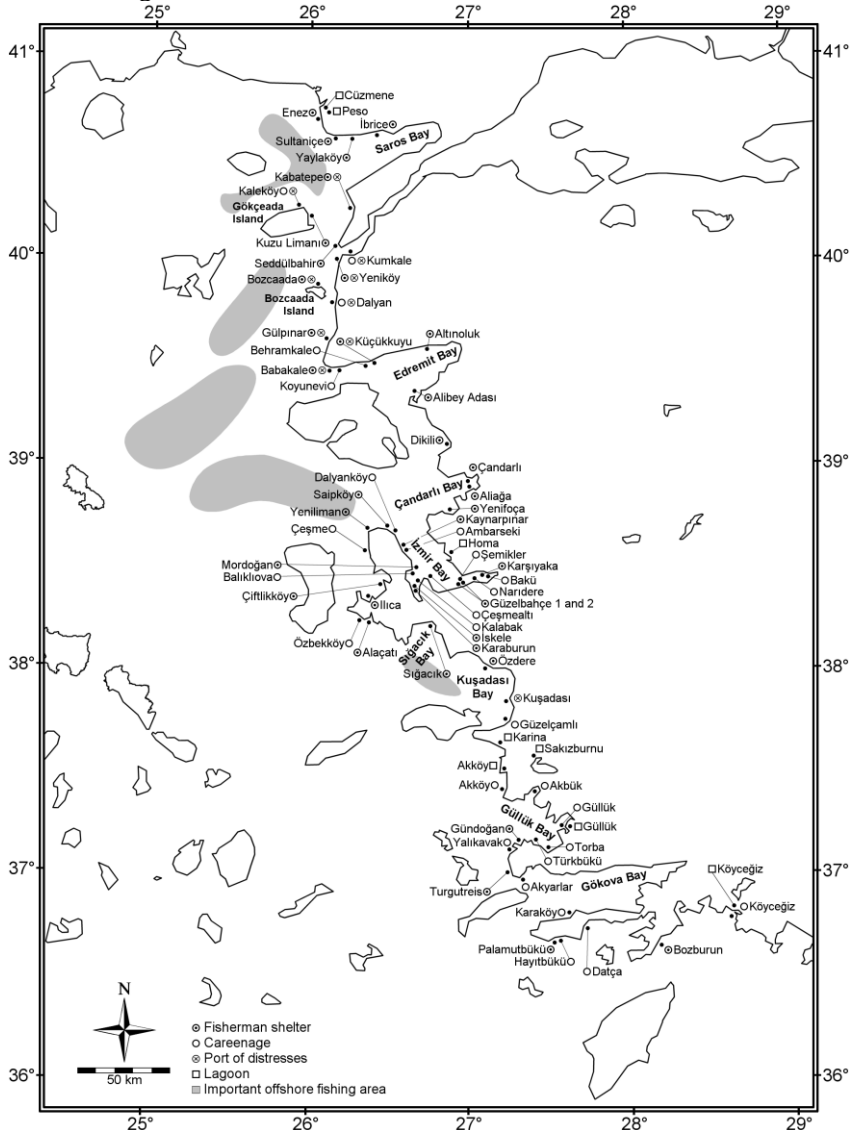


Figure 2. Fisherman shelters, carenages, port of distresses, lagoons and important offshore fishing areas of Aegean Sea.

Fisherman shelters, port of distresses, careenage, and cooperatives are the fundamental units of the fisheries sector. Total number of fisherman shelters, port of distresses and careenages in Turkey are 293; of which 158 are fishermen shelters, 84 are port of distress and 51 are careenages and one in four of these are located in Aegean Sea. There are 34 fishermen shelters, 28 port of distresses, 11 careenages (Mara 2004) and 57 cooperatives located along the Aegean coast (Ünal et al. 2009).

3. Fish Production of Aegean Sea

The Aegean Sea is richer in species diversity than the other seas of Turkey. Commercial fish ratio is nearly 1/50 and this value is 10 times that of the world seas average (Kocataş and Bilecik 1992). According to records of the Turkish Statistical Institute 2008, the most widely caught fish is pilchard with 29.7% of fishery production, followed by anchovy (16.5%), bogue (6.5%), scad (6.2%) and horse mackerel (4.3%), respectively. These species composed the 63% of the total production. Furthermore, highly commercial fishes such as red mullet, solea, sea bream, sea bass, common pandora, tuna and sword fish are also captured (Table 1) (Turkstat 2009).

Table 1. The most captured fish species (>250 tons) and the ratios to total production (tons) (Turkstat 2009).

Species	Caught	Ratio	Species	Caught	Ratio
Anchovy	5430		Little tunny	751	
Annular bream	261		Mackerel	303	
Atlantic bonito	594		Pilchard	9777	
Blue fish	556		Red mullet	475	
Bogue	2148		Scad	2031	
Chup mackerel	954		Sea bass	461	
Eurepean hake	546		Sea bream	735	
Frigate mackerel	393		Striped red	351	
Grey mullet	838		Twaite shad	1129	
Horse mackerel	1423		Other	3714	

In the Aegean Sea, shells, cephalopods, crustaceans and porifers have also been captured as well as the vertebrate fish. Among them, carpet shell is the most widely captured (33.5%), followed by deepwater rose prawn (15.6%), cuttle fish (13.9%), octopus (13.2%) and squid (9.4%). These invertebrate species, which are in the top five producers, correspond to 86% of the total production (Table 2) (Turkstat 2009).

Table 2.The most captured invertebrate species (>30 tons) and the ratios among the total production (tons) (Turkstat 2009)

Species	Caught	Ratio
Carpet shell	1255	
Cuttle fish	521	
Deepwater rose prawn	583	
Giant gamba prawn	60	
Green tiger prawn	147	
Mediterranean mussel	213	
Norway lobster	30	
Octopus	494	
Squid	352	
Other	93	

In the last decade, Aegean Sea dropped from second to third place in Turkey’s marine fish production. Total fishing catch in the Aegean Sea fluctuated between 2004 and 2008 from 36,618 to 61,678 tons (Table 3, Figure 3). Eighty eight percent of the total catch was composed of fish. Year 2006 had the highest amount of fish and invertebrate production. The reason for this increase is thought to be due to an increase in mediterranean mussel and sand smelt catch in that year (Turkstat 2006, 2007a, 2007b, 2008, 2009).

Table 3.Total marine capture fishery production in Aegean Sea (tons) (Turkstat 2006, 2007a, 2007b, 2008, 2009).

	Fish (Ratio)	Invertebrates (Ratio)	Total
2004	33,946 (88.2%)	4,543 (11.8%)	38,489
2005	38,774 (91.5%)	3,608 (8.5%)	42,382
2006	47,680 (77.3%)	13,998 (22.7%)	61,678
2007	44,386 (91.2%)	4,297 (8.8%)	48,683
2008	32,870 (89.8%)	3,748 (10.2%)	36,618

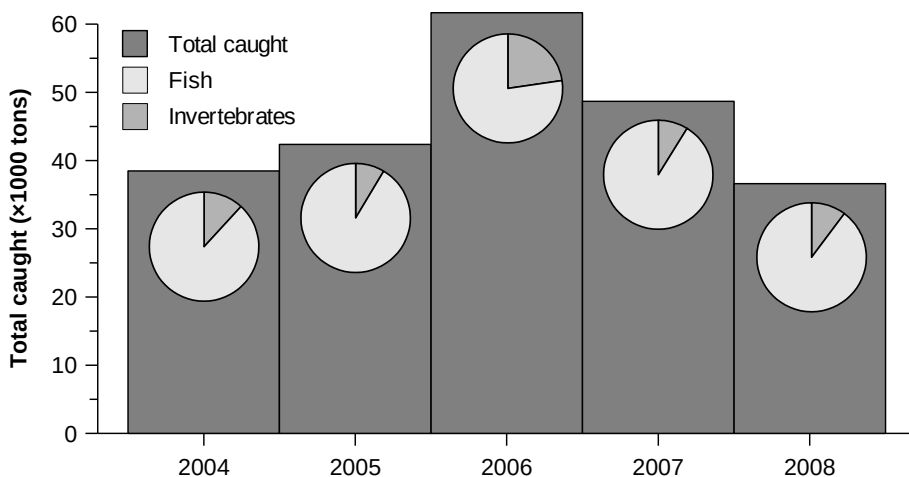


Figure 3. Total fishery production between 2004 and 2008 from the Aegean Sea (Turkstat 2006, 2007a, 2007b, 2008, 2009).

4. Fishing Fleet of Aegean Sea

The average number of fishing boats in Turkey is 17,803 despite periodic fluctuations. A total of 5725 craft are located in the Aegean Sea, corresponding to 32% of the total fleet. Among them 83 are trawlers, 89 are purse seiners, 17 are trawler-purse seiners (combined), 69 are carriers and 5,056 are small scale fishing boats, according to latest statistics (Turkstat 2009). Small scale fishing boats account for 95% of the total Aegean fleet (Figure 4). Engine capacity is less than 10 HP in 52% of the fleet. Fleet construction materials are commonly wood (97%), sheet iron (2%) and fiberglass (1%) (Turkstat 2009).

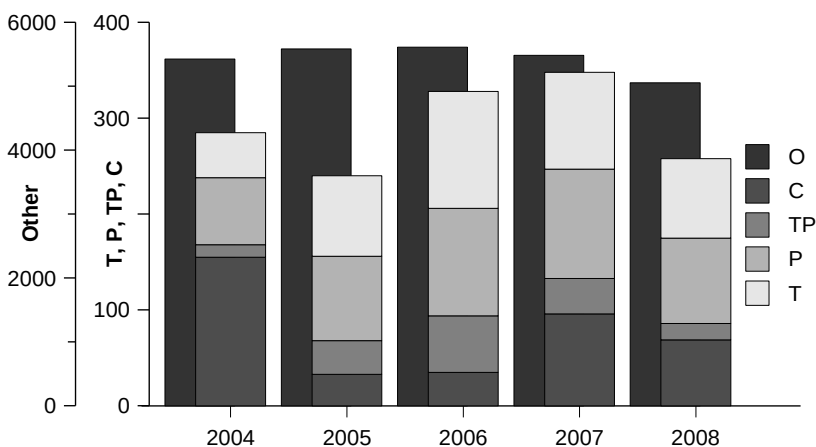


Figure 4. Number of fishing boats and ratios in Aegean Sea (T:Trawler, P:Purseseiner, TP:Trawler-Purseseiner, C:Carrier vessels, O:Other) (Turkstat 2006, 2007a, 2007b, 2008, 2009).

A total of 45,872 employees are working in the fish capture sector in Turkey. This number is 10,425 for the Aegean region, corresponding to 23% of the total employees. More than half of the employees are boat owners, partners and costless family members. Number of charged partners, family members and crew are 3356, which is one in three of the total employees. This case indicates that the fish capture sector of the Aegean Sea fishery is dominated by small family enterprises (Turksat 2009)

5. Conformation of Fisheries

Fisheries in the Aegean Sea are divided into four groups as: small scale fishery, purse seine fishery, trawl fishery and lagoon (trap) fishery.

5.1. Small Scale Fishery

There is limited area in the Aegean Sea for fishing activities because of narrow continental shelf and having recesses costs. Small scale fishery is generally carried out daily by 5-12 m long boats with 10-70 HP engines. Gill nets; trammel nets; entangled net; demersal and pelagic long-lines; pots and traps; and spear fishing are the methods commonly used in this type of fishery.

There are many small scale fishing boats in the Aegean and they compose approximately 95% of the total fleet in Aegean Sea. On the other hand, their contribution to fish production is only between 10-20% (Kara and Kınacıgil 1990), but highly commercial species in the catch composition is of crucial importance for the small scale fishery of the region. The most important species caught by small scale boats are red mullet, striped red mullet, common sole, pandoras, horse mackerel, bogue, pilchard, picarel, sea bream, two banded sea bream, annular sea bream, saddled seabream, mullets, cuttlefish and squid.

5.2. Purse Seine Fishery

A total of 80% of the production comes from the purse seine fishery. Vessels vary between 18-32 m length and 250-850 HP. Nets carried by purse seiners depend on the vessel type and commonly have 600-1200 m length and 100-150 m depth (Kınacıgil and İlkyaz 1997).

All vessels have fish finders and 70-80% of the boats have multi-beam sonar for monitoring vertical fish movements. In addition many of these boats have been equipped with radars and VHF radio receivers. Net hauling is performed mechanically by hydraulic net stowing pulleys. Important pelagic fishes of the catch composition are anchovy, pilchard, horse mackerel, bonito, mackerel, blue fish, tuna and bogue.

Contrary to the methods used by Black Sea and the Marmara purse seiners, Aegean Sea purse seiners are not using carrier boats because of less daily catch. Instead, they are using one or two light boats, generally 8-12 m long, which are used especially for aggregating anchovy and pilchard schools.

5.3. Trawl Fishery

Ninety percent of the demersal fish production of Aegean Sea has been provided by bottom trawls. Boats vary between 15-25 m in length with 150-350 HP engines. All trawlers have been designed to operate the net from the back of the boat and the sizes of the nets are between 500-1200 mesh. Most of the trawlers use traditional mediterranean type nets, which is made by rectangle shape net sheet and the trawl shape to form with constrict that net sheet; and few of them use with modern types.

Many of the boats have been equipped with echo sounder, radar and VHF radio receivers. Vessels generally are adequately technically equipped to operate up to 250 m depth and a few numbers of them operate in international and deeper waters. The most important species captured by trawlers are red mullet, european hake, common sole, pandoras, poor cod, whiting and shrimp.

5.4. Lagoon (Trap) Fishery

Lagoon fishery is a kind of trap system made of iron stakes, natural pikes or other materials are set across bays or shallow waters connected to the sea. Fish enter these areas to feed and are imprisoned by the closure of the lagoon gates after a time. Because the coast of the region has many embayments, the Aegean is very lucky in terms of such systems.

Fishing in lagoons is generally performed directly in traps and nets and fyke net are also used in lagoon areas. The most important fishes in the catch composition are mullets (flathead grey mullet, thinlip grey mullet, leaping mullet and golden grey mullet), gilthead seabream, European seabass, common sole, European eel, striped seabream, and blue crab. In addition caviar which was salted, dried and waxed, obtained from mullets is highly commercial. Karina and Köyceğiz lagoons takes the first place in terms of production capacity, followed by Güllük, Akköy, Homa, Peso, Cüzmene and Sakızburnu lagoons (Figure 2, Table 4). The total production of lagoons located along the Aegean coast is about 400 tons fish and almost one ton caviar (Kocataş and Bilecik 1992; Kınacıgil and İlkyaz 1997; Hoşsucu et al., 2001, Elbek et al., 2003; Erdem 2006).

Table 4. The Aegean Sea lagoons and annual average productions.

	Total caught (tons)	Caviar (kg)
Akköy	37	–
Cüzmene	14	–
Güllük	54	200
Homa	25	116
Karina	132	500
Köyceğiz	129	165
Peso	16	–
Sakızburnu	8	–

6. Problems of Aegean Sea Fisheries

Problems of fisheries are similar in all parts of Turkey. One of the biggest problem in the Aegean is the competition between small scale fishermen and large scale fishermen. The reasons for this are their attitude, (assuming the other as an opponent), and the problems with sharing the catch zones. The first recommendation for solution is to separate the catch zones of these two categories. For this, large scale fishermen should be encouraged towards for modernization of their gear to allow fishing in deeper and international waters.

Unbalanced fishery and over-exploitation of stocks are the other key problems of the Aegean Sea. This problem is caused by fishermen by black-fishing in closed seasons and areas. The solution to this problem is to educate the fishermen to these issues, making them realize that they are destroying their own economic position. To meet this goal, seminars should be given, cooperatives should be supported, and a base should be formed to create an auto control mechanism amongst the fishermen. Furthermore, a state policy should be created to indicate that being a fisherman is not an ordinary job from father to son and participants should be committed to graduate from a fishery education program, including developing a consensus on topics such as stock assessment and management, and evaluation of discards.

Modernization of trawl fishery and other fishing gears are another critical problem. It is necessary to adapt to modern designed fishing gear and equipments appropriate to engine power and length of the vessel instead of the traditional gear which are still in use. This will help fishermen reduce both fuel consumption and manpower as well as be less harmful to nature and environment. Fishing gear should be informed by scientific experience, be designed in accordance with the catch and the zone conditions, be patented and certified.

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FISHERIES OF THE MEDITERRANEAN PART OF TURKEY

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1. Introduction

Since the early days of human being fishing have played an important role for supplying food and it contributes to the culture, economy and employment of coastal communities (Sahrhage and Lundberg, 1992; Gabriel *et al.*, 2005). Technological improvements have modified fishing methods towards to industrial trawl, purse seine and longline fishery. However, artisanal fishery still has an important role in most of the fishing areas such as the Mediterranean Sea.

The Mediterranean Sea is a sea almost completely enclosed by land: in the north by Anatolia and Europe, in the south by Africa, and in the east by the Anatolian and has a connection to the Atlantic Ocean (Figure 1). It has an average depth of 1.500 m and covered area is approximately 2.5 million square km.



Figure 1. Mediterranean Sea and countries (d-maps.com)

The global fisheries production had showed a rapid increase between 1950 and 1980 with more fishing effort, new engine technologies, electronic equipment and netting materials. In the last three decades, globally marine fisheries production showed almost stable trend line between 90 and 95 million tons per year with the exception of the People's Republic of China (FAO, 2009). The contribution of the Mediterranean to global production was estimated as 1.7%; although an unknown amount of catches of non Mediterranean countries like, Japan, South Korea, Taiwan and Portugal are also

included in this figure. For the year 2008, global fisheries output showed a drop in catches (1.24%) compared with the global production average of the years between 2000 and 2008. Total marine fishery production in the entire countries bordering the Mediterranean Sea (4.08%) including Turkey (6.19%) also displayed the same declining trend as reflect reported for the global estimates (Table 1).

Table 1. Annual marine fisheries production of Global, Mediterranean and Mediterranean Sea Region of Turkey (FAO, 2009, Turkstat, 2009)

	W	MSC	T	MRT	MS/W	T/MSC	MRT/T
	X 1000 tonnes				%		
2000	94733	1418	461	14	1.6	32.5	3.1
2001	91930	1448	484	11	1.7	33.4	2.3
2002	92195	1433	523	11	1.7	36.5	2.1
2003	89446	1355	463	12	1.7	34.2	2.6
2004	93650	1386	505	11	1.6	36.4	2.2
2005	93251	1316	380	17	1.5	28.9	4.4
2006	90737	1512	489	15	1.8	32.3	3.0
2007	90989	1578	589	17	1.9	37.3	2.8
2008	90800	1365	453	17	1.6	33.2	3.8
2009	89776		425	29			6.9
Average	91750	1423	477	15	1.7	33.9	3.3

W; World Marine Catch, MS; Mediterranean Sea Catch, MSC; Marine catches by countries coastal to the Mediterranean and Black Sea, T; Turkey, MRT; Catches from Mediterranean Region of Turkey.

Although agriculture is one of the main economic sector in Turkey with 9.2% Gross Domestic Product (GDP), contribution of the whole fishery sector (capture, process, aquaculture and suppliers) was estimated as 0.4% of the GDP in 2006 (FAO, 2008). Despite its relatively small contribution to the GDP and lack of reliable information on most of the fisheries business, the fisheries sector is an important activity for the economy of several coastal towns, since it generates income and work opportunities, contributing to the social and economic welfare of the residents of these areas.

2. Mediterranean Fishery Production

The weight and value proportion of 2009 catches from Turkish fishery are shown in figure 2. The percentage of the Mediterranean region in Turkish total fishery production is approximately 7%, in contrast to this amount the area constitutes high economy value as 20%. However, an insignificant improvement was recorded for Turkish fishery in the last decade (T column of Table 2). The marine capture production increased by 69.1% from 2008 to 2009 during which the total Turkish production was decreased by 6.1%.

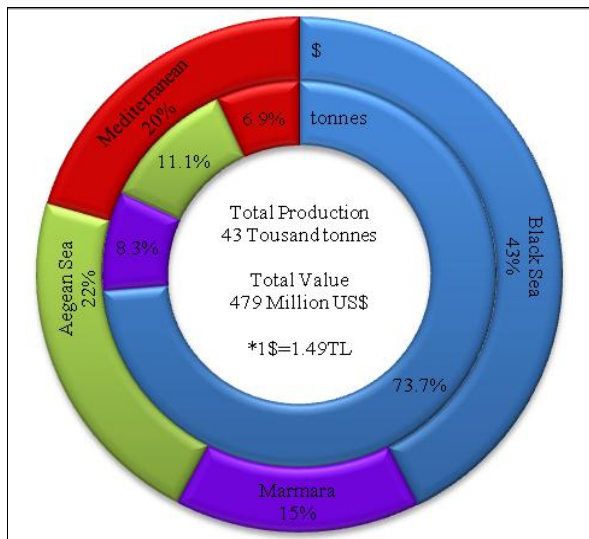


Figure 2. Total fish capture production and production value of Turkish fishery sector in 2009 by region (Turkstat, 2010). *Exchange currency (31.12.2009)

The weighted average of the unit price of 2009 was calculated $1.6 \$kg^{-1}$ for Turkish fishery. This value was maximum in the Mediterranean fishery by $3.4 \$kg^{-1}$ compare with the Black Sea, $0.7 \$kg^{-1}$, Marmara $2.1 \$kg^{-1}$ and Aegean $2.2 \$kg^{-1}$. Although, anchovy was dominated the total Turkish catch by 48%, high valued shellfish, fish and mollusk species such as shrimp, prawn, bluefin tuna, atlantic bonito, grouper, striped sea bream, cuttlefish and squid were widely caught in Mediterranean region (Table 2).

Table 2. Total amount of 36 specimens in Turkey and percentage contribution of these species by the Mediterranean region of the country (Turkstat, 2010)

Species	T	%	Species	T	%	Species	T	%
Bluecrab	77	100	Green tiger prawn	531	78	Two banded bream	282	52
Speckled shrimp	329	94	Leer fish	1167	78	Streaked gurnard	47	51
Greater amberjack	96	92	Caramote prawn	442	78	Sword fish	301	50
Grouper	566	89	Cuttlefish	1258	74	Albacore	631	50
Lizardfish	1721	89	Bluefin tuna	1210	70	Common sole	882	48
European barracuda	178	89	Brown meagre	32	63	Axillary seabream	724	48
Dusky grouper	83	88	Picarel	1116	62	Dentex	165	39
Saury	487	81	Goldon banded mullet	317	60	Grey mullet	2987	37

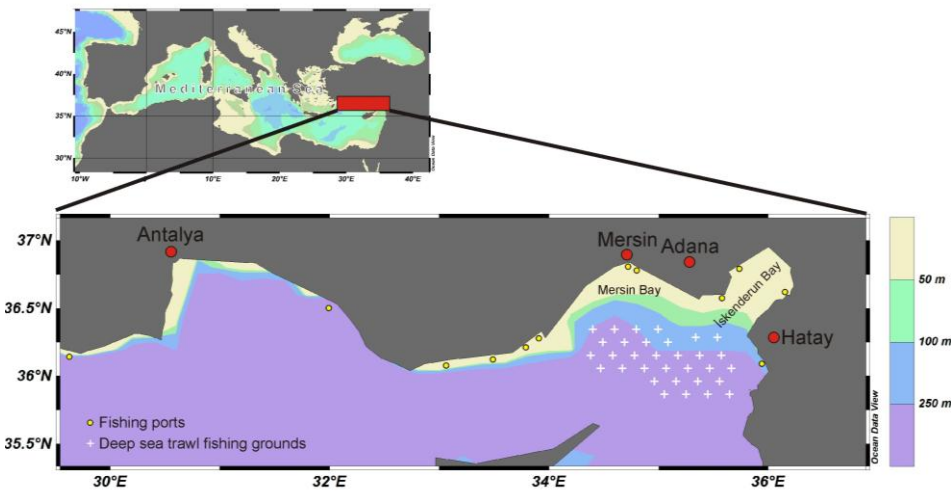
Table2 continued

Red gurnard	320	81	Red porgy	177	54	Red mullet	2461	37
Gobies	124	80	Corb	24	54	John dory	104	35
Striped seabream	390	79	Blackspot seabream	98	53	Blue spatled bream	86	34
Meagre	23	78	Gilthead seabream	1186	53	Squid	576	33

T; Total Turkish production (tonnes)

Species distribution and abundance is influenced by bathymetry of oceans. The continental shelf which constitute the main habitat of these resources are relatively narrow in most areas of the north-eastern Mediterranean with some exceptions, like the İskenderun and Mersin Bays (Figure 3). These bays are very productive for shellfish and demersal species due to having large continental shelf, bottom type and river discharge.

Figure 3. Bathymetry, fishing ports and deep sea trawling grounds of North-East Mediterranean Sea (Ocean Data View)



Coastal fishery is common fishing activity in the area however; deep sea trawl fishery is continue for a two month period after the closing of the fishing season with a special permission of Turkey Ministry of Agricultural and Rural Affairs (MARA). Catch composition of the fishing activity varies according to depth. Mostly prawn species such as *Parapenaeus longirostris* (between 200 and 500m depth), *Aristaeomorpha foliacea*, *Aristeus antennatus*, *Plesionika martia* (between 400 and 1000m depth) and fish species *Merluccius merluccius*, *Trachurus trachurus* (between 200-400m depth) and *Lophius piscatorius*, *Phycis blennoides*, *Scorpaena elegant*, *Helicolenus dactylopterus* (between 400-1000m depth) were caught in the fishing activity (Demirci, 1995)

3. Fishing Fleets of the Mediterranean Region

The main type fishery structure of Mediterranean region is small scale coastal fishery which is daily operated near shore and on the continental shelf with wooden and steel vessels. According to Turkstat (2009) the total registered number of fishing boats is 16845 and, the proportion of fishing boats in the Mediterranean region is 13% of total (Figure 4). Most the fishing vessels are generally made of wooden (94.9%) or steel (5%) and the average length is 13 m in the region. Approximately 85% of the fishing boats have smaller engine power then 100 kW in the region. The fishing boats, which are smaller than 20 m, have tax exemption and that 96% of the fishing boats in the Mediterranean region is smaller than 20 m.

Turkish Mediterranean fisheries carried out along 1307 km coast line (17 ports of 4 cities i.e. Hatay, Adana, Mersin and Antalya) are enormously diversified and can be classified in three fleet classes (bottom trawlers, purse seiners and small scale fishing boats) based all. Although, the production statistics by region, species, region, vessel types, and value were supplied by Turkstat, detailed data by vessel type are not provided (Table 3).

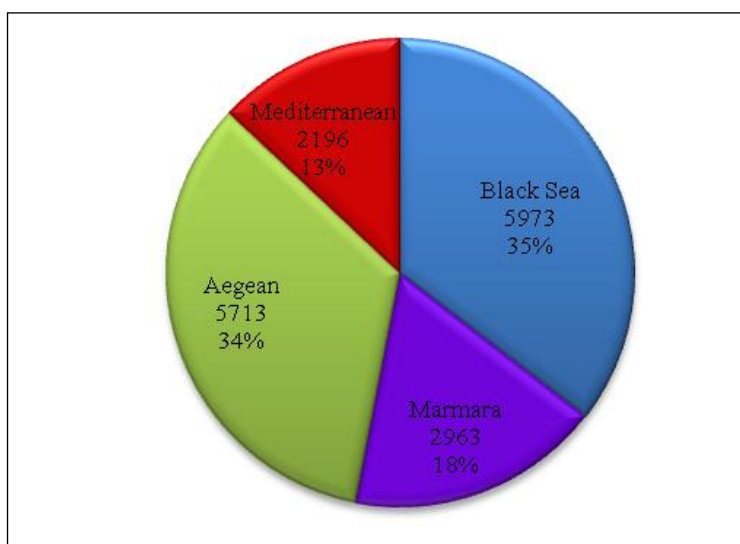


Figure 4. Total numbers of fishing boats registered in 2009

In the Mediterranean region, 37.1% of the total trawlers dominate fishing activity, given the volume and value of their catches. However, purse seiners (11.7%) and small-scale fleets (12.7%) also constitute important elements of the Mediterranean fisheries.

Table 3. Fishing boat numbers by regions

	Turkey N	Mediterranean Region N %	
Trawler	552	205	37.1
Purse seiner	505	59	11.7
Trawler-Purse seiner	431	8	1.9
Carrier vessels	156		
Other	15201	1924	12.7
Total	16845	2196	13.0

N; Total Number.

Total number of fishing boats, engine power (kW) and Catch Per Unit Effort (CPUE) of the fishing fleet of Turkish and Mediterranean region are presented in Table 2. In the last decade, two significant amendments, which caused rapid increase in number of fishing boats and power of engine, were inured to the benefit of the fishing fleet by both Ministry of Agriculture and Rural Affairs and Ministry of Finance. The first one was granted a respite to register the unlisted fishing boats in 2001 for 8 months by Ministry of Agriculture and Rural Affairs. Hence, the percentage total number of fishing boat was increased by 36% in 2002 (Blue row of the Table 4). The second one was tax exemption of the fuel oil for subsidizing the boat owners in 2004 by Ministry of Finance. So, fuel price was reduced by 60%. This subsidy encouraged the fishermen to increase or misreport the engine power to get more volume of oil for use. Lately, the percentage of total engine power of the Turkish and Mediterranean region was increased by 65 and 59%, respectively (Green row of the Table 4). In the last decade, the production trend turned to become negative. However, fishing pressure increased both in numbers and power of engine, CPUE decreased in entire Turkish fishery (CPUE-T column in Table 4) and Mediterranean region (CPUE-M column in Table 4).

Table 4. Total fishing boat numbers, engine power (kW) and Catch Per Unit Effort (CPUE) of Turkish and Mediterranean region fishing fleet

	TBN	TEP(kW)	MEP (kW)	CPUE-T	CPUE-M
2000	13381	636995	52950	0.72	0.27
2001	12989	553220	60730	0.88	0.18
2002	17696	614710	86450	0.85	0.12
2003	18542	553345	71165	0.84	0.17
2004	17953	617070	80455	0.82	0.14
2005	18396	1020330	128095	0.37	0.13
2006	17823	1100390	136600	0.44	0.11
2007	17681	1063045	123685	0.55	0.14
2008	17161	1126190	151865	0.40	0.11
2009	16845	1009040	137135	0.42	0.21

TBN; Total boat numbers, TEP; Total engine power, MEP; Mediterranean engine power, CPUE-T; Catch per unit effort.

4. Problems in Mediterranean Fishery

Fishing pressure is one of the main significant problems in Mediterranean fishery. FAO (2009) reported that in 2007, 52% of global fish stocks were fully exploited, 28% were overexploited or depleted, 20% were moderately exploited, and only 1% showed signs of recovery. Decreasing catches due to overfishing have been recorded also in the Mediterranean, particularly as far as demersal fish are concerned (Jardas *et al.*, 1997; Stergiou *et al.*, 1997; EEA, 1999). Demersal fish stocks are usually fully exploited (Table 5). Large pelagic fish stocks (tuna and swordfish) are overexploited also by international industrial fleets, especially Atlantic bluefin tuna for which the Mediterranean is an important spawning area. In spite of growing fishing pressure (by number of fishing boats and engine power), total production still shows negative trend as a sign of the overfishing in the Turkish fishery.

Table 5. Exploitation rate of some Mediterranean species (FAO, 2009 Table D5)

Species	Exploitation Situation	Country
European Hake	Overexploited	Italy, Spain, Greece, France
Whiting	Fully Exploited-Depleted	Italy, Spain, Greece, France
Red Mullet	Moderately Exploited-Depleted	Turkey, Tunisia, Spain
European Anchovy	Fully Exploited - Overexploited	Turkey, Italy
Albacore	Fully Exploited - Depleted	Italy, Greece
Atlantic Bluefin Tuna	Depleted	France, Italy, Tunisia, Turkey
Swordfish	Overexploited	Italy, Morocco, Spain, Tunisia
Atlantic Bonito	Fully exploited - Depleted	Turkey, Greece, Egypt, Tunisia

Marketing is another problem in the fishery Mediterranean region of Turkey. Products are marketed primarily in two ways. Main marketing type is done by dealers and tradesmen (Figure 4) while the second is direct sales to consumers. The proportion of the cooperatives in this marketing chain is only 2%. Even though, Mediterranean species have high commercial value the producers cannot sell their products to their real price, due to lack of auctions. Monopolistic behavior of the dealers as well as absence of auctions are the main reasons for the products to fetch good price and it is suggested that this problem may be overcome by effectively working cooperatives.

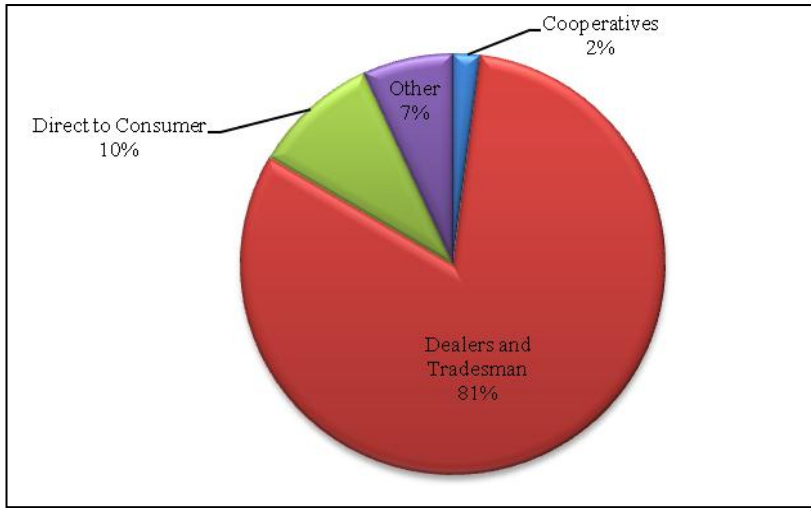


Figure 4. Distribution of Mediterranean region capture production by marketing (Turkstat, 2010)

Loss of fishing gear is another important problem in the region. In the North-Eastern Mediterranean region (İskenderun and Mersin Bays) gill and trammel nets are lost in average of 93% per year (Özbilgin *et al.*, 2009). The conflicts between trawlers and netters, bad weather conditions, reefs on the sea bottom and currents are the main reasons for losing the nets.

When increased fishing pressure, over exploitation rate of the stocks and marketing problems are taken into account, there, unfortunately does not seem to be a very hopeful scenario for a sustainable fishery in the Mediterranean region.

The percentage of the Mediterranean region fishery by weight is quite low in total Turkish production. However, its contribution to the economy, with highly valued captured-species and the effects on the coastal population has important roles to shape the area. Ignoring the national fishing industry, which might be thought of to be quite small when solely its contribution to the economy is taken into account, would be a major error that could be made, while most of the countries try to develop new politics and to protect this valuable resources in their national waters.

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SMALL SCALE FISHERY IN LITTORAL RESOURCES

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1. General Description of Small Scale Fisheries

The species live in littoral zone called littoral resources. This complex marine ecosystem is found along coastlines worldwide. It is rich in nutrients and oxygen and is home to a variety of organisms. Therefore the importance of this zone increased much more than those of others. Sea grass meadows such as *Posidonia oceanica* are take place in littoral zone (Aydın *et al.*, 2008) and also important areas for lots of species (Figure 1).



Figure 1. A view from *P. oceanica* meadows.

Specialized methods and gears used to catch these high economical valued species frequently with small fishing fleets and number of them were given in Table 1 below. But the bigger fishing fleets sail all of the Turkish waters, especially Black Sea trawlers generally come for having trips in the international waters of the Aegean Sea. The regulation of them and all of the other rules about fisheries are fixed in “fisheries regulation for marine and freshwater fishery” publication by Ministry of Agriculture and Rural Affair of Turkey, Protect and Control General Office. Forbidden fishing areas, fishing gears, seasons and length limits for species are explained in this publication properly. These inhibitions are controlled by Turkish Coast Guard fleets.

2. The Fishing Fleet

The fisheries can be separated into three main categories in the Turkish waters: small scale fisheries (Figure 2), trawling and seining fisheries. The term “small scale fisheries”, attempting to integrate aspects of the “coastal” and “artisanal” fisheries and to avoid the vagueness, inconsistencies and differences of definitions, is virtually absent from the official terminology of most Mediterranean countries (Papaconstantinou and Conides, 2007). It also has an argue platform for Turkish waters too. Not only about type of the fishing gears, but also the fishing methods have different point of views for small scale fisheries, according region to region. Because of this, it’s difficult to have a collective terminology for fisheries.

There are 16,845 formal commercial fishing vessels in Turkish waters. Totally 15,201 small scale fishery vessels are used to realize longline, trammel net and gillnet operations and the distribution of them according to regions is seen in Table 1 (TUIK, 2009).

Table 1. Number of the small scale fishing vessels (Other) fishing vessels according to regions in Turkey

Region	Other
East Black Sea	3,066
West Black Sea	2,165
Sea of Marmara	2,578
Aegean Sea	5,468
Mediterranean Sea	1,924



Figure 2. Urla fishing port is an important place for small scale fisheries

3. Small Scale Fishing Gears and Methods

We can summarize generally the commercial small scale fishing gears used in Turkish coastal zone as follows:

- *Gillnets, trammel nets and combined nets
- *Long lines, angles and jigs
- *Pots, fykes and traps (Lagoon entrapments)

Beach seining and boat seining is forbidden for all over the Turkish waters (Anonymous, 2009). Also trawl fishery is forbidden for some bays such as Izmir Bay (Middle Eastern Aegean Sea). According to this, small scale fishing activities are very popular in this region. Therefore alternative fishing gears are used for capture high economical valued demersal products such as, prawn and sole trammel nets, red mullet gillnets, long lines, jigging lines and fyke nets. Also a traditional fishing method called “dönek” is used frequently in Izmir Bay too. It’s a kind of trammel net, set like in Figure 3 below through the water column from bottom to surface. This method is based on the migration of fishes such as stripped bream (*Litgognatus mormyrus*), gilthead seabream (*Sparus aurata*), flathead mullet (*Mugil cephalus*), sea bass (*Dicentrarchus labrax*), atlantic bonito (*Sarda sarda*) and etc.

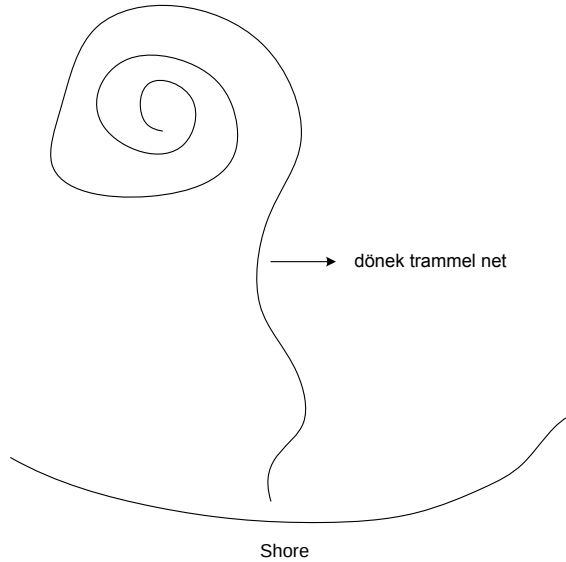


Figure 3. The settlement of dönek trammel nets

Jigging for squid is also very common fishery method in coastal waters (Figure 4). Different colors of jigs are used very frequently (Ulaş and Aydın, 2011). Cuttlefishes and sometimes octopuses are caught as by-catch species in this fishery (Figure 5).



Figure 4. Different colors of jigs in squid fishing



Figure 5. Cuttlefish that caught in squid jigging

After the prohibition of beach seines from 1999, the older pieces of prawn trammel nets used to catch squid (*Loligo vulgaris*) at the end of the autumn addition to jigging line (Gökçe *et al.*, 2005). Not only prawns (*Melicertus kerathurus*, *Metapenaeus affinis*) (Figure 6) and squid, but also red mullet (*Mullus barbatus*), and sole (*Solea solea*) hake (*Merluccius merluccius*), mackerel, horse mackerel (*Scomber spp.*), are the important high economical valued by-catch species (Figure 7) with high amounts of discard ones which takes lots of deck time for cleaning them from nets (Figure 8) (Aydın and Metin 2010).

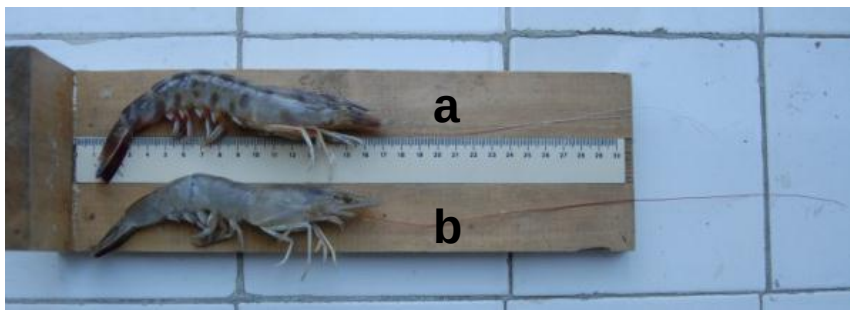


Figure 6. *M. kerathurus* (a); *M. affinis* (b)



Figure 7. Some of the commercial by-catch species caught in prawn trammel nets



Figure 8. Family members of the fishermen frequently help cleaning of prawn trammel nets

Red mullet (*Mullus spp.*) gillnets are set generally sandy and muddy areas which are boundaries of seagrass meadows called apoşı (Figure 9). The dawn and dusk times are preferred for setting gillnets (Aydın and Metin, 2008, a). The higher nets have 50 or 70 meshes through depth are also used in different seasons too. These nets are used to catch sardine (*Sardina pilchardus*), bogue (*Bogue bogue*) and blotched picarel (*Spicara maena*) together with target species (Aydın and Metin, 2008, b).



Figure 9. Red mullets in the net and a view from apoşı areas

Fyke nets (Figure 10) are forbidden in Turkish coasts except for north-east of Izmir Bay. They are used to catch octopus and cuttlefish by connections each other with an orientation net and set on the sea bottom from boat. A typical mechanized collection system is used to pick up them from water.



Figure 10. A typical fyke net

Long line fishing is a very common activity of the Aegean Sea. Different types and sizes of hooks are used with attaching mud shrimp as a bait to capture generally grouper species (*Epinephelus sp.*), common dentex (*Dentex dentex*), and common seabream (*Pagrus pagrus*) in south regions. Seabass is an also important species captured in the north regions of Aegean Sea. Longlining (Figure 11) is realized not only by professionals, but also amateur recreational fishermen too like pot fishing. Sardine (*Sardina pilchardus*), onyx (*Solen vagina*) are the most abundant baits that both longline and recreational angling fishery in Aegean coasts of Turkey (Aydın, 2011).



Figure 11. A typical long line

Pot fishing is not common for professional fisheries in the Aegean Sea. They are used generally in shores by recreational fishermen. Annular sea bream (*Diplodus annularis*), two banded seabream (*Diplodus vulgaris*), salema (*Sarpa salpa*), thicklip grey mullet (*Mugil cheleon*), are some of the captured species with these kinds of fish pots (Figure 12).



Figure 12. A typical fish pot generally used for recreational fishing

The trap shown in figure 13 is used to catch octopus (*Octopus vulgaris*) which has high economic value in the markets. Lots of them are tied each other one by one, then set into water like a long line. Before the usage of plastic types, ones that made up of clay were used mostly. The stronger structure of plastic material extends the life of the trap and this is the most important reason of this exchange.



Figure 13. A traditional octopus trap has a small piece of mirror to attract prey

The blanket net is a traditional fishing method used entries and exits in small bays (Aydın *et al.*, 2009). The aim of this method focused on migration of some fishes such as, grey mullet, sea bass, and bluefish. A rectangular net is tied between two settled iron or wooden pipes. Rest of it is set on the sea bottom and two thick ropes extended from observation tower on the land are tied to two corner of the net (Fig 14). These ropes profit to lift the net at fish migration.

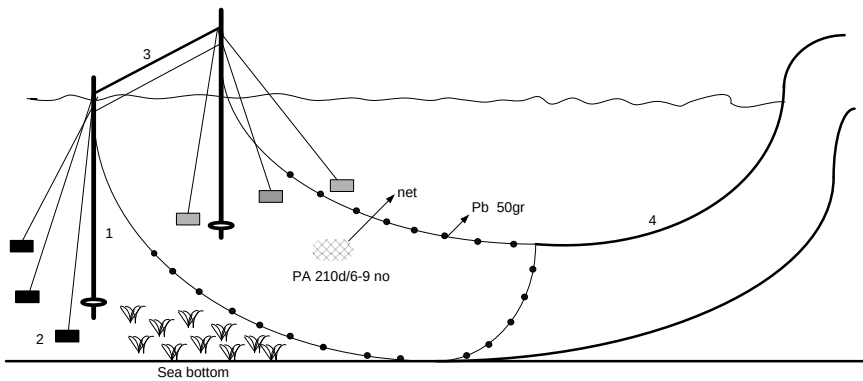


Figure 14. A rough drawing of a blanket net. (1:iron pipes or wooden sticks, 2: concrete vaults, 3: the rope connects the pipes, 4: the ropes profit to lift the net)

Spearfishing is a very common activity for Turkish coasts (Figure 15). It is realized amateur way and the sale of caught species are forbidden. Daily catching amount of some species categorized as their weight and some of them to number of their individuals in Turkish Amateur Fishery Regulations (ANONYMUS, 2009).



Figure 15. Spear fishing is also a common fishing activity can realize in amateur way in Turkish coast.

In addition to those of other fishing gears, lagoon fishery is also important for commercial marine production in the Aegean Sea (Figure 16, Figure 17, Figure 18, Figure 19). Lagoons are particularly important for fisheries in many areas of the world, since marine fish species migrate towards the lagoons which provide favorable conditions for feeding and shelter (Colombo, 1977). There are 5 lagoons in the Turkish coast of Aegean Sea which are active. Generally grey mullet, gilthead seabream (*Sparus aurata*), sole, sea bass (*Dichentracus labrax*) and eel (*Anguilla anguilla*) are the captured species from lagoons (Figure 20).



Figure 16. A view from above for Köyceğiz lagoon. Source: Muğla province cultural and tourism administration



Figure 17. Permanent fish entrapment devices separated with wire cage of Köyceğiz lagoon (Photo: A. GÜLŞAHİN)



Figure 18. Homa lagoon in Izmir Bay



Figure 19. Fishing boats using cane nets inner part of Homa lagoon.



Figure 20. Some of the lagoon fishes caught from permanent fish entrapment devices.

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FISHERIES MANAGEMENT IN TURKEY

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1. Introduction

The importance, as well as the necessity, of fisheries management has been widely acknowledged and well documented over the past decades. The obligation to ensure sustainable exploitation of renewable fisheries resources has been recognized by many coastal states and considerable efforts made to improve fisheries management (FAO 1995, 1997; OECD 1997, 1999, 2003). The sciences on fisheries, especially fisheries economics and management, have been well developed in countries like Norway, Iceland, Canada, UK, Japan, Spain where marine culture is also rich, thus fisheries have long been preserved as a tradition. With a long coastline and an intercultural heritage, the condition of Turkey, however, is far from those in these countries. It is hard to argue that Turkey has a wealthy marine and fishery culture and the organizations and management on fisheries have a long, strong history. Turkish fishery sector has been in a continuous development over the years. However, data collection and analysis, participatory management planning, establishing a regulatory framework and proper implementation of regulations have not been considered adequately. Furthermore, the management of fisheries during this period was often disturbed by fundamental changes. In the last decade some important symptoms (conflicts between interested users, decreasing CPUE of target species, increasing fishing effort, decreasing mean catch size of target species, etc.) have been noticed in Turkish marine capture fishery, which call for a reappraisal of fisheries management.

This review, first reports the status of the marine capture fishery sector briefly, and then examines the present fishery management practices and regulations, and outlines possible requirements for a better management of the sector in Turkey.

Turkey has a unique geographical location as the crossroads between Europe and Asia. Total area of the country is 780,580 square kilometers. Total population was 72.9 million people in 2008 with a growth rate of 1.3% (TURKSTAT 2009). Besides it is surrounded by the Black Sea in the north, the Mediterranean Sea in the south, and the Aegean Sea in the west. Black sea is connected to the Sea of Marmara through the İstanbul Strait and also to the Mediterranean Sea through the Çanakkle Strait.

Long Turkish coasts offer a great variety of marine capture fisheries activities including large-scale (trawl and purse seine fishing), small-scale

(gillnet, longline etc.) and recreational fisheries (shore-based and boat-based recreational fisheries, spearfishing etc.). However, marine capture fisheries show small-scale characteristics and in general; they are considered coastal fisheries. Therefore a fisheries sector with a share of 0.3 GNP (2.7% in agricultural sector) is not an important part of the national economy in Turkey (OECD 2003). Table 1 shows basic data on the fisheries sector in Turkey.

Table 1. Basic data on national fisheries sector of Turkey in 2009 (TURKSTAT 2010)

Years and characteristics	Units	Turkey
Total production	Tones	653,080
Total production value	Million \$	1,459.4*
Marine catch	Tones	445,680
Marine catch value	Million \$	636.6
Aquaculture production	Tones	167,141
Aquaculture Value	Million \$	725.7
Import Weight	Tones	80,726
Import Value	Million \$	133.9
Export Weight	Tones	55,109
Export Value	Million \$	312.9
Domestic consumption	Tones	505,059
Processed amount of fish meal and oil in factories	Tones	168,073
Unprocessed or unconsumed	Tones	5,565
Per capita consumption	Kg	6.9
Working population	Number of people	46,361
Fishery trade balance	Million \$	+179
Fishing vessels	Number	16,650

* Including marine capture + aquaculture production + freshwater production

2. Fishery Sector

Turkey has extensive water resources with its favorable geographical position between the Black Sea and Mediterranean Sea, and it is rich in fish and other marine and fresh water products (table 3). There are some 247 known marine fish species in the Black Sea, 200 in the Sea of Marmara and 500 in the Mediterranean (Bilecenoğlu *et al.*, 2001). In contrast to its rich biologic diversity, though, Mediterranean is poor in fish productivity.

In 2009, productions from marine capture, inland fishing and aquaculture were 399mt, 46,024mt, 78,568mt and 88,573mt, respectively (TURKSTAT 2010). Compared to 2009, surprisingly a very slight increase in marine capture

and aquaculture (0.95%) was seen in 2010. The main factor contributing to the growth was the increased catch of anchovy, which typically accounts for a large proportion of marine capture. Anchovy accounted for 54 and 57% of total capture in 2009 and 2010, respectively. Natural variations in the anchovy stocks have generally significant effect on the total volume of national marine capture which directly affects the pattern of total production. Atlantic bonito, pilchard, horse mackerel, sprat, whiting, grey mullet, and hake were the other main marine commercial fish species landed. The total fishery production and top ten species of Turkey are shown in table 2 (TURKSTAT 2010).

Table 2. The total marine capture fishery production by species in Turkey (TURKSTAT 2010).

Type of fish	Quantity (Tons)	%	Value (\$)	%
Anchovy	229,023	57	141,590,247	25
Atlantic bonito	9,401	2	43,934,007	8
Pilchard	27,639	7	32,245,500	6
Horse mackerel	14,392	4	1,348,467	0,2
Scad	6,055	2	1,459,787	0,3
Whiting	13,558	3	39,950,907	7
Grey mullet	3,119	1	9,357,000	2
Blue fish	4,744	1	34,156,800	6
Sprat	57,023	14	14,825,980	3
Bogue	2,761	1	5,227,493	1
Other	31,941	8	234,848,087	42
Total*	399,656	100	1,268,982	100

*Covers only marine capture fish species excluding mollusks and crustaceans

Fisheries in Turkey are characterized as multispecies, multigears and targeted both demersal and pelagic fish stocks as in most of other Mediterranean countries. Trawl and small-scale fisheries (gill net, trammel net, long line, trap etc) are exploiting demersal fish stocks, while purse seiners are concentrating small and large pelagic fish stocks. Lagoon fisheries also exist in the region focusing on sea bass, sea bream, eel and mullet.

Fishery Statistics of the State Institute of Statistics show that small-scale fisheries (having more than 90 percent of total number of fishing vessels) provide less than 10 percent of the total catch in terms of weight. Vessels involved in small-scale fishery are 5 to 12 meters in length and 10 to 25 HP in engine power. They are mostly locally built wooden vessels equipped with inboard engines and operate various gillnets and longlines.

Large-scale fishery is characterized by trawls and purse seines which produce about 90 percent of the total catch. While purse seiners catch *Sardina pilchardus*, *Engraulius encrasicolus*, *Scomber scombrus*, *Mugil spp.*, *Pomatomus saltatrix* and *Thunnus thynnus* as target species, *Merluccius merluccius*, *Mullus surmuletus*, *Mullus barbatus*, *Paraparaeus longirastis*, *Lophius piscatorius*, *Solea solea* are the main species for trawlers. Among highly migratory species, the main economic species are *Thunnus thynnus*, *Xiphias gladius*, and *Thunnus alalunga*. In TURKSTAT (2006), of the fishing fleet comprised of 17,823 vessels, only 9.3 percent were trawls and purse seines while the rest (90%) were inshore fishing vessels.

All fishing vessels involved in commercial fishing are legally required to have a license, while under the existing management regime fishing license is granted to a given registered vessel, not a person, for a particular fishing. The license is valid for two years, and it must be extended within 3 years after expiration, or it will be permanently suspended (during the 3-years period the vessel is not allowed to fish). On the other hand, the fisherman working on this vessel is required to have a fisherman license valid for 5 years. Legally, only Turkish citizens are allowed to be fisherman. Foreigners are not granted this license (FAO 2008).

Recreational fishing does not include sale, barter or trade of all or part of the catch (Pawson *et al.*, 2008). According to Turkish fishing circular, recreational fishing covers both amateur and sportive fishing but this activity is seen usually in the form of amateur fishing in Turkey. Spear-fishing competition, which is organized by Underwater Sports Federation, is the only sportive fishing activity. In any case, no official data is available on both activities and the impacts of the recreational fishing on commercial fishery are not clearly known. However, Ünal *et al.* (2010) reported that in Turkey, at the most eastern side of the basin, as a result of its increasing standard of living, marine recreational fisheries appears to be increasing. In addition, 55% of the Turkish population lives along the vast coastline (8,140 km), offering an optimal scenario for the development of marine recreational fisheries, including in the fishing tourism sector. Therefore, the fisheries management authority in Turkish waters has paid extensive attention to the regulations of marine recreational fisheries. Nevertheless, due to the difficulties in monitoring and enforcement, there are no specific policies or management plans for marine recreational fisheries in Turkey.

3. Policy Framework

The objectives of fisheries management policy in Turkey are set by State Planning Organization (SPO). Managing fishery resources in a sustainable way is the main objective of the fisheries policy. Therefore, region-based preliminary fisheries plans have been designed. The objectives set out in these plans include rebuilding of depleted stocks, long-term resource management,

introduction of fishing rights and sustainability of fishing opportunities for fishermen. Total Allowable Catch (TAC) system is currently being applied on the two commercial marine species: bluefin tuna and striped venus clam. An application of TAC for the striped venus clam was introduced for the first time in 2008 (The annual catch amount set for this species in 2008 was 35,000 mt). The Ministry of Agriculture and Rural Affairs (MARA)* plans to gradually extend the TAC system to other commercial fish species, giving priority to anchovy and mackerel (MARA 2009).

** The information in this study reflects the situation as of November 11th, 2010 when it was sent for publication. Forasmuch as per issue 27958 of the Official Gazette published on June 8th, 2011, the Ministry of Agriculture and Rural Affairs (MARA) has been reconstituted as the Ministry of Food, Agriculture and Livestock; while the Department of Fisheries, previously slated for directorate-general, has been reconstituted as the Directorate-General for Fisheries and Aquaculture.*

DPT prepares long-term development plans and annual programs conforming to the targets determined by the government; it coordinates the activities of ministries and public institutions concerning economic, social and cultural policies in order to ensure efficient implementation and advises the government on fishery policy issues (OECD 2008). A special Committee for each sector including the stakeholders from fishery and aquaculture gathers every year during the preparation of the Development Plans (as was also in the case for the 9th Development Plan), and serves as a platform for DPT to consult. Such committee can also be established when needed, even during the implementation of the plans. For instance, within the 9th Five Year Development Plan of Turkey (which covers the period 2007-2013), the Committee for Fisheries mainly focused on sustainable exploitation of resources, integration of environmental considerations to fishery, institutional restructuring and strengthening and capacity building for the necessary infrastructure for the adoption of the Common Fisheries Policy (CFP). Nevertheless, Turkey is on the way to European Union membership and has completed an institutional twinning program to support the country's legal and institutional alignment to the EU *acquis communautaire* in terms of fisheries policy in 2008. This project constituted an important step in sector planning where the findings may be used to develop a strategic plan for fisheries sector.

4. Legal Framework

MARA is the main state organization responsible for fisheries management including fisheries administration, regulation, protection, promotion, monitoring and technical assistance through four General Directorates. However, surveillance is shared among different institutions including MARA. In fact, according to Law No 1380, MARA personnel have the primary surveillance along with other official bodies such as the coastguard and the gendarmerie.

All fishery activities are based on the Fisheries Law No. 1380 presented in 1971, as amended by Laws 3288 in 1986 and 4950 in 2003. The law provides a basis for the regulations and notifications to regulate both commercial and recreational fisheries. Article 1 of the Law gives the scope of the Act-“protection, production and inspection of aquatic products” and Article 2 gives the definitions, including those of the aquatic products, which are broadened by other regulations. The law covers fishing license, fishery product hygiene, inspection and control, penalties, prohibitions, limitations and liabilities (MARA 2009).

The current MARA institutional structure is widely perceived as being inappropriate for effective fisheries management. This issue has already been discussed in greater detail in other separate reports submitted to MARA by the Fishery Acquis Centre and Twinning Advisory Team (FAC 2007).

As a part of the process of aligning the government institutions to the EU, a plan for a new fishery directorate general has been drawn up between the MARA fisheries staff and EU Twinning Advisory Team (FAP 2007).

5. Monitoring, Control and Surveillance (MCS)

In general, there are three components of the fishery management regime. MCS is one of these, used for implementation of fisheries management. Others are the fishery management system (FMS) and the fishery judicial system (FJS). FMS specifies the regulatory framework for fishing. The primary function of the MCS is to enforce the adopted management system. FJS is usually a part of the general judicial system. It issues sanction to those alleged to have violated fishery regulations and thus complements the MCS activity (Loayza 1992). Indeed, the weakness or absence of MCS operations causes a useless fisheries management system. Although MCS, in the basic previous FAO definitions, does not include enforcement, it will be included in this review as part of the means of implementing MCS operations.

Today, MCS is an integral and key component for the implementation of fisheries management plans. It encompasses not only traditional enforcement activities but also the development and establishment of both data collection systems, the enactment of legislative instruments and the implementation of the management plan through participatory techniques and strategies. A workshop organized in Ghana in 1993 offered the following clarifications (FAO 1994).

a) Monitoring includes the collection, measurement and analysis of fishing activity including, but not limited to: catch, species composition, fishing effort, by-catch, discards, area of operations, etc. This information is primary data that fisheries managers use to arrive at management decisions. If this information is unavailable, inaccurate or incomplete, managers will be handicapped in developing and implementing management measures.

b) Control involves the specification of the terms and conditions under which resources can be harvested. These specifications are normally contained in national fisheries legislation and other arrangements that might be nationally, sub-regionally, or regionally agreed. The legislation provides the basis for which fisheries management arrangements, via MCS, are implemented. For maximum effect, framework legislation should clearly state the management measures being implemented and define the requirements and prohibitions that will be enforced.

c) Surveillance involves the regulation and supervision of fishing activity to ensure that national legislation and terms, conditions of access and management measures are observed. This activity is critical to ensure that resources are not over exploited, poaching is minimized and management arrangements are implemented.

In Turkey, fisheries enforcement is needed to ensure that fishermen are catching in a right way, right size, and right place. Strong enforcement is one of the main requirements of effective fisheries management.

5.1. Fishery Port Offices

Turkey has a large number of fishing ports and MARA has traditionally not had a presence (office) in any of these ports. The need to strengthen fisheries protection and control was identified as an important priority. For this purpose, Fishery Port Offices at 34 ports were established until 2007, all of which will eventually be linked through the computer-based Fisheries Information System (FIS) to Provincial Offices and Headquarters of the MARA in Ankara. The port offices have been operational since early 2007 (MARA 2009).

These offices are an important aspect of improved fisheries management in Turkey. They will serve to improve the collection, checking and use of information on the quantities and species of fish landed, and help improve compliance with national regulations related to the grading and marketing of fish and fishing vessel licensing. A permanent presence in these ports will also help the MARA to investigate fishing offences and take the necessary and appropriate enforcement action. There will also be an additional benefit for the industry in facilitating easier communication with government officials, enabling more effective communication of industry concerns and needs (FAO 2006; MARA 2009).

5.2. Fisheries Information System (FIS)

FIS has currently been developed for Turkey in order to create the application and procedures needed to both comply with the EC Fisheries Acquis and improve fisheries management (MARA 2009).

FIS is the system that comprises a combination of resources organized to collect, process, transmit, and disseminate the fisheries relevant data. The system is composed of modules interacting to introduce and extract data to/from a centralized database. This database allocates all of the information collected from the different information source; the main property of this database is therefore its capacity to relate to all of the data contained within the different programmed modules. Details of the different modules (components) of the FIS are summarized below (MARA 2009).

5.3. Catch Information

The catch information is collected using the logbook and landing declaration document. The logbook includes the details of the catches (estimated by the skipper) by gear type and zone. The landing declaration contains landings and port arrival data as well as any information on transshipments. Fishing vessels over 12 meters in length are under legal obligation to keep logbook and complete a landing declaration. Since the end of 2008, accumulated logbook data have been recorded in FIS. MARA plans to supersede it with the electronic logbook system (MARA 2009).

5.4. Sales Notes

Data on the “first hand sale” of fish is collected. An official document is used to identify the agents involved in the sale process, the quantities and prices for each species sold at the authorized sales centers. Further information about the distribution and storage of the fish landed is also included in this module (MARA 2009).

5.5. Vessel

The vessel registry is the most important part of the FIS because the vessel is the main unit of operation related to all of the different information sources. All vessels have to be registered to obtain a fishing license. An initial census has been undertaken of the fleet, following which all the entries and exits to/from the fleet have to be controlled so as not to increase fishing capacity (MARA 2009).

5.6. Licensing

Three types of license are included in FIS – vessel, fisherman and first buyer (MARA 2009).

- **Vessel License:** This license authorizes a certain fishing activity to a certain fishing vessel included in the fleet registry. The license number is the same as the external mark carried by the vessel. The validity period for this license is two years.

- Fisherman License: Every fisherman working on a vessel must have an official registration authorized by MARA. The validity period for this license is five years.

- The First Buyer License: In order to be able to trade fish and fish products in the wholesale fish market, the first buyers are supposed to be registered in the FIS. The first buyer can be an individual person or a representative of a company. The validity period for this license is two years. However this system has not been integrated yet (V. Kürüm, pers. comm.).

5.7. Vessel Monitoring System (VMS)

Alongside the establishment of the FIS, VMS has been developed, which transmits positional data from vessels to land station and presents it on a map using a Geographical Information System (GIS) (MARA 2009). Bluefin tuna fishing vessels were the first to use the Vessel Monitoring System (VMS) in 2007. MARA is also considering holding this system obligatory soon for vessels with sizes over a specific length. Vessels longer than 15 meters are being monitored with VMS as of January 2010.

6. Fisheries Administration and Legislation

6.1. Prohibitions and Laws Regarding Fisheries in the Ottoman Period

The terms “sayd” and “sayd ü şilar” stood for prey and hunting in the related literature during the Ottoman period. Laws and prohibitions of the time regarding fishing and fishers has established roots for fishing in Turkey today. The Ottoman organization of fishing was at peak compared to the earlier Turkish states; hunting was organized through various taxing and penal sanctions such as “*emirname-yasakname-nizamname*” (codes of mandate, prohibition and regulation) or direct codes to monitor and otherwise manage fishing activities (table 3). There were also groups and individuals benefiting from certain privileges and exemptions granted unto them by the Ottoman government. Where laws on hunting were enforced severely on the locals, foreigners enjoyed a great tolerance. Towards the end of the 19th century, laws on hunting and catching were modernized and established the juridical basis of today’s catching (Yarcı 2009).

Table 3. Examples of prohibitions and laws regarding fisheries in the Ottoman period (Yarcı 2009)

Year	Scope
1840	Changes in the organizational structure and taxes
1848	Unfortunate incidents led to new prohibitions, e.g. when mussels collected from bridge floats in Yenikopru, Istanbul caused a number of poisonings, mussel collecting was prohibited in Yenikopru.
1851	Changes in the organizational structure and taxes

Table 3. Continued

1858	Penal Code entered into effect with the new penal law; an innovative milestone in terms of jurisdiction.
1879	“ <i>Rüsum-ı Sitte İdaresi</i> ” (an authority formed by foreign creditor nations to collect taxes) was established. Among six sources granted to this committee was the collection of taxes of fishery products around and in Istanbul.
1881	Establishment of “ <i>Muharrem Kararnemesi</i> ” (a finance act to regulate internal and foreign debts government failed to honor) and “ <i>Duyun-i Umumiye İdaresi</i> ” (Authority of General Debts). Also regulations pertaining to fishers were established.
Jan. 1882	Adoption of “ <i>Zabıta-i Saydiye Nizamnamesi</i> ” (Regulation for a body of reinforcement acting as police to monitor fishers).
May 1882	Adoption of Dersaadet (Door of Welfare) and “ <i>Tevabii Balıkhane İdaresi’ne Dair Nizamname</i> ” (Regulation regarding Central Fish Market Authority).
1883	Foreigners (British, Russian, and Albanian) applied for license to catch throughout Aegean and Black Sea coasts.
1886	“ <i>Düyun-ı Umumiye-i Osmaniye İdaresi</i> ” (Authority of General Debts of the Ottoman) assumed collection of catching and fishing taxes through a regulation pertaining to treasury incomes.
July 1889	Some articles of “ <i>Tevabii Balıkhane İdaresi’ne Dair Nizamname</i> ” was amended where necessary, such as revisions in the nets and fishing seasons stated in “ <i>Zabıta-i Saydiye Nizamnamesi</i> ”. All anchovy caught out of season was discharged, fishers were charged a fine of hundred Ottoman gold. A scheme of restrictions and net sizes was handed to fishers, and those not complying were fined.
Dec. 1889	Fishermen around Istanbul were notified with mesh size standards through a revision in 13 articles of “ <i>Dersaadet</i> ” and “ <i>Tevabii Balıkhane İdaresi</i> ”
1890	Official reports of “ <i>Şura-i Devlet</i> ” (a body corresponding to State Council) determined the fines, standards, equipments and gears. “ <i>Rüsumat Muhafaza Nizanmmemesi</i> ” (Customs Patrol Regulations) came into force, through which all hoisted vessels and open constructions like barns were inspected by officers.
1891	<i>Zabıta-i Saydiye Nizanamesi</i> ’ determined the periodical fees for fishing licenses and how these fees would be distributed among governmental institutions.
1893	Fishing licenses were to be first confirmed by the local municipality. Those confirmed would then be sent to the Directorate for distribution. Final decision regarding licenses were reported to authorities like <i>Zabıtiye</i> “(police forces and gendarmerie) and ministries of “ <i>Dâhiliye</i> ” (Internal Affairs) and

Table 3. Continued

	“ <i>Maliye</i> ” (finance).
May 1900	New tariffs were entered into effect regarding taxes from the emirates of Romania, Greece, Serbia and Montenegro. These tariffs also included sponge, another important sea product.
1901	Certain sea products were officially tariff-bound through a “ <i>Ticaret Mukavelenamesi</i> ” (Trade Agreement) with Romania regarding sea trade.
1902	An addition of 4 articles was made in the “ <i>Ticaret Mukavelenamesi</i> ” with Romania. According to this agreement, customs charge of every 100 kilos of salt bonito, dried fish or mackerel would be 4 francs, cuttlefish would be 10 francs, fresh oysters would be 6 francs, mussels and similar products would be 1 franc. These charges would be transferred to <i>Düyun-ı Umumiye</i> .
June 1903	Another agreement was signed with Greece. According to this agreement, customs charge of every 100 kilos of salt bonito and dried fish would be 10 kuruş (1 kuruş is 1% of an Ottoman Gold), (mackerel) mackerel and Atlantic bonito would be 6 kuruş.
Jan. 1903	Article 29 of “ <i>Zabıta-i Saydiye Nizamnamesi</i> ” was revised, through which new bans were brought on catching in Bosphorus and Marmara as well as new regulations on sponge fishing in Ottoman territorial waters. Breaching catchers would be fined, their vessels and gears would be impounded.
1904	Fishing licenses were printed and honored with the sultan’s signature. These licenses also bore the name, reputation, nationality, address, and physical features (e.g. beard, eye color, moustache) of the licensee as well as the areas he was allowed to catch, fees, liabilities and the validity of the license. “ <i>Jandarma Nizamname-i Hümayunu</i> ” (Imperial Regulation on Gendarmerie) clarified the duties and powers of the gendarmerie on denouncements, nets, traps, fishing and hunting weapons and seasons as well as prohibitions and fines.
1906	A new clause in article 27 of “ <i>Zabıta-i Saydiye Nizamnamesi</i> ” prohibited fishing with torpedos.
1912	Hunting laws were in heavy effect in Istanbul and suburbs, lawbreakers were punished.
1913	<i>Düyunu Ümumiye Varidat-ı Muhassase İdaresi</i> (Supervisory authority in charge of inspecting foreign debts) prohibited the catch and sale of sea products like mussels and oysters in Sinop due to the cholera breakout.
1924	<i>Bahri Ruhsat Teskeresi</i> (Fishing licence) fee was announced to be 100 kuruş.

The administrative history of fisheries in Republic of Turkey starts with the establishment of Directorate of Sea Products and Fishing in the Ministry of Finance in 1934 which was later transferred to the Ministry of Transport in 1939 (FAC 2007; MARA 2009). In 1960s, the Ministry of Commerce had almost all functions related to fisheries management. After a decade, MARA took over the major responsibility of fisheries (Ünal 2006).

The Fisheries Code (Number 1380) was passed in 1971 replacing the old fishing code “*Zabita-i Saydiye Nizamnamesi*”, transferring the surveillance of fisheries conservation, improvement, production, research, education and dissemination on to the MARA (Ozesmi 1999).

In 1972, Directorate General for Fisheries was founded under MARA. However, in the following years DG Fisheries changed to Fisheries Department, and, finally in 1984, was entirely abolished. In 1984, reorganization was started and new units and directorates were constituted:

- The General Directorates of Protection and Control
- The General Directorates of Organization and Support
- The General Directorates of Project and Application
- The Research Planning and Coordination Committee

Among the duties assigned unto MARA in the codes No.1380 and 3288 are:

- to assign fishing license for fishing vessels,
- to perform the duties specified in both laws,
- to develop and implement fisheries policy,
- to take measures to prevent water pollution,
- to assist the services such as credits and other inputs,
- to implement a training program for fishermen,
- to promote and support fishery cooperatives,
- to collaborate with universities, research institutes etc. to sustain fishery and to increase productivity,
- to define and determine the characteristics required of fishing gears,
- to determine the rules and requirements regarding hiring fishing ports, fish production areas,
- to take measures regarding fishery resources,
- to gather and evaluate fishery information,
- to examine aquaculture projects and ensure their environmental and economical plausibility,
- to perform investigations and research,

Today, MARA is the state organization responsible for fisheries management. It fulfils aforementioned relevant duties through four general directorates, as well as the district and 81 provincial directorates. However,

according to the present* Head of Fishery Department, MARA, in parallel with the EU adaptation processes and global developments, has taken significant steps in overcoming the deficiencies in infrastructure and legislation both on legislative and institutional levels of fisheries. One noteworthy proof is the establishment of the Directorate General for Fisheries, to organize a stronger structure in the center. A pertaining draft bill is on the agenda of the Turkish Grand National Assembly (TGNA), and when passed, all fishery and aquaculture activities currently scattered through different units of the ministry will be gathered under one umbrella (V. Kürüm, pers. comm.).

The sphere of duties for the “Directorate General for Fisheries” to be established will be as follows:

- to protect aquaculture resources and ensure their rational management; to implement and enforce policies for this purpose,
- to specify the principles of sustainable fisheries and fishing in both inland waters and seas; to conduct and enforce monitoring, inspection, licensing and authorization activities,
- to establish an information and monitoring system for fishing and farming activities,
- to designate areas appropriate for fishery and farming; to make the necessary plans to ensure their efficient use, to ensure their proper management according to the principles to be set, and take measures for the protection of these areas,
- to determine the fundamentals and means of procurement for fishing and farming,
- to set the principles regarding the establishment, management and supervision of fishermen shelters and basic facilities,
- to determine protected areas and principles of protection thereof,
- to conduct studies on marketing of fishery products and market organizations and to establish the basis of related support policies,
- to set the guidelines for imported and exported fishery products and inputs,
- to conduct technical studies in cooperation with international and regional fishery organizations and to support ongoing studies (V. Kürüm, pers. comm.).

**May 6, 2010*

7. Fisheries Regulations

The main tool for the regulation of the fisheries is the Fishing Notification (formerly known as circular). The MARA issues Fishing Notifications to regulate commercial and recreational fishing activities in order to ensure resource conservation and achieve sustainable fishing after the consultation period with stakeholders including research institutes and universities. Commercial and recreational fishing activities are regulated by two different notifications which are published and announced in the Official Gazette.

Fishing Notification establishes prohibitions, restrictions and obligations concerning commercial fishing activities in order to increase production and exportation of fish products. The Notification lays down a list of species that may be caught in maritime and inland waters and sets forth related time and species restrictions. Fishing seasons and prohibited fishing methods are indicated as well. A list of maritime and inland waters where fishing is completely or partially prohibited is given in the notification. Fishing with trawl nets is forbidden on inland waters, in the Marmara Sea, the Bosphorus and Dardanelles, as well as in certain areas of the Black Sea, in the Aegean Sea and the Mediterranean Sea.

Turkey is one of the few countries in Mediterranean that have adopted a special regulation dedicated only to recreational fishery (Gaudin and De Young, 2007). MARA is the main state administration responsible for recreational fishing regulation. MARA also publishes a notification to regulate recreational fishery. This Notification establishes prohibitions, restrictions and obligations concerning amateur fishing activities in order to ensure responsible and sustainable recreational fishing. The notification includes definitions, information (in the form of frequently asked questions), a list of species that are allowed in maritime and inland waters, a list of prohibited species and indicates related time restrictions. It also specifies those maritime and inland waters where recreational fishing is completely or partially prohibited. The activity is managed through traditional and simple methods such as bag and size limits. A compulsory license system has not been established yet; therefore it is open to public access (free for all), but a document is given to anglers who want to certify their activities. However this document does not give any privilege to users. Although legislative framework of recreational fishing is quite detailed and seems to cover almost all fundamental aspects of recreational fishing, there are some gaps and defects in practice and enforcement. Furthermore, the

capacity of recreational fishery, number of people involved in this activity and their contribution to the national economy or the ecosystem effects of this activity are not known.

Institutional consultations are conducted through two advisory bodies; Regional Fishery Advisory Board (RFAB) and Central Fishery Advisory Board (CFAB). Decisions taken by the RFAB are circulated to the MARA and other related ministries. Because of the dynamic structure and requirements of re-evaluation of technical measures in fishing, Central Fishery Advisory Board meets annually with the participation of public institutions, scientific organizations, fisheries organizations and other stakeholders under the presidency of MARA. CFAB gives recommendations to MARA based on the best available scientific data and findings of previous and current studies. The decisions taken by Fisheries Advisory Boards are duly implemented.

Local or regional management does not exist in Turkish fishery yet. On the other hand, few projects have been going on in some regions to prepare local fisheries management plan. In general mesh size regulations, catch size limitation for major species are clearly shown in the Fishing Notification. There are 43 species regulated by catch size limitation whose names and restrictions are shown clearly in Fishing Notification. Smaller sizes are tolerated particularly in anchovy and horse mackerel up to 15% and in other fish species and fisheries up to 5%. Tuna fish, which is 8% smaller by size among the ones weighing between 10 kg-30 kg is also permitted (Anon., 2006).

New regulations regarding catch size or duration of closed season for demersal species have changed numerously over the years. There are enormous changes in the fisheries management approach. For instance, Fisheries Acquis Centre (2007) suggested the Ecosystem Based Fisheries Management (EBFM) and the application of precautionary principle in fisheries management, which have never been talked about in Turkish fisheries management by then. Indeed, the first and the most important development that leads to a change in the management actions in fisheries is started through Turkey's accession process towards the EU and the Fisheries Acquis.

Although fishermen lobbies are very strong, recent researches carried out by universities and research institutes have been taken into account by decision makers in policy-making processes so that some regulations are now underway with the advises of scientific studies made by these research institutions. This has also helped MARA to dispel, through scientific studies, the negative responses for its decisions of regulation and management of fisheries. These

scientific studies have also served as a means to prevent some fisher groups from oppressing for their interests by political pressure and lobbying. Increasing effectiveness of the NGOs and their recent projects on fisheries has also enriched their roles in fisheries management.

Fish stocks are not regularly assessed. In another words, there exists no regular stock assessment program on the national level as of yet.

Input controls for management of the various fisheries is by vessel licensing. Various conservation management techniques are in use, including seasonal limitations, protected areas, fishing area, vessel size, fishing gear, mesh size and species regulations. Licensing of over 12 m fishing boats was stopped in 1991 and licensing of all types of fishing boats was stopped in 1997 (OECD 2008). However, during a six month period (June 2001 to December 31, 2001) too many new fishing vessels were legally permitted to enter fishery (Ünal 2004). No additional vessels have been issued license since 2002. At present, further growth of the fleet capacity has been suspended by disallowing additional fishing vessels into the fishing fleet. However, there is paradox in this practice. License system is in power but the present system is quite far from restricting the fishing effort. Effective control of fishing effort might be achieved by licensing the fishermen and the boats; specifying not only the fishing permits but also the areas and periods to be fished, or even the ports at which fish should be landed. Today, many fishing vessels from Black Sea are fishing in Aegean and Mediterranean Sea or fishing vessels from these regions fish in each other's waters without permission from any institution.

For sustainable exploitation of stocks, technical measures regulating fishing gear, fishing area, fishing region, fish size, and distance from shore have been imposed by a notification. Present technical measures are in practice to regulate marine capture fishing as follows;

- Minimum mesh size (e.g. trawl cod-end restrictions 40 mm and 44 mm in the Black Sea and other seas, respectively),
- Minimum landing size (e.g. 30 cm for groupers, 13 cm for red mullet or 1 kg for the octopus),
- Closed areas,
- Closed season (such as 4 months for purse seiners and 2.5 to 5 months for trawlers, depending on the fishing ground),
- Gear or fishing methods restrictions and bans (e.g. coastal seine net, drift net etc.),
- Catching prohibition for some species (e.g. dolphin, sea turtles etc.)

There have been no changes in the management tools, except quota management for (bluefin tuna and striped venus clam) and limitations for anchovy catch by vessel length for the last ten years. However, additional restrictions on closed areas, fishing season, gear restrictions have been set. Some of fishing gears such as boat seines, beach seines, and drift nets are completely banned.

According to the new regulations in notification vessels less than 15 m are permitted to land anchovy 250 box (1 box is equal 12 kg) per day during the season, vessels larger than 15-19,99 m 300 box, 20-24,99 m 500 box, 25-29,99 m 600 box, 30-34,99 m 700 box, 35-39,99 m 750 box, 40-44,99 m 800 box, 45-49,99 m 850 box, 50 m and larger fishing vessels are permitted to land 900 box anchovy per day in order to protect anchovy stocks and as well as extend the anchovy supply to the market. However, fishing with gillnets, trammel nets etc are permitted during the year. On the other hand, there is no any stock assessment program or well run monitoring program for neither anchovies nor any species yet.

Effects of coastal seine net on young fish population and littoral zone were studied by Hoşsucu *et al.*, (1997), and authors suggested that this fishing gear should definitely be prohibited due to high percentage of juvenile fishes amongst the total catch. Furthermore, Underwater Research Society (SAD) carried the subject into the court (Güçlüsoy 1999). Following years, in April 2001, this fishing gear was banned. Since 2001, in order to protect young fish and Posidonia meadows, coastal beach seine net has been prohibited in Turkish waters except Edremit Bay located in the Northern Aegean. However, it was, too, banned in this bay in May, 2009. Thus, the fishing pressure on young fish and coastal ecosystem decreased. It is believed that stocks of some species especially those belonging in Sparidae familia such as *Diplodus annularis*, *Pagellus erythrinus*, *Pagellus acarne*, *Mullus barbatus* and *Mullus surmuletus* were improved.

Trawling is completely prohibited in Marmara Sea, as well as some bays and gulfs in Mediterranean Sea in order to protect demersal species. In the areas where trawling is permitted, prohibitions related to distance from the coast are applicable. On the other hand, besides seasonal prohibition, depth area prohibition applies to purse seining. There are also some areas prohibited for any types of fishing activities.

In conclusion, during the last decade, considerable efforts have been put on development of fisheries management. However, it is not easy to claim that

management measures adopted in the past decade improved the status of the fisheries in the region or in Turkey due to the lack of estimation on total fishing effort. Implementing technical measures and to know numbers of fishing vessels are not sufficient to manage fishery. On the other hand, fisheries management is much more complex and comprehensive than that could be succeeded by a few tools and regulations.

Principal impediments to more effective management are as follows:

- Lack of effective MCS,
- Lack of historical data,
- Lack of economic and biologic monitoring of fisheries,
- Lack of coordination amongst stakeholders,
- Lack of legislation for establishing right based fisheries management,
- Lack of legislation for establishing fisheries co-management and stakeholder participation into management process at the local level,
- Difficulties of adoption of Ecosystem Based Fisheries Management (EBFM)
- Difficulties of establishing MPAs and No Take Zones,
- Conflicts and political lobbying,

It should also be noted that marine capture fishery has some weaknesses in addition to the problems mentioned above. SWOT analysis made by FAC (2007) focused on several weaknesses of the sector. Some of them are chronic and required to be solved or improved for sustainable fisheries. These are as follows:

- Restricted stakeholder participation
- Lack of legislation for enforcement of fishery regulation
- Lack of management capacity among small scale fishery
- Limited continues resource assessment and lack of database
- Lack of familiarity with modern approach i.e. ecosystem based approach
- Limited knowledge transfer from research to application
- Lack of research institutes and experts
- No MCS for inshore waters
- Fisheries licenses are not based on limiting access to fisheries
- No Fisheries Management Plans or management policy
- Gear conflicts between coastal and offshore fleet
- Fleet overcapacity and no decommissioning scheme
- Overfishing
- No central unit to manage fisheries (lack of coordination)
- Lack of knowledge about the state of the resource
- Fishing associations have limited financial capacity

8. Costs of Fisheries Management

There is no official source of information about the costs of managing fisheries in Turkey. However, DPT (2006) provides the current national budget for structural actions in marine fisheries sector. According to DPT (2006), a total sum of € 18,188,158 had been allocated for several infrastructural and research needs of the fishery sector in 2006.

The infrastructural activities are focused on construction and maintenance of fishing ports. There is an ongoing project titled “Fisheries Sector-Legal and Institutional Alignment to the EU Acquis”, which contributes to the designation of landing ports, setting up of required physical and infrastructural facilities and recruiting the personnel for monitoring and recording the landings of the catch therein. The national co-financing for the implementation of the project is also included in the table 4.

Research costs cover both marine capture fisheries and aquaculture. However, the table does not include maintaining cost of MCS and administration costs occurred in 2006. The VMS figures shown in the table includes infrastructural costs only, and it’s difficult to estimate the expenses of the coast guard spent on fishery sector only.

Table 4. Budget contribution for infrastructural needs of the fishery sector (DTP 2006)

Budget items	€	YTL
Fishing port construction	14,785,554	26,407,000
Fishing port maintenance	1,119,821	2,000,000
Research	1,931,775	3,450,150
National co-finance contribution for Project “Fisheries Sector- Legal and Institutional Alignment to the EU Acquis”	351,008	626,901
Additional construction needs for 30 fishing port facilities	215,258	384,451
Vessel Monitoring System	135,750	242,450
Total	18,188,158	32,484,051

Exchange Rate: 1 €= 1.786 YTL

After the “The Twinning Project completed in 2006, construction of six more administrative buildings have been built with the national budget generated by the ministry in addition to the existing thirty administrative buildings, to continue the actions of framework. Fishery Information System (FIS) has been activated through the use of Vessel Monitoring System (VMS). The budget for the infrastructural activities spared by the ministry for this

purpose in 2009 was 475,000 TL. Moreover, the ministry has an additional legislative budget to be used for fisheries management and protection of water resources as well as to monitor and ensure that the fishery products are produced, processed and marketed in line with the quality standards. Maintenance costs, oil costs and personnel supervision costs of the vehicles and vessels used by the ministry central and provincial organizations for inspection, organization of national and international trainings and meetings and purchases related to controlling water pollution are also covered by this budget. The budget allocated by the ministry for this purpose in 2009 was 1,550,000 TL (V. Kürüm, pers. comm.).

9. International Conventions, Implementation of Global Fisheries Mandates and Initiatives

Turkey has been constantly attending the meetings of several international organizations. It has been a member of International Commission for the Conservation of Atlantic Tuna (ICCAT) since 2003, EUROFISH-International Organization since 2002, General Fisheries Commission for Mediterranean (GFCM) since 1954 and FAO since 1948.

Turkey has neither signed nor ratified any of the United Nations Convention on the Law of the Sea (UNCLOS), the UN Fish Stocks Agreement or the Compliance Agreement although demonstrating a commitment to the protection of coastal areas. The Convention on the Conservation of European Wildlife and Natural Habitat, also known as the Bern Convention, came into force in Turkey in 1984. It placed the Government under the obligation of protecting endangered marine turtles as well as their breeding and nesting grounds along the Mediterranean Coastal System. In addition, these species are protected by the Barcelona Convention for the Protection of the Mediterranean Sea against Pollution under which an Action Plan has been adopted for the protection of the sea turtles. Within the framework of these Conventions, the Marine Turtles Monitoring Commission was set up in 1990 under the coordination of the Ministry of Environment in order to conserve the marine turtles in Turkish Mediterranean coastal areas. The Environment Management Plan has been designed for other equally important coastal areas. Studies aimed at protecting these coastal areas, the endangered sea turtles, and their nesting areas (DPT 2002).

With regard to the sustainable use and conservation of marine living resources of the high seas, Turkey attaches vital importance to the UN Conference on Straddling Fish Stocks and Highly Migratory Fish Stocks and plans to take into consideration the principles established by this Conference. Turkey also considers the Food and Agriculture Organization (FAO) Code of Conduct of Responsible Fishing an important development for the sustainable use and conservation of marine living resources under national jurisdiction and plans to develop national policies in harmony with the Code (DPT 2002).

International conventions related to coastal zone, biodiversity and protection of the seas ratified by Turkish Government are as follows (FAC 2007);

- Convention on the Conservation on Birds 1950, ratified 1966
- Barcelona Convention 1975, ratified 1976
- World Heritage Convention 1975, ratified 1983
- Bern Convention 1976, ratified 1984
- MARPOL Convention 1973, ratified 1990
- Basel Convention 1989, ratified 1994
- RAMSAR Convention 1971, ratified 1994
- Convention on the Protection of the Black Sea Against Pollution 1992, ratified 1994
- Convention on the Biological Diversity (CBD) 1992, ratified 1996
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973, ratified 1996.

10. The Extent of IUU Fishing and Related Problems

Illegal, unreported and unregulated fishing (IUU) i.e. pirate fishing is believed to be of the most serious threats for long-term sustainability of fisheries. IUU fishing constitutes 20-25% of the overall fishing worldwide. It is also estimated that global IUU practices amounts to approximately between 3-10 billion Euros per year worldwide (Anon. 2008). However, there is no national research which shows the amounts or figures of illegal fishing in Turkey. Ünal and Erdem (2009) focused on illegal fishing in Gökova Bay and concluded that IUU fishing has disastrous environmental and socio-economic impacts in Gökova Bay. It causes depletion of local and high valued fish stocks which play vital role in traditional fishermen's life. Besides, it leads to the decrease of the income of local fishermen as well as unfair competition. Authors reported a series of suggestions to combat IUU in the region which might be also suitable for all Turkish seas.

11. Summary and Conclusion

Continuously increasing fishing effort, overcapitalization, overfishing, conflicts amongst users, inequity and dissatisfaction of fishers, which are major problems of Turkish fishery, today have been resulted from fisheries mismanagement and lack of MCS system to monitor fishing activities and enforce fishing rules over the years. Under the present scenario a major issue that emerges is that of "need for a better management". It is clear that actions in the future will be directed toward practicing a more effective management through the establishing Directorate General for Fisheries* and EU membership. However, EU membership will not solve all the problems of Turkish fishery. EU itself also suffers from fisheries management problems.

Much progress has been achieved concerning fisheries management. Turkey completed the construction and the equipping of 36 fisheries port offices (FPOs). Furthermore, 121 fisheries control inspectors have been appointed. FIS was established, allowing inspectors to record daily catch and landing data in a central database. This system fulfils some basic requirements of CFP. However, further work is needed to make this system fully operational to allow for crosschecks of data from logbooks and landings declarations. Technical works on the development of the fishing fleet register and VMS have progressed. A pilot application of VMS was started with about 80 vessels of the blue-fin tuna fishing fleet. Some improvements can be recorded on inspection and control activities following the construction and equipment of the FPOs and the appointment of the inspectors (EC 2007). The Twinning Project has been completed, but according to the EC (2007), the renewal process of the Fisheries Law is still undergoing. Fisheries administrative structures require to be redesigned. In fact, institutional restructuring of the fisheries sector with a single Directorate General for Fisheries* is currently an issue receiving attention but is likely to take several years to implement, if considered politically acceptable. Simplification and decentralization of the organization of fisheries management within Turkey should be considered (FAC 2007).

As a candidate country, Turkey has to adopt its relevant fisheries legislation to the EU CFP. This requires some changes in existing legislations, management regime and policy. In this context, newly developed pilot applications have been introduced in order to create a framework on exploitation of fisheries marine resources. Examples include development and pilot application of a VMS, FIS, and construction of offices at landing sites, regulations on market standards, preparation of preliminary fisheries management plans and a preliminary sector strategy.

Despite all the progress in policy development, issues such as the Code of Conduct for Responsible Fisheries have not been incorporated into national fisheries legislation yet. However, Turkey does have 524 Fishery Cooperatives, 14 Regional Fishery Cooperative Associations, one Central Association of Fishery Cooperatives (SUR-KOOP), and 24,920 fishers organized under these cooperatives (Ünal *et al.*, 2009). This cooperation could represent an important management source for the future development of fisheries management and policy. It enables the authorities to address access to marine resources and management issues through the empowerment of well-organized communities. Effective input controls, community-based property rights and co-management schemes are potential ways towards solving the problems of overcapitalization and excessive fishing pressure in coastal waters. In this aspect, several noteworthy steps have been taken in the recent years on the local scale. For instance, the EU SMAP III project completed in 2009 in Gokova Bay, and the following SAD-Rubicon project which includes the entire Gokova SEPA, led to the execution of “Fishery Management Plans” during which shareholder

meetings are arranged to secure the participation of different groups in order to encourage and improve these plans.

Consequently, to ensure the effective management of fisheries, the government should take further action in order to:

- Harmonize fishery laws and regulations in accordance with relevant EU directives (This is currently in process but priority should be given to management practices that prevent overinvestment and the resulting overfishing and resource depletion).
- Establish a Directorate General for Fisheries (currently in progress)*,
- Amend the Fisheries Law (Draft amendments have been introduced),
- Consider separate fisheries management plan for region (Mediterranean and Black sea fisheries) and local based,
- Improve the fisheries researches (More funds should be allocated for research and development projects),
- Implement VMS as soon as possible for all boats larger than 12 meters of length,
- Start reliable and periodical data collection and stock assessment program,
- Improve the dialogue between the stakeholders, scientists and decision makers,
- Add stakeholder participation to management process in a legal basis,
- Start a collaborative approach between government and industry,
- Prepare an appropriate fisheries policy based on the FAO Code of Conduct for Responsible Fisheries.

It is hoped that recent developments, considerable efforts and progress that have been carried out so far as well as recommendations mentioned in this review will contribute to the establishment of a fisheries management system that can guarantee both biological sustainability and economic efficiency in the Turkish fisheries.

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FISHERIES OF THE LAKE VAN AND TRANSITION TO SUSTAINABLE FISHERIES MANAGEMENT

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1. Introduction

The pearl mullet is the sole endemic fish species that can survive in the salty and alkaline waters of Lake Van. Covering an area of 3712 km², with mean depth of 171 m, maximum depth of 451 m, and 1648 m above sea level, this is Turkey's largest lake. Its waters are extremely alkaline and salty. Due to the nature of these waters, it is characterized as a "soda lake". Researchers have reported a pH level of approximately 9.8, with saltiness at 19‰ (Kempe *et al.*, 1978). The lake's biological diversity is significantly different from both fresh and salt waters. Its phytoplankton resources consist of 103 species belonging to the *Diatome*, *Bacteriophyta*, *Cynophyta*, *Chlorophyta*, *Flagellate* and *Phaeophyta* groups, and its zooplankton resources include 36 species from the *Rotatoria*, *Cladocera* and *Copepod* groups (Selcuk 1992). The pearl mullet (*Chalcalburnus tarichi*, Pallas 1811), a species belonging to the *Cyprinidae* family, is the only fish that can survive in Lake Van. The pearl mullet is a migrating species. Although it generally lives in the lake, it immigrates to the surrounding freshwater rivers for reproduction purposes and returns to Lake Van after the reproduction period.

The earliest available information on the fishery practices related to the pearl mullet comes from travelers that visited the Lake Van region. Among them, Evliya Celebi (17th century) provides the most detailed account. Having arrived to Van with a general, Melik Ahmet Pasha, Celebi speaks of the lake as the "Van Sea", stating that a certain species of fish exist in these waters that migrate annually to the Bendi Mahi River creek for a month as a flock. He goes on to explain that the fish are captured on their way back to the lake by the provincial treasurer, salted and then taken to the Iran, Nagorno Karabakh, and Azerbaijan area to be sold. He says 900 loads of silver coins are thus collected for the treasury each year and this income is then distributed among the soldiers serving in the fortress around the lake (E. Celebi, 17th Century). The first detailed study on the biology of the pearl mullet was carried out by Akgul (1980); further research was conducted by Danulat & Selcuk (1992) and Danulat & Kempe (1992) revealing new parameters about some physiological and biological characteristics not articulated in the previous study. Other studies on the pearl mullet include: Arabaci's (1995) research on physiological changes that take place during reproductive migration; Cetinkaya *et al.*, (1995) on some selectivity characteristics of nets used for pearl mullet fishing; Sari's (1997a)

research which presents the basics of current fishery management practices and proposes an alternative model based on estimated pearl mullet stock quantities; Sari's study (1997b) on mesh selectivity for pearl mullet fishery; Sari and Tokac's research (1997) on the technical features of Lake Van fishing boats; Sari & Ipek's study (1997) specifying new fishing areas around Lake Van, drawing on satellite imageries; and Sari & Tokac's research (2000) about the productivity of nets used for fishing the pearl mullet.

As of 1997, technological approaches have prevailed in fishery management at Lake Van. With the establishment of a center at the Yuzuncu Yil University focusing specifically on this field, these studies have acquired an institutional identity (Sari 2000a). Sari (2000b) has declared that new fishing grounds have been successfully determined with the aid of the remote sensing and geographic information system. Using the daily AVHRR satellite images taken from the NOAA HRPT ground station situated at the remote sensing center to determine the surface temperature map (SST), in conjunction with depth and flow data, this study has verified that the pearl mullet's distribution area can be successfully established. The effects of these applications, which will ease the transition from the erroneously administered spawning period fishing practices to professional fishing, have been clarified in detail by Sari (2001).

In the event of a failure to prevent spawning period fishing, the new technology will be an added fishery pressure on the pearl mullet population; in light of this possibility, the need for cooperation among relevant public authorities, and local, national, and international non-governmental organizations is clearly an imperative. This paper is a detailed examination of the transition process to sustainable fishery of the pearl mullet, the role of relevant governmental and non-governmental bodies, security forces and universities within this process.

2. The Biology of the Pearl Mullet (*Chalcalburnus tarichi*)

A member of the Carp family (*Cyprinidae*), the pearl mullet is a fish species that only inhabits the Lake Van Basin (Figure 3). Generally of bright-silver color, its back is grayish green, and the abdominal region is silver (Figure 1). Its body is covered with small scales, and its eyes are large (Kuru 1987, Geldiay & Balik 1988). On the average, it measures around 19.5 cm in length, and has an average weight of approximately 80 g. It feeds on phyto and zooplanktons. Its average life span is around 7 years, and the fish reaches reproductive maturity at 3 years old. The reproduction period, at which time the fish immigrate to freshwater rivers in flocks, starts in early April and lasts through the end of July. As they cannot make the move from salty-alkaline water to freshwater directly during the migration, the fish have a brief waiting period at the river mouths for osmotic adaptation, both on their way to the area where they will lay their eggs and back. As the river water temperature reaches

approximately 12 °C, the pearl mullets go into the freshwater and start to lay their eggs. Having laid the eggs in small pebbly, sandy areas where the river tends to sprawl out and the speed of the flow is lessened, the adults return to the lake. Fish jump on small waterfall during the migration like salmon (Figure 2).



Figure 1. Pearl Mullet (*Chalcalburnus tarichi*) (Sari, 2006)



Figure 2. Flying Pearl Mullet on Delicay River, North Lake Van (Photo: Ali DAGER)



Figure 3. Lake Van, important settlement areas surrounding

Their youngsters start on the journey towards the lake within a week or two after the eggs are hatched. The young pearl mullets wander and feed in flocks around the nutritiously rich shore areas of the lake throughout the summer. Pearl mullets tend to disperse all over the lake in the summer months, but avoid areas where the water is deeper than 25 m. In the wintertime, the fish move within parts of the lake that have a maximum depth of 60 m (Sarı 2001, Sarı 2003).

3. Historical Development of Pearl Mullet Fishery and Its Management

The pearl mullet is captured by two different fishing methods, in two different seasons. The fish migrates to freshwaters in order to breed between the months of April and July. However it is not able to have direct access from the salty-alkaline waters of the lake to the freshwater rivers. Due to its biological constitution, the fish must undergo an osmotic adaptation process whereby it needs to wait for a certain time at the river mouths known as “mansap”. During

this “waiting” period, large flocks gather within the river mouths. The first fishing method involves the capture of the pearl mullets, by casting beach seined nets along the shore (beach seining), from small fishing boats as they are waiting to continue on their reproductive migration by the river mouth. Simple traps laid along the rivers are also employed to capture the fish during this period. Whereas 90% of the total pearl mullet fishing was done by this method in 1996, by 2006 around 40% was done during the breeding period. The local population has been employing this traditional method, capturing the fish during its migration period since ancient times (Sarı 1997b, Sarı 2001).

The second method is “winter or professional fishing”, whereby the fish is captured at Lake Van, which is its main habitat, between September and April. During this period, fishermen use 8-16 m boats with trammelnets that mesh sizes of 20-22 mm. They start fishing at depths of around 15-20 m in September, proceed to 50-60 m as the weather gets colder, and go back to 20-30 m depths as spring approaches and temperatures get higher. This fishing technique was started during the 1970s and is becoming increasingly more widespread. Nevertheless, at present only 60% of pearl mullet fishing is being carried out in the winter months (Sarı, 2006).

Until the 1960's, pearl mullet fishing was at a minimum due to several reasons such as lack of adequate fishing gear and equipment, and the fact that fresh fish consumption culture had not yet developed among the local populace. In those years, the fish could not find a place to migrate for breeding purposes, and sometimes went as far as the irrigation canals at the surrounding fields. As a result, piles of dead fish would be seen for days on end by the river shores in the springtime (Sarı 1997b). Albeit in small amounts, all fishing activity was carried out only during the breeding period. Since it affected a minimal part of stock distribution within the lake, there was no need for fishing regulations. However after the 1950s, as fishing activities that took place during the breeding season took on a commercial characteristic and as “winter or professional fishing” also started to become more prevalent in the 1970s, pressures increased pearl mullet fishery. Following the '70s, it became imperative to take some administrative measures.

The first regulatory measure related to pearl mullet fishery was the “closed season”, put into application during the reproductive migration period even if it was for a short duration. The dates through which fishing was prohibited during the reproduction period (closed season), and hence the number of days when the lake was off-limits for pearl mullet fishers, kept changing each year due to political or social conditions. However in the 1980's, the ban became more or less consistent and started to be applied between the dates of May 15 and July 1st. In the years that followed, while there was noticeable negligence in monitoring illegal fishing activities, it was also observed that for some reasons, the dates of the closed season on Lake Van was

haphazardly designated in different regions and the fishing ban, devised as precautionary management strategy, was abolished in practice, even if not legally. In the 1980s, along with the above mentioned closed season application, a limit was also set on the mesh size to be used, both for winter and reproduction period fishing. However, as in the case of the closed season application, since the limitations on trammel net mesh sizes were based on the views and demands of the fishermen rather than scientific data, this resolution too failed to be effective (Sari, 1997b). In addition, fishing during the reproduction season was encouraged in a way, because the National Real Estate Organization rented out the river mouths exactly at this period. Unfortunately, this practice was continued until the lastet few years.

As a result of these management strategies, the 600-ton pearl mullet yield in 1967 showed an increasing trend, which can be seen when production is analyzed in 10-year periods as follows: 4000 tons in 1977 (approximate increase of 700%), 10000 tons in 1987 (250% increase), 21000 tons in 1997 (200% increase) and has reached the highest yield within the inland fish production category, with 15654 tons in 2000. Whereas the ratio of pearl mullet production to total inland fish production varied between 5-9% in the initial years, recently this figure has gone up to 36%. This increasing trend in pearl mullet yield has shown a decline in the last years due to overfishing (Figure 4). Sari (2001) has pointed out that pearl mullet fishery has taken a course that corresponds to the “the theory of development of uncontrolled fishing”, stating that preventive measures must be taken.

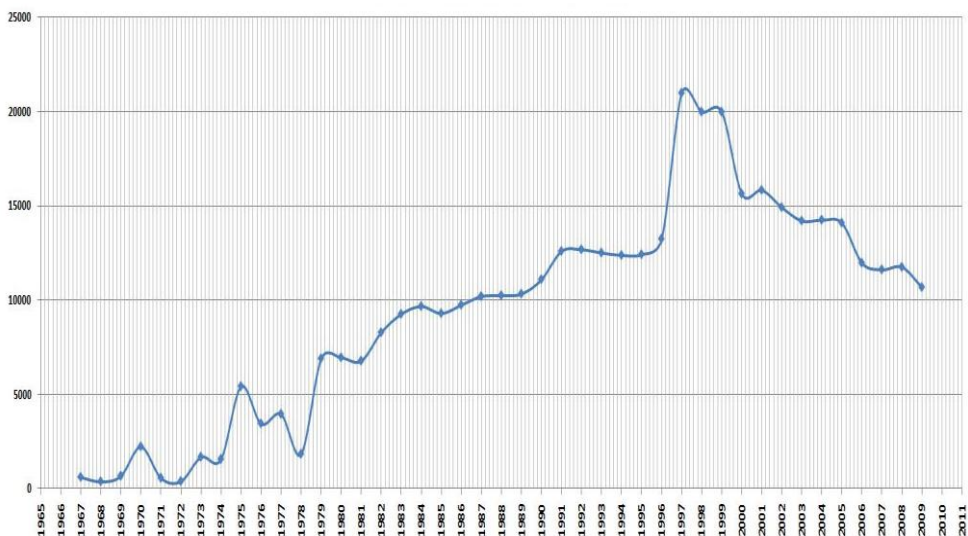


Figure 4. Caught Pearl Mullet as yearly (Data from TUIK)

4. Transition to Sustainable Fishery

Basically, transition to sustainable fishery of the pearl mullet means that fishing during the reproductive period must be prevented, and should only be practiced at other times. In essence, this is the main factor that threatens the species. This approach is prevalent in the new management model recently developed by Sari (1997b). Effective prevention of fishing during the reproductive period will not only result in increased revenues, but will also require less labor and input, as well as ensure the preservation of the species. Efforts to achieve this goal can be evaluated in three phases.

4.1. Phase 1. Defining the Existing Situation

Despite the fact that the pearl mullet presently constitutes 36% of inland fish production in Turkey, unfortunately it is a species that has not been researched sufficiently. As a result, studies on the general biology, stock quantity and fishery of this fish were practically non-existent. As emphasized above, the existing studies were realized with inadequate number of samples and within limited time restrictions. Therefore, revealing the species' reproductive, growth, recruitment and other characteristics had to be the first priority. Studies conducted between the years 1993-1996 focused on the parameters of reproduction, growth, and recruitment, thereby enabling an assessment of stock sizes and the determination of fisheries management basis (Sari, 1997b). The same researcher also stated that calculations related to fishing practices had revealed a exploitation ratio (E) mean of 0.684, and reported that existing fishing practices led to over-exploitation of the pearl mullet population, resulting in a decrease in average length of the species, and a decline in unit and total catch yield. A series of proposals were set forth, with a core approach that can be summarized by the following suggestions: minimum mesh size must be 20 mm in order to prevent over-exploitation; each boat must hold no more than 5000 m of trammel net; the dates of the fishing ban to be applied during the species' spawning season must be re-adjusted according to the reproductive migration patterns of the fish; a separate unit must be established for centralized fisheries management. At that time the sole restrictions on pearl mullet fishing were the unmonitored "closed season" whereby the dates of the fishing ban were determined according to the fishermen's requests, and a limitation of minimum mesh sizes of "16-18 mm" for the beach seine nets— an apparently random figure for which there is no scientific basis. The "closed season" application for the lake started at two different dates, but ended on the same date. As a result, the fishing ban was applied between May15-July 1st for Van (central province) and the river mouths, rivers or streams within the boundaries of the districts of Gevaş, Edremit and Muradiye, whereas the ban was put into effect between the dates of May 25-July 1st for the district of Erciş and within the boundaries of the province of Bitlis. Yet, the distance between Bendi Mahi River (within the

boundaries of the district of Muradiye) and Delicay or Haydarbey Stream (within the boundaries of the district of Erciş) consisted of 17 km only.

As the first step for the realization of these proposals, local and federal authorities responsible of fisheries management were informed about the situation, and were asked to make the necessary regulatory adjustments. However, coming from a region that had not requested any change for years on end, this appeal for change which could easily be considered “radical” for that period- did not immediately elicit any response. Following lengthy disputes with local and national fisheries management agencies, a decision was reached to unite the dates for the “closed season” application. As of the year 1996, the fishing ban would be applied throughout the entire lake between the dates of May 10-July 1st, in accordance with the recommendation of the university. Thus, as the ban was put into effect synchronously, it was also pulled forward, even if only by 5 days. On the other hand, the subject was brought to the attention of the media, and the dangers of incorrect fishing were explicated.

This transformation was initially met by the negative reaction of the villagers, who regarded spawning-period fishing as their “irrefutable birthright”. The previously established dialogue was not enough to convince them. Unfortunately, NOT A SINGLE OUTCOME could be obtained from the measures taken to prevent fishing during the reproductive phase. Spawning-period fishing continued full blast, and there were no controls whatsoever. The local public agency responsible of monitoring fishery activities recommended that the security forces should solve the problem. The security forces responded by emphasizing that basically, this was not their responsibility.

4.2. Phase 2. Developing New Approaches and Experimenting with These Methods

An evaluation of the results (failure) of the first phase led to the conclusion that a “state-centered” approach to fisheries management was not applicable for Lake Van, at least at that time and under those circumstances. Therefore, non-centralist new methods were required. As of 1996, efforts were focused in this direction. First, the correlation between the amount of fishing and prices was clearly explained, based on observations from the previous period. Emphasis was put on the fact that intense fishing activity during the spawning-season was leading to decreased earnings for the fishermen. Having gained an insight about this relationship, the fishermen were inclined to find some solutions by themselves. These fishers were brought together with the sellers, and were encouraged to agree on a quota system, which they, themselves would monitor. The most important aspect of this strategy based on the quota system, was that it would bring a novel approach to the monitoring process that was somehow never accomplished by the state authorities, by drawing on the supply and demand balance as a brand new leverage element, while at the same time preventing erroneous fishing practices through the active

involvement of voluntary inspectors. The fishermen and sellers, under the supervision of lead researcher, reached a consensus on this issue and signed a page-long mutual agreement document. The agreement stipulated that the “closed season” application would start on June 1st, rather than May 10th of each year; the fishermen would not catch more than 3 tons of fish daily, and the sellers would not buy below a price specified in the document. This management strategy would be in practice for 2 years, by the end of which, spawning-period fishers would have saved some capital. At the end of the 2-year period, they would all join forces to support the prevention of spawning-season fishing. The official authorities would not be involved in any part of this process, except for making the necessary adjustments in the circular (Sari, 1998). However, the local fisheries management authority opposed this proposal on the grounds that it would lead to a “fish massacre” in spite of the fact that they had never taken action to enforce control mechanism. So this novel approach, the result of nearly a year’s work and built on hard-earned trust, never came to realization. Nevertheless, many national NGOs became aware of the issue during the preparation of this proposal. The errors of the methods used for the capture of pearl mullets took place in the media time and again. National NGOs declared to the relevant ministries and fishers that they would keep on pursuing this subject. This cooperation, while perceived as a hard-to-beat union by the fishermen, also enabled the pearl mullet to become a national issue rather than a local matter. On the other hand, the General Directorate of Fisheries Circular Number 33/1, put into application in the years 1999-2000 required that the above-mentioned dates stay the same, but also stipulated a limit on mesh size and on the number of nets that can be used for pearl mullet fishing. In effect, the circular enforces a 20 mm mesh size and does not allow more than 5000m netting per boat. Throughout this process, the dialogue that had established with the fishermen developed even further. Those who were convinced that spawning-period fishing is the wrong method were brought together, and training programs that explicated the damage caused by erroneous fishing practices were carried out in villages where spawning-period fishing prevailed. These efforts, encouraging spawning-period fishers to convert to winter-fishing instead, were not viewed positively by those fishers who were already fishing during the winter season. They were uneasy about the possibility of newcomers exploiting the few fishing grounds they had found through years of experience, and further decreasing the already lowered yield. In order to determine new fishing areas, a “Remote Sensing Center” was established within the Yuzuncu Yil University structure. New fishing grounds have started to be located using the satellite imageries obtained daily from this center.

4.2.1. Remote Sensing Applications

Remote sensing is broadly defined as collecting and interpreting information about a target without being in physical contact with object. The term remote sensing is commonly restricted to methods that employ electromagnetic energy (such as light, heat, and radio waves) as the means of detecting and measuring target characteristics (Priede 1983, Sabins 1986).

Satellites of NOAA series are scientifically designed and supply two types of imaging products. One of them is Automatic Picture Transmission (APT) and the other is High-Resolution Picture Transmission (HRPT). *Advanced Very High-Resolution Radiometer* (AVHRR) sensor produces 1.1-km resolution images, which are suitable for terrestrial, aquatic, and climatic studies. NOAA AVHRR images have 5 channels and cover visible and infrared range of the electromagnetic spectrum (Sari *et al.*, 2000). In a study conducted by Sari (2000), 12 identical fishing net was used; during the study 6 locations became the chief focus of the investigation. Three of these locations were old, which fishermen have been using for fishing for a long time. The other three were newly-determined- locations being based on the maps showing water surface temperatures and the currents in the lake. Throughout the course of the study it was determined that the average catch obtained from old fishing locations was found between 4.8 to 22.3 kg, while the average catch in newly determined locations was between 15.4 and 52.3 kg. This translates to 2 to 5 times more product in new fishing locations than old ones (Sari, 2000). The difference between old and new locations possibly stems from the direct relation between the distribution of pearl mullet and high water of the temperature of the lake in the winter.

Smith & Baker (1978) determined the higher primary productivity areas using remote sensing techniques and then tracked the locations of sardine shoals in the seas. Kemmerer & Benigno (1973) successfully detected the locations of fish herds in the open seas using sea surface temperature maps. On the other hand, Narayana *et al.*, (1995) produced sea surface temperature maps by using remote sensing techniques which are beneficial for determining potential fishing locations.

In the light of all these findings it might be inferred that temperature plays a determining role in finding new locations for fishing through the use of NOAA AVHRR images; but it would be misleading. Because temperature can not be considered as the single factor determining these results. Biological characteristic of pearl mullet, the currents and bathymetric properties of the lake are considered as the other factors causing this condition. Simpson (1994) pointed out that the most important event of remote sensing in fishing was the determination of potential fishing areas; and then he reported water temperature, coastal and bathymetric borders, currents and salinity as natural factors, which affect the distribution of fish.

When the maps charted and measured by Sarı (2000) related with surface temperatures of Lake Van are overlapped with bathymetric and current maps measured by satellite images. When analyzing maps, temperature changes are observed to take place in locations in which currents were much intense while currents show changes depending on the depths of lake. In Van Bay in which bathymetric values change rapidly and irregularly temperature changes are also observed to be higher. If such a relationship (fish distribution, surface temperature of lake, depth and currents) can be put into expression through a mathematical model, daily-obtained- satellite images of fish distribution could be observed quite effectively and fishermen could be directed to much productive areas for fishing. Sarı (2000) pointed out that the algorithm compiled through the limited data showing the relationship between surface temperature, currents, depth and distribution of pearl mullet in Lake Van would be insufficient and that much more comprehensive information of every season of the year should be collected in order to compose much valid algorithm to be used every time. When primary productivity values directly affecting fish distribution are added to this relationship, a perfect algorithm could be formulized and put into expression in observing potential areas of fishing through satellite data.

In this way the technical and economical aspect of fisheries management will come to the fore and survey studies of fish lasting for years in order to determine fish distribution areas will be conducted in a relatively shorter period of time and much effectively. The duration for fish finding directly effecting the cost of fishing will be shortened and the expenditures caused by the fuel floating the boats will also be reduced.

Besides this positive contributions to fisheries, remote sensing could also turn out to be negative when it is misused in every branch of technologies. If the fishermen have not enough professional discipline and moral conduct of their works, and have a lack of supervision and control they will exploit the fish stocks easily determined by satellites images in a short time. For this reason, it would be of greater importance to fill the gaps and irregularities wrought by lack of education and awareness for this profession before this new type of fishing is introduced to communities in the region.

4.2.2. GIS Applications

Geographic Information Systems (GIS) is a computer-based tool for mapping and analyzing things that exist and events that happen on earth. GIS in fisheries are being effectively used in fisheries management, in tracking of spawning grounds of some pelagic fish, in classification of habitats according to environmental factors, in monitoring and conservation of spawning ground of the anadrom species, in coastal and river basin management (Sarı *et al.*, 1998).

Lake Van Fisheries Geographic Information System (LVFGIS) has been designed for managing fisheries in an effective way and determining the technical, economical, social, cultural and demographical aspects related with fisheries in Lake Van as well as for compiling data in ArcView software environment. . With this study which encompassed all the communities dealing with fisheries around the Lake Van, LVFGIS facilitated to effective decision making and interpretations of the impacts of every kind of change in the means and modes of this profession.

In the previous chapter, we stated that pearl mullet was the only species adopting itself to live in Lake Van due to extreme values in the water quality in it. For this reason, in this study of LVFGIS only the fisheries management within in the context of pearl mullet has been investigated and information provided here could only be available for such management. We overlapped on LANDSAT MSS images with the borders of the lake, streams, settlements in which fisheries are carried out. Topological pinpoints pertained to the determined settlements were setup and then two categories were composed by defining two different times of fisheries as winter fishery and reproductive period fishery. Then the attribute table related with the sub-branches of every category was composed and linked with layers.

In the category of winter fishing such topics as the name of settlement dealing with winter fishing according to years, its location, the name of cooperative, if existed, the number of boats, the number of nets, number of fishing days, total catch, unit catch, total population of the settlement, people working in fisheries, demographical structure of the population dealing with fishing, mean family members and educational status of fishermen. In the category of fishing in reproductive period, such topics as the name of the settlement dealing with fishing according to years, their locations, number of beach seine net, the number of fishing days, the demographical structure of fishermen, mean family members and educational status of fishermen were investigated.

All of the data compiled through LVFGIS from 1994 on were brought together within the context of GIS. In case of any queries concerning the access of information, decision making and applications made by the authorities LVFGIS can be easily used. For instance, when we want to view the entire domains of the settlement in which the number of the boats are more than 10 it is possible to access information in seconds on the query screen; on the other hand if we want to see the relationship between the education status of fishermen, demographical condition and catch yield, it is possible to evaluate the results by overlapping to different layers in seconds by this system.

Fisheries management is a complicated and difficult task. Especially in such countries as Turkey in which fishermen have no access to scientific data, the fishermen are quite liable to violate the laws and rules of fishing in a way to

persuade the authorities for exploiting the fish stock in an irregular and immoral way of fishing. Such fishermen usually come to the authorities and pledge that fishing is the only way of source of their financial and economical well-being; they also threaten the authorities that they would begin strikes and uprisings by migrating to the city center. However the functionality of such system as LVFGIS will never allow the ill intentions and misuse of such fishermen for the fact that the pretexts put forward by them will quite easily be refuted through the scientific data provided by such system since this system will monitor all the information about fisheries, total populations, financial sources, the situation of settlement; and thus a much more sustainable and reliable environment for fishing will be established. Fishermen are also having the other demands such as benefiting from subventions and subsidies as well as support from the government on the pretext that their fish were exploited by the other fishermen of the near-by communities and a decrease in catch yield occurred, as well as replacements which they claim to have taking place in their fish stocks. Such cases show us that the applications of LVFGIS are of vital prominence in filling these gaps and regulating such chaotic environment of fishermen (Sari&Guven, 2004).

4.3. Phase 3: Putting New Approaches into Practice

Even though the first and second phase of this study did not produce tangible outcomes, they did enlighten our path to find the true solution to the problem. Having concluded by the end of the first phase that a “state-centered” approach was not applicable, and by the end of the second phase that relying on a “fisher-centered” strategy also did not lead to a solution, the third phase was designed so that the NGOs would have a pivotal responsibility in solving the issue, with the support of “public administrative bodies” and the “fishers”. At the outset, the initiative involved touring the fishing villages at regular intervals explaining the damages incurred through the use of improper fishing methods. The local authorities and security forces were also visited at regular intervals and the ecological, economical, social and cultural significance of the pearl mullet was explicated. Brochures and posters addressing the fishing community, local authorities, security forces and consumers were prepared and distributed. Flow of information was established with the Ministry of Agriculture and Rural Affairs, the Ministry of Environment and Forestry and similar federal organizations responsible of fisheries management, in order to ensure that the subject was accurately perceived. Consequently, the gendarmerie in rural areas, and security forces at provinces increased their monitoring activities. Whereas no action had been taken against a single fisherman for violation of the law since 20 years, as a direct result of improved controls, now there were times when action was taken against more than 20 fishermen per day. Whereas 15 truckloads of fish was being sold right across the street from the Governor’s office at the center of Van City during the “closed season”, it was now difficult to find pearl mullets even at the smallest vendors at remote neighborhoods.

However, the spawning-season fishers felt that they had been pushed into a corner and convinced the General Directorate of State Hydraulic Works authorities to direct all of the water in the Bendi Mahi River into the irrigation canals for agricultural purposes, just at the period when the fish were about to migrate to the streams and rivers to lay their eggs. Despite all efforts, no water was channeled into the streambed until the end of the spawning season. As a result, approximately 1000 tons of fish died in the Bendi Mahi Streambed due to dehydration and the fishers collected truckloads of fish from the streambeds. As of the year 2001, after the issue was taken to court and a dialogue was established with the farmers' and irrigators' unions, a sufficient amount of water was left within the streambeds. An "irrigation training project" was launched in the Muradiye area, so that the farmers would learn proper irrigation techniques and would stop using the wrong methods. Two posters, and 4 different booklets were published for the training project. In parallel with this venture, another project was started to help steer the spawning-season fishers towards professional-fishing, with the support of the United Nations Development Program Global Environment Funds Small Grants Program (UNDP-GEF/SGP). Within the scope of this project, two separate training sets were designed for fishing villages, and were applied throughout all of the villages in the region. In 2002, all of the parties dealing with pearl mullet fishery management were gathered together for the "Sustainable Fisheries Management Workshop". The workshop was concluded with the signing of a proclamation stating all the subjects on which all of the participants had reached an agreement. Thus, even though there had been some arguments, for the first time all the parties had put their signature under a single text. In fact, this agreement was the turning point for sustainable fishing of the pearl mullet. After this stage, every unit began to own up to their institutional responsibilities regarding fishery management. The Preservation and Control General Directorate of the Ministry of Agriculture and Rural Affairs, which had also participated in the shaping of this agreement, in its circular to be effective in the 2001-2002 periods, accepted the joint proposal made by the university and the NGOs to set the dates of the fishing ban from April 15 to June 30. In support of the on-going scientific efforts, the Preservation and Control General Directorate also declared in its circular that the fishing ban would continue to be in effect for the preservation of the pearl mullet and that the same dates (April 15-June 30) would apply for the periods covering 2002-2004 and 2004-2006. This put an end to the legal inconsistencies that had been creating the greatest obstacle to sustainable fisheries management. With the beginning of the fishing ban on April 15, the long held practice of renting the river mouths for fishing purposes in the spawning-season was effectively ended. At present, none of the river mouths around the lake are being rented for spawning-season fishing activities. In fact, although focused specifically on the fishery of Lake Van pearl mullets, these efforts have turned into a model for Turkey's inland fishery management because the problems confronting our lakes are pretty much the same throughout the country, with

minute differences. Lake Van is unique in one aspect: the severe pollution seen around the lakes of the Mediterranean and Aegean regions is only at the beginning levels in Lake Van. Contrary to the first and second phases, the third phase of this project has provided positive results. The over-exploitation pressures on the pearl mullet stock have been decreased, fishing yield has increased, and profit levels in the fishing sector have risen. The sustainability of these outcomes depends on the dedication of relevant local institutions and organizations, and their determination to maintain these applications. Inevitably, the need has arisen for a local NGO that can ensure coordination between the local institutions and organizations, own up to the heritage of previous efforts, and develop projects geared towards the future. The Association of Nature Observers was established in 2003 as a result of this necessity.

5. Results of the Transition to Sustainable Fishery

The achievement of sustainable pearl mullet fishery is a subject that is of great importance for the 14000 people around the lake who depend on it for their livelihood. Therefore, even though the studies that have been carried out bear ecological implications, in reality, their economic justifications are the main priority. The studies conducted between the years 1993-2006 in three phases as summarized above, provided excellent results, especially with the NGO-centered local fishery management strategies adopted in the third phase; and have become a model for inland fishery management in Turkey. 17 different training and cautionary materials were produced within the span of this 13-year study. Clearly, the endurance of the messages resulting from studies that deal with societal issues depends on the adequacy of educational and cautionary documents.

The results and benefits attained through the 3-phase studies conducted with the support of these training-cautionary materials are presented in Table 1. As can be seen in Table 1, the number of seine nets employed for spawning period fishing has decreased by half, whereas the number of professional-fishers has gone up by the same proportion. This indicates that most of those who gave up spawning season fishing have started to engage in winter fishing (Sari, 2004).

Table 1. Output data obtained during transition to sustainable pearl mullet fishery (Sari, 2008)

Parameters	Years	
	1996	2006
Number of seine nets used for spawning season fishery	92	32
Number of river mouths rented for spawning season fishery	12	0
Number of villages entirely opposed to the project (total 15 fishing villages)	9	2

Table 1 Continued

Number of professional-fishers	101	165
Unit catch in professional fishing (kg/100 m/day)	2.622	8.50
Mean fork length (cm)	16.74	19.8
Number of fish per 1 kg (unit)	16-18	10-12
Total fishery revenues (USD)	3659000	7143000

Whereas there were only 6 villages out of a total of 15, that supported the efforts to prevent spawning-season fishing at the initial stages of the transition to sustainable fishery management, today this number has gone up to 12 villages. Unit yield obtained through winter fishing has increased by three-fold in comparison to 1996 figures, going up to 8.50 kg. Decrease in size of captured fish due to over-fishing had been observed in over-exploited grounds (Pauly, 1983). Sari (1997b) has stated that this decrease in size of captured pearl mullets is a direct result of over-exploitation and has emphasized that the fish size will increase once over-fishing is successfully prevented. As can be seen in Table 1, the increase in mean size of the pearl mullets is very noticeable. In the meantime, as a result of the decline of spawning season fishery, a supply and demand balance has started to emerge, and the revenues obtained from this fish have increased nearly 100%.

6. Conclusion and Suggestions for Sustainable Fishery

Although there is a rising trend in pearl mullet fishery towards sustainable fishery practices, it must be clarified that “sustainable fishery management” has not yet been achieved. Considering the fact that tens of species have been lost within our inland waters in the last 50 years, the achievement of this current level of protection for the pearl mullet – the only species that can survive in the extreme ecosystem of Lake Van- definitely cannot be underestimated. On the other hand, neither is it possible to paint a rosy picture, or to claim that every problem has been solved.

Presently, 3 of the 15 fishing villages still insist on fishing during the spawning period. A new project has been launched in these villages, with the support of UNDP-GEF/SGP. This study aims to determine the reason for this difference in attitude by researching the social, cultural, and traditional structure of villages that have abandoned spawning season fishery practices and those that have not, while at the same time trying to change the traditional style of consumption, which encourages fishing in the reproductive period. Also within the context of this project is the assessment of alternative income resources for all the fishing villages, with a special emphasis on those villages that have abandoned spawning period fishing practices. Possible alternative income resources pinpointed during previous studies, such as winter fishing, canned fish and salted fish production workshops, and eco-tourism, are being studied for their adaptability to the local population’s socio-cultural and traditional

structure. Other alternative income resources generated by the local townspeople will also be appraised.

The first priority for full transition to sustainable fishery management is the acceptance of an NGO-centered local fishery management scheme by the fisheries management authorities. Significant steps have been taken to this effect, demonstrated by the fact that the dates for the fishing ban have been determined as a result of regional meetings, and the efforts that are being made to reach decisions with the highest possible participation in the last few years. However, the same sensitivity has not been observed in the application of the legislature. Presently, the security forces still play a major role in monitoring fishing activities at Lake Van. Yet legally, the security forces are only expected to assist the local branches of the Ministry of Agriculture and Rural Affairs, which are actually responsible of monitoring the lake. As a result, inspections are at times slackened, depending on how the administrators of the security forces interpret their range of responsibility. Institutionalized sustainability can only be attained if the responsible organizations are provided with the personnel and equipment they need, and are enforced to fully take on their monitoring responsibilities. This goal is only achievable through the establishment of a single “local administrative unit” that will be the sole decision-maker with regards to all fisheries management decisions for major inland waters such as Lake Van.

Preservation of the habitat is a basic component of sustainable fishery. Precautionary measures that need to be taken for sustainable fishery management of the pearl mullet and the preservation of its habitat can be listed as below:

- Establishing a local administrative unit that can achieve fishery management single-handedly in special ecosystems like Lake Van;
- Creating alternative employment opportunities that will provide a livelihood for the fishermen who decide to abandon spawning season fishery;
- Instigating amendments in the Fisheries Statute for the confiscation of fishing equipment and transport vehicles in order to prevent poaching, taking the Forest Statute as an example;
- Initiating measures to protect Lake Van, the natural habitat of the pearl mullet, from pollution;
- Preventing the transfer of sand from riverbeds, this damages their spawning areas;
- Mandatory construction of fish passage to ease the migration of the pearl mullets on all kinds of water structures that are to be built on rivers;
- Building boats' shelters at suitable places for effectual management and monitoring of fishery activities;

- Setting up processing and cold storage facilities in order to enhance the value of the fish for marketing purposes;
- Applying ecological water distribution in order to ensure that enough water is left in riverbeds for spawning during the reproduction period;
- Ensuring that the ecological needs of the pearl mullet are recognized as the first priority in all the long term planning related to the lake basin.

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SEAFOOD PROCESSING IN TURKISH FISHERIES

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Today in the whole world, seafood production's total is approximately 142 million tons (FAO, 2008). Turkey provides approximately 623 thousand tons of this production. 54 354 tons of this production are exported while 72 686 tons are imported. 545 597 tons are used in domestic consumption while 90 211 tones are processed in fish meal and oil factories. 5 175 tones are not used. Consumption per person is approximately 7.6 kg (Table 1).

Table 1 Production, export, import and consumption of fishery products, 1999-2009 (TÜİK, 2009)

Consumption							
	Production (1)	Export	Import	Domestic consumption	Processed fish meal and oil factories	Not processed or consumed	Per capital consumption (2)
	Tons						Kg
1999	636,824	15,955	39,552	503,249	150,000	7,172	7,59
2000	582,376	14,533	44,230	538,764	71,000	2,309	7,985
2001	594,977	18,978	12,971	517,832	62,755	8,383	7,547
2002	627,847	26,860	22,532	466,289	156,000	1,230	6,697
2003	587,715	29,937	45,606	470,131	120,000	13,253	6,649
2004	644,492	32,804	57,694	555,859	105,000	8,523	7,812
2005	544,773	37,655	47,676	520,985	30,000	3,809	7,229
2006	661,991	41,973	53,563	597,738	60,000	15,843	8,191
2007	772,323	47,214	58,022	604,695	170,000	8,436	8,567
2008	646,310	54,526	63,222	555,275	95,742	3,989	7,812
2009	623,191	54,354	72,686	545,597	90,211	5,715	7,589

- (1) This includes the sum of sea fish, crustaceans, molluscs, aquaculture and freshwater fish.
- (2) Includes fresh, chilled, smoked, frozen, salted, canned and other types of fish. Per capital consumption is obtained by calculating consumption.

The most important countries from which Turkey imports seafood are Norway, Georgia, France and the USA (Table 2).

Table 2 The 10 countries with which Turkey Imports or Exports Seafood Most, 2009
(TurkStat, Fishery Statistics, 2009)

The name of the country	Import			The name of the country	Export		
	Quantity	Value			Quantity	Value	
	(Tons)	(TL)	(\$)		(Tons)	(TL)	(\$)
Norway	24,559	80,557,806	51,879,387	Japan	3,903	103,275,948	65,853,740
France	7,783	16,681,339	10,737,873	Netherland	8,413	86,176,195	55,650,320
Iceland	1,057	6,227,758	4,130,089	Italy	11,234	71,826,290	46,175,963
Spain	3,100	6,023,484	3,951,397	Greece	6,248	51,385,381	32,954,098
Uzbekistan	621	5,114,002	3,281,822	Germany	5,724	49,225,235	31,636,891
China	3,197	4,255,687	2,815,874	Spain	4,298	34,068,572	21,760,155
USA	4,159	4,171,151	2,748,152	Lebanon	4,559	22,241,207	14,274,709
Georgia	16,411	4,347,159	2,682,665	United Kingdom	1,413	14,439,801	9,357,656
Greece	1,007	4,140,770	2,670,659	USA	621	8,305,212	5,312,882
Morocco	2,665	3,764,890	2,524,471	France	1,138	7,093,003	4,585,772

The largest part of Turkey's seafood importation comprises of frozen or chilled sea fish. The main imported seafood; Frozen *Scomber scombrus* and *Scomber japonicus* (21 675 167 kg), fresh/ chilled anchovies (16 625 229 kg), whole frozen skipjack or stripe-bellied bonito (11510 099 kg) pacific salmon, atlantic salmon, danube salmon, fresh /chilled (2 543 643 kg) (TÜİK, 2009).

While the chilled or frozen fish importation was 43 802 tons in 2005, it increased to 53 439 tons in 2008. The dried, salted or smoked fish importation was 142 tons in 2005 and was again 142 tons in 2008. While the canned fish importation was 242 tons in 2005, it decreased to 98 tons in 2008. While the canned shellfish and molluscan importation was 63 tons in 2005, it decreased to 46 tons in 2008. While the oil importation was 1 740 tons in 2005, it massively

increased to 14 761 tons in 2008. While the fish meal importation was 39 296 tons in 2005, it increased to 55 504 tons in 2008 (Table 3) (FAO, 2008)

Table 3 Imports and exports by country and by seven fishery commodity groups (FAO,2008)

Country of area	Imports (tonne)				Exports (tonne)			
Turkey	2005	2006	2007	2008	2005	2006	2007	2008
Fish,fresh, chilled or frozen	43,802	50,253	56,114	58,439	29,274	31,878	37,677	45,906
Fish, dried, salted or smoked	142	294	160	142	1,216	2,007	1,859	2,129
Crustacean and molluscs	3,225	2,675	2,582	3,539	6,836	7,812	7,438	5,831
Fish, canned	242	422	172	98	4,041	2,420	2,713	1,854
Crustaceans and molluscs, canned	63	35	58	46	3,797	2,496	2,568	2,669
Oils	1,740	11,969	11,635	14,761		0	2	13,209
Meals	39,296	50,375	56,389	55,504	95	135	374	515

The most important countries to which Turkey exports seafood are Japan, the Netherlands, Italy and Greece (Table 2). The main imported seafood are fresh/chilled sea bass (*Dicentrarchus labrax*) (14,297,441 kg), fresh chilled sea bream (*Sparus aurata*) (7,280,354 kg), fresh chilled bluefin tunas (*Thunnus thynnus*) (3,780,040kg), smoked trout (2,337,913kg) (TÜİK, 2009). While the fresh, chilled or frozen fish export was 29,274 tons, it increased to 45,906 tons in 2008. While the dried, salted or smoked fish export was 1 216 tons in 2005, it increased to 2,129 tons in 2008. While the shellfish and molluscan export was 6 836 tons in 2005, it decreased to 5,381 tons in 2008. While the canned fish export was 4,041 tons in 2005, it decreased to 1,854 tons in 2008. While the canned shellfish and molluscan export was 3,797 tons in 2005, it decreased to 2 669 tons in 2008. While there was no oil export in 2005, it was determined to be 13 209 tons in 2008. While the fish meal export was 95 tons in 2005, it increased to 515 tons in 2008 (Table 3) (FAO, 2008).

Fishery production decreased by 3,58% in 2009 with respect to the previous year and became approximately 623 thousand tons. The total fishery

production consisted of sea fish by 61,12%, other sea products by 7,13%, inland water products by 6,29% and aquaculture by 25,47%. The most important types produced at inland waters are trout by 47,66%, sea bass 29,33% and seabream by 17, 87% at sea. Sea products production showed an decrease of 6,14 % and became 425 thousand tons. Of all the sea production, East Black Sea is the first by the ratio of 57,81%. West Black Sea follows it by 15,89%, Aegean by 11,15%, Aegean by 11,15%, Marmara by 8,28%, and Mediterranean by 6,87% (Table 4) (TUIK, 2009).

Table 4 Quantity of catch of sea products by sea products regions and marketing type, 2009. (TÜİK, 2009)

Sea products regions	Total production	Total	Marketing Type							(Tons)	
			Fish Meal and oil factories	Cooperatives and associatons	Comission agents, who lesale dealers and tradesman	Canning factories	Breeding farms	Direct to consumer	Other	Self consum-ption	Not processed or consumed
Total	425,275	416,018	90,211	19,330	269,255	21,079	330	10,842	4,971	3,542	5,715
East Black Sea	245,862	243,589	85,684	5,911	148,389	2,810	164	626	5	1,169	1,104
West Black Sea	67,567	63,225	2,949	950	36,983	17,333	2	2,690	2,318	921	3,421
Marmara	35,223	34,256	1,575	336	28,439	827	146	2,522	411	511	456
Aegean	47,414	46,377	-	11,532	31,673	97	18	2,183	874	535	502
Mediterranean	29,209	28,571	3	601	23,771	12	-	2,821	1,363	406	232

The number of the seafood facilities, among Turkey's seafood processing facilities, to which export license was given for non-EU countries in terms of technical and hygienic conditions in 2001 was 118. The number for EU countries was 65. A decrease was observed in 2005 in the number of the facilities to which export license was given and while the number of the seafood facilities to which export license was given for non-EU countries was determined to be 29, this number for EU countries was determined to be 85 (Çaklı, 2007). According to 2009 data, approval number and export license for EU was given to 98 fishery, 9 alive bivalve, 15 processed frog and snail and 12 alive frog and snail facilities which comply with the European and World standards. Besides, export license for non-EU countries was given to 32 facilities. In the list of fishery products facilities prepared for EU, there are 16 processed sand mussel and 2 canned tuna facilities. The number of the facilities which work for export in Turkey is 138. Among the tuna processing facilities, there are 22 facilities which have export license for both EU and non-EU countries while there 8 tuna processing facilities which have the export license only for non-EU countries (TKB, 2009). According to 2010 records, the number of the seafood processing facilities which have the export license for the EU are the following: The number of the facilities having fresh and chilled products is 9 in the Mediterranean Region, 28 in the Aegean Region, 3 in the Central Anatolia Region, 7 in the Black Sea Region and 23 in the Marmara Region. While there are no facilities having alive products in the Black Sea and Central Anatolia Regions, there are 4 facilities each in the Mediterranean and Aegean Regions and 3 facilities in the Marmara Region. While there is 1 facility having processed bivalve in the Central Anatolia and Black Sea Region, there 5 facilities in the Aegean Region and 7 facilities in the Marmara Region. The number of the facilities which have processed products such as frozen, canned, marinated and smoked products is 12 in the Mediterranean Region, 30 in the Aegean Region, 4 in the Central Anatolia Region, 27 in the Marmara Region and 13 in the Black Sea Region. (TKB, 2010).

Seafood Processing Facilities are placed, in the order of density, in the Marmara, Aegean, Black Sea, Mediterranean, Central Anatolia and Eastern Anatolia Regions in Turkey. Among the Turkey's Seafood Processing Facilities, in the facilities in the Marmara Region, the processes of especially tuna can and sand mussel and oyster, shrimp, octopus, squid and various sea fish are done. For many types, frozen storage technology is used. . In the facilities of the Aegean Region, the main usage type is the frozen storage of products such as sardine, shrimp, calamari and octopus. In some facilities, alive shellfish export and marinated . In addition, since there is a considerable amount of sea and inland water culture fishing in the Aegean Region, there are facilities which carry out fresh fish packaging, and filleting and eviscerating processes. Apart from that, there are smoking units for the culture salmons' usage in the region. The facilities in the Central Anatolia Region mostly work for the usage

of the pike perch. However, as the amount of pike perch decreases, inactivity problems start to occur in the processing capacities of the facilities in the region. In the Black Sea Region, there are processing facilities for the usage of anchovy, sea snail and, to a small extent, jellyfish. The facilities in the Mediterranean Region, on the other hand, are quite few in number and in the existing facilities, various sea and freshwater fish as well as a sum of blue crabs are processed (Çaklı, 2007).

In the recent years, it is seen that while there is not a considerable increase of the production's industrialization rate in the seafood sector, there is a considerable tendency to increase in the alive and fresh seafood export. The seafood consumption of Turkey is quite low when compared to the other European countries in the Mediterranean. There is a big difference among the regional consumption patterns. The consumption in the coastal regions is much more than the inlands. . The studies to increase fish consumption in Turkey should be sped up and the public should be informed about the effects of the fish on health.. . In this subject, an important mission falls to the private sector and education and mass media institutions.

The scarcity of the integrated industry facilities which regulate the production and marketing in the sector is an important factor which obstructs the development. The fact that measures for protecting the sector in terms of import are not taken obstructs the development of the industry aspect of the sector. The main problem of the sector is that it does not hold a fishery and seafood policy complying with its potential power in the national economy. This ambiguity in the policy causes important setbacks in both the production and domestic and foreign trade structures of the sector, creates crucial difficulties in the sectoral integration especially with the EU.

The sector of fishery and seafood still has not a main bureaucratic representation power authorized in the Turkish Republic Ministry of Agriculture and Rural Affairs. The main aim of our industrial institutions should be to increase to added value and the profit in the production chain. Along with the increase in the export volume, the increase in the added value should be focused on as well. The product export with the strong technological content and high added value should be aimed.

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TRAWL FISHERIES

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1. Introduction

Trawls are an important set of fishing gears in Turkish fishing sector as are all over the world. Funnel-shaped in structure and towed along the seabed or in the water column, trawling is a method of fishing that actively involves dragging a trawl through the water behind one or more trawlers (Sainsbury, 1996). As the net is towed through the water, fish entering the net eventually tire and fall to the end of the net where they are held until the net is retrieved (Hayes *et al.*, 1996).

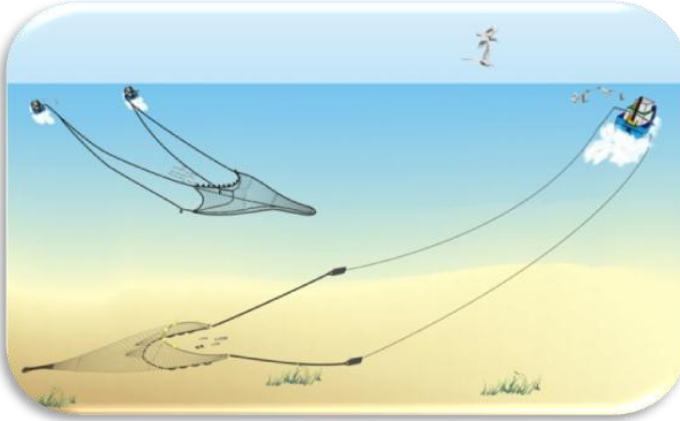


Figure 1.Single bottom otter trawl and mid-water pair trawl

They are called either bottom trawls or mid-water (pelagic) trawls depending on whether they are trawled along the bottom or in mid-water (Figure 1). There are many variants of trawling gear as well as many types of trawling. In Turkish fisheries, they are classified as in Table 1. Among these, single bottom otter trawls and mid-water pair trawls are extensively used by Turkish fishermen.

Table 1.Classification of bottom and mid-water trawls

Bottom Trawls	Midwater Trawls
Beam trawls	Single boat midwater trawls
Single bottom otter trawls	Midwater pair trawls
Twin bottom otter trawls	
Multiple bottom otter trawls	
Bottom pair trawls	

1. Single bottom otter trawls

Bottom trawls are a type of mobile fishing gear consisting of very large nets dragged along the seafloor to catch ground fish and other species. The most common type of bottom trawl used in Turkish seas is the single bottom otter trawl. Otter trawling owes its name to the large rectangular otter boards/doors used to keep the mouth of the trawl net open. It consists of a body ending in a codend which retains the catch and the bottom contact with gear is needed for successful operations.

Bottom trawls are efficient fishing gears for capture of demersal fish species. The amount of fish caught by bottom trawls in Turkey is highest in terms of demersal fish production, and follows purse seiners in terms of total production. In addition to over 50 fish species in Turkey, cephalopodes and crustacea are also caught by bottom trawls (Tokaç, 2001; Başusta *et al.*, 2002; Tosunoğlu *et al.*, 2003). Among species with highest commercial value are red mullet, striped red mullet, common pandora, auxiliary sea bream, hake, annular sea bream, gilthead sea bream, two-banded sea bream, tub gurnard, bogue, common sole, picarel, whiting, poor cod, flounder, common octopus, striped sea bream, deep water rose shrimp, Norway lobster, European hake, horse mackerel, greater forkbeard, blackbelly rosefish, fourspotted megrim, blue whiting, John Dory, angler fish, tub gurnard, piper gurnard, blackspot sea bream, common octopus, European squid, broadtail shortfin squid, pink cuttlefish, musky octopus, and thornback ray.

2. Mid-water Pair Trawls

A mid-water trawl consists of a cone-shaped body, usually made of four panels, ending in a codend with lateral wings extending forward from the opening. It is usually much larger than a bottom trawl and designed and rigged to fish in mid-water and surface. The front parts are sometimes made with very large meshes or ropes, which herd the targeted fish inwards so that they can be overtaken by smaller meshes in the aft trawl sections. The horizontal opening is maintained either by otter boards or by towing the net by two boats (pair trawling).

Fishermen in Turkey generally perform fishing with mid-water trawls towed by two boats. Scattered pelagic species such as anchovy and sprat are caught by such pair trawling in the Black Sea region. Some small-scale fishermen have reported that occasionally mid-water trawls are used illegally as a bottom trawl to provide contact with the seabed.

3. History of the Turkish Trawl Fisheries

Nets towed between two vessels such as beach seines (trata) have been defined as towed gear and firstly used in 1897. Due to their advantage in catching large quantities and thus adversely affecting the market prices, towed gears have been a controversy among fishermen. This led to the prohibition of

trawling (buy such vessels as steamers and sailboats) at the behest of the Sultan through article 29 of “Zabıta-i Saydiye Nizamnamesi”, the fishing regulation of the time. In 1903, article 29 of the regulation was amended to include the straits, part of Marmara Sea, the bays and ports, leaving out 3 miles offshore other parts of the Ottoman Seas (Yaralı, 2009).

After the foundation of the Turkish Republic, the prohibition was completely lifted, kindling the controversy among fishermen and thus leading to the revision of the regulation. In 1931, pair trawling with two sailboats, ships or boats was prohibited through scientific advisory of scientists that it is corruptive. Later, in 1947, it was decided that machine trawling was not among the prohibited and corruptive types thereof (Fish and Fishery, 1957). Trawl fishery started in the Aegean region in late 1940s (A. Yaman and N. Turguttekın, pers.comm.) (Ünal, 2004). Öker (1956) has reported that the number of bottom trawlers which was 2 in 1940 rose to 11 in 1954. Based on this information, it can be concluded that fishing by trawl nets in Turkish seas started properly between 1940-1950 years.

Mid-water trawling attempts in Turkey started with the use of high opening bottom trawls in pelagic fishing (Akyüz, 1981). Later, mid-water trawling nets modified by Robert Larsen, a Danish engineer, were used in 1948 (interview with Akyüz, 1955; Öker 1956). Researches made in connection with the Turkish Meat and Fish Authority in 1950s showed that pelagic species were caught with mid-water trawls (Akyüz 1959; Atahan 1974). However early commercial pair trawl activities began in 1982 to address the anchovy demand in the Black Sea region (Erdem and Erkoyuncu, 1997). On the other hand, Ayaz *et al.*(2000) reported that a company processing and exporting shark had been using mid-water trawl in 1978. Depending on the information on mid-water trawling, we could say that first exercises of mid water trawling in Turkey started in 1980s.

Development of nets used in trawling in Turkey was slow compared to that of fish finding equipment (fish finder, echo sounder, sonar etc.) used in the vessels. While the technology on devices for navigation and locating fish were followed closely by the fishermen, same was not true for material and design of nets. Turkish fishermen did not give up traditional nets for a long time, while in countries with more developed fisheries, design of trawl gears using factory-woven nets had considerable improvement in parallel to the rapid industrial growth after 1950s. In Turkey, however, development of net design and use of different materials have only been followed over the last decade by fishermen.

Trawl nets used in the old times were named after the structure and the region they had been used (such as Ottoman, Italian or Mediterranean type) in Turkey. Later all of these types were merged into a single group as traditional nets, which have non-symmetric structure with low opening trawls and respectively less yield (Tokaç, 1989; Tosunoğlu *et al.*, 2003). Their most significant feature is that they are made from rectangularly shaped pieces of nets, with no specific cutting method (Figure 2).

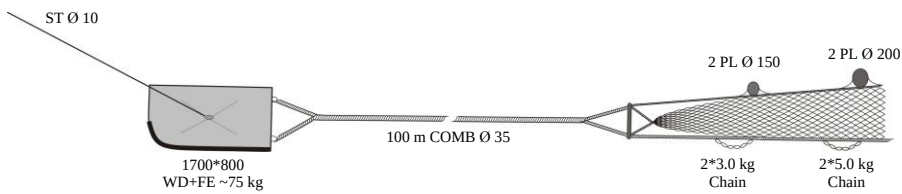
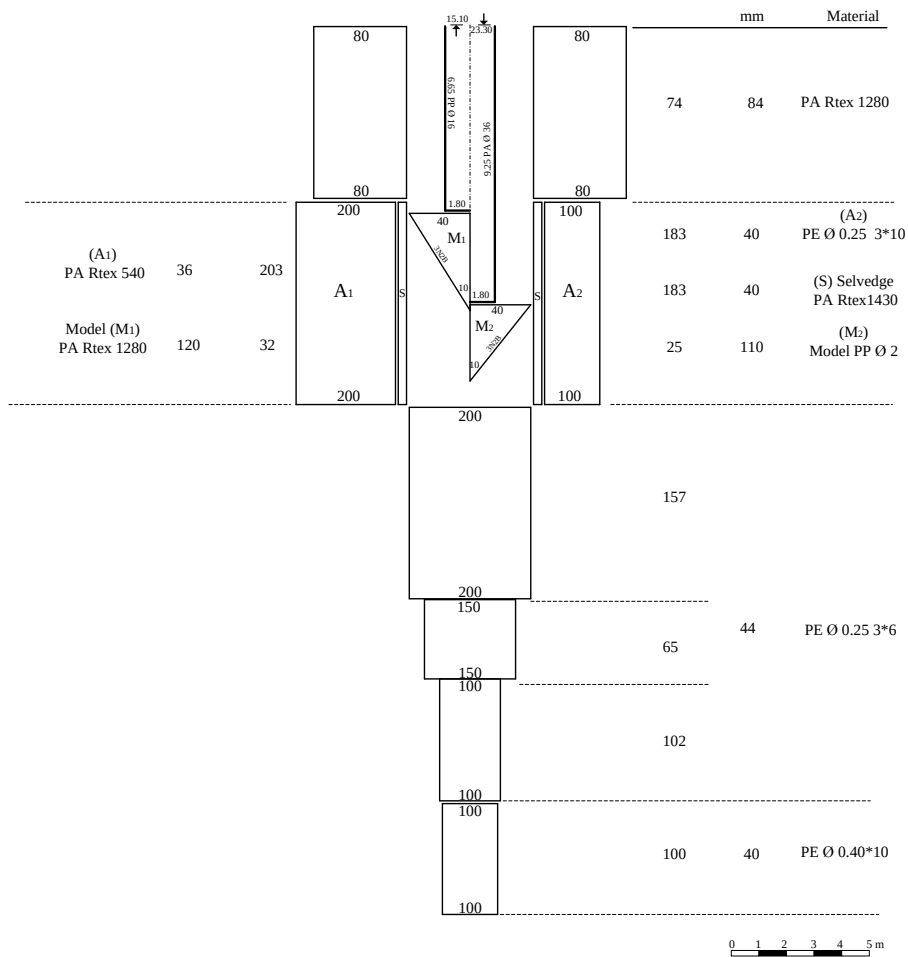


Figure 2.Technical drawing of a traditional 600-mesh commercial trawl net (Kaykaç, 2007)

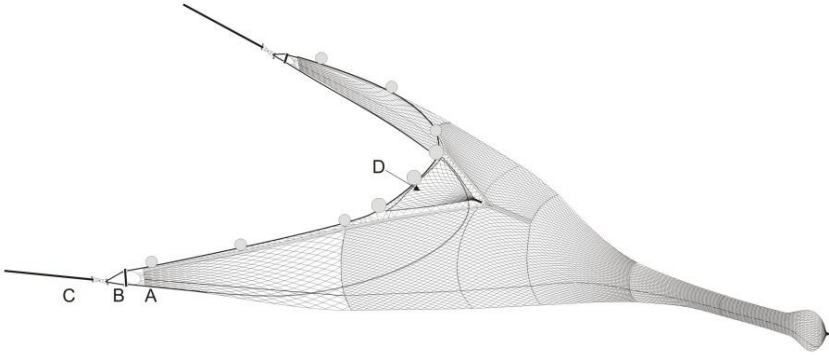


Figure 3. Illustration of 900 mesh trawl net in underwater (Tokaç *et al.*, 2005)

Nets of trawling gears are usually made of polyethylene (PE), polyamide (PA) and polypropylene (PP) materials. The middle part of the head rope is geared up with triangular pieces to increase horizontal spread (Tokaç *et al.*, 2005) (Figure 3). In our country, the trawl nets are defined by the number of meshes in the head and foot ropes where the wings are joined with the belly. Accordingly, nets with 400, 600, 800 and 1200 meshes are used in trawl fishing (Mengi, 1977; Tokaç, 1989; Tosunoğlu *et al.*, 1996; Akamca, 1996; Akamca and Polat, 1997).

Species-specific trawls are also used in Turkish fisheries, such as shrimp trawl, named after the species for which they are caught. Sweep lines in shrimp trawls are shorter while the wings are kept longer. Shrimps are also intensively caught by other bottom trawls along with shrimp trawls. Recently there have been modifications in shrimp trawls by using cut nets (Figure 4).

For the last decade, fishermen have been designing different nets with high opening and better yield by increasing the number of meshes (between 900-1500 meshes) and cutting techniques (Figure 5).

In countries with more developed trawling, gears are designed with engineering expertise in current tanks according to the power and size of the vessel as well as the area and the species to be caught, with necessary modifications to match the performance and yield value of the gear. In such countries the gears are produced in specialized factories while in our country they are designed through empirical testing or by making modifications on the nets as necessary.

4. Turkish Trawl Fisheries

Trawls are efficient fishing gears for Turkish demersal fisheries. Commonly used bottom trawls are the first to mention in Turkish trawl fisheries. Apart from these, there are about 40 boats using mid-water pair trawls in the Black Sea region. These boats have been using the mid-water gears to catch the pelagic species lately scattered in the region (Erdem and Erkoyuncu, 1997).

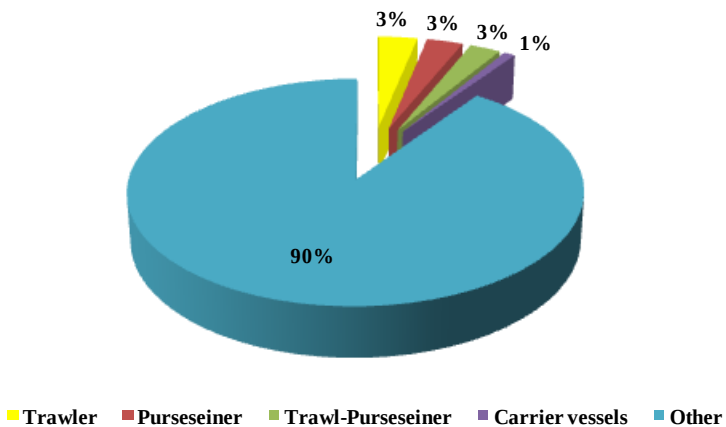
Bottom trawling is the most important fishing method in the catch of demersal fish species with a share of 60%. They have a significant 90% contribution to the Turkish demersal fish production (Tokaç, 2001), and are a cost-effective method with minimal need for manpower (Çelikkale *et al.*, 1993).

Number of trawlers, 403 in 1984, was reported to be 552 in 2009. Fishing vessels in Turkey had been recorded in 4 subgroups until 2001 as trawler, purse seiner, carrier and others. In 2000, number of trawlers reached the top with 750, and in 2001 another group, trawl-purse seiner, was added as those were capable of operating both. This led most of the fishermen to put their boats in this group, thus adding some boats from either group of trawlers and purseseiners to be included in this new one. There were, of course, vessels that were retired. Consequently the number of trawlers dropped in 2001 from 750 to 538. Number of trawl-purse seiners, which were 146 in 2001, reached 431 by the year 2009 (Table 2).

Table 2. Distribution of fishing vessels between 1984 and 2009 years in Turkey

Years	Trawler	Purseseiner	Trawl-Purseineer	Carrier vessels	Other	Total
1984	403	373	*	436	6479	7691
1985	422	611	*	567	7004	8604
1986	269	560	*	496	7336	8661
1987	554	554	*	466	7020	8594
1988	270	426	*	389	7619	8704
1989	441	605	*	239	7203	8488
1990	483	457	*	613	7196	8749
1991	481	426	*	225	7514	8646
1992	532	621	*	253	6390	7796
1993	531	615	*	214	6941	8301
1994	408	544	*	136	7758	8846
1995	359	509	*	140	8702	9710
1996	516	520	*	238	8316	9590
1997	477	533	*	701	8029	9740
1998	501	505	*	88	8929	10023
1999	685	521	*	195	12396	13797
2000	750	575	*	131	11925	13381
2001	538	472	146	172	11661	12989
2002	566	448	416	53	16213	17696
2003	404	408	492	134	17104	18542
2004	433	400	342	306	16472	17953
2005	688	510	443	295	16 460	18396
2006	725	543	394	202	15 959	17823
2007	655	493	423	252	15 858	17681
2008	543	526	469	213	15 410	17161
2009	552	505	431	156	15 201	16845

According to 2010 TUIK records, there is a total of 16845 vessels, a 3% of which is comprised of trawl-purse seines and trawlers (Figure 6).

**Figure 6.** Distribution of fishing vessels by qualities (Anonymous, 2010)

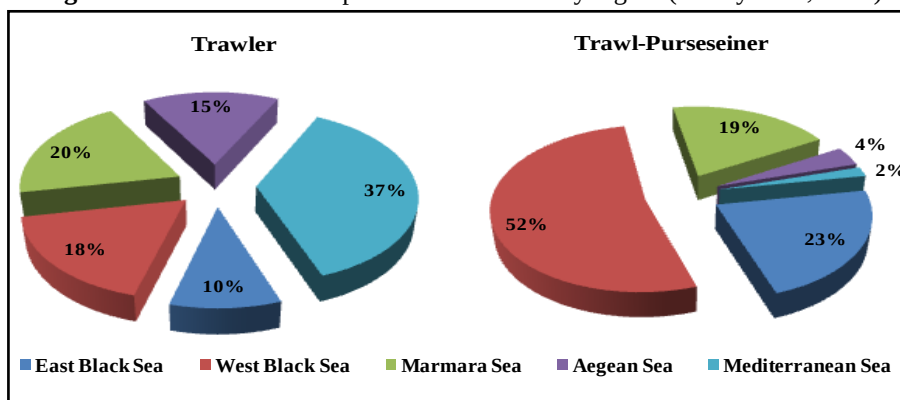
Depending on the size, trawlers can employ 4 to 7 crew, and the number of people working in Turkish fisheries counts 47413 depending on their jobs, where 8% are those who work in trawlers and 9% in trawl-purse seiners. 90% of the vessels are run personally by the fishermen themselves. In Turkey, over 2000 people work in trawlers and between 3500-4000 in the latter generally. The higher percentage in trawl-purse seiners owes to the higher number of the crew working in purse seiners. Majority of the crew consists of people between 20-55 years of age. Over 90% of the trawlers are equipped with a radar, GPS-satellite and radio as seen in Table 3. 42% of these vessels are equipped with sonar devices and 74% with echo-sounders (Anonymous, 2010).

Table 3. Fishing vessels by operating types, radar, sonar, eco-sounder, gps-satellite and rodin set (Anonymous, 2010)

Operating type	Total	Trawler	Purse seiner	Trawler-Purse seiner	Carrier vessels	Other
Total	16845	552	505	431	156	15201
Radar	3684	488	484	394	92	2226
Sonar	2136	248	404	158	28	1298
Eco-sounder	2834	390	411	376	67	1590
Gps-satellite	2459	518	446	397	77	1021
Rodin set	2849	522	481	413	100	1333

When we look at the density of registered trawlers by region, they are distributed as Mediterranean followed by Western Black Sea, Marmara, Aegean and lastly Eastern Black Sea regions. When the numbers of trawl-purse seiners are considered, Western Black Sea region leads with 51% and Mediterranean comes last with 2% (Figure 7). This is because of the fact that trawl-purse seiners in Black Sea are intensively used for both trawl and purse seine operations.

Figure 7. Trawler and trawl-purse seiner vessels by region (Anonymous, 2010)



Legislations pertaining to commercial fisheries in Turkey are regulated in the circular by the Ministry of Agriculture and Rural Affairs. These regulations contain some restrictions for trawl fisheries. Some restrictions are present for the nets and neither are they allowed to operate at random spots and times. These restrictions include strict no-take zones (Figure 8) as well as seasons, distance, and the shape and size of mesh in the codend. All of these restrictions are detailed in the circular and all fishermen have to abide by these regulations, infringement entails monetary and prison sentence. The foremost reason trawling is depreciated in Turkey are the problems caused by those fishermen violating these regulations.

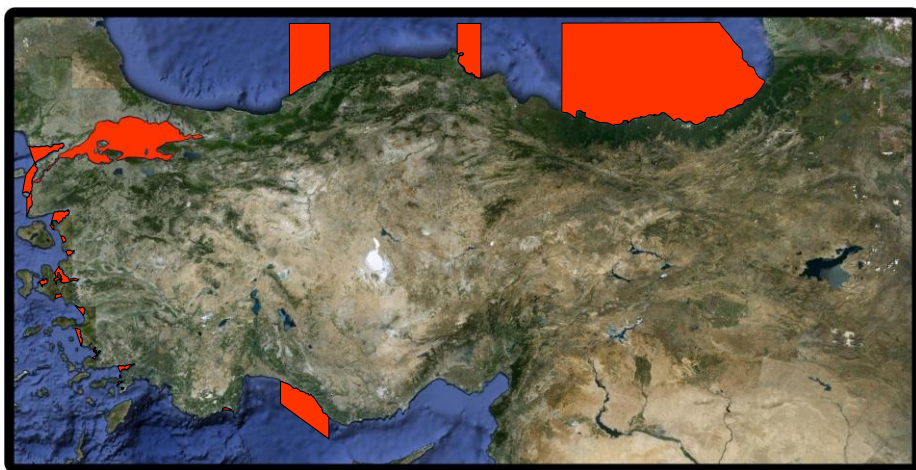


Figure 8. Forbidden area to trawl operation (this illustration has been arranged using by notifying).

There is a seasonal closure for coastal trawling (within 6 miles from the coast) between 15th April and 15th September. However, the boats are allowed in some years with a special permission to work in the international waters (Figure 9) during a portion (15 July to 15 September) of the closed season (Tokaç *et al.*, 2010).



Figure 9. International Waters of Aegean Sea where Turkish trawl fleets are generally operated Wikipedia 2011.Aegean Sea map bathymetry-tr.svg. WikipediaThe Free Encyclopedia<http://tr.wikipedia.org/wiki/Dosya:Aegean_Sea_map_bathymetry-tr.svg>

Many studies are and have been carried on trawling, one of the major fishing operations in Turkey. The goal of these studies is to aid in the development of more efficient trawl nets and to contribute to the sustainability of the fisheries.

Trawls are the second large fishing gears after purse seines in Turkish fisheries and they are among the important gears used to catch both demersal and some scattered pelagic species. They provide significant input for the Turkish fishery economics in terms of total catch size and the variety of species they catch. However, this gear has created a bad public impression due to illegal fishers violating the regulations. It should yet be acknowledged that there are also rules in the traffic, which would lead to bad consequences when not followed. Therefore when used in the right time, area and with proper trawl nets (mesh size, mesh shape etc.), it is evident that trawling will serve both to the economy and the consumer.

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PURSE SEINE FISHERY IN TURKEY

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1. Introduction

Purse seining is the one of the most efficient fishing methods, and by virtue of its efficiency relatively few vessels are required to harvest resources that are suitable for exploitation by purse seine methods (Ben-Yami, 1994). A purse seine (Figure 1) is made of a long wall of netting framed with float line and lead line (usually, of equal or longer length than the former) and having purse rings hanging from the lower edge of the gear, through which runs a purse line made from steel wire or rope which allow the pursing of the net. For most of the situation, it is the most efficient gear for catching large and small pelagic species that are shoaling (FAO, 2010). Generally it is supposed that the typical purse seine, with rings and purse line, is of American origin. It has also been said that the first purse seine was developed in the fjords of Rhode Island in 1826. Others think that a fisherman of Maine invented the purse seine for catching menhaden in 1837 (Gabriel *et al.*, 2005). In any case, most resource agrees that the general use of purse seines for menhaden began after the American Civil War (1861–65) (Schaff 1975). The first purse seine mentioned in Turkey was described by Deveciyan in 1915 (Deveciyan, 2006). He said that in order to catch mackerel, purse seine was invented by Kumkapı fishers before 40 years from 1915. Besides, Çelikkale *et al.* (1999) stressed that surrounding nets were used to start for anchovy fishing after World War I. The nets were 110 fathoms in length and 15 fathoms in depths and were made of natural fibre. The operations were done with manpower and 4-5 tons anchovy can be caught after each haul. However, the nets were easily damaged and repair took a long time. After World War II, natural fibers were replaced with synthetic materials (1960s) and using engine power in fishing boats improved the purse seine efficiency. Turkish purse seine sector has rapidly developed since 1970s through the adoption of technological innovations (Knudsen, 2005). Especially thanks to using power block, the net was hauled quickly with a small crew. Utilizing fish finder, echo sounder and sonar, enlarged the purse seine gear and improved fishing boats capacity (Çelikkale *et al.*, 1999). In 1980s, the government adapted a new policy to develop fisheries, credited building new boats and had a special tax waiver. Consequently, the fishery has been developing (Karakulak and Oray, 2009).

Total amount of fishery products in 2011 was 653,080 tons. 61.2 % (399,656 tons) of this product belonged to sea fish; aquaculture compromised 25.6 % and other sea fishery and freshwater was 7.0 % and 6.2 %, respectively.

Anchovy was the dominant species in total amount of the sea product, with 57.3% (229,023 tons). Sprat was the second species with 14.3 % (57,023 tons) followed by pilchard (6.9 %, 27639 tons), horse mackerel (3.6 %, 14,392 tons), whiting (3.4%, 13,558), Atlantic bonito (2.3 %, 9,401 tons) scads (1.5%, 6055 tons), Blue fish (1.2 %, 4,744) and Grey mullet (0.8 %, 3,199 tons) (Anonymous, 2011). These species except whiting are mostly caught by purse seine. However, due to the lack information in fishery statistics, exact percentages of purse seines could not be estimated. On the other hand, more than 80-90% of sea fish product in total catches was obtained by purse seine (Hoşsucu, 1998, Çelikkale *et al.*, 1999).



Figure 1. Purse seine

2. Kind of Purse Seines

In relation to target species, purse seines have been categorized differently by various authors. Hoşsucu (1998) described six (Anchovy, sardine, tuna, grey mullet, bonito-blue fish, and mackerel), Çelikkale (1993) described five (Anchovy, mackerel, bonito-blue fish, tunas and garfish purse seine) and Mengi (1977) described four (Bonito, mackerel, anchovy and garfish) kinds of purse seines. Furthermore, types of purse seines show differences depending on the region (Karakulak *et al.*, 2002; Tokaç *et al.*, 2007).

Although, all purse seine shapes are almost the same, depending on the target species, there are some differences such as net and mesh sizes. Actually all purse seiners make their own nets. Therefore, net construction can change

even for each vessel. Furthermore, the characteristics of the nets change in itself depending on the size of the boat, deck capacity, engine power. etc. However, most common important feature in all Turkish purse seine is “Şalvar nets” (Figure 2). Şalvar net is attached under the main nets preventing getting mud when the net touches the bottom.

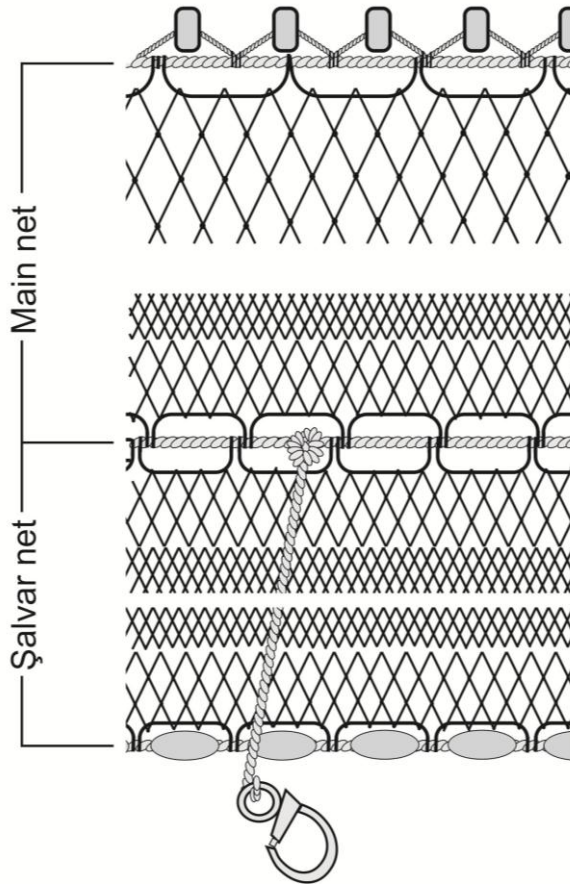


Figure 2. Şalvar net

2.1. Anchovy Purse Seine

The first anchovy purse seine was used after the World War I (Çelikkale *et al.*, 1993). At that time, nets were 110 fathom in length and 15 fathom in depth. The nets size got bigger in time in parallel to technological developments. Today, anchovy purse seine length varies between 400- 1400 m and depths range between 80-160 m according to boat capacity, fishing area and etc. Figure 3 shows the anchovy purse seine used in Istanbul region (Karakulak *et al.*, 2002). According to Figure 1, length of net was 480-720 fathom; depth of net was 60-100 fathom; main nets; 210d/ 6-12 no (6,5-7 mm), wing net;

210d/18 (16 mm), bunt; 210 d/ 18-32 no (6-9 mm), selvedge; main line; PA Ø 24, buoy line; 24-28 mm, buoy; PVC 8-10-15 no, Şalvar nets; 210 d /20-55 (22-50 mm). sinker line; 18-20 mm, sinker; pb 250-500 gr, purse line; stell Ø 20 mm, hook; metal 500 gr, Ø 10-12 no.

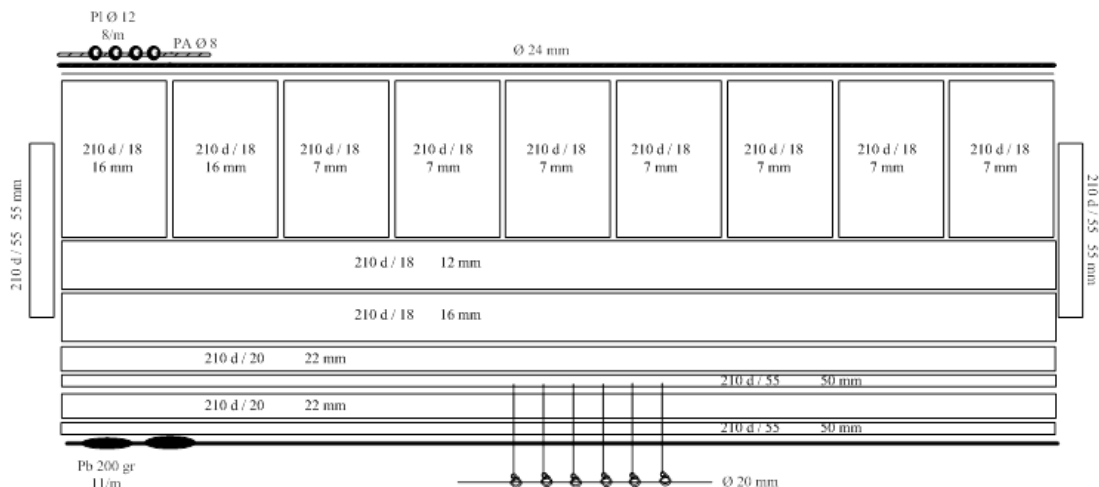


Figure 3. Anchovy purse seine used in İstanbul (redrawn from Karakulak *et al.*, 2002)

2.2. Sardine Purse Seine

Due to the usage for anchovy catch as well, sardine purse seine is also described as anchovy-sardine purse seine by some researchers especially for the Aegean Sea. The main construction of the sardine and anchovy purse seine is similar, only minor differences exist. Figure 4 shows the sardine-anchovy purse seine used in the Aegean Sea (Tokaç *et al.*, 2007). According to fig. 4 length of net is 900m; depth of net is 200 m; main nets are 210d/ 12-21 no (16-36 mm); bunt is 210 d/ 18-27 no (18 mm); selvedge is 210 d/ 75-95 no (36-72 mm); şalvar nets are PP Ø 5 (84 mm); buoy line is Ø 8-24 mm; buoy is Pl 8 no; sinker line is Ø 8 mm; sinker is lead in weight of 200 grams

Figure 4. Sardine-anchovy purse seine used in Güzelbahçe, İzmir (Tokaç *et al.*, 2007)

2.3. Mackerel Purse Seine

Mackerel can be caught by the anchovy-sardine purse seine, however the net construction is different. The main difference is the mesh size of the bunt. The bunt has generally bigger mesh sizes compared to the anchovy-sardine purse seine. Figure 5 shows the net construction of the mackerel purse seine used in the Marmara Sea (Ceyhan, 2005). Length of net was 522 m; depth of net was; 140m; main nets; 210d/ 15-27 no (24-44 mm), wing net; 210d/18 (16 mm), bunt; 210d/ 15-36 no (24 mm), selvedge; 210 d/ 90 no (44 mm), main line; PA Ø 24, buoy line; 24-28 mm, buoy; PVC 10-12 no, şalvar nets, 210 d /90 no (44 mm), sinker line; 8 mm, sinker; pb 200 gr, purse line; steel Ø 16 mm.

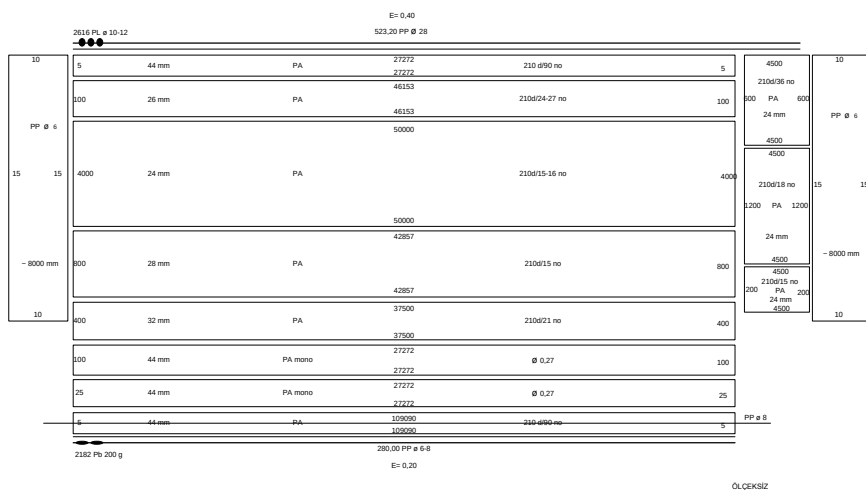


Figure 5. Horse mackerel purse seine used in Marmara (Ceyhan, 2005).

2.4. Bonito-Blue Fish Purse Seine

Bonito and blue fish have high economical value. They migrate from the Aegean Sea to the Black sea for spawning in spring and return back from the Black sea to the Aegean Sea in autumn. During migration, they are caught with different fishing techniques such as hand line, trammel nets and dalian. However, this species is mostly caught with purse seine. It is reported that the significant part of the bonitos fishery (84,6 %) is carried out by purse seining (Zengin *et al.*, 2005). Like in horse mackerel purse seiner, bonitos-blue fish purse seiners also caught anchovy. The main construction of the bonito-blue fish purse seine is similar to anchovy purse seine. However, length and depth of the nets are bigger than the anchovy purse seine. Length and depth of the bonito-blue fish purse seines can reach up to 700 and 90 fathoms, respectively.

2.5. Garfish Purse Seine

Garfish purse seine is being using for catching garfish and mullet especially when they approach the coast (Çelikkale *et al.*, 1993). This purse seine is the smallest one compared to the others. It can be picked up with manpower. The rigged is the same as the former. The only difference is the location of the bunt. While the bunt is placed on the corner of the nets for all others operated with one boat, it is located in the middle of nets in the garfish purse seine (Figure 6). According to figure 6, length of the garfish purse seine was 200-250 m; depth of net was; 25-30 m, main nets; 210d/ 4 no (10.5 mm), bunt; 210d/ 4-6-8 (6.5 mm), selvedge; 210 d/ 90 no (44 mm) buoy line; PP Ø 12mm, buoy; PVC 6 no, sinker line; PP Ø 8 mm, sinker; pb 250-300gr, purse line; PP Ø 16 mm (Çelikkale *et al.*, 1993).

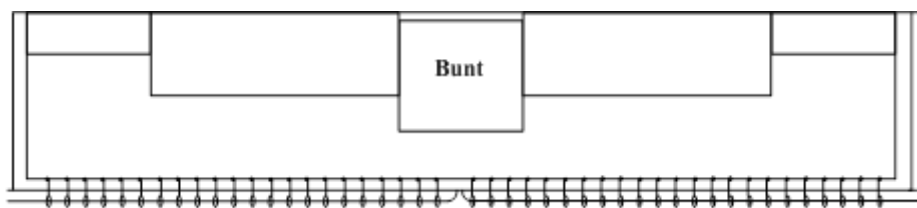


Figure 6. Schematic view of the garfish purse seine (Redrawn from Çelikkale *et al.*, 1993).

2.6. Tuna Purse Seine

Until 1950, blue fin tunas were caught mostly by traps (dalian), hand-line and spears. In 1950s tuna fishing by purse seiners began in Turkish waters (Iyigüngör, 1957). Particularly since mid 1980's, the high prices for the blue fin tuna in the Japanese market draw a lot of attention of the Turkish fishing industry to blue fin tuna (Mert *et al.*, 2000). The rapid development of the bluefin tuna fishery for export to the lucrative Japanese fresh market caused an increase in the size and engine power of the purse-seining boats, as well as enhanced development of their fishing nets. Echo sounder, sonar devices and most recently the sea bird radars are now commonly used by tuna purse-seiners. (Karakulak, 2004).

The tuna purse seiners also target anchovies. During the open fishing season they catch anchovy, sardine and others. When the season closes, they change nets, then travel to the southern part of Turkey to catch schooling tunas for mainly fish farming. In the notification, tuna purse seine shall be more than 90 fathoms and mesh size in the bunt shall be no less than 44 mm (Anonymous, 2008). The tuna purse seines are much bigger than all other purse seines (Figure 7). According to fig 7, length of the net is 1465 m, depth of net was; 200 m, main nets; 210d/ 36-90 no (25-42 mm), bunt; 210d/ 90-120 no (22-24 mm),

selvedge; 210 d/ 90 no (25-28 mm), şalvar nets 210 d/ 36-90 no (42 mm), buoy line; PP Ø 8 mm, buoy; Pl 8 no, sinker line; PP Ø 8 mm, sinker; pb 250 gr, purse line; PP Ø 16 mm (Hoşsucu *et al.*, 2001).

2.7. All Purpose Purse Seine Net

In addition to purse seines for specific species, fishers began to design a new kind of purse seine called “canavar ağ” in Marmara and “voli” in the Aegean sea owing to decreased pelagic fish populations. All purpose purse seine net has thicker material than all others and they can be easily used in current (Karakulak *et al.*, 2002). Anchovy, sardine mackerel, bonito, mullet, blue fish can be caught. Figure 8 shows the all purpose purse seine named “voli purse seine” used in Güzelbahçe, İzmir region (Tokaç *et al.*, 2007). According to fig 7, length of net is; 500m, depth of net is; 70 m, main nets; 210d/ 6-24-21 no (14-36 mm), bunt; 210d/ 12 no (14 mm), selvedge; 210 d/ 54 no (44 mm), şalvar nets 210 d/ 65 no (44 mm), buoy line; PP Ø 8 mm, buoy; Pl 8 no, sinker line; PP Ø 8 mm, sinker; pb 200 gr.

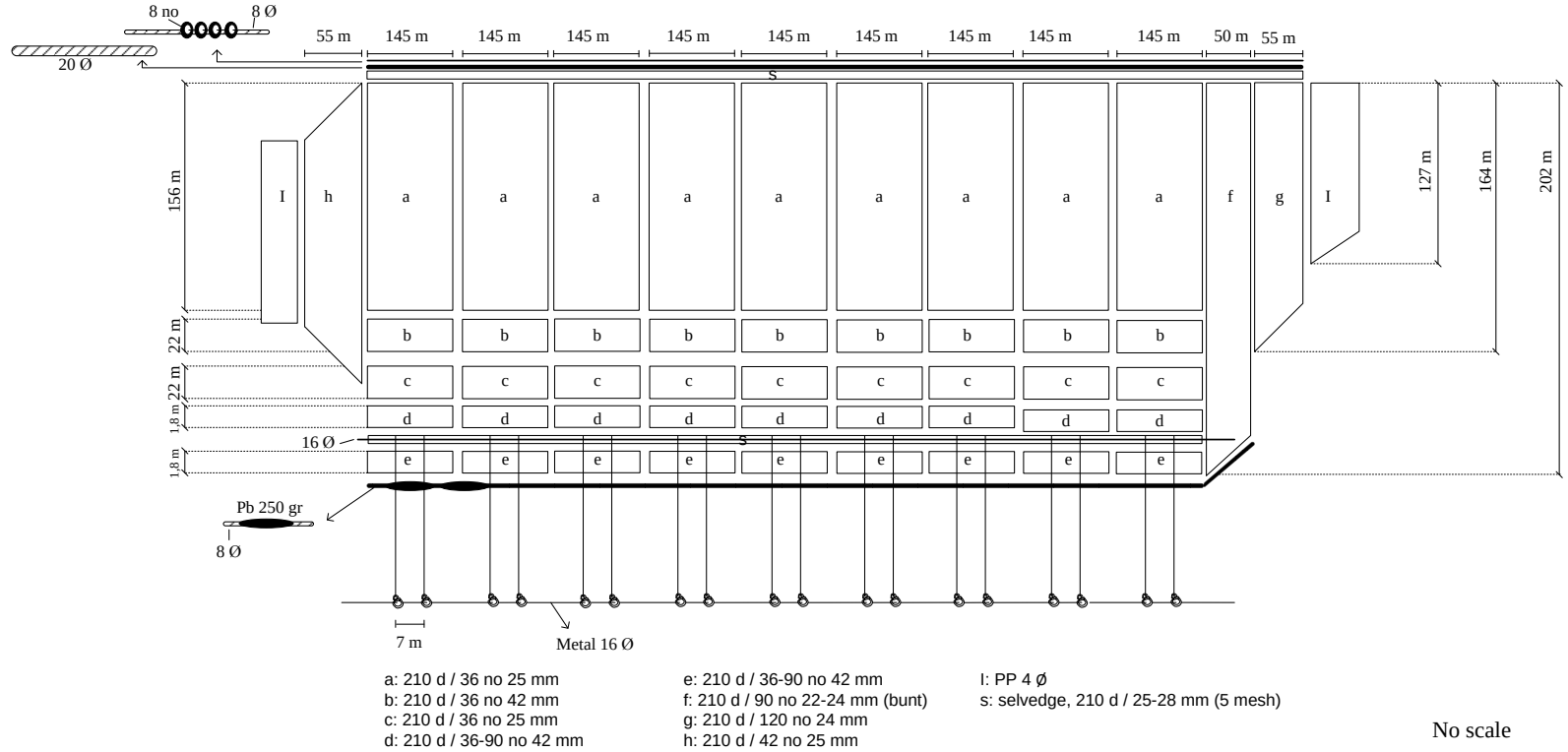


Figure 7. Tuna purse seine (redrawn from Hoşsucu *et al.*, 2001).

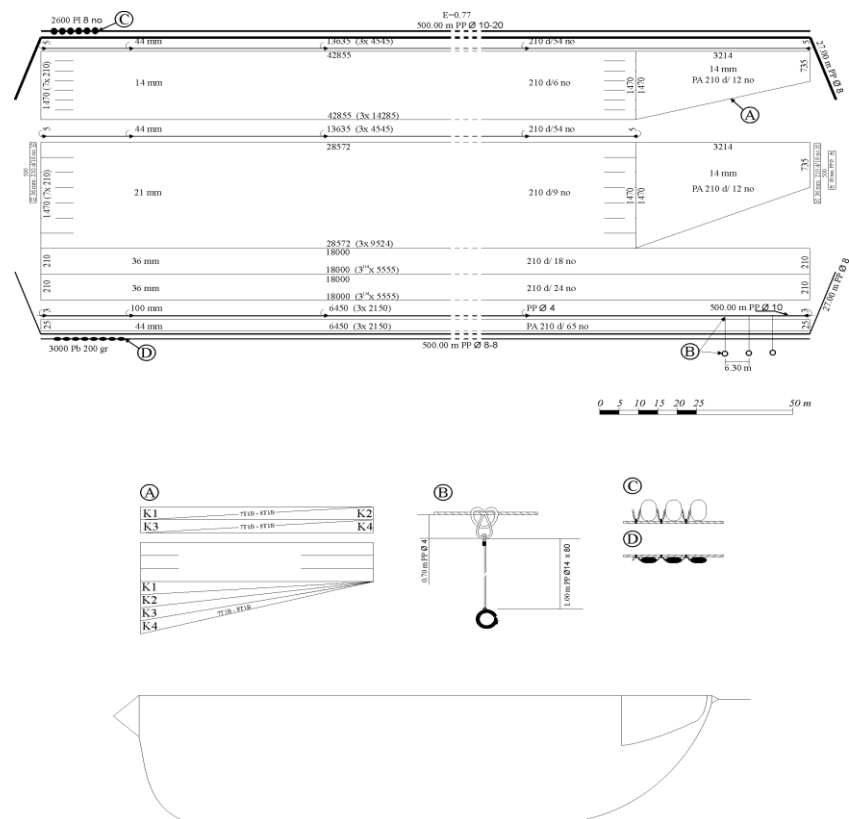


Figure 8. All purpose purse seine used in Güzelbahçe, İzmir (Tokaç *et al.*, 2007)

3. Fishing Operation

Fishing operations are carried out exclusively during the night. Besides, day time operation can be performed. Light is used for fish attractions in night operations. Hydro acoustic instruments, like sonar and echo sounders are used to detect school of fish in both day and night operations. Some purse seiners use more than one sonar and echo sounder to determine different fish species (Karakulak *et al.* 2002). The basic equipment of purse seine fishery include in general a hydraulic power block, a powerful purse seine winch, a number of derricks, including a brailer or a fish pump, and small winches, an auxiliary boat "skiff".

Purse seine is operated with one or two boats. One boat has been preferred since many years due to economical advantages. The basic differences of one or two boats operated purse seine nets is the location of the bunt. While in the one boat operation the bunt is in the middle of the net, in the two boat operation it is on the left or right side of the nets.

4. Some Statistics for Purse Seines

There were a total of 16650 fishing vessels in 2010 (Anonymous, 2011). Numbers of purse seiners and trawl-purse seiners were 485 and 337, respectively (table 1). Usage of generator, deep freeze, ice machine, radar, sonar, echo sounder, GPS satellite and rosin set distributions of purse seiner and trawl-purse seiner vessels are given in table 2 (Anonymous, 2011).

There were a total of 46361 fishers in Turkish fishery. Purse seiners and trawler-purse seiners comprised 9163 and 3513 fishers, respectively. Seven thousand six hundred fifty nine and 3004 fishers work full time in purse seiners and trawler -purse seiners, respectively. Each purse-seine vessel occupies 8-40 people depending on the vessel and gear size. Most crew work per diem compromising a percentage of the daily profit (Anonymous, 2011).

Table 1.Qualities of fishing vessels in 2010 by sea products region (Anonymous, 2011).

	Total	E.Black Sea	W. Black Sea	Marmara	Aegean	Mediterranean
Operating type	16650	3388	2549	3028	5533	2152
Purse seiner	485	104	64	184	81	52
Trawler-Purse seiner	337	58	183	66	19	11
Trawler	669	154	126	87	84	218
Carrier vessels	130	73	7	9	41	0
Others	15029	2999	2169	2682	5308	1871

Table 2. Purse seiner and trawl- purse seiner vessels by usage of generator, deep freeze, ice machine, radar, sonar, eco sounder, GPS satellite and rodin set in 2007 (Anonymous, 2011).

Number of fishing vessels with	Purse seiner (Total: 485)	Trawler-Purse seiner (Total: 337)
Generator	283	163
Deep freeze	257	159
Ice machine	221	77
Radar	460	318
Sonar	365	151
Eco-sounder	411	299
GPS satellite	424	297
Rodin set	450	327

4. Purse Seine Regulations

Turkish fishery is managed by Turkish Fishery Regulations (TFR). According to TFR harvesting of fisheries by purse seines is prohibited in all seas during the term 15th April – 31st August. Use of purse seines with a depth of more than 90 fathoms, except the purse seines used in tuna fishing, shall be prohibited. In all territorial waters purse seining is prohibited in waters shallower than 10 fathom (18 m). However, purse seining in waters up to 6 fathom deep (11 m) is permitted in the territorial waters in the Black Sea between Köpekaya Cape in Cide District of Kastamonu Province and Bulgarian border, and in the Marmara Sea during 1st September– 1st December. In the Mediterranean, purse seining in waters up to 6 fathom deep (11 m) is permitted in the territorial waters between the mouth of Seyhan River and Susanoğlu-Atakent (Anonymous, 2008).

Use of lighting power up to 100 watts is not allowed to the permission in purse seine fishery. Total lighting power of the main boat, accompanying boats and carrier boats shall not exceed 8000 Watts, in the areas where light fishing is permitted. Enlightening shall only take place above the water in light fishing. It is compulsory to appoint a staff in lighting boats and a minimum 200 m distance shall remain between the lighting boats of two different teams. In addition to general regulations, there are some further legislations for given species such as anchovy, horse mackerel, tunas (Anonymous, 2007).

Purse seine vessels for fishing anchovy must obtain “Fishing license” from the provincial offices where they are registered. Anchovy fishing of purse seine vessels can be done only between 16.00-08.00. Purse seine nets cannot be kept in the sea in other times for anchovy fishing. Tuna fishing by purse seine between 16 July-15 August is prohibited throughout all our territorial waters.. However, in case the catch quota allocated for our country by the International

Commission for the conservation of Atlantic Tunas (ICCAT) has been fulfilled, the Ministry has the authority to extend periods of the ban. It is mandatory for tuna fishing vessels to obtain "Fishing Permit for Tuna", the form and content of which is determined by the Ministry, it is compulsory for the vessels which fish for and carry bluefin tuna Vessel Monitoring System (VMS) those fish for bluefin tuna must keep phone and fax machine on board operating. Each vessel with a "Tuna Landing Permit" shall be liable to keep records demanded by the Ministry about the tuna amounts it has caught and sold, and to comply with the regulations made in this respect. Certificate of Origin for Fisheries" and "Health Certificate" shall not be issued for the amounts caught in fishing season. These said amounts shall be released if alive and shall be seized if dead. Catching of tuna weighing less than 8 kg is prohibited.

Little tunny, Plain bonito, Leer fish, Greater Amberjack and Albacore: Fishing little tunny, albacore, plain bonito, leer fish and greater amberjack by entangling net is permitted during the season throughout our territorial waters and by purse seine from 15 April to 15 May in the territorial waters between Mihli creek (39° 33,209' N- 26° 39,472' E) and Syrian border.

It is mandatory for the purse seiners who will benefit from this exception to obtain "Fishing Permit" from the provincial directorates issuing vessel's license, to land the catches on the points specified in the points to be determined by the Ministry and to obtain the arranged "Certificate of Origin" as well.

5. Conclusion

Purse seine is one of the most important fishing techniques for Turkey. Depending on the boat size, there are restrictions for landing of the anchovy, sardine and mackerel. The boat which has length over all 15 <, 15-19.99, 20-24.99, 25-29.99, 30-34.99, 35-39.99, 40-44.99, 45-49.99 and 50m > have to land boxes of 250, 300, 500, 600, 700, 750, 800, 850 and 900, respectively (one box not to exceed 12 kg ($\pm 10\%$)) (Kürüm, 2010). This is not sufficient enough for management of the fishery. Because stock sizes of important commercial species are unknown. Therefore, it is urgent to investigate the size and structure of not only pelagic but also demersal populations.

The current statistical systems do not give exact percentages of the purse seine and other fishing techniques. This suffers from unrealistic catch estimates, obtaining retained catches. For this reason there is a need to establish a structure which allows for regular recording of the amount of landed catch by the local units, and for monitoring of biological data of important stocks for specific periods.

Due to structure, purse seine can catch not only the pelagic but also demersal species. There are a number of scientific works concentrated on structure, catch and effort of purse seine. However, no available information is present about impacts on the environment, by catch and selectivity. Future studies should focus on the amalgamation of fishers' and scientists' knowledge.

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GILL NETS AND TRAMMEL NETS USED IN TURKISH FISHERIES

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1. Introduction

In 2000, use of beach and boat seining was prohibited for all Turkish waters partially (except Marmara Sea). Ever since artisanal fishermen have been using stationary fishing gears such as gillnets and trammel nets instead of seines. Those of which are one and three oblong sheet of netting respectively, hanging on a rope along their upper and lower part. Upper parts have floats named float line, and lower parts have sinkers named leadline (Figure 1). Floats are made up of plastic material generally. In addition, EPS (polistren) material is also used for float production, but these floats have less usage than plastic ones for gill and trammel netting. Sinkers for lead line are made up of lead (Pb) and polypropilen (PP) material is used for construction of line ropes. The diameters of ropes vary between 2.5 – 7 mm depending to their usage aim.

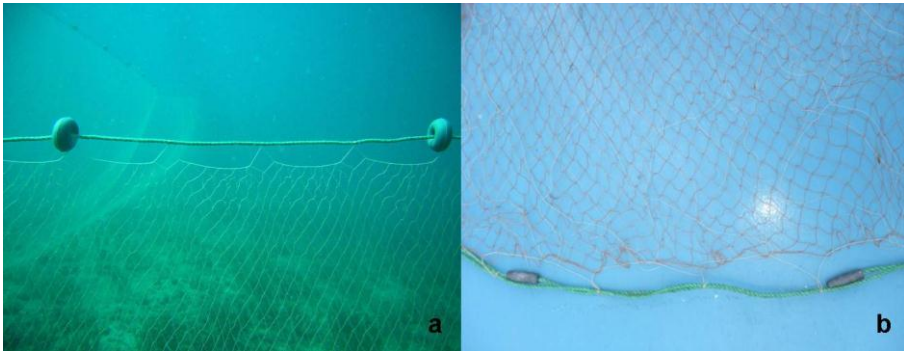


Figure 1. Float line (a); lead line (b)

Lots of marine species which have highly economical values such as prawns, red mullets, and squid are the major targets for these fishing gears. Although they have been produced to target species, some of these could be the prey of both gillnets and trammel nets. Generalized characteristics of some gill and trammel nets were tried to explained in this study which used in Turkish coasts.

2.1. Gillnets

Gill nets have widely usage all around the Turkish coasts. Gillnets that are used in Turkish waters, made up of both multifilament and monofilament twines (usage of monofilament twine will be prohibited in September 2011). Their technical details change belonging to the species and region. The mesh sizes of them vary between 24mm to 240mm in Aegean Sea small scale fisheries (Metin *et al.*,1998). Depending to their target species, the depths range 35 to 600 meshes. Hanging ratios are generally closer to 0 (0.35-0.45) for species which have round body shape such as mullets, bogue, pickarel, mackerel. It causes more loosely structure to entagled fishes easily to nets. In addition 0.5 and 0.60 are used in some regions too.

According to these, the most common types of them are for red mullets (*Mullus spp.*), sardine (*Sardina pilchardus*), bogue (*Boops boops*), blotched picarel (*Spicara flexuosa*), mackerel, horse mackerel (*Scomber spp.*), hake (*Merluccius merluccius*), whiting (*Merlangius merlangus euxinus*), sharks (*Mustelus spp.*, *Scyliorhinus spp.*, *Raja spp.*), Bluefish (*Pomatomus saltator*) and Bluespotted seabream (*Pagrus caeruleostictus*). Some of the most important propoities of these fishing gears are as follows:

Lengths of the gill nets for red mullets are ranges between 80-100 m (one unit) depend to their hanging ratios which are between 0.4-0.5. Even though depths are generally fixed to 33-35 meshes, it ranges between 50-70 meshes too. Stretched mesh sizes range from 36 to 44 mm. The diameters of twines are ranged 210d/1-2 no (Figure 2). If *M. surmuletus* is targeted, the nets are set into rocky bottoms and “apoşı” (Ayдын *et al.*, 2009) areas where the sandy and muddy sea floors join with rocky and grassy zone (*Posidonia oceanica*, *Zostera spp.*) between 3 and 40 m depth. When *M. barbatus* is targeted, nets are used in sandy and muddy grounds at 10-60 m depth. The soak time of the nets are generally 2-3 hours at dawn or/and dusk. The usage period of these gears are all months except December to February.

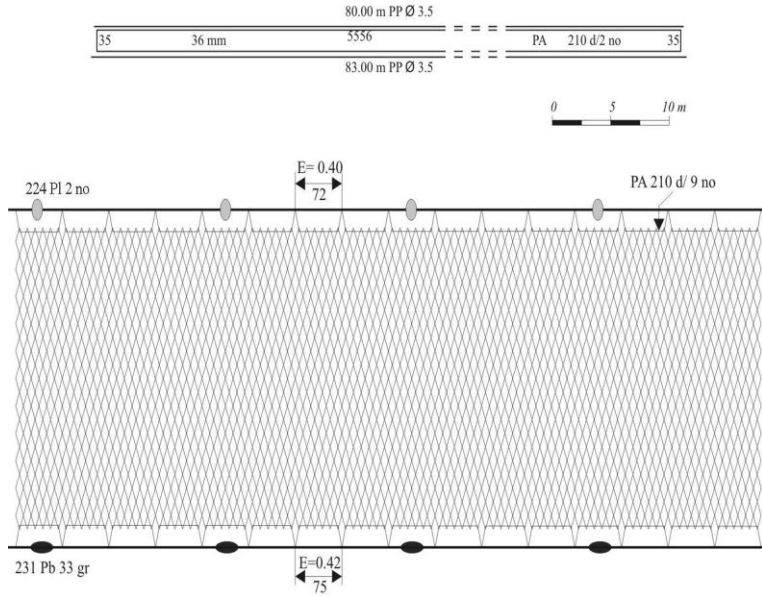


Figure 2. Technical plan and details of a red mullet gill net

Gillnets for sardine (*Sardina pilchardus*) are 80 to 120 m (one unit) long (Figure 3). Hanging ratios are varied between 0,4-0.66 and have 400 (100*4) - 1040 (520*2) meshes in depth. Stretched mesh sizes of those of which range from 25 - 25.5 mm and the diameter of twines range 210d/4-6 no. The operation time starts at midnight after detecting the sardine school with aqstic equipments in vessel, nets are set to pelagic and after 1-2 soaking time the nets are pull to vessel by hydraulic crane. The fishing period is from May to September when the purse seine season is closed for Turkish coasts. Although for providing fusiform fishes to bait longlines, 34-36 mm stretched mesh sized gill nets that have 240 meshes in depth used as sardine gill nets in southern coasts of Turkey too (Ceyhan and Akyol, 2005).

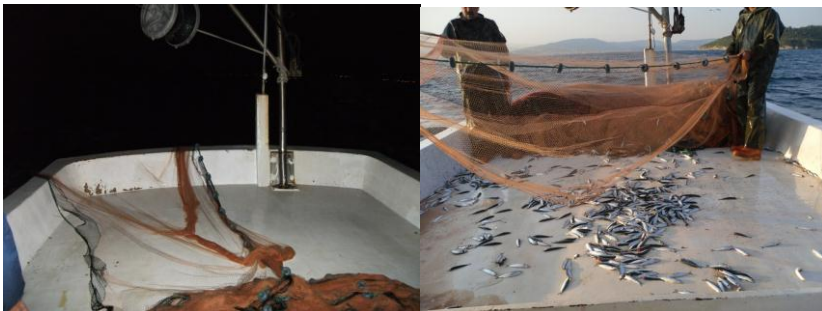


Figure 3. A view of sardine gillnet fishery operation in Turkish coasts

Bogue and picarel are one of the important by-catch species for lots of gillnets and also trammel nets. However some specialized gillnets are used for those of which too. Generally gillnets have hanging 0.5 ratio, that is 100 m (one unit) long have 100-200 meshes in depth. The stretched mesh sizes of them range 36-44 mm and diameter of twine is 210d/3 no. The fishing period of them is between April and November. Preferably seagrass meadows (Figure 4) or/and sandy bottoms are used for operation and soaking time is limited 2-3 hours in dawn and dusk.



Figure 4. Gillnets for bogue on seagrass meadows

Gill nets for mackerel and horse mackerel are usually have 0.5 hanging ratio and 100 m length (one unit). Stretched mesh size is ranged 46-50 mm and they have 120-240 meshes in depth. The diameter of twine is 210d/4 no. Pelagic depths of the water column are used for netting, where located on seagrass meadows and sandy bottoms. The operations start in dusk and after an 8-9 hours soaking time, end just before the sunrise. Especially the closed purse seine season is preferable for gill net fishery of these high valued species when is between May and September.

Although hake and whiting are some of the major species of demersal trawl fishery, some specialized gillnets are used for catching those of which too. Gill nets for hake and whiting have 0.45-0.5 hanging ratio and generally 90-100 m (one unit) long. Stretched mesh sizes are 46-50 mm for whiting, 50-60 mm for hake and diameter of twines are 210d/3 no. Depth of the nets are varied 80 to 120 meshes and mostly used on muddy bottoms where are in 50 – 130 m. Gill nets are set to water in dusk and after a 10-12 hours soaking time, operation ends with dawn. The trawl fishery season is forbidden between May and September for Turkish coasts. However the international area is opened in the middle of the July. Not only because of there isn't any trawl product in this

season, but also having high economical value, hake gillnets also preferable and have an intensive usage between May to July.

Gill nets for some shark species is also present in Turkish coasts. According to 0.5 hanging ratio one unit of the net is approximately 100 m long. Stretched mesh sizes are varied between 140 to 240 mm and they have 18 to 25 meshes in depth. The diameters of twines are 210d/12-21 no. These nets are set to muddy and sandy bottom areas between May – August before dusk and after dawn the operation is finished.

Bluefish (Figure 5) is also one of the important species that is mentioned previously with Marmara Sea. Gill nets for those of which are hanged 0.66 ratios, approximately 120-130 m (one unit) long with 100 meshes in depth and stretched mesh sizes are 64 mm. In addition some gill nets for bluefish have more than one piece in depth. 48 and 64 mm stretched mesh sized gill nets have 300 (100*3) and 600 (120*5) meshes in depth, these are hanged with 0.5 and 0.66 ratios respectively. The diameters of twines are 210d/4-6 no. May-June and September-November periods are the intensive usage time of them for targeting the migrations through Marmara Sea and Dardanelles.



Figure 5. Bluefishes in the basket after the fishing operations (Photo: C. PELİSTER)

Bluespotted seabream (*P. caeruleostictus*) is also one of the important species for gillnet fishery in Mediterranean and Aegean coasts of Turkey.

2.2. Trammel nets

Trammel nets are made up of three rectangular sheets of netting in parallel order, that hang jointly on a single float line and lead line along their upper and lower part respectively (Adamidou, 2007). The sheets that in the middle have smaller mesh sizes than other two rectangular ones. Also heights of the outer sheets are longer than inner parts, according as to build more loosely structure. These loosely situations cause to create small cubbies when the preys try to pass through the net.

Mesh sizes of inner parts are varied between 36mm to 240mm in Aegean Sea small scale fisheries (Altınağaç *et al.*, 2008). Depending to their target species, the depths range 35 to 600 meshes. Although the 0.5 hanging ratios are used for most of them, 0.4-0.6 are suitable for some types.

Trammel nets are generally specialized for target species. However, lots of commercial ones are also caught near target ones which called by-catch species. The most common trammel net types are for prawns, squid (*Loligo vulgaris*) common sole (*Solea solea*), red mullets (*Mullus spp.*) and members of sparidae family (*Sparus aurata*, *Diplodus spp.*, *Dentex spp.*, *Pagellus erythrinus*, *Pagrus pagrus*, *Lithognatus mormyrus*), lobsters (*Hommarus gammarus*, *Palinurus elephas*, *Scyllarus spp.* *Scyllarides latus*). The most important properties of the trammel nets used for these species are as follows:

Prawns are mostly high-economic valued species and generally in the first place in fish markets. From İskenderun Bay, where is the eastern area of south coasts of Turkey, fishermen exploit them up to middle coasts of east Aegean Sea. Not only being a closer location to Suez Canal, but also offloaded ballast water of the commercial vessels in ports are caused to entrance for lots of exotic prawns. As a result nine species of alien penaeid prawns occur in the Levant Basin, eastern Mediterranean, all of them known from the Turkish coast: *Marsupenaeus japonicus* (Bate, 1888), *Metapenaeus monoceros* (Fabricius, 1798), *Penaeus semisulcatus* de Haan, 1844, *Melicertus hathor* (Burkenroad, 1959), *Metapenaeopsis aegyptia* Galil, 1990, *Metapenaeopsis moigensis consobrina* (Nobili, 1904), *Metapenaeus stebbingi* (Nobili, 1904), *Trachysalambria palaestinensis* (Steinitz, 1932) and *Fenneropenaeus merguiensis* (De Man, 1888) (Galil, 2008a,b). Aydın *et al.* (2009) reported large *Metapenaeus affinis* catches in Middle East coasts of Aegean Sea with trammel nets, which are highly commercial. In addition, Bayhan and Gökçe (2010), introduced also six species are commercially exploited with trammel nets (*Melicertus kerathurus*, *M. hathor*, *M. monoceros*, *M. stebbingi*, *M. japonicus*, *P. semisulcatus*) in Turkish coasts. The details of a duplex prawn trammel net (two nets hanged each other with a rope) are given in Figure 6.

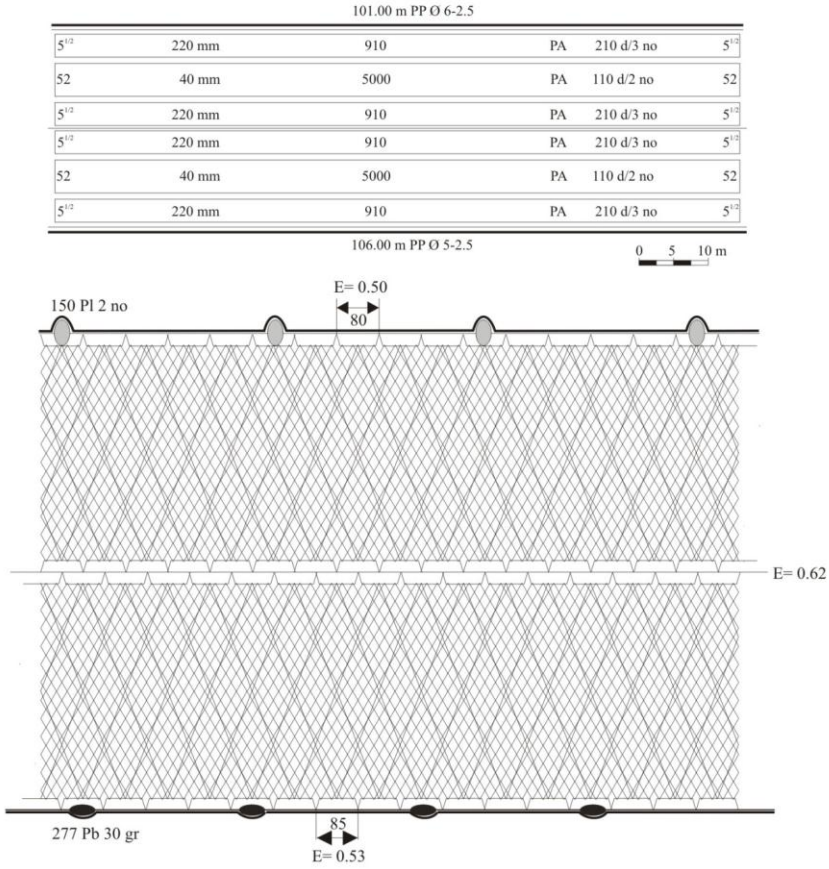


Figure 6. Technical plan and detail of a duplex prawn trammel net (Gökçe *et al.*, 2007)

Not only duplex, but also single nets are used in some regions too (Özyurt *et al.*, 2009). Stretched mesh sizes of inner layers range between 40-48 mm, 50 meshes in depth and diameter of twine is 110d/2 no, outer layers are 200-250 mm, 5 meshes in depth and diameter of twine is 210d/4 no. The nets are set into muddy ground in dusk. Approximately after 8-9 hours, nets are lift to boat before dawn. Effective fishing periods are between March-June and September-November in eastern coasts, May-October in Aegean Sea. Also Aydın *et al.*, (2011) mentioned, the dark nights (no moon) are more efficient for *M. kerathurus* catches. In addition after the prohibition of both beach and boat seines in Turkish coasts, fishermen started to use old prawn trammel nets for squid fishery (*L. vulgaris*) too (Figure 7). Nets are set into sandy-muddy bottom at dawn. After 7-8 hours, nets are lifted to boat at noon. The effective fishing period is between October-January.



Figure 7. Fishermen try to disentangle the common squid from trammelnet.

The trammel nets for common sole are usually hanged with 0.5 or 0.66 ratio and 100 m long. The inner sheets are generally 33-40 meshes in depth, stretched mesh sizes are ranged 72-84 mm and diameter of twines are 210d/3-6 no. The outer sheets have 5 meshes in depth, varied 280-320 mm diameter of twines are 210d/6-9 no, depending to mesh sizes of inner sheet. The soaking time for sole net is approximately 1-2 day.

The trammel nets for red mullet have 0.5 hanging ratio and 50 meshes in depth for inner layer. Stretched mesh sizes of these layers are range between 36–48 mm made up of 210d/2 no netting twine. Mesh sizes of outer layers vary 240-280 mm and have 6-6.5 meshes in depth. 210d/6 no twines are use for these outer layers. Not only red mullets, but also cuttlefish (*Sepia officinalis*) individuals are one of the abundant species for these nets too. Trammel net fishery for red mullets is between March-November, however, because of including cuttlefishes in catch composition, the usage period of these trammel nets is all year.

Trammel nets for sparidae fishes have a large variation depending to their target species. Trammel nets for *L. mormyrus*, *D. vulgaris*, and *Sarpa salpa* is called “marya nets” in Aegean coasts of Turkish waters. Inner layer of these nets made up of 210d/3 no twine which is 100 meshes in depth. 50-84 mm stretched mesh sizes are changed region to region, but 56-60 and 64 mm have more usage. Outer layers have 13-14 meshes in depth and stretched mesh sizes are ranged 260-320 mm. They have usage in all year depending to target

species. Similar trammel nets are also used in Turkish coasts especially for *S. aurata*, *Diplodus spp.*, *P. erythrinus*, *P. pagrus*, *Dentex spp.* too. Inner layer of them have generally 100 meshes in depth and 64 – 68 mm stretched mesh size made up of 0.20 mm monofilament twine. Outer layers have 20 meshes in depth and, 280 mm mesh size made up of 210d/4 no twine thickness. Hanging ratio is fixed to 0.50 in general. These are set to rocky grounds or closer to shore and after several minutes they pick up to boat. While this short period the fishermen who are in the boat hit the water surface with a cone. Wagging a piece of chain or hitting to deck with a stick is also some other methods. These frighten actions causes to scare fish schools. Frighten fishes try to escape quickly from this encircled area; however they are caught by loosely trammel nets. This method is called “voli” in Turkish.

Stretched mesh sizes of trammel nets for *Dentex spp.* vary between 40-42 mm which is made up of 210d/6 no twine for inner part. Approximately have 25 meshes in depth. Outer layers have 5.5 meshes in depth and 140 mm stretched mesh sizes which made up of 210d/9 no twine thickness. Hanging ratios are fixed to 0.66 in general.

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BLUEFISH (*Pomatomus saltatrix* Linnaeus, 1766) FISHERY

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1. Introduction

Bluefish, *Pomatomus saltatrix*, is a migratory pelagic predatory species that is globally distributed on continental shelves and estuaries in temperate waters with the exception of the northern and mid-Pacific Ocean (Briggs 1960, Wilk 1977, Juanes *et al.*, 1996). Directed fisheries for the species have developed over its entire range, but in many cases basic biological information is lacking (Juanes *et al.* 1996) which likely affects the effectiveness of fisheries management regulations. This lack of information is especially critical along the Turkish coast in the eastern Mediterranean, the Sea of Marmara, and the Black Sea, where historically important fisheries exist (Ivanov and Beverton 1985, Kocatas *et al.*, 1993).

The bluefish is a moderately long and flatted from lateral proportioned fish, with a forked tail. The spiny first dorsal fin is normally folded back in a groove, as are its pectoral fins. Coloration is a grayish blue-green dorsally, fading to white on the lower sides and belly. Bluefish has scales and upper chain of its is shorter than under chain (Slattenenko 1955,56). There are one row, strong, sharp and spaced out, inequal teeth on the chains. There are small teeth between them. There are a second teeth series behing the first series in upper chain. In addition, there are vomer and palantine teeth. Front of the tonque is flat, backside of tonque has teeth (Türkan 1959). This kind of mouth is rather important, because bluefish feed on other fish (Figueiredo *et al.*, 2002), crustaceans and cephalopods (Maigret and Ly 1986). In addition, bluefish is a prey of shark, tuna and swordfish. The juveniles are also prey of marine birds (Fahay *et al.*, 1999). Bluefish live 12 years and they reach 100 cm in size and 14 kg in weight (Anonymous 1993). Three morphological differentiated groups of *P. saltatrix* determined by (Turan *et al.*, 2006).

Total annual bluefish catch in Turkey was 25,000 metric tons in 2002 (DIE 2004). The maximal amount in the world was recorded as 60,000 tons in 1983, and declined to about 50,000 tons in 2002 (FAO 2000). The figure 1 indicated that the Turkish bluefish fishery reached approximately to the half of the world annual yield. But huge quantities are traditionally obtained from young individuals of the bluefish, and there is a likely heavy fishing pressure on bluefish.

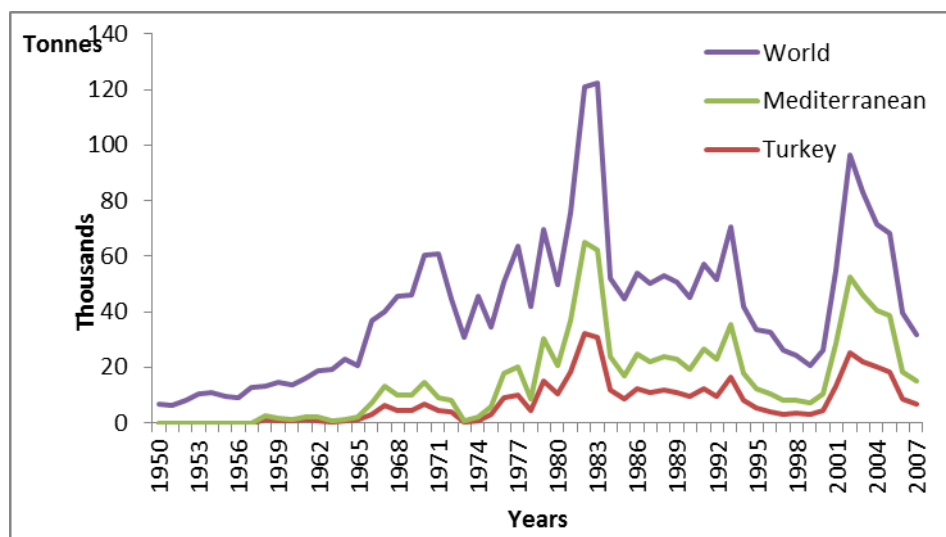


Figure 1. Total catch amount of swordfish between 1950 and 2007 (FAO 2000)

2. Fishing Grounds, Gears and Seasons

Bluefish are found all along the Turkish coast; migrating via the Aegean Sea northwards from the Mediterranean in spring and returning south in early autumn. They are the target of an important artisanal fishery, which includes handlines, encircling nets, and gillnets in all Turkish seas, otter trawlers in the Black Sea, and purse-seiners in the Sea of Marmara. Üner (1961) notified that the bluefish have been caught by encircling nets, bottom set nets, trap net, purse-seines and various types of handlines in the İstanbul Strait since late 1950's.

2.1. Purse Seine

There are many purse seine vessels in the Black sea and Marmara sea for bluefish fishery. The length of vessels are between 18-38 m and engine power of these vessels vary between 250-1800 HP. The bluefish has been caught mostly in western Black Sea between September and December by purse seines. Furthermore, the special purse seines called as “monster nets” has been used in Marmara Sea to catch bluefish and horse mackerel during the fishing season (Figure 2). Length of purse seine net which are used in bluefish fishing is about 522 m and its depth is 140 m high while the gear is stretched. Twine thickness of bunt is 210d/15-36 and mesh size of the net used in bunt is 24 mm.

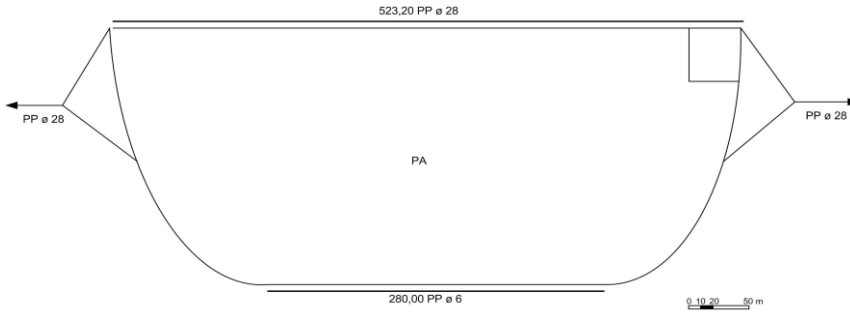


Figure 2. Purse seine using for cathcing bluefish

2.2. Trammel and Encircling Nets

Trammel nets are, especially used densely in the Marmara Sea. Trammel nets are contained 210d/4 no thickness for fine-meshed net which have 64 mm mesh size, and 210d/9 no thickness for wide-meshed net which have 280 mm mesh size (Figure 3). The hanging ratio (E) is generally 0.5. The deepness for fine-meshed net is 100 mesh and the deepness for wide-meshed net is 10 mesh. Total length of the nets is 100 m.

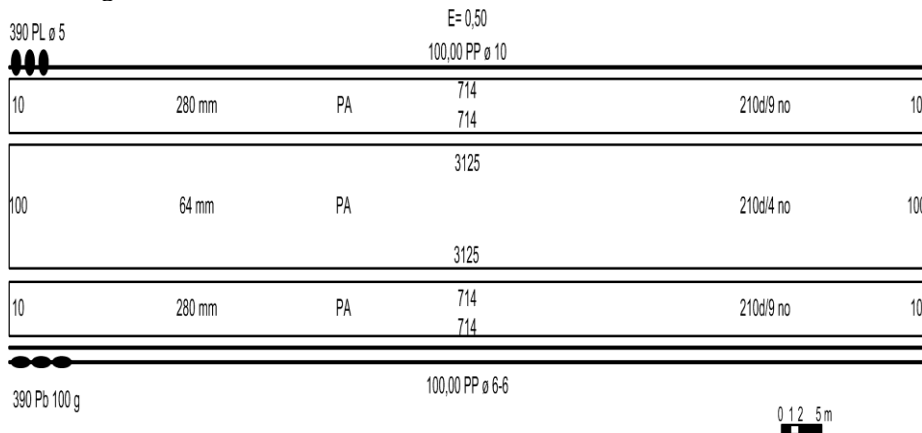


Figure 3. Bluefish trammel net

Encircling nets, especially used densely in Aegean and Marmara Seas are used for fishery of bluefish which are widely distributed in Turkish seas. The encircling nets are generally preferred to catch in bluefish migration seasons, autumn and spring. Two types encircling nets (gill net and trammel net) are contained 210d/3-4 no thickness for fine-meshed net which have 46-64 mm mesh size, and 210d/9-12 no thickness for wide-meshed net which have 250-280 mm mesh size (Figure 4). Total lengths of the encircling nets are varied between 265 and 660 m. Hanging ratios (E) are between 0,5 and 0,67. Each layer of the nets are 60-120 mesh deep for fine-meshed net and 5,5-13,5 mesh deep for wide-meshed net. Encircling nets can be formed 3-8 in layers (Ceyhan *et al.*, 2005).

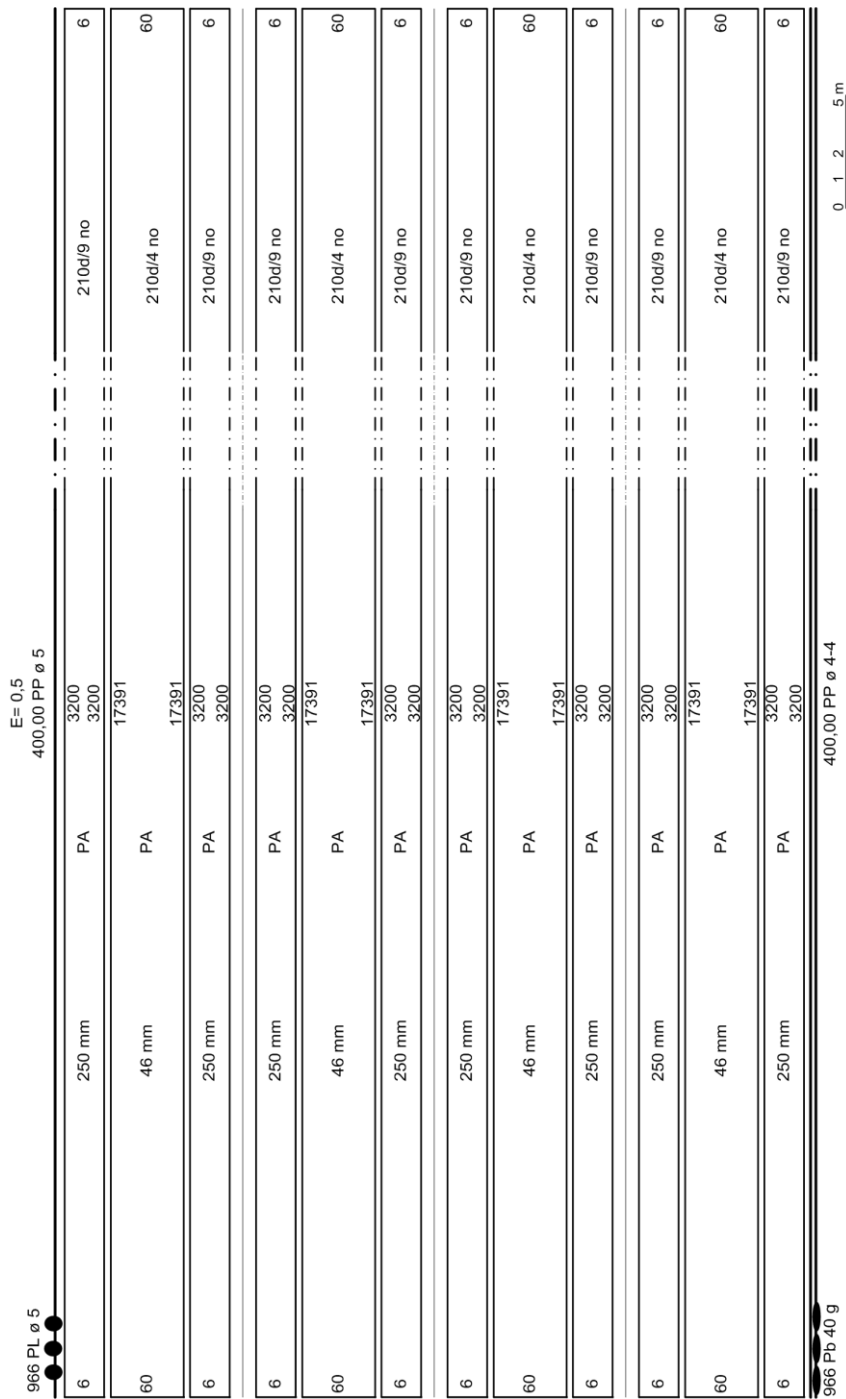


Figure 4. Encircling net, used in bluefish fishery

The encircling nets are being operated both day time and night time. The fishermen use a glass located at the bottom of boat to observe bluefish schools in daytime (Figure 5). After determineting the bluefish school, they begin to settle the encircling net around the fish school. They make a noise to stimulate the fish forward to nets. After the operation (Figure 6), The fishermen make the nets ready for the next time.



Figure 5. Glass located at the bottom of boat



Figure 6. Bluefish tangled the encircling nets

Gillnet fishermen utilize bioluminescent patterns on moonless calm nights to detect schools of targeted fish species, mainly bluefish, *Pomatomus saltatrix*, and Atlantic bonito, *Sarda sarda*. While cruising in shallow water with all lights except the navigational lights extinguished, experienced fishermen are able to identify the species and predict the size of the school based on the bioluminescent pattern. The fishermen can then decide whether it is worth encircling the fish school (Altınağaç *et al.*, 2010).

a. Trawls

The pelagic and demersal trawls have been used to catch bluefish in Black Sea. The fishermen generally use demersal trawls between October and November. The pelagic trawls have also been used between December and January in Black Sea (Ozdemir, 2006). In spite of banning of the trawling in Marmara Sea, bluefish has been caught illegally by some trawlers.

b. Handlines

Various types hand lines for bluefish fishery in Turkey, especially in Marmara Region have been used for along time. Commercial and sports handline fishing for bluefish has particularly been concentrated in Bosphorus and Dardanelles.

The one type of handlines commonly used is “*Lufer handline*”. It is consisted of a 0.8 mm diameter monofilament main line with 0.4 mm diameter monofilament at intervals of approximately 3 m. These handlines are containing 2 or 3 hooks. The hook number used is 4/0 or 5/0 (Figure 7). Depends on deepness and drifting, the weight used in handline has been ranging between 300 g and 500 g. Although the fishermen prefer European anchovy (*Engraulis encrasicolus*) as a bait, the garpike (*Belone belone*), horse mackerel (*Trachurus sp.*), round sardine (*Sardinella aurita*) and chub mackerel (*Scomber japonicus*) has been used as live-bait.

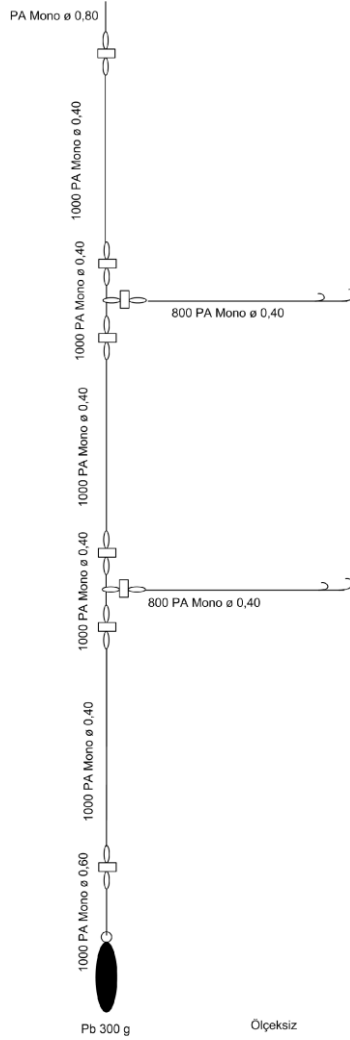


Figure 7. Handline for bluefish

There is lack of control on recreational fishery for bluefish. Approximately 250 boats per one day was determined in Dardanelles to catch bluefish. Besides, fishing pressure of commercial fishing methods, the fishing pressure of recreational fisheries should be determined.

2. Conclusion

The Bluefish fishery in Turkish waters is an important fishery and is carried out handlines, encircling nets, gillnets, otter trawlers and purse-seiners. However, bluefish were primarily exploited by purse seines in the Marmara Sea (Akyol and Ceyhan 2007).

Ceyhan *et al.* (2007) observed maximum fork length of 34.2 cm is much lower than the 68 cm (3.71 kg) reported by Türgan (1959) for the Black Sea and lower still than maximum lengths reported by Salerno *et al.* (2001) off the northeast coast of the US (88 cm). In another recent study on bluefish in the Marmara region, Akyol and Ceyhan (2007) reported a maximum length of 45.3 cm (just one fish) and a mean length of 16.9 ± 0.01 cm (range 8.4– 45.3 cm). In contrast, in a much earlier study, Türgan (1959) reported a maximum length of 68 cm and a mean length of 28.5 cm (range 5–68 cm). These size differences are not surprising because there has been a decrease in the mean length of fish caught by purse-seines and gillnets between 1959 and 2004.

According to Turkish fishery regulation circular (TFRC), the minimum landing size (MLS) for bluefish is 14 cm (Anon. 2008). Ceyhan *et al.* (2007) estimated that 50% maturity of females would occur by age II at a minimum size of 25.4 cm fork length. Fishing mortality (F) has been much higher than the natural mortality and exploitation rate ($E=0.62$) were high. The MLS for bluefish below the likely size-at-maturity and perhaps therefore contributing to growth-overfishing and the absence of larger fish in the exploited population and may also caused to rise of fishing mortality (Akyol and Ceyhan 2007).

The absence of larger, older fish suggests heavy fishing pressure on bluefish in the Turkish Seas. Because, the structure of fish stocks which has never been subject to fishing changes when the fishing starts (Yuksel and Celayir, 2010). Russel (1942) argue that in a heavily exploited fishery, the average age of the population decreases and the growth rate increases

Non-Governmental Organisations made a campaign called as “*How Many cm Are You?*” to stop catching of juvenile fish. The Ministry of Food, Agriculture and Husbandry published an announcement that they will discuss legal catch sizes of commercial fish during the scientific committee’s meeting in June.

In conclusion, the resource may not be sustainable, however, if minimum landing sizes remain as they are now because of the potential for growth-overfishing. Fishing effort of the fleets have to determine and selectivity studies of the gears must made, and MLS of bluefish has to re-assessment for sustainable bluefish fishery.

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SWORDFISH (*Xiphias gladius*, Linnaeus, 1758) FISHERY

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1. Introduction

Swordfish, *Xiphias gladius*, is a large pelagic and highly migratory species and they have a wider geographic distribution (50°N-50°S). They live solitary or in small groups, and feed on small schooling fish and squids. Like other billfish and tuna, swordfish are highly fecund that grow quickly in their early years and become apex predator. They routinely move between surface waters and great depths where they tolerate extreme cold (below 8°C). They reach their maximum size (usually ~350 kg) at about 15 years (Ward 2000, Golani *et al.*, 2006).

Swordfish fishing started thousands of years ago as near shore subsistence activities in tropical areas. The early fishing mostly involved the harpooning of large female swordfish as they were basking at the sea surface (Di Natale 1991, Ward *et al.*, 2000). In general, world swordfish fishing is carried out by pelagic longline, driftnet, harpoon and occasionally purse-seine, trap, troll-line and pole-and-line. Total catch amount of swordfish both in the world and the Mediterranean was fluctuated the minimum 14978 tons and 1500 tons in 1953, and maximum 118090 tons in 2003 and 20365 tons in 1988, respectively (FAO 2000) (Figure 1).

Swordfish landings in the Mediterranean showed a strong upward trend from about 4000 tons in 1976 to 20.000 tons in 1988. Since then, landings have fluctuated between 13.000 and 15.000 tons. Greece and Italy are among the most important swordfish producers in the Mediterranean (Tserpes *et al.*, 2003).

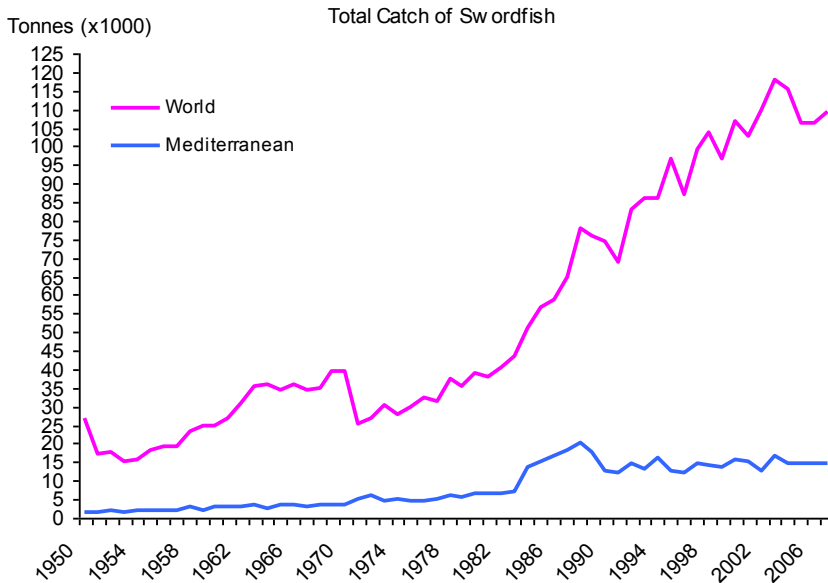


Figure 1. Total catch amount of swordfish between 1950 and 2007 (FAO 2000)

The exact time when swordfish fishery starts in Turkey is unknown. However, Turkish swordfish fishery dates back to XVIIth century. In 1630's, Evliya Çelebi mentioned in his journey book "*Seyahatname*" that swordfishes had been caught via tuna trap nets, deployed along the coasts of Beykoz, İstanbul (Kahraman and Dağlı 2008). Quite earlier, Deveciyan (1926) stated that the fishing for swordfish in the Sea of Marmara in early 1900's had been carried out by using harpoon and drift net in Bosphorus from 15 August to 8 November, and then swordfishes were disappeared due to the colder weather conditions in formerly. Afterwards Artüz (1963) , Onat (1970) and Alıçlı(2010) reported that in the 1960s, swordfish fishery in the same area was done with gillnet, longline, traps, but mostly by harpoon; the harpooning started in April and it sustained during May and early June, and also gillnetting carried out on moonless nights between September and November in the Bosphorus.

2. Total catch of swordfish in Turkey

Among the large pelagics exploited in Turkey, the swordfish catch was sharply fluctuated from 7 tones (1976) to 589 tones (1988) (Figure 2). In 2007, the catch amount of swordfish was only 423 t (FAO, 2000). This is about 3% of total landings from GFCM area.

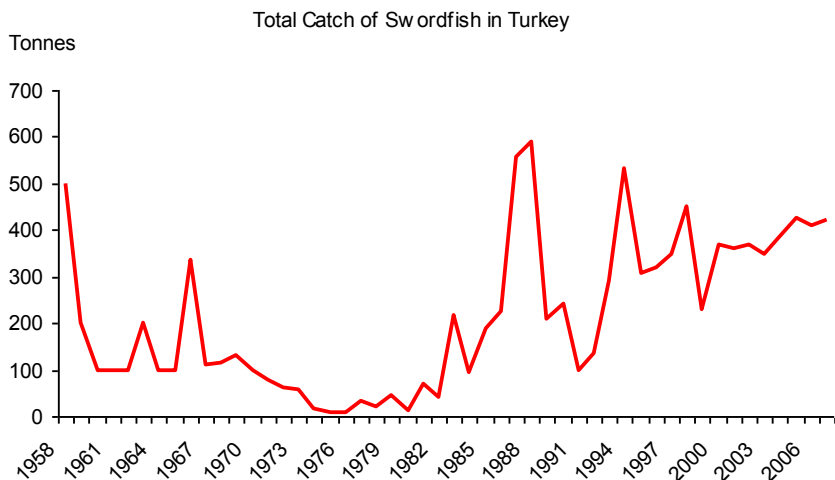


Figure 2. Total catch of swordfish in Turkey since 1958

3. Fishing Ports and Grounds

The swordfish fishery in Turkish waters is carried out by using harpoon, purse-seine, pelagic gillnet and longline between Aegean and Levantine Seas (Figure 3). Although, no existing of swordfish in the Sea of Marmara, about 50 fishing boats from Marmara coasts are participated to swordfish fishery along the Aegean and Levantine coasts. Approximately 150 fishing boats from 21 fishing ports are participated to swordfish fishery from Istanbul to Iskenderun (Akyol and Ceyhan 2011).

According to Turkish fishery regulation circular (TFRC), the seasonal closure for swordfish fishery is between Oct, 01 and Nov. 30 in all of Turkish territorial waters, and every fishing boats have to get registration licence for swordfish fishing (Anon. 2008). The rest of the year, this fishery is carried out only about 6-7 months per year due to the meteorological conditions and phase of the moon.

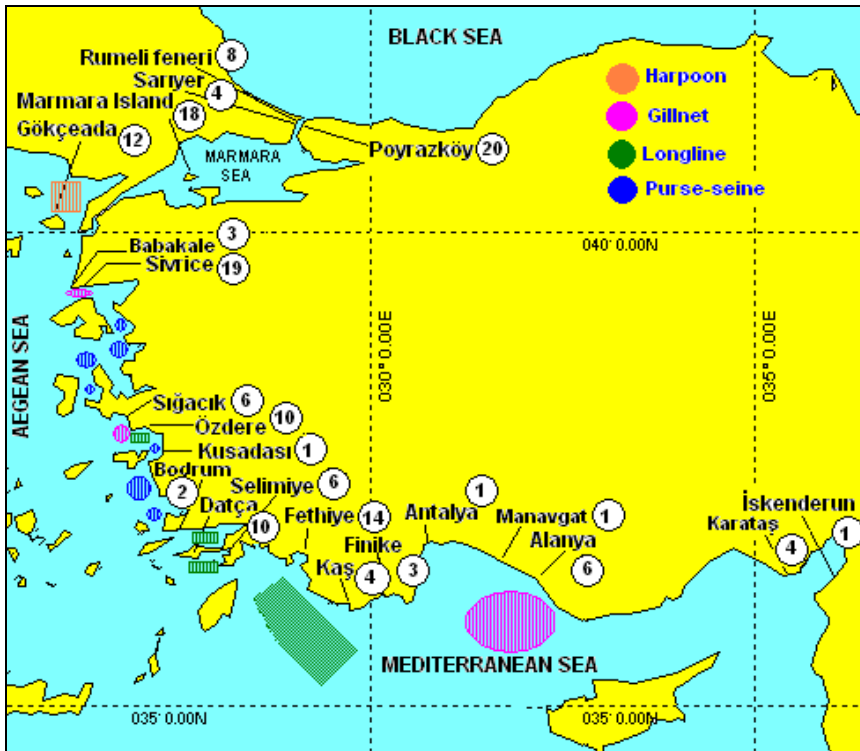


Figure 3. Distribution of fishing ports and fishing areas according to operation types in Turkish waters (numbered circles indicate the total number of swordfish boats)

4. Fishing Gears and Seasons

4.1. Harpooning

Harpooning involves stalking via sighting platform a swordfish that is basking or finning at the sea surface, and then spearing it with a 4-5 m long harpoon with a metal heads attached to a line. The line is usually attached to a buoy or floating drum to allow the swordfish to tire before being hauled on board (Von Brandt 1984).

Harpooning for swordfish started in early 1950's in the Bosphorus. While, harpooning in Bosphorus and whole of Marmara Sea had effectively been used until 1970's, but nowadays, the Saroz Bay is the unique harpooning area anymore. Thirty boats from Marmara and Gökçeada Islands are hunting with harpoon in Saros Bay between April and June.

4.2. Pelagic Gillnetting

Pelagic gillnets also known driftnets; entangle fish when they swim into them. Driftnets are defined by FAO as a fishing gear "consisting of a string of gillnets kept more or less vertical by floats on the upper line and weights on the

lower line, drifting with the current, in general near the surface or in mid-water” (FAO, online Fisheries Global Information System-FIGIS). Large scale pelagic driftnets are surface or sub-surface driftnets of large dimensions (exceeding 2.5 km and up to 50 kms) the use of which is banned by a UN resolution.

In northern Aegean, there are 22 boats in Babakale and Sivrice ports for swordfish gillnetting. Some of the boats in these ports usually go to the coast of Doğanbey, Sığacık Bay for swordfish catch. The fishing season is between May and September. Some boats from Fethiye and Kaş fishing ports are also used the pelagic gillnets between April and July.

This fishery is also spread eastwards to off Antalya Bay. More than 50 vessels are hunted by using pelagic gillnets in the area. Especially, most of the vessels from Istanbul (Rumelifeneri, Sarıyer, Poyrazköy) and from Kaş, Finike, Antalya, Manavgat, Alanya, Gazipaşa, Mersin, Karataş, Iskenderun are joined in this region both albacore (*Thunnus alalunga*) and swordfish fishing between May and July.

A sample swordfish gillnet from Fethiye region is shown in Figure 4. It is made of multifilament polyamide (PA) netting yarn, 210d/54 no rope thickness, 460 mm stretched mesh size and 30 meshes depth. The net is equipped with 5 mm polyurethane band on the floating line, but no sinkers. Total length of this net is between 4600 and 6900 m.

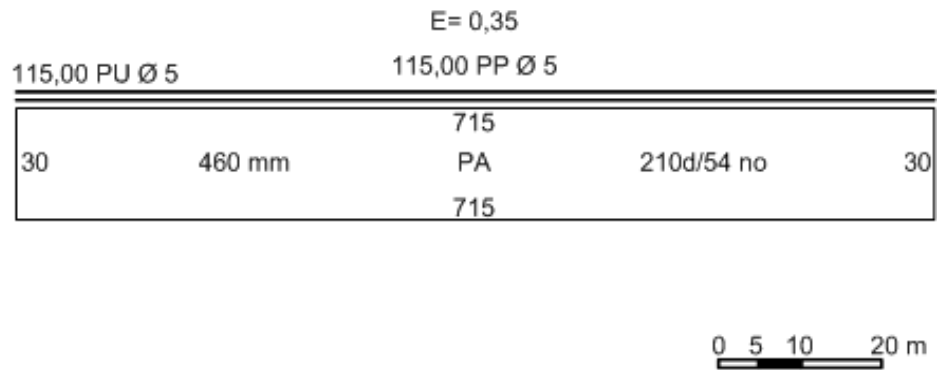


Figure 4. A gillnet for swordfish, used in Fethiye region

The non-target species from swordfish gillnetting in Turkish seas are bluefin tuna (*T. thynnus*), albacore (*Thunnus alalunga*), Atlantic black skipjack (*E. alletteratus*), Mediterranean spearfish (*T. belone*), bullet tuna (*A. rochei*), dolphinfish (*Coryphaena hippurus*), manta ray (*Mobula mobular*), sunfish (*Mola mola*), blackfish (*Centrolophus niger*), pelagic stingray (*Dasyatis violacea*), blue shark (*Prionace glauca*), tope shark (*Galeorhinus galeus*), sandbar shark (*Carcharhinus plumbeus*), striped dolphin (*Stenella coeruleoalba*), bottlenose dolphin (*Tursiops truncatus*), Risso’s dolphin (*Grampus griseus*) and loggerhead sea turtle (*Caretta caretta*) (Akyol and Ceyhan 2011).

4.3. Longlining

Fishermen have used pelagic longlines – a series of baited hooks attached to a mainline suspended from buoys at the sea surface- to catch tuna since the early 1800s (Wildman 1997). Distant-water longlining started in the 1950's. More than half of the world's swordfish catch is now taken as an incidental catch of the distant-water longliners that target tuna (Ward *et al.*, 2000). The swordfish longline fishing is the most important fisheries in the Mediterranean with this target, accounting more than 76% of the total Mediterranean catches of swordfish in 2006 (ICCAT 2008).

In Turkey, pelagic longline for swordfish is usually used during winter and spring months when not use of the nets. Ozdere, Datça, Selimiye and Fethiye are the main longliners' ports. About 50 boats deploy its longlines off Kuşadası, Gökova and Yeşilova Bays and open seas of Fethiye between December and May.

A sample swordfish longline from Fethiye region is shown in Figure 5. Main line (PA, mono) has 1.20–1.50 mm diameter; shackle line with 3–4–5 m different lengths has 1.50 mm diameter. A total of 500 numbers of 2 no. J and/or circle shape hooks are attached with shackle lines every 50 m. Besides, extra buoys are equipped to the main line per five shackle lines. There are two illuminated buoys and/or black flags both sides of the gear for daytime or nighttime operations.

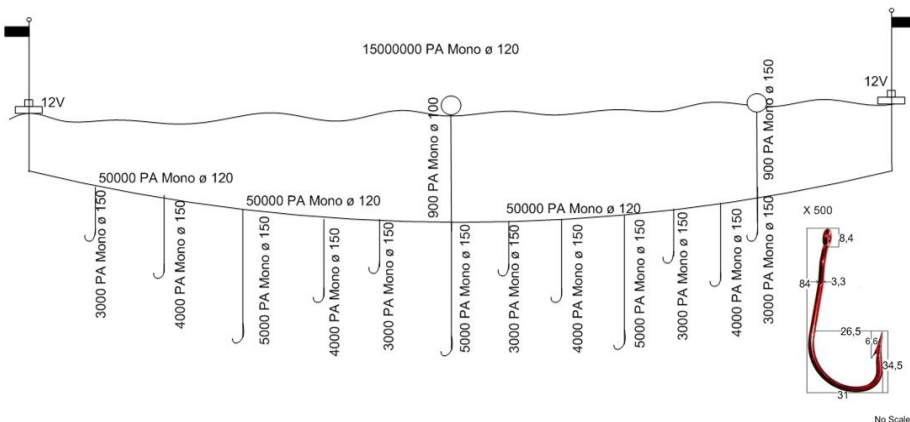


Figure 5. A pelagic longline for swordfish, used in Fethiye Region

The non-target species from swordfish longlining are bluefin tuna (*Thunnus thynnus*), Atlantic black skipjack (*Euthynnus alletteratus*), Mediterranean spearfish (*Tetrapturus belone*), bullet tuna (*Auxis rochei*), oilfish (*Ruvettus pretiosus*) and some sharks.

4.4. Purse-Seining

Although, purse-seiners do not target the swordfish, sometimes young fish aggregated with sardine and anchovies under the light boats of purse-seiners can also be caught incidentally. This fishery is sustained between September and April, and juvenile swordfish especially comes from Dikili and Çandarlı Bays, off Karaburun, Çeşme, Didim and Bodrum (Akyol and Ceyhan 2011). About 0.6% of the total Mediterranean catches of swordfish in 2006 were caught by purse-seine as by-catch (ICCAT 2008).

5. Conclusion

In 2002 and 2003, EU and ICCAT enforced a recommendation prohibiting the use of drift-nets in the Mediterranean. Afterwards, drift-netting in Turkey was also banned in 2006 (Anon. 2006). But many of fishermen, used pelagic gillnet for swordfish has been shown the reaction againts to the prohibition. Afterwards, they were found the “*Association of the Fishing for Swordfish and Albacore*” in Poyrazköy, Istanbul in 2008 with joining of 60 fishermen. Moreover, they have been started the struggle for their rights since then. They argued that the pelagic gillnet fishery, dates back to early of the 1900’s was traditional and it was uncomparable with the large scale Mediterranean drift-net fishery.

Pelagic gillnetting has currently been tended to decrease due to the banning since 2006. However, most of fishermen have made some modifications in their nets and put some weights and buoys on both sides of the nets in order to get out of scope of conventional drift net definition in Notification 2/1 Regulating Commercial Fishing. So, the Turkish fisheries authority and ICCAT have given a limited permission for traditional pelagic gillnet fishery in Turkish seas until the July 2011. As a matter of fact, the fisheries authority stimulates the transition to the using pelagic longline as recommended of ICCAT. For the sustainability of swordfish fishery in the Mediterranean is essential the collaborations of institutions, fishery co-operatives, universities, non-governmental organizations, international conservation commissions and fisheries authorities.

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**SOME REMARKS ON THE CATCHES OF ANCHOVY, *Engraulis encrasicolus* (Linnaeus, 1758), IN GEORGIAN WATERS BY
TURKISH FLEET BETWEEN
2003 and 2009**

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1. Introduction

Engraulis encrasicolus (Linnaeus, 1758) is a pelagic and thermophilic marine fish. It forms large schools in the coastal water along the European and African coasts in the eastern Atlantic Ocean and in the Mediterranean, Black and Azov Seas. The fish tends to move further north and into surface waters in summer, retreating and descending in winter. It can tolerate salinities of 5-41 ppm and in some areas, enters lagoons, estuaries and lakes, especially during spawning (Froese and Pauly 2011). The spawning takes place in summer in the warm upper layer (16-28°C). Reproduction occurs mostly in low saline (7-18‰) coastal waters, especially in estuarine areas. The embryonic period lasts for about 24 hours (at 22.0-23.4°C) and the pelagic eggs are elliptical (long axis: 1.5-1.9 mm; short axis: 0.8-1.2 mm) (Lisovenko and Andrianov 1996).

The anchovy is the most abundant species in the Black Sea supporting commercial fishery and it has a significant role in the Black Sea ecosystem for energy transfer to higher trophic level. It is also important as a consumer of zooplankton and a competitor of other planktivores in the system (Daskalov *et al.*, 2007). Two anchovy subspecies exist in the Black Sea: the Azov anchovy, *Engraulis encrasicolus maeoticus* Pusanov and the Black Sea anchovy, *Engraulis encrasicolus ponticus* Alexandrov. The Black Sea anchovy is more abundant and important for commercial fishery. Recently, the Black Sea anchovy has been considered one of the populations of the European anchovy by some authors, while others consider it a distinct subspecies (Prodanov *et al.*, 1997)

The Azov anchovy spawns and feeds in the Azov Sea from May to August. It migrates through the Kerch Strait to the Black Sea in September-October with cold waters of autumn, and hibernates along the northern Caucasian (Novorossiisk-Sochy) and southern coast of the Crimea Peninsula. Sometimes, the shoals reach to the Turkish coast (Bingel and Gücü 2010). Spring migration of the Azov anchovy start in mid-April through the Kerch Strait and is over by the end of May (Chashchin 1996 and references there in).

The Black Sea anchovy covers nearly all over the sea during summer. It migrates to warmest waters in the southern Black Sea from October to March (Ivanov and Beverton 1985). The migration route usually takes place along the Romanian and Bulgarian coastlines and followed by the approach of the wintering schools to Turkish Anatolian and Georgia. The Black Sea anchovy migrates in April toward north, thereby across the open sea as well as following the east and west coast of the Black Sea. From the end of May to September, the Black Sea anchovy spawns in the shallow waters along north shelf of the Black Sea (Ivanov and Beverton 1985; Prodanov *et al.*, 1997; Daskalov *et al.*, 2007). However, some studies have revealed that the anchovy spawns also in the south Black Sea along the Turkish coast (Einarson and Gürtürk 1960; IMS-METU 1993).

The anchovy is the main fishery resource in the Black Sea and its total catches had reached the maximum level of 606,000 tons in 1984 (FAO, 2011). The predator and competitor effects of *Mnemiopsis leidyi* mainly on anchovy eggs and larvae was a general fishery problem for all riparian countries around the Black Sea during the 1980s (Öztürk and Öztürk 2005).

The anchovy shoals are subject to the intensive commercial fishery along the Turkish and Georgian coasts during the winter period (Komakhidze and Mazmanidi 1998; Gücü and Bingel 2010). Considering the catch fluctuation of the anchovy in Turkey between 2000 and 2008, it was the lowest in 2003 with 163,549 tons while the highest in 2007 with 407,991 tons (Figure 1). Anchovy comprises of more than 70% of total fishery yield in Turkey (Figure 2).

Anchovy fishery is performed with purse seiners in the Turkish part of the Black Sea and the boat size generally varies from 15 to 50 m and net mesh size is 16 mm (net length: 730-1460 m; height: 110-180 m). There are several speculations, questions and wrong information for the anchovy catch in Georgia by Turkish fishermen in the Turkish public opinion and abroad.

The aim of the study is to examine actual situation of the anchovy fishery in the Georgian water by the Turkish purse seiners to better understand the catch amount by the Turkish fishermen and to propose some recommendations for sustainable fishing activities in Georgia.

2. Georgian Fisheries

The coastline of Georgia on the Black Sea is 310 km, territorial waters extend from coastal line to 12 NM, while the exclusive economic zones (EEZ) extends to 200 NM (Figure 3). The total Georgian territorial sea area is about 6900 km², while the area of its EEZ is about 115,000 km². The Black Sea coast of Georgia is characterized by narrow shelf area. Poti and Batumi are the most important ports for Georgian fisheries.

There are 75 marine fish species and subspecies recorded from the Black Sea coast of Georgia and anchovy, sprat, whiting, spiny dogfish, scad, pickerel, red mullet, some gobies and Pacific mullet are the most important commercial species (Prodanov *et al.*, 2004; Khavtasi *et al.*, 2010).

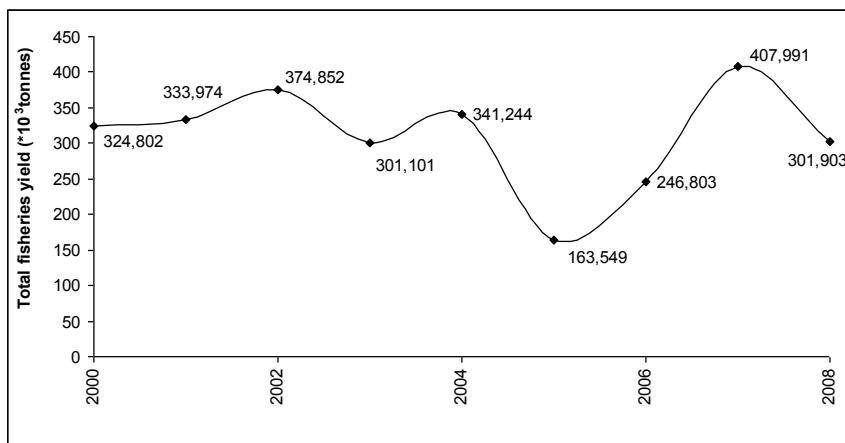


Figure 1. Total fisheries yield of Turkey in Black Sea coast from 2000 to 2008 (Source: FAO, FishstatJ, 2011)

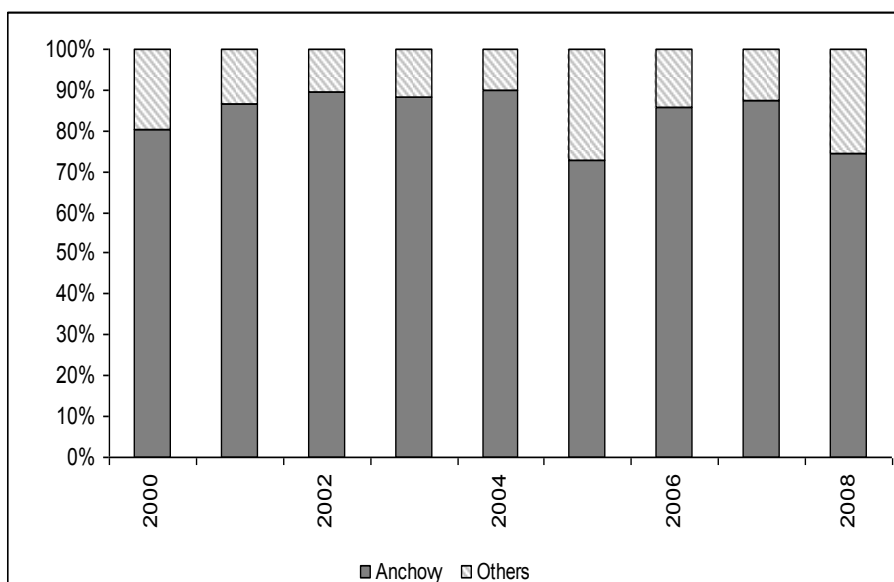


Figure 2. Percentage of the anchovy in the landings from the Turkish Black Sea from 2000 to 2008 (Source: FAO; FishstatJ 2011)



Figure 3. Map of Georgia (Source: <http://commons.wikimedia.org>)

In Georgia, the diversity of commercial fish decreased during the last 30 years. However, the catch increased, despite a near collapse in 1990, but this was almost entirely owing to the large anchovy fishery of Turkey (Khavtasi *et al.*, 2010). Georgian fishing fleet consists of 36 medium sized seiners (110-225 HP) built in the Soviet era lack maintenance and modernization, and there are nearly 342 small-scale fishing vessels, most of which are motorized and wooden for coastal fishery (Khavtasi *et al.* 2010). These are equipped with seine nets (103), gillnets (324), bottom lines (12), cast nets (12) and fishing rods (100) for coastal fisheries activity (Van Anrooy *et al.*, 2006).

While the average annual catch of anchovy in the Georgian Black Sea water was about 80,000 tons before 1988, this figure decreased to 2,000 - 7,000 tons during the 1990s. Small and insufficient fishing fleet in Georgia did not have the capacity to utilize its yearly anchovy quota (60,000 tons) (Khavtasi *et al.* 2010). Georgia did not struggle with decreasing fisheries trend during the 1990s. For this reason, Turkish fishermen have started to catch the anchovy in the Georgian Black Sea since 1996 by purchasing the permission from the Georgian authorities to catch fish, as well as receiving the permission from the Turkish authorities for operating overseas, their catch has started to increase since 2000.

The catch amount in Georgia has shown an increasing trend since 2005 (Figure 4). The proportion of anchovy in the total fisheries yield was the lowest (51%) in 2002 but increased to 98% in 2008 (Figure 5), as a result of increasing fishing effort. After 2007, a quota system started in Georgia for all fishing fleet and this quota was fixed as 60,000 tons for ten years.

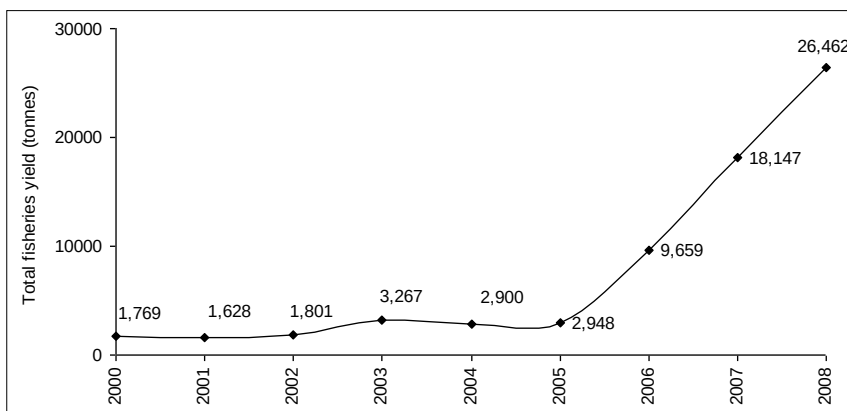


Figure 4. Total fish yield off the Georgian Black Sea coast between 2000 and 2008 (Source: FAO; FishstatJ, 2011)

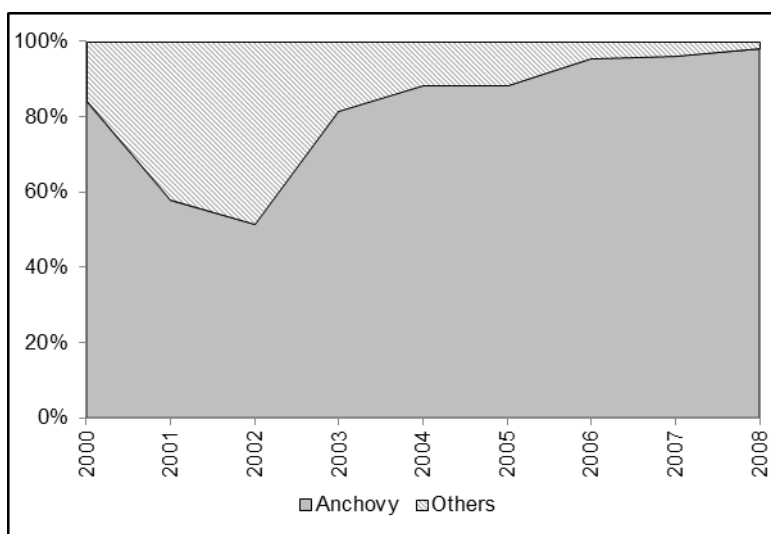


Figure 5. Percentage of anchovy in the total fishery yield from the Georgian Black Sea coast between 2000 and 2008 (Source: FAO; FishstatJ, 2011)

3. Discussion

The official numbers of the Turkish purse seiners and transport vessels from 2003 to 2009 are shown in Table 1, based on the data provided by the Turkish Ministry of Agriculture and Rural Affairs (MARA). In spite that several boats have a yearly permission by the Turkish authorities, it is not obligatory to catch fish in Georgia every year. The fish landing port was designated only at Poti.

Total yearly quota has been 60,000 tons since 2007 for all fishing fleet, and this number has not been exceeded by the Turkish fishermen. Furthermore, the anchovy catch by Turkish fleet was the maximum in 2009 with over 22,000 tons (Fig. 6). In 2004, the catch amount was 3,906 tons with the minimum level. The total amount of the anchovy catch by Turkish fleet was 60,968 tons from 2003 to 2009. The anchovy is supplied to the fish oil and meal factories but this amount is not included. Some Turkish and Georgian companies established a joint venture for processing and producing fish oil and meal in Georgia. Anchovy fishery in Georgia by Turkish fisherman is done generally from January to March.

Table 1. The number of Turkish vessels taking the permission for catching the anchovy in the Georgian Black Sea waters (Source: MARA)

Year	Number of fishing boats	Number of transport vessels
2003	27	7
2004	55	4
2005	68	24
2006	74	28
2007	55	15
2008	23	11
2009	18	9

According to Van Anrooy *et al.* (2006), Turkish and Ukrainian fleets started anchovy fisheries in the Georgian EEZ in the Black Sea in 1997, and there are some catch data. Considering the fisheries yield in 2003, the anchovy catch of Turkish fleet (4,235 tons) in this report was less than that in the present study (6,408 tons).

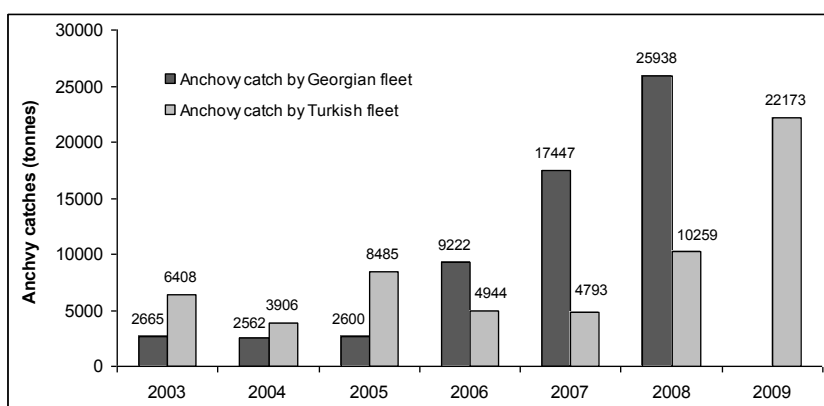


Figure 6. The anchovy catches by Georgian fleet from 2003 to 2008 (Source: FAO; FishstatJ 2011) and Turkish fleet from 2003 and 2009 (Source: Hopa Costom Directorate)

In addition, the same authors stated that the number of Turkish vessels for anchovy fishing increased from 200 to 316 in the waters near the Turkish-Georgian boarder and coast, and these vessels are threat to anchovy resources. However, this information is not confirmed and the officially reported number of boat is given in Table 1. Khavtasi *et al.* (2010) also claimed that the Turkish hired fleet would have a capacity to catch from 120,000 to 200,000 tons of anchovy per month. But, this estimation is not accurate and reliable considering that yearly permissible allowable anchovy quota was maximum 60,000 tons for all pelagic fish species for all fleet (Georgian, Ukrainian and Turkish) in Georgian waters. It seems that the authors did not carefully examine all information collected from the fishermen as well as with interviews.

Besides, the existence of illegal and unreported fisheries have also been reported from Georgia and 32 Turkish purse seiners were arrested between 2000 and 2010 due to the violation of relevant Georgian marine acts. Most of the Turkish fishermen and crew complained that Georgian detained procedures were not legally clear, their claims were weak, and the local authorities abused their rights.

The Bucharest Convention on environmental protection was signed in 1992 by six coastal states, and the Black Sea Strategic Action Plan was signed in 1996. The riparian states, however, have been unable to agree on a joint fishery convention so far, and cross-border fishing activities remain largely unregulated. All Black Sea states have established EEZs stretching up to 200 nautical miles beyond their territorial waters, where they generally treat vessels of different nationalities as trespassers (Knudsen and Toje 2008).

Fisheries management is fairly poor within the Black Sea states and there are no any legal banding documents for the fisheries management or sustainable fisheries. First fishery convention concerning the Black Sea was signed in Varna on 7 July 1959 between Bulgaria, Romania and Soviet Union but Turkey was excluded from this convention in that time. Besides, the anchovy was not a regulated species in that convention. The Black Sea Economic Cooperation (BSEC) has taken some limited initiatives concerning maritime affairs. In the early 2000s, negotiations took place within the BSEC on whether a BSEC-wide agreement on a fisheries convention could be reached. Although extensive discussions took place, it was decided that BSEC should not conclude a fisheries agreement. However, BSEC takes part as an observer in continued negotiations about fisheries conventions under the auspices of the Black Sea Commission (Knudsen and Toje 2008). Duzgunes and Erdoğan (2008) also reported that the fishery resources need to be managed in the Black Sea.

In recent years, Romania and Bulgaria have become members of the European Union and a part of the common fishery policy of the European Union even though they have very few purse seiners and fishing fleet in the

Black Sea. Except for these two states, the Black Sea riparian countries are not members of the European Union and to harmonize common strategies seem to be difficult in terms of living resource management. Moreover, Georgia has an agreement with Ukraine to catch fish, mainly anchovy, in the Georgian waters with otter trawlers. The catch statistics, however, were not reliable due to insufficient implementation at the fish landing harbours. As a consequence, even though some figures have been provided by several organizations such as FAO, these figures were not consistent and agreeable with each other and may not be reflecting actual situations.

In addition, Abkhazia has become *de facto* state and recognized by some countries at the political level as an independent state. Georgian state authorities do not have control over the area beyond the Anaklia River to Russian Border in the north of Abkhazia. In fact, more than 150 km shoreline and significant high sea area is under the control of Abkhazia and the fishing permission is given to whoever wants to fish by the local Abkhazian authorities with payment. Several Russian and Ukrainian trawlers and Turkish purse seiners caught anchovies at the beginning of 2011 with 30 fishing boats and the catch of 50,000 tons of small size anchovy was estimated. However, this type of fisheries is continuing somehow and real catch figures are not recorded at the Turkish or Abkhazian market as fresh fish or materials for fish oil and meal. Russian and Ukrainian fishery in Abkhazia also needs detailed examination. This unreported and illegal fisheries needs to be managed and regulated according to the bilateral and regional cooperation to preserve anchovy stocks with respect of sovereignty of the neighbouring countries.

An urgent anchovy stock assessment study is suggested in order to manage Georgian fisheries in a sustainable manner. Because allocated 60,000 tons quota for pelagic fish for ten years is not based on scientific evidence, but on the necessity due the economical difficulties. This quota allocation may cause depletion of the anchovy stocks in the Georgian waters. Chashchin (1996) reported that in Georgian coast in 1991 total biomass of anchovy was 165,000 tons. But this information is quite old.

Finally, in the Black Sea, there are several shared stocks occurring within the economic zones of the two or more coastal states such as anchovy, bluefish, bonito and horse mackerel. These resources need sustainable management by riparian countries. GFCM should play more effective role for the fisheries regulations and to collect accurate fisheries information such as landing data, accurate catch records etc with the help of the riparian states.

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ATLANTIC BLUEFIN TUNA (*Thunnus thynnus thynnus* Linnaeus, 1758) FISHERY IN TURKISH WATERS

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1. Introduction

Atlantic bluefin tuna, *Thunnus thynnus thynnus* L. (BFT), are highly migratory species. It can be found seasonally coming close to the shore and can tolerate a wide range temperature. This species is found from Labrador and Newfoundland south into the Gulf of Mexico and the Caribbean Sea and is also known off Venezuela and Brazil in the western Atlantic; in the eastern Atlantic it occurs from the Lofoten Islands off Norway south to the Canary Islands and the Mediterranean Sea. Some interchange seems to occur between the east and west (ICCAT, 2008).

Archaeological excavations have shown that fishing on BFT has occurred in the Mediterranean since the 7th millennium BC (Desse and Desse-Berset 1994). BFT has been documented as an important element of Mediterranean culture. With the exception of the last 30 years, this great fish has always provided sustainable fisheries in the Mediterranean Sea. During the course of numerous historical periods, from the beginning of the fisheries to the present day, the magnificent BFT have been a source of food, have provided an economic base, and functioned as a central core of the culture for the people of the region. They have been a source of income that goes far beyond just the fishermen because it includes net makers, boat builders, the processing, shipping and selling of fish products for coastal communities of the Iberian Peninsula, the Atlantic coast of north Africa, the Mediterranean, Adriatic and Aegean Seas, the Dardanelles, the Sea of Marmara, Bosphorus and the Black Sea.

BFT is one of the most important species in Turkish fisheries. Because of their flesh quality, BFT are among the most desired and expensive species; the Japanese market (“sushi” and “sashimi” tradition) is the main driving force the fishery.

2. History of BFT fishery

The history of BFT fishery in Asia Minor dates back to ancient ages. Besides the taxes paid by the sailing ships passing through the İstanbul Strait, bonito and BFT fishery was, formerly, another important financial source during the Byzantium era. During this period, these fish have been selected as the symbols of the city. Reliefs of bonito and BFT had been imprinted on

Byzantium coins, emitted between the 1st and 3rd centuries A.D. Many ancient authors, such as Homeros (8th century B.C.), Plinius (1st century A.D.) and Athenaios (2nd - 3rd centuries A.D.), wrote about bonito and BFT captured both in the Dardanelles and İstanbul Straits (Tekin, 2000). According to Devedjian (1926) and Sará (1964), BFT and bonito were once very abundant in the waters of Byzantium, especially in the “Golden Horn”.

The history of the BFT fishery with fish traps (dalian) dates back to centuries ago. Evliya Çelebi, a famous Turkish world traveller, mentions in his memories the presence of 300 dalian-locations, whereas especially in Beykoz Dalian, big quantities of swordfish and BFT were caught (Kahraman and Dağlı, 2003). BFT traps may have been bigger and deeper than other dalians. The BFT dalians are traditionally called *Şıra* and *Kurtağzı* dalians (Devedjian, 1926; İyigüngör, 1957; Sarıkaya, 1980) In the 1950's the 8 dalians namely (Filburnu, Çankaya, Beykoz, Bülbülsokak, Anaşya, Küçükçekmece and Karamanoğlu) were set up in the last week of May and operated till August. The production of each dalian was about 100-150 BFT. Each BFT caught weighed 100 to 450 kg (İyigüngör, 1957). Till 1950, BFT were caught by traps, hand-line and spears. In 1950's fishing by purse seiners began (İyigüngör, 1957). The catch of BFT by traps ended in 1986 (Oray *et al.*, 2000).

As the trap catches declined, Turkey started developing purse seine fisheries. In 1980, the Government took a new policy to develop the fisheries, crediting building new boats and having a special tax waiver. As a result, the fisheries developed quickly and the BFT purse seine fishery was no exception. Particularly since mid-1980's, the high prices for BFT in the Japanese market draw a lot of attention of the Turkish fishing industry to BFT (Mert *et al.*, 2000).

The purse seine fisheries in mid 1980's were limited to the Sea of Marmara catching large fish (even over 300 to 400 kg per fish), and the fishing season was in winter months. Many tuna seiners replaced their old boats with newly built boats, utilizing the governmental special credit mentioned above, and improved the fishing power tremendously (Mert *et al.*, 2000). Since 1989, the fishery began in the north Aegean Sea, expanding gradually to the south Aegean Sea (Figure 1), catching small to medium size fish (25 to 45 kg) from winter to early spring time, and later (since 1995) from early spring to the end of May (Oray and Karakulak, 1997). This expansion was accelerated with the low production of anchovies in 1988 to 1990.

The BFT purse seiners also targeted anchovies. When the catch of anchovies declined, naturally their effort went targeting more BFT. In 1994, the purse seiners started operating even in the Mediterranean Sea where catches consisted of medium sized fish (60 to 100 kg), and the fishing season was from March to Middle of June. In the summer months, the quality of fish is relatively poor and fishermen abstain from fishing BFT. Currently the BFT fishing is

carried out in the Aegean and Mediterranean Seas, mainly in the months of March till the end of May. In 1998 and 1999, only 3 and 30 tons of BFT (60 to 100 kg/fish), respectively, were caught in the Sea of Marmara (around Marmara Island), in April (Karakulak, 1999; 2004).

In 2002, after the on fattening/farming of BFT started, the catch is carried out mostly in the eastern Mediterranean Sea (northern Levantine Sea) in May and June (Karakulak, 2007). Although there are changes in years in the fishing grounds, the catch of BFT in the Aegean Sea and Sea of Marmara is still continuing (Figure 1).

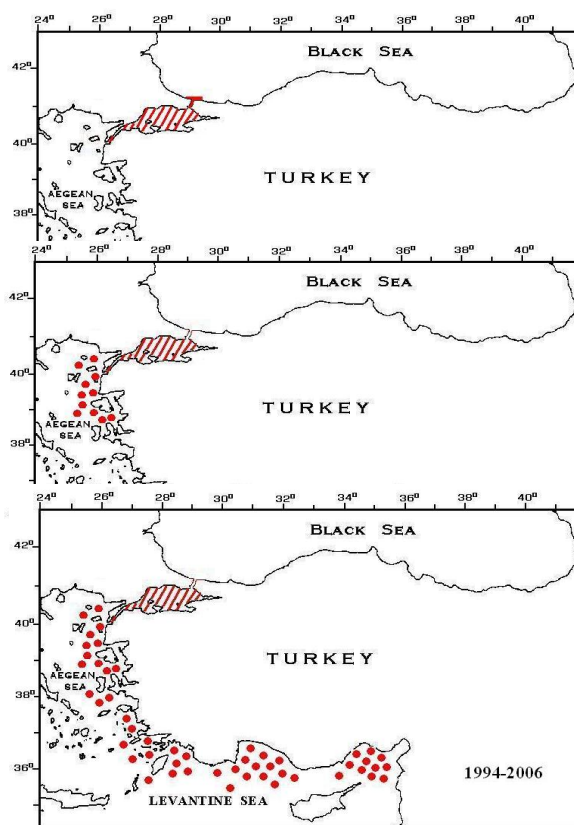


Figure 1. Geographic distribution of BFT catches by purse seiners, from the 1957-2006 periods (Karakulak and Oray, 2009)

Figure 2 shows the catches of BFT, 1970-2008. In 1970, 138 t of BFT were captured in Turkish waters. The catches increased almost steadily from 1980 until 1998, when they peaked at nearly 5899 t, and thereafter declined (ICCAT, 2009). At least a part of the recent decline is due to ICCAT management measures.

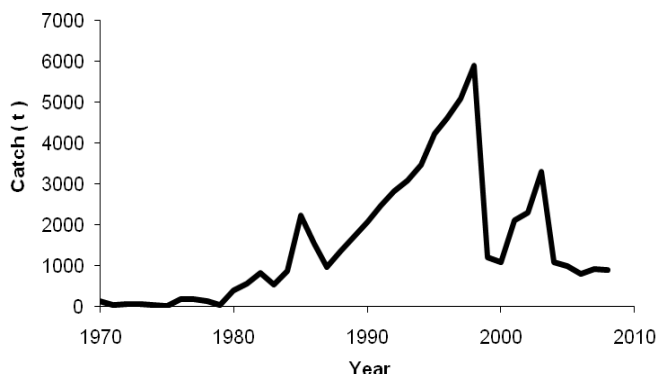


Figure 2. Catches of bluefin tuna in Turkish waters

3. Current Status of BFT Fishery

BFT fishery in recent years is carried out for fattening. This new industry resulted in a better price being paid to fishers and an increasing demand for specific sizes and species. Through the farming/fattening process, the relatively small tunas taken by purse seiners which used to be sold only for canning, can now be used for the sashimi market.

The fattening of BFT was initiated in Turkey in 2002 by 3 farms (Karakulak, 2007). Presently, there are six BFT farms; four were established in the Aegean Sea (Çeşme-İzmir), and two in Antalya Bay (Alanya-Antalya). While 28 purse seine vessels carried out BFT fishery in 2002, the number purse vessel increased to 98 in 2008 (ICCAT, 2009). Development of mentioned farming activities cause to increase of purse seine vessel. Majority of the BFT purse-seiners had an overall length of 30 – 50 m and a tonnage between 200-300 GRT. All of these fishing boats were equipped and monitored with a Vessel Monitoring System (VMS). In addition to the fishing vessels, 96 vessels were licensed as tug boats transporting BFT cages.

In accordance with ICCAT recommendation BFT fishery is permitted between May and June (15 May-15 June). The fishing ground has further been extended by purse seiners. They carry out fishery in the eastern Mediterranean, in the international waters between Turkey-Cyprus and Turkey-Syria. Furthermore, by conducting “joint fishing operations (JFO)” with other Mediterranean countries such as Egypt, Libya and Algeria, they use these countries’ continental shelf and JFO between two or more catching vessels flying the flag of different flag states is conducted in this manner.



Figure 3. The transfer of the BFT from the purse seine nets to the towing cages and a dead BFT in the net

4. Management

Some legal regulations concerning length and time prohibitions for BFT are presented by Turkish Ministry of Agriculture and Rural Affairs General Directorate of Protection and Control within the circular on regulating commercial fishing in seas and inland waters. Legal regulations for BFT included in mentioned circular between 1987 and 2002 are shown in Table 1.

Table 1. Relevant regulations of the BFT fishery in the fishery circular between 1987 and 2002 (Anon., 1985-2002)

Year	Min. length (cm) permitted	Limitation for season
1987	40	-
1988	70	-
1989	90	-
1990	90	-
1991	90	-
1992	90	-
1993	90	15 May - 1 September
1994	90	1 May - 1 September
1995	90	15 May - 1 September
1996	90	1 June - 1 August
1997	90	1 June - 1 August
1998	90	1 August - 1 September
1999	90	1 June - 1 September
2000	90	1 June - 1 September
2001	90	16 July – 15 August
2002	90	16 July – 15 August

The Atlantic BFT fisheries are therefore regulated by the International Convention for the Conservation of Atlantic Tunas (ICCAT). Since Turkey became a member of ICCAT in 2003, it has to implement ICCAT's Recommendations.

ICCAT recommended the first regulatory measures for BFT in the Atlantic in 1974. The measures included minimum size limits and limits on fishing mortality. Since 1981, Atlantic BFT have been managed under the premise of two-stock structure (west and east). Spawning occurs in the Gulf of Mexico and in the Mediterranean. There are considerable biological differences between the two with BFT in the Mediterranean maturing at 4-5 years of age, whereas in the Gulf of Mexico are believed to mature 8 years of age or older at a considerably larger size. The two management units are separated at 45°W north of 10°N and at 25°W south of the equator, with an eastward shift in the boundary between those parallels.

Catch limits have been in place for the eastern Atlantic and Mediterranean management unit since 1998. The Commission also set a quota at 32,000 t for the east Atlantic and Mediterranean stock for the years 2003, 2004, 2005 and 2006 [Rec. 02-08] and at 29,500 t and 28,500 t for 2007 and 2008, respectively [Rec. 06-05]. As a result of stock assessments in 2006 and 2008; since reproductive stocks have declined, recruitment of stock has decreased year by year and fishery based mortality rate is high it was decided by ICCAT that catch quota to be allocated as 22,000 t for 2009; 19,950 t for 2010 and 13,500 t for 2011 [Rec.08-05]. Additionally, it was recommended catch capacity has to be decreased and observers should be covered both for vessels and farms. Turkey was allocated catch quota for the first time in 2007. Total allowable catch (TAC) was 918 t for 2007, 879 t for 2008 and 683 t for 2009.

Additionally, an Atlantic-wide size limit of 6.4 kg (i.e. age 2) has been in force since 1975 [Rec. 74-1]. In 2004, this was raised to 10 kg and 30 kg for the Mediterranean Sea and west Atlantic, respectively [Rec. 04-07]. In 2008, minimum size was adopted as 30 kg for each species [Rec. 08-05].

In the Mediterranean, in order to conserve juvenile fish, purse seine fishing has been prohibited for the first time in 1998 during 16 July-15 August. Closed fishing season was established during 15 June to 15 April for 2008 [Rec. 08-05] and 15 June to 15 May for 2009 [Rec.09-06].

5. Stock Status

There are considerable data limitations for the assessment of the stock. These include poor temporal and spatial coverage for detailed size and catch-effort statistics from many fisheries, especially in the Mediterranean. For the eastern Atlantic and Mediterranean, the assessment results indicate that the spawning stock biomass (SSB) has been declining rapidly in the last several years while fishing mortality (F) has been increasing rapidly, especially for

large BFT (i.e. ages 8+, Figure 4). The increase in mortality for large BFT is consistent with a shift in targeting towards larger individuals destined for fattening/farming. The Standing Committee on Research and Statistics (SCRS) believes that the total allowable catch (TAC) regulation have been largely ineffective in controlling overall catch with actual catches believed to be 18,000 t to 20,000 t higher than reported (ICCAT, 2008).

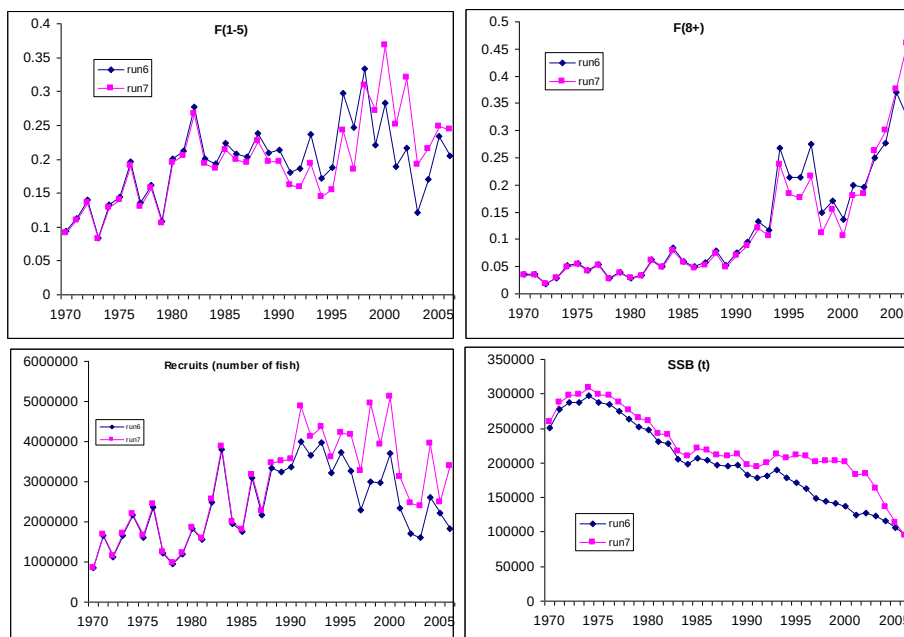


Figure 4. Fishing mortality (for ages 1 to 5 and 8+), spawning stock biomass and recruitment estimates from VPA run 6 (reported catch) and run 7 (adjusted catch) (ICCAT, 2008)

6. Conclusions

In spite of ICCAT Recommendations, illegal fishing in eastern Atlantic and Mediterranean is still maintained. The catch reported in 2004 (34,500 ton) was slightly over the TAC of 32,000 ton, but SCRS estimated it to be about 50,000 ton.

85% of total fishing in the Mediterranean is carried out by purse seine vessels. For stock assessment research, values of unit catch effort for purse seine fishing and growth ratio of farmed tunas are needed. Although this need is continuously reported by ICCAT, any success could not be achieved so far. Improvements in scientific research are thus necessary but not sufficient conditions for improvements in long-term management. However, better

understanding of key ecological processes is also needed, especially on the habitat and the spatial dynamics of this highly migratory species.

For sustainable BFT fisheries, current fisheries management should be changed. As long as over-fishing is not controlled and death of mature tunas is not reduced the stock is faced with collapse. As a result of stock assessment, in 2008, SCRS recommended to close fishing season in the Mediterranean during reproduction period, to allocate TAC as 15,000 ton and to reduce death ratio of mature tunas (ICCAT, 2008). Scientists and non-governmental organizations are expecting ICCAT to take radical decisions.

Clearly, an overall reduction in fishing effort and mortality is needed to reverse current trends. Current fishing capacity largely exceeds the current TAC and has even increased over the last four years. Therefore, management actions are also needed to mitigate the impacts of overcapacity as well as to eliminate illegal fishing. Deferring effective management measures will likely result in even more stringent measures being necessary in the future.

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OCTOPUS (*Octopus vulgaris* Cuvier, 1797) FISHERY

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1. Introduction

O. vulgaris was previously believed to have a worldwide distribution, but is now considered to occur in the Mediterranean and the eastern Atlantic only (Mangold 1997). A truly coastal species, it is found in the upper 100 m of the continental slope, with abundance decreasing down the slope (Guerra 1981). It mostly inhabits shallow rocky areas, but does occur on sand and muddy substrates in some regions (Mangold 1983). The spatial distribution and population dynamics of octopuses is very diverse. The abundance and population size structure of *O. vulgaris* in the Mediterranean was shown to be highly variable (Mangold 1983; Guerra 1981), with migrations between inshore and deeper offshore areas related to spawning behaviour and temperature variations (Mangold & Boletzky 1973; Guerra 1981). Cephalopods play an important role in marine food webs. They are both predators of smaller fishes and invertebrates, and the prey of larger fishes and mammals (Smale 1996; Klages 1996; Clarke 1996). *O. vulgaris* feeds on a variety of prey including crustaceans, molluscs, other cephalopods and fishes (Nigmatullin & Ostapenko 1976; Guerra 1979; Hatanaka 1979; Smale & Buchan 1981).

Given that short-lived species such as cephalopods are widely believed to benefit from anthropogenic changes to faunal abundance, the relationship between cephalopods and their predators can be influenced by commercial exploitation of the predator (Clarke 1983). Several authors have suggested that octopus fisheries started in the Saharan Bank region as a consequence of overexploitation of seabream populations (Garcia Cabrera 1968; Bas *et al.*, 1970; Caddy 1983; Caddy & Rodhouse 1998).

2. Global Octopus Fisheries

The global cephalopod catch consists mostly of the families Sepiidae (cuttlefish), Loliginidae (squid), Ommastrephidae (squid) and Octopodidae (octopus) (FAO 1997). Octopus and cuttlefish each contribute only 12% to the world cephalopod catch, which is dominated by squid (75 %) (Paust 1997). World catches attributed to *O. vulgaris* declined from peaks in the late sixties (more than 100,000 t per year) to 20,000 to 30,000 t in recent years (FAO, 1983). (Figure 1). Part of the nonidentified world catches of Octopus oscillating between 120,000 and 160,000 t annually, also pertain to this species (including part of the nearly 45,000 t caught by Japan in the Inland Sea, Fishing Area 61, and most of the catches (between 40,000 and 50,000 t) taken by Spanish vessels

on the Sahara Banks off West Africa, Fishing Area 34). The species is highly desirable and commands high prices throughout its distributional range and supports artisanal as well as industrial fisheries. It is taken mainly with lures, hooks and lines, clay pots and traps, (Rathjen and Voss 1987) (Whitaker *et al.*, 1991; Sanchez & Obarti 1993) (Hartwick and Barriga 1997) and spearing (Young and Harman 1997) and otter trawls. Large fisheries for *Octopus vulgaris* are concentrated on the Aegean coasts, in the Mediterranean Sea and Japan (Hatanaka 1979; Mangold 1983, Takeda 1990), while small-scale fisheries exists in countries such as Mexico (Solis-Ramirez 1997), Canary Islands (Hernandez-Garcia *et al.* 1998), Chile (Defeo and Castilla 1998) and Hawaii (Young and Harman 1997). Experimental fisheries have also been attempted in several countries, among them Canada (Gillespie *et al.*, 1998) and the USA (Whitaker *et al.* 1991).

In the Inland Sea of Japan, some 12,000 to 17,000 pots are laid out annually to provide shelter and enhance egg conservation as a measure to safeguard recruitment of the fishable stock. This species is marketed fresh, frozen and dried salted, mostly for human consumption. The total catch reported for this species to FAO for 1999 was 34 262 t. The countries with the largest catches were Mexico (19 081 t) and Italy (8 844 t).

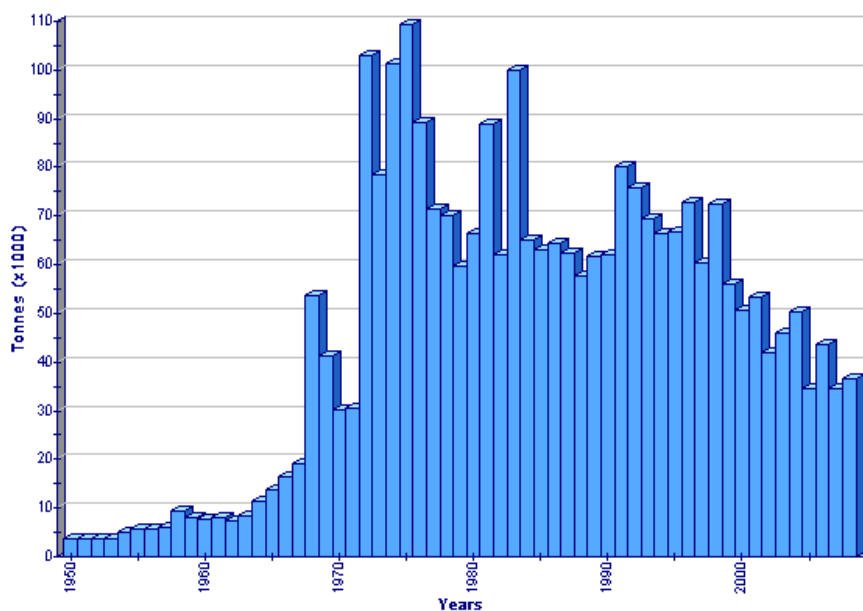


Figure 1. Global Capture production for *Octopus vulgaris* (FAO Fishery Statistic)

A review of fishery type, CPUE trends, fishing methods, management measures, market conditions, and environmental and anthropogenic influences on these octopus fisheries provides much-needed baseline information pertinent to the development of a new fishery. The fishery on the northwest coast of Africa is the largest trawl fishery for octopus worldwide, with the catch harvested by vessels from Spain, Korean Republic, Morocco and Mauritania and exported as frozen product to Japan (Guerra 1997). The fishery started during the 1960s when traditional finfish catches began to decline (Caddy 1983; Rathjen & Voss 1987) and showed a variable increase in catch, reaching 135 000 tons in 1994 (FAO 1997). During the early 1990s, after fishing activity was reduced by 40% (FAO 1997). In the northern areas, management measures comprising a reduction of foreign vessels and a two-month closed season (FAO 1997) were implemented. During 2001, a second closed season was introduced.

3. Octopus Fisheries in the Mediterranean

Octopus fisheries in the Mediterranean region are comprised of both pot and trawl fisheries. The Mediterranean pot fisheries have existed since classical times and currently account for approximately 36% of the annual octopus landings in the Spanish Mediterranean (Mangold 1983; Rathjen and Voss 1987; Sanchez and Obarti 1993). Catches in the Mediterranean have shown an increase in landings of most cephalopods in the last 40 years (FAO 1997), with *O. vulgaris* catches rising from approximately 2 000 tons in the 1950s to 20 000 tons during the 1990s (Guerra 1997). In the western Mediterranean, octopuses (*O. vulgaris*) are caught in nearshore waters using pots (Sánchez and Obarti 1993) and further offshore by trawling (Quetglas *et al.*, 1998; Sartor *et al.*, 1998). The pot fishery catch peaks in early winter, when approximately 0.15 - 0.3 octopuses are caught per pot. Only large octopuses (>1 kg mass, >11 cm ML) are caught in this inshore pot fishery (Sánchez and Obarti 1993). In the trawl fishery, octopus represent 8 - 40% of the total catch (Quetglas *et al.* 1998; Sartor *et al.*, 1998). The CPUE for the trawl fishery is highest during early summer (40 kg/h), and the largest animals are much smaller than those caught in the inshore pot fishery (Quetglas *et al.*, 1998). This suggests that mature octopuses migrate for spawning and brooding purposes to the nearshore environment, where they become available to the pot fishery. Spanish demand for octopus increased substantially during the last decade, and most of the catch is consumed locally (Sánchez and Obarti 1993). In Portuguese waters, octopus and other cephalopods are caught as a bycatch to finfish directed trawling (Fonseca *et al.*, 2002), yet they fetch approximately three times the price of fish. Although the minimum legal size for octopus is 0.75 kg, the legal trawl mesh size mostly retains octopus smaller than this.

4. Octopus Fisheries in Turkey

Cephalopod fishery in Turkey started in 1980s. Especially the beginning of octopus export in this period caused an increase in the fishery of this species. When octopus fishery amount per year is examined, it is seen that 1400 and 1500 tones were produced in the years 2001-2002 and approximately 650 tones were produced today. Octopus fishery in Turkey is practiced in the Aegean and Mediterranean coasts. Cephalopod species are not found in the Marmara Sea and Black Sea in which the salinity is low. In Turkey, octopus fishery is practiced as by-catch fishery using troll and drag nets which are among the large scaled fishing tools. The octopus pot, octopus longline, spear gun and diving methods which are among the small scaled fishery tools are fishery methods which are applied particularly for this species (Ulaş *et al.*, 1998). In addition to these, the octopus is hunted as by-catch with the trammel nets used intensively in the seafood fishery. The fact that octopus is a nest-dependent species enables that it is caught using pots and traps as well as it is caught in its nest by divers (Ulaş 2001). In Turkish coasts, seasonal fishing ban and minimum size ban are applied in octopus fishery. Octopus fishery is practiced during November and March, in which octopuses get closer to the coasts, and there is a 1,000g minimum legal catching size.

5. Octopus Fishing Methods

The fact that octopus is a product having a high economic value among other seafood products has been influential for the development of new fishing methods particular to this species. The fact that the octopus is a habitat-dependent species and its interest to the nest-like objects left to the sea lead to that the fishery of this species can be practiced with traps and diving.

5.1. Octopus Pots

Octopuses are among the most curious livings in the sea. Since it is a nest-dependent species, it exists with its nest. The octopus which usually stays in its nest in the daylight prefers the night to feed. Many objects which are left to the sea by humans and are appropriate for nesting are visited by octopuses and can be used as shelter during the day. This behavior enables that octopus can be caught with the pots and boxes left to the sea. While building the fishing tool, pots made of clay, tin cans and PVC pipes are tied to a main body and left to the sea, and fishery is practiced with checking these pots once in 2 or 3 days (Figure 2). Fishing depth varies between 3-10 m in which the octopuses come closer to the coast in winter. This method is a fishing tool special to the species and the fact that the octopus is taken to the deck alive provides the opportunity to leave the octopuses which are smaller than the legal size back to the sea.



Figure 2. Octopus pots (<http://static.panoramio.com/photos/original/1510324.jpg>)

The most important problem of this fishery method is the difficulty of storing the pots and boxes on the boat. For this reason, the pots are left to the sea again and are not carried to the port after checking in this fishery method. On the contrary to the other fishery tools, the pots of which floatings shear off and which are lost can be used as nests and provides the opportunity that octopuses can settle and take shelter.

5.2. Octopus Line-Hook

Line-hook, which are among the moving fishing lines group, are used for octopus fishery with affixing some attracting devices. An octopus line-hook comprises of shiny metal pieces cut in the shape of a fish, triple fish hooks, and straight fish hooks of 1/0 size and weight tied in an order to the end of a stick. In the fishing line body, 100mm monofilament fishing strings are used. By casting the boat drift on the sea grass of usually 10-20m depth, it is enabled that the fishing line is dragged on the bottom. The metal plates tied to the main body at certain intervals shine in the water and look like fish caught at the fishing line, and the octopus is rolled to the longline while trying to reach this catch. Then, it is stuck to the triple fish hooks and the fish hooks in the end of the stick, and caught (Figure 3).



Figure 3. An octopus caught with the octopus line-hook

In this method used in the daylight, a fishing line which passes by a nest attracts the octopus in the nest and moves it towards the longline. Octopus fishery with this method is practiced intensely during September and November in the Middle Aegean Sea. The most important problem of this method is that the octopuses smaller than 1000 g are caught with the fishing line and cannot be left to the sea again.

5.3. Diving Method

Octopus fishery with diving is an intensely used method in November and March in the Middle Aegean Sea. Octopus is a nest-dependent species and spends the day in hiding in its nest. Many fish species are natural predators of octopus, for this reason nest is the most important defense area for octopus to survive. The diver uses the free diving method until 12-15 m and the surface supply diving method for the deeper, locates the octopus nests and hunts the octopus using a spear gun or a skewer (Figure 4).



Figure 4. Diving method for octopus

In this method, driving octopuses out of their nests are made possible using some chemicals (CuSO_4). The most important problems of this method are that the chemicals used subside down in the nest and that the nests are devastated. Besides, the octopus in the spawning period lays its eggs in the nest and provides fresh water to the nest during the incubation period. The chemicals left to the nest in the spawning period leads to the devastation of the nest and affects the population's growth negatively.

5.4. Fyke Nets

Fyke net, which is among the group of Traps in fishery tools, is a method used for the fishery of species which migrates vertically or coastwise. It is used intensely for the fishery of cuttle fish, octopus and sea bass especially in fishgarths between 0-10 m of depth. The octopus enters into the fyke to eat the crabs stuck in the fyke nets and gets caught. Leaving fyke nets in the sea for a long time causes that the floating shear off and are lost in the sea and that these traps continue fishing as ghost fishing tools. Therefore, leaving the fishing tool in the sea permanently causes that the fish in the region change their migration path and that the fishing methods in the region collide with each other.

5.5. Trammel Nets

Trammel net is a fishing gear which is among the passive fishing gear which are not banned during the whole year. At the same time, it is the most used fishing method in the Turkish coasts. The fishery of many species is practiced using trammel nets in the night. The octopus is caught as by-catch species using trammel nets. The octopus gets closer to the trammel nets to eat the fish caught in the trammel nets and is caught. Although trammel net is not a fishing tool peculiar to the octopus species, it has an important role in octopus fishery in the littoral region during the winter time.

6. Conclusion

Commercial octopus fishery in Turkey is practiced as by-catch species using troll and drag nets, and as target species using small scaled fishery methods. Octopus fishery starts with September and ends in March in the whole Turkish coasts. This period is octopus' spawning season in the coastal water. The fishing of the octopuses which are smaller than 1000g and cannot reach the first breeding size in August and September using octopus longline and diving methods and fishing of the octopuses which migrate to the shallow water in order to breed in December and January, their breeding season, affect the octopus population negatively. There is not any study regarding the population distribution of the octopuses in Turkey. Regulation of the fishing methods with stock assessment of this animal, which has a short lifetime, within the fishery management will provide the opportunity for the sustainable fishery of octopus.

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TURBOT FISHERY

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1. Introduction

Turbot prevails as *Psetta maxima* and *Scophthalmus rhombus* (Fisher *et al.*, 1987) along the coasts of the Atlantic Ocean across Europe and North Western Africa, especially in North Sea and Mediterranean sea. *P. Maxima* and *S. rhombus*, subspecies of turbot are known to inhabit the Black sea (Nielsen 1986). *Scophthalmus maeotica* (Pallas, 1811) is an endemic species in the same sea, inhabiting the Black sea and Azak sea as the most prevalent of all the present turbot species (Mater *et al.*, 1989, Zengin and Düzgüneş 2003).

According to the long term data of the nations which have fisheries sources in the Black sea, much of the annual turbot production there is supplied by Turkey (71%), followed by Russia (19%), Bulgaria (7%) and Romania (3%) (Pradanov *et al.*, 1997).

Turkey ranks as the first and the most leading country to catch turbot (2700 tons per year) 29–60 % in the 27th region including 26 European and Mediterranean nations and the 37th region composed of the Black sea countries, according to FAO's statistical sub regional system (Anon. 2002).

The major fishing region is the Black sea with a total of 74% of all Turkish seas output. The Black sea produces 95% of all turbot catch in Turkey, followed by Marmara and Aegean seas (5.9% and 0.4%), respectively. The total percentage of turbot in other species commercially captured in the Black sea is 0.7%, though its market value is much higher than that of other commercial fishes (Zengin 2000).

In commercial fisheries in Turkey, turbot is caught as a target species using single walled tangle nets. Previously, longlining used to be preferred in fishing turbot as a target species. However, longlining has been banned since 1993. Turbot is captured as a bycatch by trawl and purse seine nets. On the other hand, spears and handlines are used to catch turbot in game fishing. Turbot is universally captured as a target species using tangle net, trawl and fyke net and as a bycatch by trawl, beam trawl, demersal boat seine, Danish seine and trammel net. Zengin (2000) reported in his study that tangle net is a major gear which is used in turbot fishing with a catching efficiency of 71.8%. Turbot is reported to have been caught by 26.1% and 2.1% using trawl and purse seine nets as a bycatch species, respectively.

Insufficient output of turbot has increased its price, economic value despite domestic demand in recent years. Consequently, imports of turbot have been started with fresh and frozen turbot of 5,194 kg being imported in 1996 (Anon, 1997). Its high commercial value has encouraged farming processes as a target species in many nations (Moteiki *et al.*, 2001). Because turbot has a desirable growth performance in aqua cultural processes, research into its farming has been accelerated. The fact that turbot with a high ratio of growth can adjust itself to controllable environment comparatively easily and shows resistance to diseases has increased interest in research on farming processes. Western European countries and Ukraine have successfully performed aquacultural activities concerning Atlantic turbot, *Scophthalmus maximus* and Azak turbot, *Maeticus* over the last two decades, respectively (GEF-BSEP 1996). Such processes were initiated in Turkey in 1997, with the Project of Development of the Black sea Culture Fisheries being continued in technical cooperation between Japanese (JICA) and Turkish (TKB-TÜGEM) governments in Central Fisheries Research Institute, Trabzon, Turkey. The Project aims at research and study into breeding larvae of flat fishes and related techniques and processes and promotion of aquaculture along the Black sea coasts of Turkey as well as breeding and introduction of young individuals into current stocks. Turkish fisheries regulation circulars issued by the Ministry of Agriculture and Rural Affairs impose a series of legal proceedings and regulations which can be categorised into three groups, the first of which is an allowable fish length, the second on location and time of fishing and the third on quality and properties of fishing gears.

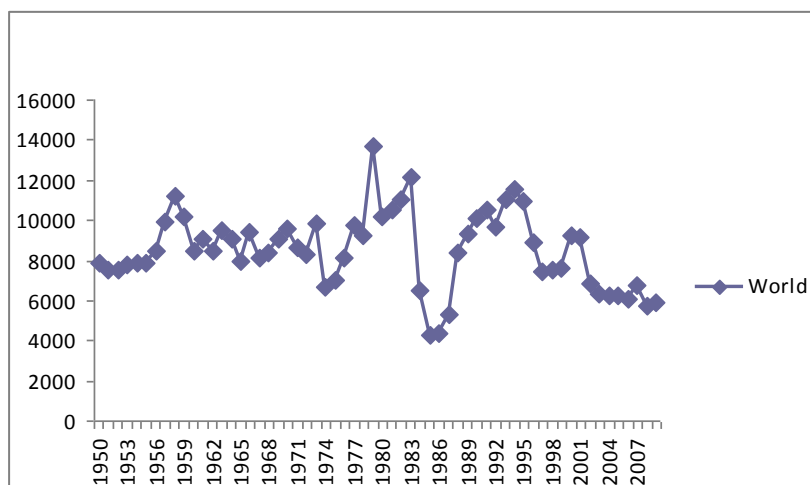


Figure 1. Total catch of turbot in the world between 1950 and 2007 (FAO 2000)

Amounts of turbot caught in the world is shown in Figure 1, with a minium of 4,236 in 1985 and a maximum of 13,701 tons in 1979. According

to the records between 1950 and 2009, the average value was about 8515 tons. (Figure 1), with a minimum of 497 and a maximum of 5,408 tons in Turkey in 1985 and 1983, respectively. Between 1957 and 2009 when records were kept, mean value was 1,903 tons. On the other hand, from Black sea region where 95% of the total output was captured, minimum and maximum harvests were 300 and 5,398 tons in 2003 and 1983, respectively, with a mean value of 800 tons (FAO 2000).

It is clear from Figure 2 that there has been a decrease in turbot catching both at home and in the world in recent years. Share of the output from the Black Sea in Turkey tends to decrease as well, which does not mean that catching efficiency in all Turkish seas but the Black sea has increased. There are two reasons for this; the first is that imports of turbot has increased. The second is that Turkish fishermen buy turbot from those who have caught them in the other nations of the Black Sea and come back home to Turkey. The process of purchasing turbot generally occur in international territorial water. Turbot bought from foreign fishermen is not brought to customs as if it was captured by Turkish fishermen.

Regarding time, location and fishing gears, bans and prohibitions are as follows: Turbot is banned to be captured using all sorts of catching gears across all territorial waters of Turkey between May 1st and June 30th every year, during which longline and trammel net are prohibited to catch turbot. Individuals of 40 cm long and above are allowed to be captured, with small individuals below being legally caught by 5%. Turbot recorded to be stocked after caught prior to the date of fishing ban by provincial and country directorates of the ministry concerned are mandatory to be marketed within seven days at the latest from the date of the fishing ban. The regulations to be applied to game fishing processes between 2008 and 2012 establish that minimum length of turbot be 40 cm with an exception of 5% in length and only 2 individuals under the concerned length (Anon. 2008).

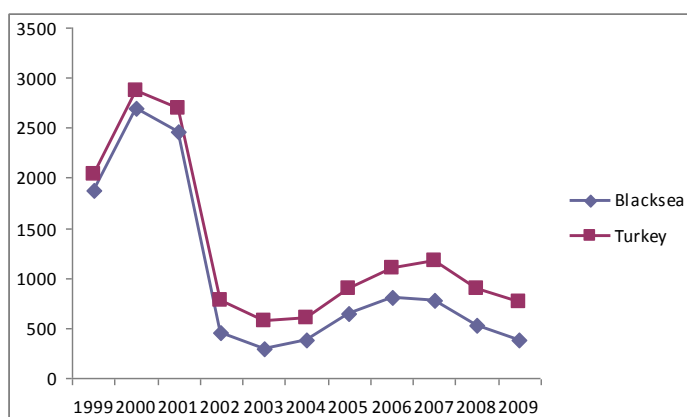


Figure 2. Total catch of turbot in Turkey and Black Sea from 1999 to 2009 (FAO 2000)

Yüksel (2007) reported that fisheries significantly progressed in Trabzon, one of the most important cities on the Black sea coast during 15 and 16th centuries of Ottoman Empire and every kind of fish were levied under Ashar taxation. Modern historians assert that catching processes were suggestive of development of fisheries in those years. Salname in 1888, an information on city of Trabzon reported that turbot was the first and most important species to be captured of all. On the other hand, another Salname of 1900 ranked the turbot as the first to be caught and exported from Trabzon.

Kahraman and Dağlı (2008) reported that Evliya Çelebi's travel notes include information on fisheries processes as one of the most significant businesses in Trabzon and on turbot as the important species to be abundantly caught and consumed. Deveciyan (1926) stated that turbot was caught and sold between Inebolu and Hopa ports along the Black sea coast. Acara (1985) noted that fishing turbot in modern sense started in 19th century, with gill nets being used in relatively shallow waters of 40-50m. The author also said that when business of fishing turbot became efficient and profitable, trawls were replaced by gillnets in some fields by the late 1960's and therefore turbot catching further flourished thanks to more efficient and economical methodologies.

2. Turbot Fishing Gear and Methods

2.1. Turbot Fishing with Single Walled Tangle Nets

It is known that commercial turbot fishing is performed all the year round but increases during given periods to reach a maximum between January to June in particular. The period between March and June is the highest of all in catching efficiency. Zengin (2000) noted that 87% of turbot is captured in the Black sea in January-June period. However, 74% of turbot is caught in April-June period. Genç (2002) reported that turbot fishing is less than in other seasons with spring months showing a maximum performance especially during April and May when turbot migrates to shallow water to spawn. Koca (2001) reported that 46,9% of turbot is caught by gillnets during April-June period in Sinop. Samsun *et al.* (2007) noted that turbot catching increases from January and reaches a highest level in April, adding that 43.8% of turbot is captured using gillnets in April and May. Tonay and Öztürk (2003) reported that turbot catching season is April, May and June in western coasts of the Black sea in Turkey. According to Pradanov and Mikhailov (2002) much of the turbot was caught in spring (April and May) along the coast of the Bulgarian Black sea region.

Turbot nets are typical catching gears which are single walled tangle nets with a hanging ratio of 0.30 – 0.38 and 0.33 – 0.41 in float and lead lines, respectively, the reason for which between them is that lead line is a little longer than float line by 5%.

Mesh size of turbot tangle nets used in Turkey is 160, 165 and 170mm in mean lengths; Sağiroğlu (1985) reported a mean of 160 – 200mm, Tonay and Öztürk (2003) 160 – 200mm, Mengi (1977) 190 – 200mm, Hoşsucu (1991) 200mm, Erdem (1996) 120 – 160mm, Çelikkale *et al.* (1993) 180mm, Zengin (2000) 140 – 180mm and Samsun and Kalaycı (2004) 140 – 185mm, with a mean of 160mm. Although twine width of turbot tangle nets ranges from 210d/6 to 210d/12, it is generally 210d/9. Height of mesh size in turbot tangle nets set up for catching varies between 5 and 13.5 meshes, with a mean of 6.5 – 7.5 in height.

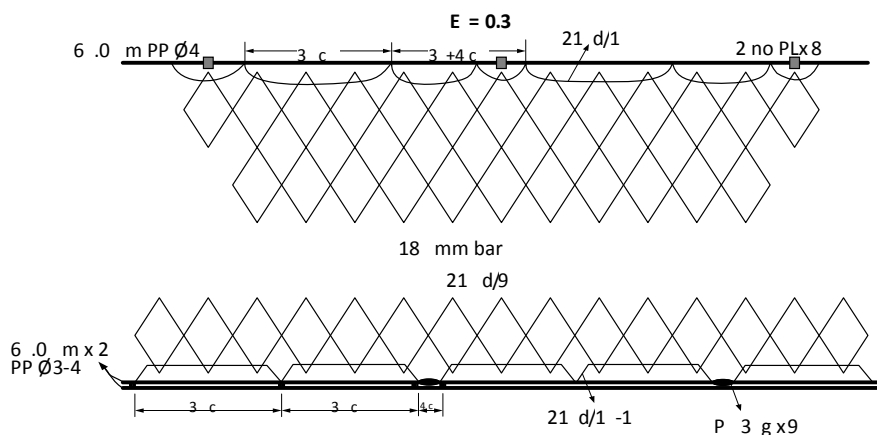


Figure 3. Structural properties of single walled tangle nets used to catch turbot.

A turbot tangle net set is usually composed of 40 units of net which are attached to one another in series, each of which is generally about 60m long. Number of sets of turbot tangle nets varies depending on size of the fishing boats used to catch turbot. Fishermen often have sets of tangle nets for this purpose, one of which has already been thrown into water.

They throw the net set prepared earlier into sea first then haul the already soaked one aboard to return to the port where they would clean and prepare the net sets for turbot fishing again. The process can take 1-2 days depending on the length of the turbot tangle net. The soaking time of the nets is about 6 days after thrown into water, ranging from a minimum of 5 to a maximum of 10 days, which could of course be affected by both market and meteorological conditions.

Main buoys to determine the position of the tangle nets in catching turbot and intermediary buoys are also used as identity tags in Turkey. Flags on buoy poles are different in shape, colour, symbol, signs and floats or buoyants for every fisherman. There can be marks and tags on the same buoys made of various materials. Every fisherman can easily recognise his own buoys and

distinguish them from others as identity tags. With sizes of boats and engine powers increasing in recent years, number of sets of tangle net thus total tangle net lengths, soaking times and depths of the catching gears have also been increased. According to the previous literature by Mengi (1977), Hoşsucu (1991), Çelikkale *et al.* (1993) the above-said values were less than those in recent years. On the other hand, mesh size has been much less than those previously used in turbot fishing. Considering interviews with fishermen and studies made such modifications in tangle nets can be attributed to the fact that catching efficiency has been gradually decreased while number of fishermen engaged in turbot fishing activities increased.

Bycatch and discard species; Turbot is the target species captured by single walled tangle nets in Turkey, which can also catch discard and by catch species that we call undesirable fish. Observations and studies found the following discard species along the west Black sea line between Kızılköy and Kefken. Studies by Kara *et al.* (2004) contributed to the identification of the species as well; Discard species are *Tursiops trunculus*, *Phocaena phocaena*, *Squatina squatina*, *Squalus acanthias*, *Scyliorhinus canicula*, *Alopias vulpinus*, *Gymnura altavela*, *Raja clavata*, *Dasyatis pastinaca*, *Squalus blainvillieri*, *Neolithodes grimaldi*, *Mytilus galloprovincialis*, *Venus gallina*, *Rapana venosa*, *Cancer pagurus*, *Eripha verrucosa*. Bycatch species are as follows: *Acipenser guelden staedti*, *Acipenser nudiventris*, *Acipenser stellatus*, *Acipenser sturio*, *Scaphthalmus rhombus*, *Platichthys flesus luscus*, *Lophius piscatorius* ve *Eripha verrucosa*, *Rapana verrucosa*.

Samsun and Kalaycı (2004) captured turbot of 1957 kg using a set of single walled tangle net composed of 40 unit nets of 60m each in Sinop province (central Black Sea region). They found CPUE to be 0.489kg/60m net-operation using 0.62 kg/60m net-operation, 0.08 kg/60m net-operation, 0.22 kg/60m net-operation and 0.42 kg/60m net-operation (operation = soak time) in spring, autumn, winter and summer, respectively with seasonal variations. Percentages of catching efficiency in a yearly period were 46%, 5.89%, 16.71 and 31.4% in spring, autumn, winter and summer, respectively. The authors also found that 54 fishing boats captured turbot using single walled tangle nets of a total of 260,000m composed of 3,413 unit net (60m in length). Tonay and Öztürk (2003) reported that 204 fishing boats at 12 fishing ports catch turbot using some 25,000 units of net with each being 60 fathoms (108m). Kara *et al.* (2004) found that in terms of CPUE records of the study made in western Black Sea 0.520kg turbot was caught with a CPUE=0.520kg/60m net-operation (operation = soak time) between early April and late June in 2000–2003. There is no evidence of CPUE for single-walled tangle net to catch turbot.

3. Angling Turbot

Handlines used to catch turbot are sorts of bottom hook and lines which are shown in figure as sets of handlines employed to fish turbot across Turkish seas. Turbots generally prefer sandy sea bottoms. The period of time for angling turbot is generally between November and May. Sets of handlines shown in Figure 4 usually have 2 or 3 branch lines attached to the main line. Branch lines can range between 4 and 6 in number. However, if number of branch lines is three or more, lead or any other sinkers can be added to the main line just above the swivel. Weight and number of sinkers can be increased based on number of branch lines attached. Additional sinkers or pieces of lead are attached to the main line so that the section below the swivel could remain on the bottom. Number of the lead used on this section can be 1-3, with a total weight being 50-150gr. The set of hand line in Figure 4 is widely used to catch turbot, having a branch line with a hook on it under the lead weight. However, number of branch line on the main line is 1-3 above the lead or sinker. If number of branch lines is more than one, lead or sinkers are added to the main line above the swivel, being heavier than others though of the same type. All sets of handlines can have 1 or 2 colored or phosphorous beads attached to the heads of the hooks to attract attention of turbot at night in particular. Some sets of handlines can be combined with a grip lead or a breakaway lead instead of using other sinkers or lead weights. If necessarily used, weight of such sinkers is less than other ones. Turbot handlines generally have hooks galvanised or made of chrome with straight and long heads, ranging from 1/0 to 4/0 in size.

Handline is not usually thrown away ashore and 10-40m is an ideal distance from the point where the fisherman stands. Baits can be pieces cut out of fish or complete fish, among which horse mackerel is the most suitable in that it is hard enough to be tangled on the hook, easily available anywhere, cheap and efficient in catching. Anglers usually have 5-10 sets of lines which are thrown in intervals of 10-20m between one another in water. Sets thrown into water are stabilised somewhere ashore. The main line has a variety of signalling devices to show that the fish has been captured under water. Turbots are generally caught more when sea surface is a little rough and wavy than when it is calm or rough. Angling for turbot can be performed both ashore and aboard at sea using the same angling gears

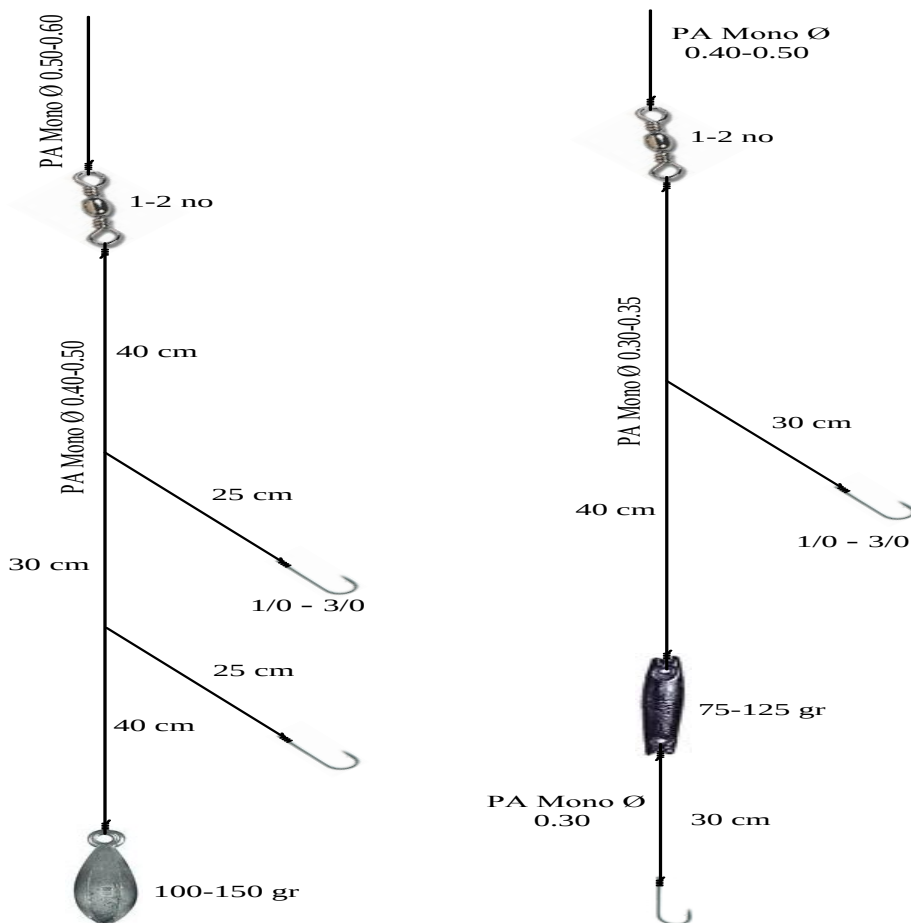


Figure 4. Turbot handline

3.1. Catching Turbot with Spears

Spearing turbot is performed in February-July period when turbot approaches ashore in particular. The head of the turbot generally lies towards the shore on the bottom and its body is wholly or partially covered with sand. Water movements and waves create parallel striations along the shore in up and down sections which are disturbed when the turbot has buried itself under the sand with a slight protrusion on it. When the fisherman has noticed it, he plunges or throws the 2-4 barbed point-spear into the sand under which the fish lies and catches it. Divers can also use a variety of air or gas powered or elastic powered spears for turbot which tend to move slowly with their body loaded with eggs. Turbot fishing is occasionally easy to perform by manually groping the sand heap on the bottom just because the prey has probably been covered under.

3.2. Fishing With Feet

Ordinary people or fisherman can step on the turbot covered under the bottom sand firmly hold it by feet while wading through shallow water, catching it with his hands and throwing it ashore or putting into a net tied to his waist to continue the same process. Ordinary people enjoy such a catching activity when they bathe in the sea during summer holiday. Professional fishermen fishing with feet wear a special glove on one of hands and use long iron hooks with twisted tips. Fishing with feet is to catch sole and plaice in the same way as in catching turbot. In addition, young individuals of gilthead seabream can be captured by fishing with feet using noisy devices in and around the catching area. The fishermen wading in water step on juvenile gilthead seabreams and grasp them after they have hidden themselves under the bottom sand because they are scared of the sounds and movements that the fishermen have produced. According to Brandt (1984) the process of fishing with feet has been widely performed along Friesian shores of the North Sea to catch turbot, sole and plaice. It is also reported that fishing with feet is used across Pacific coasts of India and America as well as some Asian and Australian regions to capture various fish species.

4. Turbot Fishing with Trawl

All sorts of trawl uses for fishing are prohibited along the territorial coasts from Taşkana cape, Ünye county, Ordu province, to Georgian territorial waters, between Inceburun cape, Sinop province and Çayağzı cape, Yakakent, Samsun province and from Ereğli port, Zonguldak province to Tarlaağzı port, Amasra, Bartın province.

Two or more boats are banned to use bottom trawl across regions officially open to fisheries. Bottom trawl gears are prohibited for fishing activities within three mile zone along the coasts open to trawl uses all the year round and off the three mile zone between May 1 and September 30, for all sorts of fisheries. Trawl gears whose codend mesh size is at least 40mm and flapper mesh size at least 80mm are allowed to catch fish.

Studies on catching efficiency of bottom trawl in the Black sea showed that the most available species to be caught are red mullet and whiting which are both target species for trawl fishing in the Black sea. Turbot generally ranks as 3rd to 6th in percentage of catch amount. Surveys performed by trawl gear in the Black sea can summarise percentages of turbot in total catch compositions as follows: 2.49% (Kutaygil and Bilecik 1979), 2.3% (Kara *et al.* 1991), 2.4% for 1990, 1.5% for 1991 and 1.3% for 1992 (Bingel *et al.* 1995), 1.2% for 1991, 1.6% for 1992, 2.5% for 1993, 2.2% for 1994, 1.3% for 1995 and 0.5% for 1996 (Genç 2002), and finally 1.3% (Zengin 2000). Görener (2003) found CPUE to be 8.49kg/day for turbot caught by bottom trawl in Central Black sea between September 2002 and April 2003.

Commercial traditional bottom trawl gears used in the Black sea has a two-piece asymmetric structure, the most significant characteristic of which is that it is produced by combining rectangular web panels with one another in series as well as triangular shape panels called models on the shoulder section to provide horizontal opening in water. Trawl gears are called 700, 800 and 900 mesh nets, the reason for which is that the shoulder section is made according to total number of mesh in the junction with the wing panels, with 800 mesh trawls being preferred in general. Number of mesh is 700-800-900 on the shoulder, decreasing to 150 - 300 in the codend. Wing nets are 10–14m, shoulder nets 9–10m, tunnel 10–12m and the codend 7–9m in trawl gears with a total of 28–40m lengths of float ropes and lead ropes are 22–28m and 28–33m. Ends of the wing panels are combined by the cylindric stakes 40-50cm long and 5-10cm in diameter with ropes tied externally to hand ropes. Boards connected to the trawl warp on each wing. The trawl wings are often firmly compacted to the stakes and therefore can not open wide enough. The stakes are tied to the trawl warp with the external ropes. The trawl warp, or towing rope connects the stakes to the other boards. Trawl warps are 60 – 100m in length, including lead inside as either synthetic or cotton or linen twines. The front section of the trawl belly is completely combined with the wings. The wings and triangular models are tied to the float line and the lead line. Trawl gear is of a conic shape narrowing from the wings down to the codend. Similarly, number of meshes in the nets decreases towards codend with rope width of the twine increasing. The lead rope is longer than the float line in trawl gears. The wings have triangular walls in shape and their heights increase from the stakes down to the trawl belly. The mouth of the net is elliptical in form, becoming oval down to the codend. Because trawl net panels are not combined with strengthening metal wires, they are made on a mesh-to-mesh basis. 60 – 80kg in weight, trawl otter boards are 150- 170cm x 75 – 85 x 5cm³ wooden material framed with iron stretchers over them. There are two steel rope sets of 500 – 700m in length and 8 – 16mm in diameter which are wound over the wire drums. Bottom trawls in the Black sea are normally towed aboard at a rate of 2 – 3 mile/hour for 60 – 90 minutes.

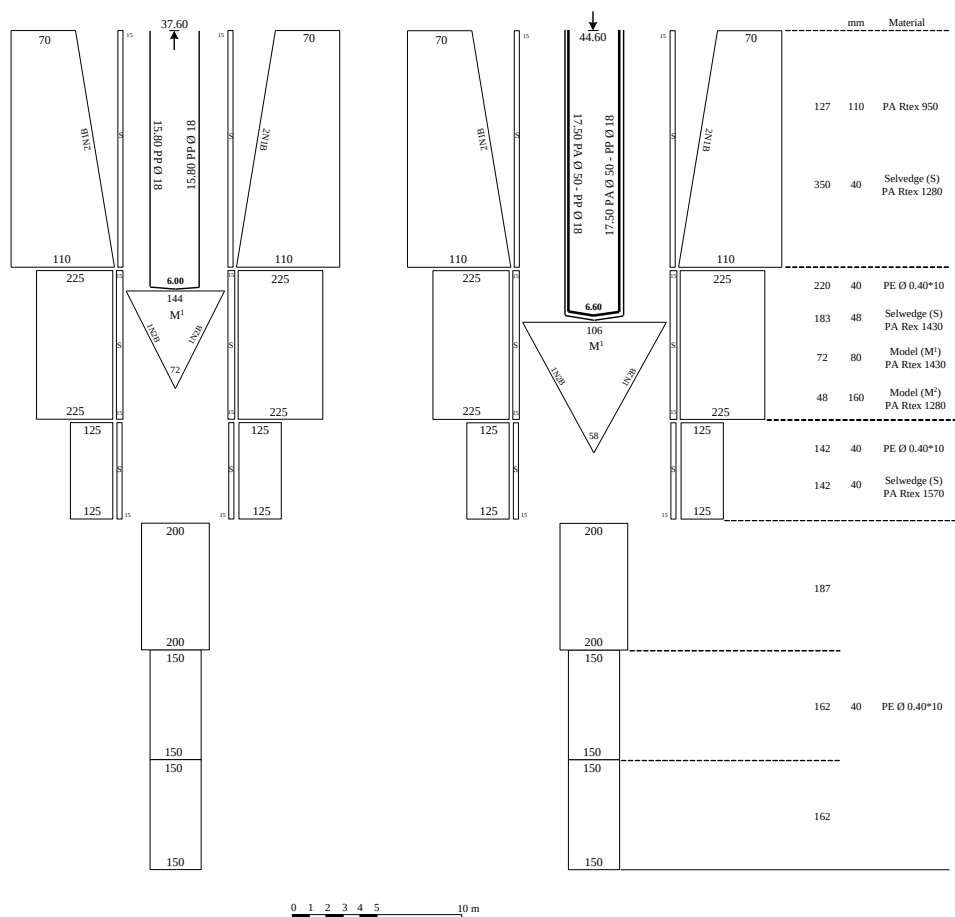


Figure 5. Structural aspects of trawl used to catch turbot (Tokaç *et al.*, 2005)

5. Catching Turbot with Longlining

Turbot can be captured using longlining which has actually been banned in Turkey since 1993. The longline equipment was composed of a set of 250 – 300 hooks tied to the main line with branch lines of 50 – 60 mm at 2,5 – 3m intervals. Longline hooks have white, straight and thick metal shank (1/0–4/0 mostly 3/0 size). Baits used to catch turbot in longlining are usually pieces of horse mackerel, garfish, blotched, picarel, anchovy, sprat, whiting, smelts, etc. Generally, cheap and abundant species are chosen as bait to catch turbot. Soak time for longlining is about 24 hours. Longlines equipped with less hooks are collected every two days after thrown into water. However, longlines with more hooks (over 2000 hooks) require throwing line into sea from the first to the last buoys and then returning to the first buoy to haul the longline back aboard. Greater longlines can take 2 to 3 days to throw and haul. Buoys are equipped with sings and marks or tags to specify their owners of the longlining devices.

Performance of catching turbot is higher in pre and post-spawning than in other seasons.

Longlines are often used in depths of 60–120 m which is determined by migration, habitats and feeding habits of turbot. The deeper water, the bigger individuals are captured which are demanded more greatly than smaller ones in the market. Longline is equipped with main buoys at the beginning and at the end of the main line. According to length of the longline, intermediary buoys can be tied to the main line at specified intervals. The main line can be properly placed in series using additional sinkers such as lead or stone at a given intervals.

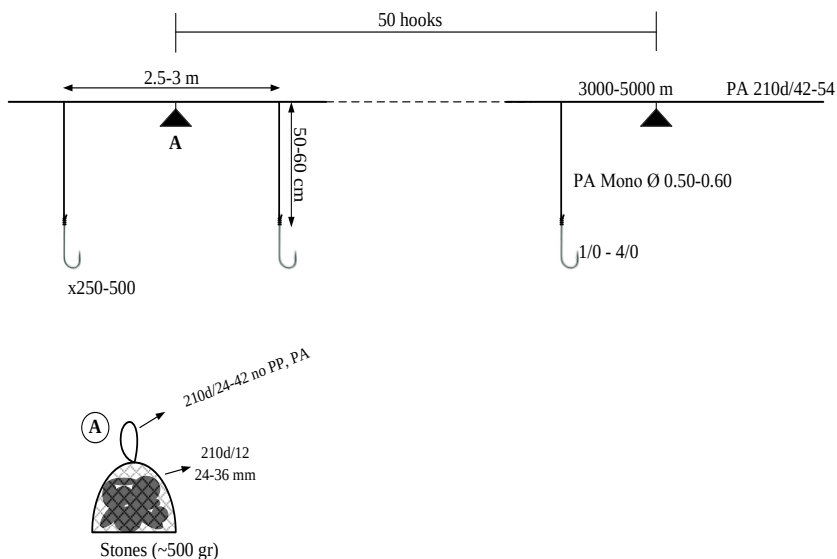


Figure 6. Structural characteristics of longline used to catch turbot

Longlining process is more difficult to perform and therefore requires more effort than any other fishing activities. Turbot often swallows the baited hook which is difficult to extract out of the fish. Therefore, the branch line should be cut off close to the hook. Lost or swallowed hooks need to be replaced by new ones or branch lines should be reequipped with new hooks or tied to the main line and occasionally bait can be replaced, which are all difficulties to cause time and effort losses as negative and undesirable aspects of the longlining process. The longlining actually calls for skilled and experienced fishermen to be capable of working efficiently and rapidly.

Longlining can capture sharks and rays as bycatch as well as plaice, angler fish, John dory and gurnard (Personal interview with a fisherman Kadir Ögüç from Garipçe, Sarıyer-Istanbul). On the other hand, It is reported that dolphin and sturgeon caught as bycatch using tangle nets are not captured by longlining.

6. Conclusion

Turbot is generally captured across all shores of the Black sea using bottom tangle nets and with bottom trawl gears especially where trawl fishing is officially allowed. Turbot is caught by trawl nets during catching season while it is captured by gill nets in shallow waters during spawning. Acara (1985), Ivanov and Beverton (1985) and Zengin (2000) reported that gill nets are often used in neritic waters of Turkey whereas bottom trawls are preferred in Sinop and Samsun bays from west of Sinop towards neritic sea sections of Bulgaria, Romania and Ukraine where continental shelf expands. Because the Black sea continental shelf significantly expands in the northwest, turbot is captured in international water as well as across regional shores using bottom trawls. Samsun (1995) stated that turbot and other bottom fishes of economic value are always caught by bottom trawl nets with officially accepted 20mm mesh size in the Black sea regions where trawl fishing is allowed. Zengin (2000) reported from his study that total length of turbot caught by gillnets ranged from 31 to 61cm with an average of 42.8cm, adding that those captured with trawl nets showed total length between 20 and 56cm with an average of 35.3cm.

Ivanov and Beverton (1985) suggested that minimum mesh size of gillnets used to catch turbot should be 180mm for sustainability of turbot stocks in the coasts of the Black sea regions of Bulgaria and Russia. Erdem (1996) reported that turbot reaches to sexual maturity at 3 years of age in and around Sinop region in the Black sea with a mean length of 36.59cm, suggesting that turbot individuals of at least 3 years and 40cm in length should be caught in view of the sustainability of the population and reporting that gillnets of 184,5mm bar length is more suitable than others following the selectivity study involving turbot gillnets. Zengin (2000) noted that the length of first sexual maturity is an average of 34.6cm (min., 31.8 cm max., 37.5cm) and 38.8cm (36.7-40.9) for males and females, respectively with turbot reaching sexual maturity at 3 years of age and recommended that optimum length for catching turbot should be over 40cm and 172.5mm bar length should be used for gillnets considering correlation between total length and height of the fish. Kara *et al.* (2004) reported that gill nets with 170mm bar lengths had a mean catching length of $L_{170} = 50.66\text{cm}$ and minimum bar length mesh size could be 170mm which is sufficient for turbot to be captured.

There are few studies made on structure of gillnets and tangle nets used to catch turbot across the world, some of which are those by Potter and Powson (1991) England, Lowry and Teilman (1994) Denmark, Kastelin *et al.* (1999) North Sea, Brothers (2002) Canada, Stankus (2003) Lithuania and Florin (2005) Baltic Sea (Polland, Lithuania, Sweden and Russia). The mesh size (bar lengths) of the gillnets used in the above-mentioned nations are much less than those used in Turkey. The reason is that by-catch species caught together with turbot are desirable almost everywhere but in Turkey. The bar lengths of tangle nets

used for turbot are as follows; 190 - 200mm, (Mengi 1977). 160-200mm, (Sağıroğlu 1985). 200mm, (Hoşsucu, 1991). 180mm, (Çelikkale *et al.*1993). 120-160mm, (Erdem, 1996). 140-180mm, (Zengin, 2000). 160-200mm, (Tonay ve Öztürk, 2003) and 140-185 mm with a mean of 160 mm, (Samsun and Kalaycı, 2004).

Laws and regulations of Romania, Bulgaria and Ukraine in the Black sea determine that mesh sizes (bar lengths) of the gill nets for turbot should not be less than 180mm (Nicolaev *et al.*, 2003, Mikhailov and Pradanov 2003, Shlyakhov and Charova 2003). According to Turkish fishery regulation circular no 36/1 for 2004-2006 years, bar length of the tangle nets used should be at least 180mm. However, 37/1 no. circular for 2006-2008 years and 38/2 no. circular for 2008-2010 years cancelled the ban for bar length of tangle nets upon the objections from fishermen. On the other hand, the bans of seasonal, longline and trammel nets are still valid for turbot. As with measures and regulations by the ministry concerned with increasing bar lengths, it is recommendable to collect all tangle nets with small bar lengths from fishermen paying for them, which thus enables them to conform to the related laws and regulations.

The reason why longlining is banned for catching turbot is claimed to be that juvenile turbot are abundantly captured by longlines in Turkey. It is also reported that use of big - size hooks rarely benefit reduction of rate of juvenile catch in that turbot have large mouths whether they are mature or juvenile. Professional fishermen used to employ their longlines in deep water (60-120m) to catch big turbot whose prices have always been higher than those of small individuals which find poor demand in the market. However, amateur fishermen previously used longlines in shallow water to catch juvenile turbot especially in spring, summer and autumn, with the result that longlining was banned. On the other hand, Turkish public opinion has become more considerate about such issues as juvenile fish lengths and related minimum standards and freeing catches into water. Thanks to collaborated efforts of various private and public institutions as well as mass-media, awareness of sustainable and responsible fisheries has been positively increased in Turkey. There are some researchers and fishermen who advocate that longline gears should be employed again and related prohibitions abolished regarding turbot catching. Therefore, it seems beneficial to study present and potential impacts of longline gears on turbot stocks in pre-determined areas with given water depths and available periods of time.

In recent years, lengths of tangle nets and their soak times have increased thanks to improvements in fishing boat sizes and their engine horsepower. Moreover, hauling number and times have been considerably increased in trawl nets as well as in angling gears. These are all caused by gradually decreasing catching efficiency, which is supported by numerous studies.

Much of turbot catch used to be captured from traditional fishing areas off Kerch Strait and Danube delta on the Black Sea. In the same period, turbot was caught along the Turkish Black Sea coasts only in spring months. The Agreement of Black Sea Economic Zone signed in 1982 enabled every nation to expand their territorial sea line up to 200 mile off their Black Sea coasts. Involving fisheries processes, the zone has inevitably been under the inspection of Russia, Ukraine, Romania and Bulgaria (Acara 1985). The process associated with Agreement of Black Sea Economic Zone has dramatically affected livelihood of fishermen who catch turbot in Turkey. Samsun and Kalaycı (2004) Great economic value of and increasing demand for turbot has recently encouraged Turkish fishermen to poach across Russian and Ukrainian Black Sea fishing zones and therefore undesirable events have happened between Turkish fishermen and coast guard of the related nations involving turbot poaching.

Economic losses which Turkish fishermen have undergone should be compensated for by Organisation of Black Sea Economic Cooperation and fishermen be financially aided or supported to cover present and potential losses accounted for by the Agreement of the Black Sea Ekonomik Zone which was signed by the Black Sea nations.

The Black Sea nations need to establish quotas to be allocated for every nation to catch turbot after the stocks in the Black Sea have been determined in quantity. Every nation is obligated to make research and studies involving their fishermen to catch turbot, number of boats and catching gears, mesh size and minumum length of turbot to be captured and other associated acts and regulations as well as decisions to be made concerning the above-said issues. Research and studies require collaboration and resolutions to be made as common processes among the related nations of the Black Sea. In doing so, present and potential losses that fishermen would suffer from should be compensated for by the Turkish government and/or the above-said organisation. Economic subsidies and a variety of loans or aids should be created and provided for improvement of catching gears and other banning regulations as well as for those who plan to choose or shift to different fisheries. Regulations and practices of ICCAT for tuna catching will be of great use in studies and watch-up concerning turbot fishing to conclude comparable results.

Recommendations

- 1) The optimal capture size must not be below 40mm.
- 2) Turbot fishing should be banned completely between April 1 and June 15.
- 3) Fishing turbot with tangle nets should be banned in depth more than 40m.
- 4) Specific turbot trawls should be developed to catch turbot as a target species.

- 5) Natural stocks should be enriched with additional young individuals bred in incubation facilities.
- 6) Pilot studies should be performed by banning turbot fishing at least in one of the spawning areas to be determined out in the sea.
- 7) A recording system should be established to collect data of fisheries output including bycatch and captured fish be landed to the specified ports, recorded and brought to fish market.
- 8) Common fisheries strategies should be established together with the Black sea nations and decisions to be made should be accurately complied.

Turbot whose meat is white, succulent and delicious is of great economic value in fish market of Turkey. Turbot is also one of the important species in view of sustaining biodiversity of marine ecosystem. It is of great importance that present turbot stocks should first of all be stabilised, developed and protected in a sustainable way considering its contribution to economy and nutrition value for Turkish fisheries sector.

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EEL FISHERIES

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1. Introduction

Eels have been of great interest since ancient times. Although they have not been found any locations where water is present, interest in the species appeared millenia ago because they were not seen to spawn or breed across the old world where people have long been inhabiting (Alpbaz and Hoşsucu, 1988).

The family Anguillidae, order Anguilliform subclass Antinopterygii (ray-finned fish) includes 17 species, two of which have two sub species. Eels are catadromous, migrating from rivers through other inland water to the sea to reproduce; the young return to the continental shelf as leptocephali where parents left and, having metamorphosed into glass eels, migrate up the rivers. The Japanese eels (*A. japonica*) spawn in mid Pacific. Eel (*A. rostrata*) migrates to the middle of the Atlantice Ocean to spawn in the Sargasso Sea (Ottolenghi *et al.*, 2004).

Eels became commercially important after the World War II had begun. Of 19 eel species in the world, 3 have been of commencial values which are European eel, American eel and Japanese eel. In Turkey, only European eel abundantly inhabits almost all lakes and rivers connected with Aegean, Marmara and Mediterranean seas. On the other hand, Eels prevail in water bodies associated with the Thracian Black Sea coasts and western Black Sea coast up to the Sakarya River. Eel individuals are rarely seen sporadically along the Central and Eastern Black Sea coasts and their related inland waters.

Eels enter into Turkish rivers through sea currents from the southern up to the northern coasts between December and March when the young individuals grow into mature eels for 6-9 years to migrate back to sea and spawn there. Variations in migration periods are caused by higher temperature in water in Turkey than in European sea water. In Europe, eels are generally captured in May-October while they are caught in Turkey during September-October (Usui 1974, Alpbaz and Hoşsucu 1988, İkiz *et al.*, 1998, Güven *et al.*, 2002). Elver catching is not performed in Turkey.

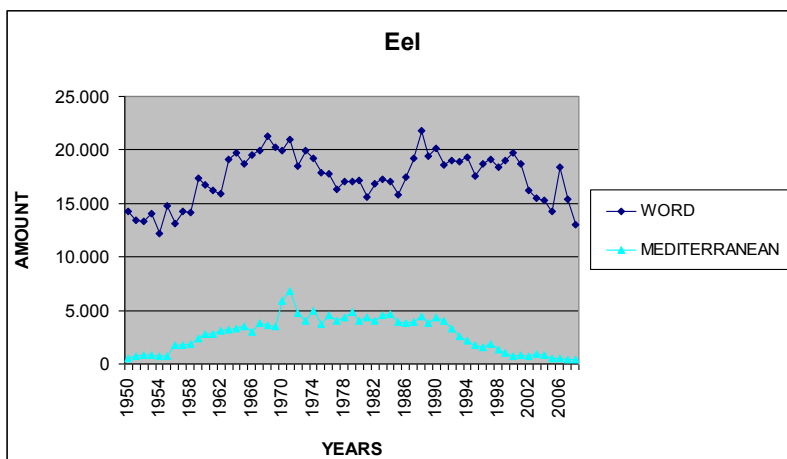


Figure1. Total of eel catch in the World and the Mediterranean zone between 1950 and 2008 (FAO, 2000)

Catching gears and methods used to catch eels across the world are as follows; Brandt (1970, 1984) Without gear, wounding gear, stupefying method, linefishing, traps, fishing by bag nets with fixed mouth, dredged gear, seine nets, surrounding nets, drive-in-fishery and lift nets. Larsen (1971) pound nets, fyke net, trawl fishing, beach seine, longlines, angling, bobbing and eel traps. Koops (1980) refuge traps, eel baskets, fyke nets, pound nets, stow nets, eel weirs, seinen for eels, trawling, puls, angling, spears, poisoning or chemical stupefying. Catching gears and methods used to catch eels in Turkey are as follows; fyke nets, barrier traps and angling (Nümann 1952, Çelikkale *et al.* 1994, Hoşsucu 1998). In addition, bobbing, tubes for shelter and longline are popular. Catching eel with electricity has been banned but special permissions are granted to collect samples for a variety of research and studies for some scholars in Turkey.

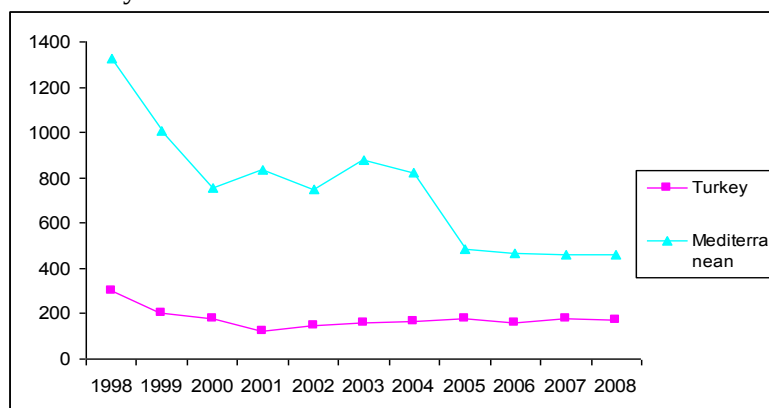


Figure 2. Total catch of eel in Turkey and the Mediterranean zone from 1998 to 2008 (FAO, 2000)

Total catch amount of eel was a minimum of 12,203 tons in 1954 and maximum of 21,242 tons in 1968 with a means of 17,525 tons according to the official records between 1950 and 2008 all over the world. On the other hand, total catch amount of eel in the Mediterranean was a minimum of 459 tons in 2008 and maximum of 6,865 tons in 1971 (Figure 1). In Turkey, minimum 122 tons in 2001 and maximum 756 tons in 1988 were found as total catch amounts of eel, with a means of 344,6 tons between 1969 when official recording was started and 2008 (Figure 2) (FAO, 2000).

2. Fishing Locations and Grounds

Inland rivers and lagoons associated with sea mainly house eels in Turkey, though Aegean and Mediterranean seas are richer in presence of eels including their related inland water bodies. Rivers of Asi, Ceyhan, Seyhan, Göksu, Köprüsuyu, Aksu, Acısu, Manavgat and Dalaman flowing into Mediterranean sea. Demirköprü dam, Bafa and Göl marmara lakes and rivers of Bakırçay, Gediz, Küçük Menderes, Büyük Menderes and Karaçay associated with Aegean Sea. Çekmece lagoons, Manyas and Gala lakes and rivers of Sakarya, Kocabaş (Biga) and Meriç in Marmara region, rivers of Sakarya, Karasu and Kızılırmak in the Black sea region, Hirfanlı dam reservoir, Sakarya and Kızılırmak rivers in Central Anatolia and Fırat (Euphrates), Karasu, Murat and Dicle rivers in Eastern Anatolia.

Skilled and experienced in catching eels in the Mediterranean an Aegean region of Turkey, professional fishermen are those who are currently dealing with eel fishing and engaged in commercial businesses which purchase, market, store and export captured eels. Eel fishermen are mobile catchers looking almost everywhere for eels and equipped with sophisticated marine and land devices. Moreover, there are those who are not themselves fishermen but buy, store and market eels for the fish-processing business to remarket and export processed seafoods. Such professional persons, teams and businesses usually provide fishermen with what they need in fisheries activities, for example fuel, food, equipment, etc. and bring them to catching areas where eels are potentially found or abundant.

Aegean region is where eel catching activities are performed most. Number of fishermen is about 160 including 110 seasonal catchers professionally engaged in fishing eel in and around rivers, lakes, dams and lagoons associated with sea.

In the Mediterranean region, some 30 fishermen deal with catching eels, with their number occasionally increasing to 120. Boats used for catching eels are often wooden and 5-7m in length with 6-9 hp engines aboard. There are also generally 4-5m long flat-bottom wooden boats which can float on shallow waters with fyke nets without any engines. Fishermen engaged in fishing eel

can usually possess both. The eel-fishing team mostly consists of two fishermen (crew) (70%) and the rest is composed of three-man teams (30%).

Other regions of Turkey rarely have any professional fishermen who can catch eels and thus they if at all leave their fishing basins for other locations where longline and handline processes are popular.

Turkish fishery regulation circular establishes that eel fishing be performed under a given quota determined by the related ministry since 2010. Rules and principles concerning eel fisheries under the quota are established by the above-said ministry. Processes and procedures for the matter involved are implemented not on a general but local basis. There are given inland areas where eel fisheries are completely banned. Some equipment and method such as electricity uses are entirely forbidden in areas and regions where eels are or could be found. Minimum length to catch eels is 50cm. In spite of such radical limitations for inland waters, there is not any legal or regulatory banning involving eel-fishing in sea (Anon. 2008).

3. Fishing Gears and Methods for Fishing Eel

3.1. Fishing with Barrier Traps

Barrier traps are gears made up of cones with V-shape passages between a few divisions serially placed along the canal between the lagoon and the sea. Fish enter into the trap through the V-shape passage to go through the 2-3 sections and gather in the last division in which to harvest it using scopes (Figure 3). One of the most important types of exploitation is to use barrier traps to catch fish during their seasonal period of antigenic offshore migration. The lagoon fishery is based on the passage of fish through the important nursery and feeding grounds. Such lagoons are called “Dalyan” and barrier traps named “Kuzuluk” in Turkey. Composed of iron instead of cane sticks, traps are used to catch fish in lagoons such as eel, which is however mostly captured using fyke nets. Therefore, catching efficiency for eel is higher in barrier traps made by iron sticks (for example, Bafa Lagoons).

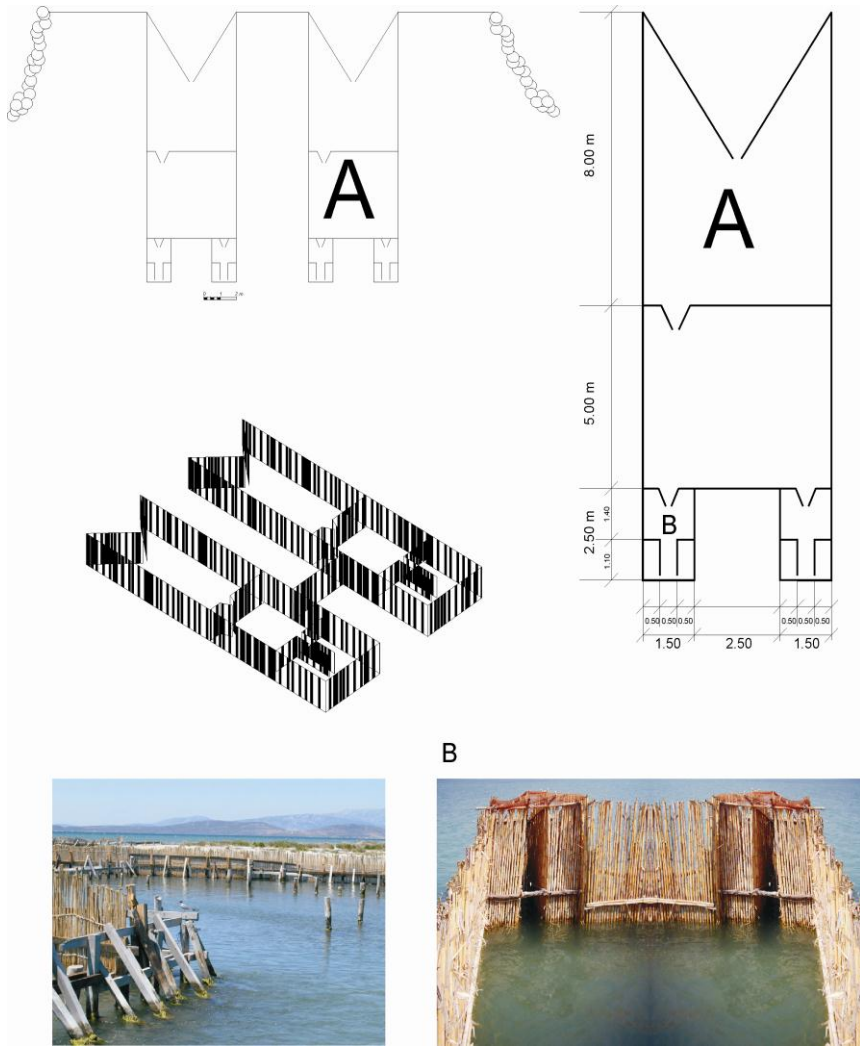


Figure 3. Diagram of construction of barrier trap employed to capture eel in Homa Lagoon in Izmir, Turkey (Tokaç *et al.*, 2010)

Dimensions of barrier traps used in Homa lagoon in Figure 5 are similar to those of other lagoon barrier traps except that iron bar traps replace cane stick ones in Bafa lagoon while iron frames and wire grids are used for the same purpose in Köyceğiz lagoon. Construction of barrier traps made up of iron or cane fences can influence catching efficiency in eel. Intervals between those sticks determine whether eel individuals could pass through them or not. One of the reasons for high catching performance in Köyceğiz and Bafa Lagoon is constructional properties of barrier traps.

In Turkey, there are 14 lagoons still active for fishing processes and host eels to be caught in them. However, performance of catching eel has recently decreased due to the fact that lagoons become shallow, fresh water inflows diminish and thus eel individuals enter less frequently than ever. Köyceğiz lagoon is the only reservoir to show maximum catching efficiency, followed by Güllük lagoon.

10% and 90% of total eel output from lagoons is caught by barrier traps and other gears such as fyke net, longline, etc, respectively. However, this ratio is just the opposite for other fishes captured in the same lagoons. That is, 90% and 10% of total catch are captured by barrier traps and other gears such as trammel nets, gillnets, etc, respectively.

3.2. Angling and Bobbing

3.2.1. Angling

Almost all sorts of live or dead baits can be used to catch eels. In addition, all kinds of fish pieces are also used for this purpose. However, the most efficient bait is claimed to be earth worm which can be easily swallowed by eels. Once caught, the eel can spin around itself to make the line hook useless, which therefore requires a lot of main line and hooks to be prepared for use in case the hooks could be swallowed or broken off the line. Moreover, hooks are recommended to be of straight J type with long shank and ball eye.

In Turkey, eels are caught using all sorts of bottom line, the most popular of which is that equipped with a clips-swivel and one-hook line. Between the swivel and the main line is placed a 10-20gr rip lead. When necessary, a light or normal holed buoy can be attached to the main line (Figure 4). The locations where eel fishing is most efficient are estuaries, grass and reeds on water bottoms of 1-2m depths.

Sizes of hook, species of type of bait and time of catching have on impact on species and number of by-catch and discard fishes. When earth worm is used as bait in particular, catching efficiency is significantly higher for eel than in other bait types. Earth worm enables fishermen to catch small amounts of sea bass, juvenile Gilthead, Sea bream, Grey mullet and occasionally striped sea bream as by-catch. Some other species of bait can capture eel as well but other species can be caught more frequently using different types of baits. For example, Conger is captured plentifully. In addition, crabs can cause losses of bait. Eel is fished using hand line overnight generally when catching performance is highest an hour before dusk and dawn in particular.

Average CPUE was found to be 4 eels/angler-day according to months measured by interviews with eel anglers in and around river mouths of Gediz and Bakırçay.

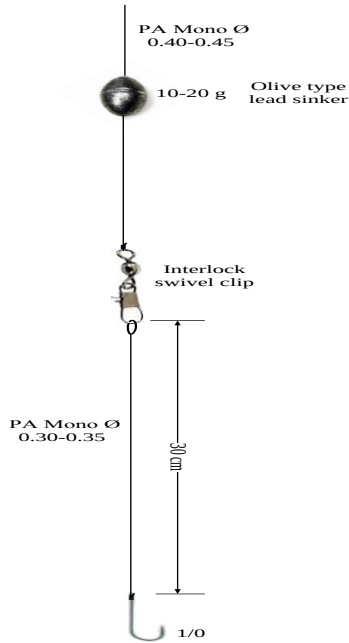


Figure 4. Eel hand line popular to use in catching eels

3.2.2. Bobbing

The bait to be used in eel bobbing is either pieces of fish meat or 30-40 whole worms which are serially passed through a single or double twin made of cotton, hemp or wool. The threaded worms passed over the twine are tied to both ends in the form of a loop of 2m long through which a 3-5m cotton, hemp or nylon line is passed and tied to the wormed loop, which is then wound over the hand and raveled into a bunch weighted with a lead sinker of 30 to 40 gr and finally slowly lowered through weeds into water. When the eel has bitten the wormed loop with its incurved teeth, it can be softly hauled into a wooden box or an open umbrella aboard or ashore. The bobbing equipment is locally called “Zülüf” mostly used in and around rivers connected with sea coasts of Adana, Mersin, Antalya and Istanbul from the southern sealine of the Mediterranean up north to the eastern Black sea (Figure5). CPUE was found to be 7 eels/angler-day as an average value of months based on an interview with an angler who catches eel using zülüf in Seyhan River and its related marine sections. On the other hand, Brandt (1984) reported that bobbing is employed to catch eel in Australia and southern Africa as well as in Turkey.

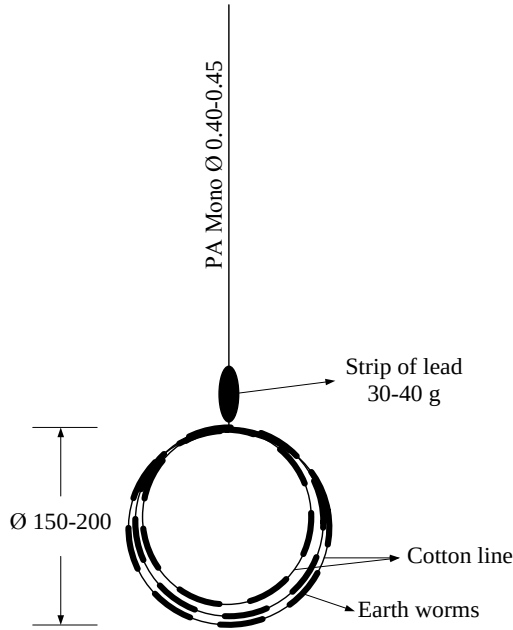


Figure 5. The apparatus without hook which is called “zülüf” in Turkey (hookless handline, eel bobbing)

3.4. Tubes for Shelter in Catching Eel

Eels enter into shelter tubes to hide or save themselves from their predators. Generally they spend daytime in such tubes which are made from bamboo, PVC, clay, concrete and tin (Brandt, 1984). Stove pipes are also used for this purpose in Turkey. One end of the stove pipe is clogged with a cement block. These are pipes made of metal stove sheets and have 80-100cm length, 10-12cm diameter and 2-3mm thickness. However, such metal stove pipes have recently been replaced by narrower PVC pipes with several advantages. Stove pipes are either used as a long series of 10-20 pipes connected to the main line with short branches with a length of 5m between them or employed individually. This sort of trap is used in irrigation canals of Demirköprü dam in Manisa where eels can seldom find shelters to hide in. Stove pipes are therefore used as shelter tubes into which eels are attracted and trapped. Average CPUE was found to be 6 eels/100 tubes-night following observations, studies and interviews with fishermen who employ these gears in this region.

3.5. Fishing with Fyke Nets

Fyke nets are those traps with a long bag covered with a net over the oval metal hoops which become narrower just after the D-shape towards the final smallest hoop and bag-shaped nets held open by hoops gradually smaller in diameter through which eels enter into the conic end and are trapped. In Turkey,

eel is captured using a fyke net called Söke fyke net whose first D-shape hoop and 6 hoops and 3 funnels are serially bound to each other (Figure 6). In addition, German type fyke net is used to catch eels which have 5 hoops and 2 funnels, with the first hoop being D-shape or circular. Oray (1987) tried using the 2 funnel German and 3-funnel Söke type fyke nets to capture eels and reported that the German type showed more successful results in his study in the eastern Mediterranean lagoons.

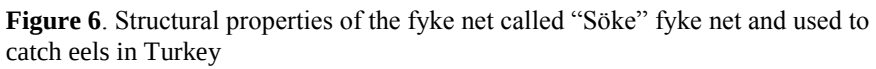
The reason why Söke type fyke nets are preferred to catch eels in Turkey is to prevent eels in fyke nets from escaping or decrease number of escapes. Some fishermen catching eels prefer 2 or 3 funnel German type fyke nets whose first hoop is circular, not D-shape, the reason for which is that such fyke nets prevent moss or other plant materials from covering over and therefore keep the outer sections clean as they turn around on the mossy sea bottoms.

Fyke nets can be set almost anywhere in aquatic environments. Those employed to catch eel are set in and around sides of river mouths, estuaries and lagoons where creeks are blocked or partially closed by sands and pebbles. On the other hand, fyke nets can also be set in rivers and lakes.

Fyke nets can capture eel as a target species as well as other by-catch and discard ones. Number and quantity of by-catch and discard species vary depending on time, depth and locations when and where fyke nets are set. For example, by-catch and discard species captured by fyke nets set in lakes, lagoons, sea and rivers are different as well.

Various factors influence CPUE of fyke nets such as properties of catching area, catching time, construction of fyke nets and their methods of using etc. It was found from the observations and studies on fyke net CPUE's that annual means of CPUE were 7, 34 and 22 eels/100 fyke nets-days for Homa, Izmir lagoon, Köyceğiz, Muğla lagoon and Bakırçay river, respectively. Catching efficiency of fyke nets set in muddy and turbid waters where bottom sand and mud mingled with water is much high than that of other gears. In addition, fyke nets used at night show a better catching performance than those set in daylight.

Water depth and catching time and location are determinant factors regarding catch composition for fyke nets. Those set in and around sea shores to catch eel as the target species can also catch sole, sea bass, mugil spp., sparidae (gilthead sea bream, annular sea bream, common two-banded sea bream, striped sea bream, salema), goby, rays, smelts, scorpion fish as by-catch species.



3.6. Fishing with Longline for Eels

Used for Sparidae fisheries, eel longline is a conventional bottom longline composed mainly of a 0.70mm-monofilament line. Branch line is about 5m in length (Figure7). Along a long line basket includes 100-150 hooks, each of which can be increased up to 200-250. However, use of many more hooks is not recommended. Eel catching is often performed using 5-10 baskets with 100-150 hooks etc. It is important when to use a long line. Generally it is used one hour before dusk and down moon cycles are also effective on catching efficiency which is often much higher during moon dark periods. Soak time of the long line is significantly short. After throwing the long line into water, one returns to the first buoy (main buoy) to begin to haul the catching gear, which takes 1 - 2 hours.

Earth worm is used in long line in general but when it is scarce or unavailable, mammon is chosen as second bait. Types and species of bait determine number and amount of target, by-catch and discard species. It is also important where and in what depth longline is used, which is also effective on catch composition. Longlines are generally used in shallow water of river mouths and in and around lagoons. Catching eel with longline is often performed in and around Güllük lagoon in Güllük bay in September-December. CPUE's of eel longlines used in Güllük lagoon and around its marine sections were found to be 11 and 9 eels/100 hooks-operation, respectively. On the other hand, In estuaries of Büyük Menderes, Küçük Menderes, Gediz and Bakırçay river, fishermen occasionally use eel longline in 1-2m depths, which are usually employed in September-December period.

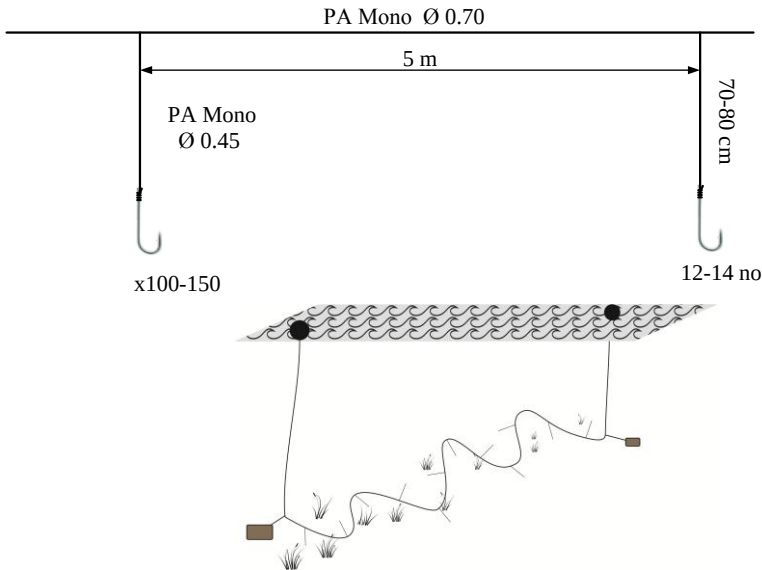


Figure 7. Diagram of the eel longline

4. Conclusion

Eel is a rare species whose farming and thus elver catching is recommended in Turkey by FAO. Because eel is seldom consumed, almost much of eel is exported after captured. Concerns of those who plan on eels farming are about the likelihood that they could not find local consumers in Turkey in case of any failures to export their aquaculture-eels as well as about problems of elver collecting processes. On the other hand, establishment of eel farms is certainly encouraged by the fact that aquaculture techniques, especially close-loop systems have minor impacts on environment and require little land and that market for eel feeds is available in terms of economic return on the market price as positive factors. There are already two established eel farms in Bergama, and Yatağan in İzmir and Muğla provinces in Turkey, respectively. However, interest in this issue is not so high as expected. Construction of new eel farm would tend to increase elver-catching activities just because of the demand for elver. It is of great importance to know when elver enters into Turkish rivers considering that Turkey could be a nation to export elver in coming years.

Elvers reach to Turkish coasts in large schools entering into terrestrial waters such as rivers (Alpbaz and Hoşsucu 1988, İkiz *et al.*, 1998, Güven *et al.*, 2001,2002). Elvers are not captured in Turkey. However, a majority of elvers is perished because they try to climb up and enter through dam turbines due to lack of dam ladders for eels to swim up in rivers flowing into Mediterranean and Aegean Sea.

As seen in Figure 2, total annual amounts of eel captured between 2003 and 2008 were about the same, which means that there is a regular trend. Since March 2002, fishing licenses have not been given to new fishing boats, which is one of the reasons why eel fisheries has not show a regular trend in recent years. In addition, the fact that demand for eel is limited at home or not increased from abroad causes interest and participation in eel fishing to decrease among fishermen and therefore number of fishermen remains stable or at least does not increase.

Catching efficiency is observed to have increasingly fallen when using barrier traps in large lagoons, the reason for which fresh water flow into lagoons has been dramatically reduced by several factors, such as occurred in Homa and Çamlık lagoons in İzmir and Adana, respectively ((Elbek *et al.*, 2003, Acarlı *et al.*, 2009). Reduction of fresh water flow into lagoons causes catching efficiency to decrease in sea bass and sole. Improvement or Restoration of such areas as above is vital for eels to be bred in aquaculture processes.

Water depth is generally shallow in lagoons except in a few ones in Turkey with a range of 0.5 – 1m. Influence of water temperature and sun on eel is significantly high, which causes the fish to move under shadowy parts or into

deeper sections. Various types of brush parks can be constructed in lagoon. For example, Boulders and pebbles are heaped into small mounds of about 10m diameter to form a brush park occasionally combined with bushes. Catching is easier and more efficient in and around brush parks created with a variety of materials combined with boulders and pebbles.

Autumn period including September, October and November is generally overcast and rainy in Turkey when eroded soil and pesticides are mingled with rivers by rainfall, which causes oxygen to decrease, and therefore forces eels and other fishes to move towards sea. Adult eels can be captured using stow nets set around mouths of rivers by the sea during this period when they migrate to sea for spawning. Because stow nets are hardly known or not used in practice, they are not preferred to catch eels, but nevertheless they can be legally used in fisheries.

Environmental pollution caused by urbanization and industrialization inevitably affects rivers as well. Discharge of waste water from industries and cities into rivers without being treated has increased contamination in rivers. Such pollutants are carried away from rivers into sea, disturbing ecological equilibrium and thus catching activities, particularly eel fisheries.

Almost all eels captured in Turkey are exported. Fluctuation in demand for eel abroad can influence its catching directly. Therefore, catching eel is proportionally related to the demand for it. It is necessary that a planning process should be made involving eel fisheries in Turkey, for the purpose of which it seems essential to establish the present eel stocks. Following determination of stocks, studies must be conducted to increase or decrease catching force and quota procedures can be initiated when necessary, as well as private licenses covering particular conditions and terms as specified precautions.

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SPONGE FISHERY

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1. Introduction

The sponges were used for cosmetic aims since antiquity due to their soft and high water containing capacity spongin skeletons. Most of the studies were about their use in the fields of pharmacy, medicine and cosmetics. Turkish sponges are highly seeking in the world markets due to its high quality. There were some sponge research centers in Turkey that one of the well known is Bodrum in Central Aegean Sea and the other one was in the Gökçeada Island in the North Aegean Sea. But Turkey does not dominate in world markets due to its unregulated sponge fisheries and processing. The sponge disease that first appeared in 1986 caused serious damage on stocks and sharp reductions in sponge production (Katağan *et al.*, 1991). Aquaculture of sponges has gained impetuous following this period.

The first sponge study in Turkish waters was published by Forbes in 1844 (Saritaş, 1972). Devedjian (1926) mentioned bathing sponge (*Euspongia equina*) and toilet sponge (*Euspongia mollisima*). Places of concentration of these species were given as well. Besides this, Kalimnos, Symi and Castellorizo Islands, Bodrum and Kaş, were also mentioned as main locations for sponge fisheries. He also paid attention to the fact that sponge diving methods and sponge divers changed after 1867 because of the diving suit. Four different fishing methods were mentioned. These were: fishing with a diver suit, skin diving, spear sponge fishing and trawling. Teams that were equipped with diver suits were differentiated to three. The least equipped of these referred to as third class diving teams were mentioned as fishing sponges on the Anatolian coast. Çoruh (2009) was compiled sponge fisheries during to Ottoman Empire period. He pointed out that, the sponge fisheries was start in starting of 1840's in western Anatolian coast, Cyprus, some Aegean Islands (Crete, Sporades, Simi, Khios, Lesvos, Samos and, Kalymnos) and the coasts of Syria, Egypt and Tripolitania (Libya). But, the main places for sponge fisheries were Crete, Rhodes and close islands in the area including shallow water of west Anatolian coast. The sponge fishery mostly has three methods. These are by diving suits (called as Scafander) (Figure 1), naked diving with spear and specially designed dredge (called as algarna).



Figure 1. Old style diving suit “Scafander”

After Ottoman period the sponge studies in Turkish waters were mostly focused on possibilities of aquaculture (Gökalp, 1974; Dalkılıç, 1982 and Ergüven, *et al.*, 1988). According to Canyığıt (1962) (a), the sponge production of Turkey had continued for a long time due to favorable weather conditions. The author gave statistical information on sponge production and exports for 1961 in the same article. Canyığıt also reported that Bodrum led the production with 15 tones follow by Marmaris 7-7,5 tones and Gökçeada and Bozcaada with 5 tons each. Author also pointed out four different ways for sponge fisheries: spear fishing, beam-trawl, skin diving and diving suit with surface air supply system (Canyığıt (1962) (b).

Arısoy (1971) reported sponge industry in Turkey based on the distribution according to different locations and the sponge export of the country between 1951-1962. Attention was drawn to the correlation between sponge and sponge fishing boats registered in Bodrum port and sponge

production with export. The author concluded that the most important buyer of Turkish sponges was Greece.

According to an article in the magazine of the Ministry of Agriculture Forestry and Rural Affairs (1986), Turkish sponge were popular in all world market Turkey's sponge export plunged from 100 tons in 1910 to 13 tons in 1980. The reasons for this were given as technical insufficiency, negative trends in ecological conditions and unsuitable working conditions of sponge divers. The article pointed out decrease in the number of divers has been observed due to the insufficiency of the diving infrastructure and due to decompression disease.

According to Atahan *et al.* (1989) variations in annual production and sponge disease are as important reason of the decrease in sponge production to overfishing. The author concluded that sponge disease that appeared in Turkish waters in 1986 had affected the economical sponge species negatively. According to author, Çanakkale (Dardanelles) Strait and the Marmara Sea were not hit by the disease. With respect to sponge fishing methods he wrote that surface air supply diving method was getting prevalent displacing trawl which had caused overfishing and the depletion of sponge stocks.

Same author also reported that until 1986, Bodrum was the center of sponge fisheries when the sponge disease was first seen. There were 40 sponge fishing boats with 120 personal in Bodrum. There were 7 sponge fishing boats and 21 personnel in the Çanakkale Strait and Marmara Sea in the same period. It can be conducted from these data Bodrum was hit worst by the disease. Sponge fishing boats increased to 43 with 144 personnel in the Çanakkale Strait and the Marmara Sea following the appearance of the disease due to the sponge fishing boats changed the sponge fisheries area and harbor from Bodrum to Çanakkale and the Marmara Sea. One of the other factors of this increase can be started as the prevalence of sponges between depths of 2-15 meters and fisherman substituting sponge fishing instead of fishing in summer. Sponge fishing boats decreased to 8 with 21 personnel in the Aegean and the Mediterranean. Number of sponge fishing boats are given in Table 1. The disease was more destructive where salinity and water temperature were higher according to the author.

Table 1. Sponge fishing boat registered in Bodrum (Aegean Sea) (Arisoy, 1971)

Boat type	Number
Trawl boat for sponge fishing	26
Diving equipment sponge boat	12
Surface air supply sponge boat	5
Total	43

Katağan *et al.* (1991) evaluated by comparing with the world sponge production accompanied by same figures. It's concluded that even though Turkish sponges were highly sought due to its qualities in the world market, insufficiencies in processing caused Turkey not to exert any influence on the same market. The authors pointed out that great losses in sponge stocks engendered by the sponge disease which has led to overstrain on nondiseased stocks and also poor working and living conditions of sponge divers which have caused sponge fishing boats to be used in tourism have been pointed out as factors for the decrease of sponge production.

According to Topaloğlu (2002), until 90's Gökçeada was one of the important sponge fisheries center in the area. Until 70's sponge fisheries were important jobs in the Gökçeada. According to Yücel (1968), there were 22 sponge diving boats registered in Gökçeada harbor. Total catch was around 15 tons per year.

Until 68's, old diving suits were used and sponge fisherman living conditions are not good. After a while a new generation of diver started air supply system but the living conditions were not good at that time too. Kankava fishing method had been never used in Gökçeada. Following the sponge decreasing in the Bodrum and around, sponge fishermen began the sponge fishing around Gökçeada and Marmara area. This over fishing resulted with a total catastrophe on sponge stocks in the area and sponge fishermen could not support themselves by sponge fishing they either changed hunting areas or their jobs (Topaloğlu, 2002)

2. Results

According to all results the sponge fisheries was prevalent mainly in Bodrum, Anamur, Antalya, Finike, Kaş, Fethiye, Marmaris, Gökova Bay, Güllük Bay, Çeşme, Edremit Bay, Ayvalık Bay, Gökçeada Island, Bozcaada Island, Saros Bay in Aegean Sea and Çanakkale Strait; also in İmralı Island and Marmara Island in the Marmara Sea which was not affected by the disease.

A significant decrease in sponge export was detected from 1960's to present. Between 1960-1993 the highest amount of export was recorded in 1965 (40.3 tones), followed by 1972 (24.8 tones), 1978 (18.9 tones), 1986 (15 tones), 1988-1989 (13.5-13.6 tones). Amount of sponge export is shown in Figure 2.

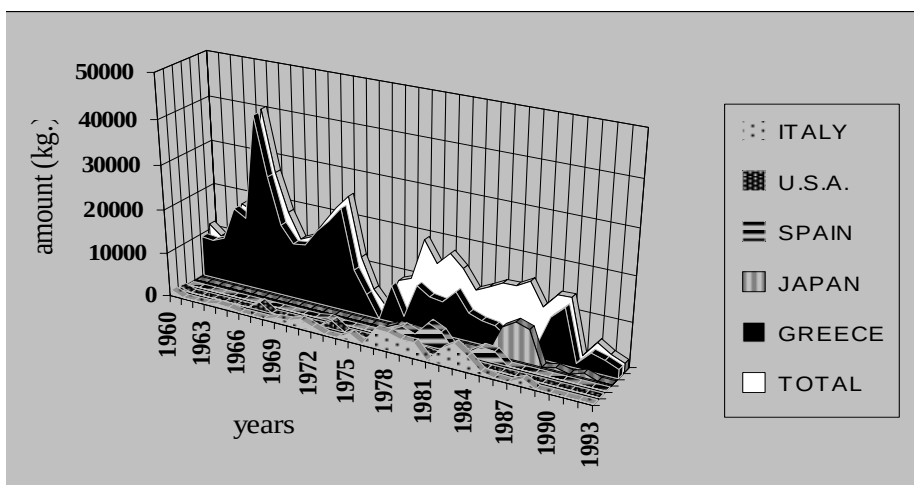


Figure 2. Some major sponge importers from Turkey in 1960-1993

The sponge disease which was first observed in 1986 affected the export in 1990. The reason for this could be, sponge can be stored raw or semi processed products for 3-4 years until good buyer comes. After finishing such stored sponges, in 1990 the annual sponge export of Turkey decreased to 1-5 tons a year.

Heavy working conditions of sponge divers are other factors in the decrease in sponge production. The decompression disease which effects to sponge divers has claimed many lives and injured many others due to the lack of equipment and pressure chamber. Tourism has emerged as an easier job for sponge divers, providing also better income. Thus a traditional profession is going to disappeared in the Aegean and Marmara Sea basin. Besides, many sponge fishing boats moved to the Çanakkale Strait and Marmara Sea. This, in turn, has caused depletion of sponge stocks in the above mentioned areas.

At the present, sponge fishing is prohibited in the Turkish waters according to the fishing regulation of Ministry of Agriculture and Forestry aimed for protect sponge stocks. Only one sponge diving boat is working at out of the Turkish coastal waters for the touristic aims. Very limited numbers of the sponge dealer are importing and selling sponge in the market (Figure 3). The sponges mostly imported from Greece. According to the observations and collected information from fishermen, the new and healthy generations of the sponge population are growing slowly. For the new regulation of sponge fisheries in Turkey the long term monitoring program is necessary immediately.



Figure 3. A typical sponge seller in Bodrum

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BIVALVE FISHERIES IN TURKISH SEAS

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1. Introduction

Consumption of fishery products as food dates back to ancient times. Having tried using of primitive fishing methods (on hand, spear, etc.) in the early ages, humans resort to advanced technology for fishing now. More than 90 percent of fishery products are obtained from seas through the use of a variety of modern fishing tools (Hoşsucu, 1998). A considerable increase has been achieved in fishing with modern fishing tools today, but this rise leads to the reduction and deterioration of fish stocks in the sea (Tidwell and Allen, 2001). In order to meet the increasing need for animal protein, alternative fishery products have become an option, and bivalves specifically started to be harvested for this purpose.

Today, 90 million tonnes out of total 140 million tones of fishery products of the world are obtained from fishing. Bivalves constitutes 2,7 percent of these products, and it is reported that the USA ranks first, followed by Japan, Spain, France, Italy, China, Germany, England, Korea, Denmark and Holland in this sort of production (FAO, 2009). Bivalves, a leading source of food in Turkey, make up averagely 6 percent of the total fishery products. However, in recent years, an increase in its production due to the rising foreign demands has been reported. The production rate of the food rose to 12 thousands of tonnes in year 2000 and to 38 thousands of tonnes in 2008, which is recorded as a 300 percent increase. Figure 1 shows the amounts of bivalves fished in Turkey between 2001 and 2008 (TUIK, 2010).

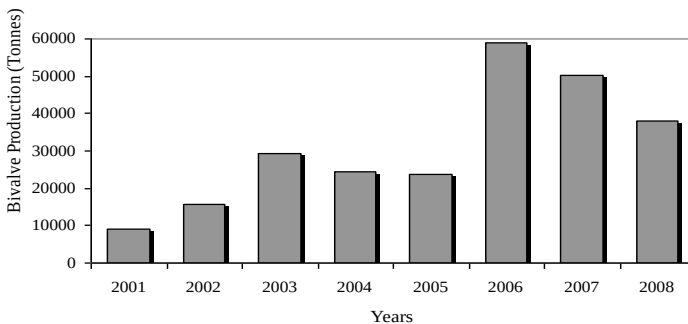


Figure 1. The amounts of bivalves fished in Turkey.

Table 1 shows the total amount of bivalve production as well as the production amounts of bivalves; named here as clams (*Chamelea gallina*, *Donax trunculus*, *Tapes decussatus*, *Tapes phillipinarum*, *Spisula sp.* etc.) which was reported in the world in 2007 (FAO, 2009). Table 2 shows the production of bivalves in Turkey (TUIK, 2010).

Table 1. The amounts of bivalves fished in the world (x1000 tonnes).

Species	2001	2002	2003	2004	2005	2006	2007
Oysters	197	184	195	149	163	140	149
Mussels	240	225	187	188	132	109	110
Scallop	702	750	804	791	725	760	733
Clams	823	799	898	835	690	751	788
Other Molluscs	1,301	1,281	810	854	895	904	895
TOTAL	3,263	3,239	2,894	2,817	2,605	2,664	2,675

Table 2. Bivalve's production of Turkey (tonnes).

Species	2006	2007	2008
<i>Tapes sp.</i>	1,266	1,334	1,255
<i>Chamelea gallina</i>	48,344	47,215	36,896
<i>Mytilus galloprovincialis</i>	9,234	1,466	N/A
<i>Modiolus barbatus</i>	N/A	27	N/A
<i>Venus verrucosa</i>	N/A	73	1
<i>Ostrea edulis</i>	31	31	13
<i>Pecten sp.</i>	30	N/A	N/A
TOTAL	58,905	50,146	38,165

167 species belonging to the class of bivalves have been reported inhabiting in the seas of Turkey. The ones having economical value are striped venus clam (*Chamelea gallina*), mussel (*Mytilus galloprovincialis*), oyster (*Ostrea edulis*), manila and native clam (*Tapes decussatus* and *Tapes phillipinarum*), warty venus (*Venus verrucosa*) and wedge clam (*Donax trunculus*). The extensive habitats of these species produced commercially are Black Sea, Sea of Marmara, Aegean Sea and Bosphorus (Demir, 1952).

The main problems of bivalve fishing in Turkey include standardization, classification, technology, and recording of fishing tools. In addition, the existing sources need to be rationally utilized and planned in the production stage. Therefore, knowledge is needed that can solve these problems and lead to suggestions for solution. There are various publications regarding with what kind of fishing tools and how fishery products are fished. In these publications bivalve fishing and fishing techniques are superficially explained (Hoşsucu,

2000; Tokaç, 2010). Further, little knowledge of the technical features of fishing tools used in bivalve fishing in Turkey makes it harder to sustain the harvest of stocks as well as to identify the regional fishing. Therefore, it is important to explore more about bivalve fishing tools in order to sustain fishing sources. The fishing tools and fishing techniques used in commercially important bivalve fishing are presented in the following chapters.

2. Main bivalve fishing methods used in Turkey

2.1. Dive fishing

This is the most utilized technique in bivalve fishing. The commercially important bivalves such as mussel (*Mytilus galloprovincialis*), oyster (*Ostrea edulis*), manila and native clam (*Tapes sp.*), striped venus clam (*Chamelea gallina*), warty venus (*Venus verrucosa*) and scallop (*Pecten sp.*) are extensively fished. The diver collects bivalves and puts them in a net at the bottom of the sea with the help of the air supplied by the compressor. Then, the diver brings the harvest to the boat. In addition to this method, there are also species-specific techniques such as wedge, slap, soaking and hand rake.

2.1.1. Wedge method

A fisher dives in the sea and navigates in the bottom with the help of the air supplied by the compressor running in the boat. He then locates the habitat of particularly manila and native clam (*Tapes decussatus*, *Tapes philippinarum*), striped venus clam (*Chamelea gallina*) and wedge clam (*Donax trunculus*) and pushes them into the sea by pulling them out with a wedge. The fisher gathers the bivalves in file. Information about the size of a wedge is given in Table 3.

Table 3. The size of wedge.

Wedge grip (cm)	The metal part entering to ground (cm)
15–20	25–30

2.1.2. Slapping method

The fisher navigates easily in the bottom of the sea with the air supplied by the compressor in the boat. The diver destabilizes the sand in the bottom with his hands. When the sand disperses, manila and native clam (*Tapes decussatus*, *Tapes philippinarum*) and striped venus clam (*Chamelea gallina*) cannot, so the diver collects the products with his hands and puts them in the net.

2.1.3. Soaking method by diving with double hose with a compressor

The diver takes with him a pipe long enough to reach the boat and dives into the bottom. In the pipe, there is another thin pipe into placed upwards in convey that blows air. When air is blown upwards through this pipe as big as a

diver hose, bivalves are carried towards the boat. If the depth is too much, the diver collects the products in his bag. This method is particularly used in the fishing of striped venus clam (*Chamelea gallina*) and manila and native clam (*Tapes philippinarum*). Such fishing is also performed in the Sea of Marmara.

2.1.4. Hand rake harvesting method

The hand rake is especially used in fishing of “warty venus” (*Venus verucosa*) and it has three teeth of 5.5 cm (Figure 2 and Table 4). The diver scans the ground and takes out the warty venus through a rake and puts them in the net. The fishing of warty venus through this method is done in İzmir and Bodrum in Aegean Sea.



Figure 2. Hand rake used in the fishing of warty venus.

Table 4. Technical features of hand rake.

Hand rake grip (cm)	Teeth length (cm)	Number of teeth	Teeth spacing (cm)
14,5	5,5	3	2

2.1.5. Fishing of razor clam (*Ensis sp.*) with the steel rod.

In the fishing of razor clam (*Ensis sp.*), a tool with a bullet core in the tip and a steel spear of 1–1,5 m. The diver locates where razor clam hides in the bottom of the sand (in fact, there are large and noticeable holes where razor clam hides). The diver sinks the spear into these holes suddenly and when razor clam closes itself, it is said to sticks to the spit. The diver then collects these products in the net .

In addition, in this type of razor clam fishing, hand collection method is also used. In this method, copper sulphate or very salty water is dripped through a medicine pipe to make razor clam to come out. The razor clams rushing out are collected. Such razor clam fishing is done in the coastal locations.

2.2. Man power coast fishing

2.2.1 Sieving shovel method

Sieving shovel especially used in the fishing of manila and native clam (*Tapes decussatus*) is placed on the bottom sand and forced into the sand (Figure 3 and Table 5). Then it is shaken in the water and from among the rest, bivalves are selected and put in the fisherman's net bag.



Figure 3. The sieving shovel used in the fishing of manila and native clam (*Tapes decussatus*).

Table 5. The technical features of sieving shovel.

Mouth width (cm)	The sieve length (cm)	The sieve rear width (cm)	The sieve mesh size (mm)	The sieve side margin (mm)	Teeth spacing (cm)	Grip length (cm)	Stand (right-left) (cm)
40	34	28	9	8	4,5	120	4-8

A similar method to the sieving shovel method, works with a big coal shovel and a 2x2 square sieve placed into a wooden box of 40x40. The two ends of coal shovel are cut through the sides and sharpened. These sharpened ends make it easier to submerge on the ground surface. The materials collected from the ground are put on the sieve. When it is shaken in the water, the sand and

tiny materials fall down through the sieve, after which big materials and bivalves appear on the sieve. These products are placed into the fisherman's net bag. The fishing of manila and native clam with these two methods is done in the coastal premises of Izmir.

2.2.2. Coastal mussel (*Mytilus galloprovincialis*) fishing with a rake

The rake used to harvest mussel on the coast has 4 teeth. The fisher harvests the product from the port-side legs or using a rake on the bottom surface (Figure 4 and Table 6).



Figure 4. The rake used in mussel (*Mytilus galloprovincialis*) fishing.

Table 6. Technical features of a rake.

The rake grip (cm)	Teeth length (cm)	Number of teeth	Teeth spacing (cm)
130	8–10	4	3–4

2.2.3. Fishing (*Donax Trunculus*) with a hand dredge

On the tip of hand dredge used to harvest wedge clam (*Donax trunculus*) is a knife and a sieve, while at the back is a tightly knitted net bag (Figure 5 and Table 7). In order to hold the fishing tool, there is an dredge handle of 1,35 m and a belt to tie it to the waist. The fisher harvests the products pulling the hand dredge towards himself. Once the bag is full, he comes to the shore and empties the net bag (Çolakoğlu, S., 2011). Fishing wedge clam (*Donax trunculus*) is done on the 1-2 m depth sandy location around the Marmara Sea.



Figure 5. Hand dredge used to harvest wedge clam (*Donax trunculus*).

Table 7. Technical features of hand dredge.

Dredge mouth width (cm)	Dredge mouth height (cm)	The sieve mesh size (mm)	The sieve length (cm)	Dredge cutting edge (cm)	Dredge towing arm (cm)	Rear width (cm)
65	13	8	58	5	135	35

2.3. Boat power fishing

Dredge capacity or dredge size is chosen according to the boat size in fishing. Different dredges are used in Turkish Seas for fishing. The boats used in sea are bigger and also they can hold more than one dredge. If the dredge is built on the side then, the stern of the boat need not be in a special construction type. Moreover, it does not matter if the boat's exhaust hood is closer or far from the bow part. The poop part of a developed dredge is constructed skewed and split so that the dredge can easily be thrown into the sea and pulled back. The dredge boats used in our waters are generally 8–12 m in length and 2,5–3 m in width. The low capacity boats allow the dredge to be taken to the boat on the side through human power, while those with higher capacities through engine power. Therefore, there are poles and bom in the board construction of these boats for the hoist and dredge to be suspended and emptied on the board. The engine capacity of these boats ranges from 18 to 70 HP (Kara, Ö.F., 1992).

2.3.1. Dredges

A dredge is a trolling fishing mechanism used to harvest bivalves. It is mainly composed of three parts: net, bag, frame and pulling rope. There is a perpendicular or half moon iron frame to help keep open the mouth of the net which is like a bag. There are also knives and teeth used to scan the bottom of the sea on the lower part of the iron frame. It is pulled by the low capacity boats by trolling on the sea bottom. It is called either striped venus clam dredge or mussel dredge according to the fishery products it harvests.

2.3.1.1. Oysters (*Ostrea edulis*) dredge

This dredge consists of weight iron including three arms and a bag tied to the half moon iron frame. The lower part of the iron frame is designed like a knife to scrape the bottom of the sea (Figure 6). The width of the mouth ranges from 0.75 to 2 m, while the length of the bag from 0.50 to 2 m and the width of the open net eyes from 40 to 60 mm (Table 8). Leads are also used for balance in order for the dredge to subside as well as to harvest more products. The dredge is used to harvest oysters generally in 2-15-deep shallow waters in Aegean and Marmara Seas.



Figure 6. Oysters Dredge.

Table 8. Technical features of oysters dredge.

Dredge mouth width (cm)	Dredge towbar (cm)	Length of half moon iron frame (cm)	Net bag length (m)
120	120	220	1,5

2.3.1.2. Mussels (*Mytilus galloprovincialis*) dredge

This dredge consists of weight iron and a bag tied to a perpendicular or halfmoon iron frame (Figure 7). It has the same technical features as oysters dredge (Table 9). It is especially used in 2–20 m deep waters where there are mussels (Doyuk, S.A., 2006).



Figure 7. Mussels Dredge.

Table 9. Technical features of mussels dredge.

Dredge mouth width (cm)	Dredge towbar (cm)	Length of half moon iron frame (cm)	Number of Teeth	Net bag length (m)
64	84	114	3	1

2.3.1.3. Striped venus clam (*Chamelea gallina*) dredge

This dredge is used in shallow waters where striped venus clams are found especially in Marmara Sea and West Black Sea. As in the other dredges, it consists of a bag tied to a perpendicular iron frame and weight. The lower part of the iron frame is made of teeth like a comb to better scan the bottom of the sea. Two types of dredges are used in striped venus clam fishing, which are mainly mechanic and hydraulic.

2.3.1.3.1. Sliding mechanic dredge

This dredge is pulled through the engine power at the back of the boat 10–15 cm deep in the sand. In these sieving dredges, there are teeth in the head, a bag at the back, and wheels on the side to prevent sinking and fixing (Figure 8 and Table 10). It is taken in the boat through human or engine power.



Figure 8. Mechanic Dredge.

Table 10. Technical features of mechanic dredge.

Dredge mouth width (cm)	Dredge mouth height (cm)	The sieve mesh size (mm)	The sieve length (cm)	Teeth length (cm)	Teeth spacing (mm)	Number of teeth
55	30	8	44	16	12	25

2.3.1.3.2. Hydraulic dredge

Hydraulic dredges that are various sizes changing according to the boat size are used in striped venus clam fishing in Turkey (Figure 9). The width of the mouth of dredges ranges from 2 to 4 m, the height of the mouth from 30 to 50 cm, the length of teeth from 8-to 9 cm and the teeth intervals from 7 to 10 (Table 11). Once the dredge is put in the water, pressurized water is sent to the bottom through a hose system tied to the dredge by means of the power supplied by an external diesel engine, and fishing is practiced. In addition, there are sieve systems on the boats that help sieve striped venus clams that are harvested (Dalgıç et al., 2005). These dredges are generally used to harvest striped venus clams in 10–20 m deep shallow waters in the Black Sea.



Figure 9. Hydraulic Dredge.

Table 11. Technical features of hydraulic dredge.

Dredge mouth width (m)	Dredge mouth height (cm)	The sieve mesh size (mm)	The sieve length (m)	Teeth length (cm)	Teeth spacing (mm)
2–4	30–50	8–9	1–3	8–9	7–10

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BLUE CRAB (*Callinectes sapidus* Rathbun, 1896) FISHERIES

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1. Introduction

Blue crab (*Callinectes sapidus* Rathbun, 1896) is a crab species of primary commercial value in Turkey with increasing importance and consumption among the inhabitants of especially Aegean and Mediterranean regions (Figure 1). Until 1980s, there were no commercial catching methods for it and was rather considered a discard species. Although, due to religious beliefs and traditions of the inhabitants there is no consumption and no demand in the domestic market for blue crab, especially in the summer months it's a commercial item in the menus of tourist restaurants.

Since crabs have high commercial value thus high prices, they also have an established industry in developed countries where they go through a number of processing levels for three types of products: crab meat, whole crab and crab wastes. Crab wastes are composed of crab pieces, carapace, waste meat and giblets and therefore are rich in protein and mineral, which make them a perfect diet for cattle, poultry, pig and even fish. The chitin present in the carapace is also used in a variety of industries such as textiles, glue, ink and cosmetics (Paul and Haefner, 1985a).

2. Biologic characteristics of blue crab (Rathbun 1896)

2.1. Taxonomy

Phylum	: Arthropoda
Classis	: Crustacea
Subclassis	: Malacostraca
Series	: Eumalacostraca
Ordo	: Decapoda
Supersection:	Reptantia
Section	: Brachyura
Superfamily	: Brachyrhyncha
Family	: Portunidae
Genus	: <i>Callinectes</i>
Species	: <i>Callinectes sapidus</i> (Rathbun, 1896)

2.2. Morphology

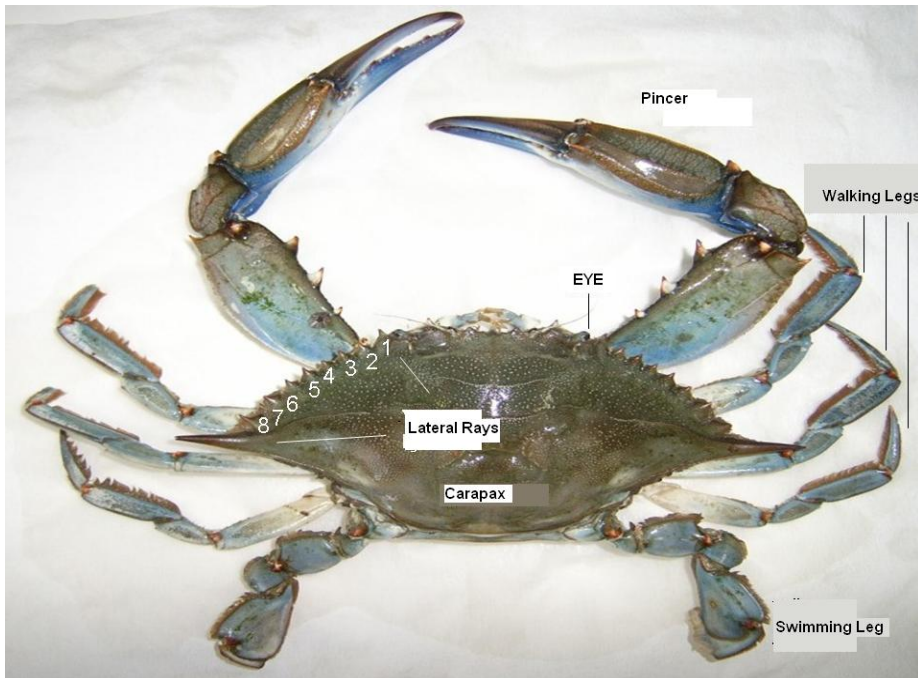


Figure 1. Anatomy of Blue Crab (Gülşahin, 2007)

- 5 pairs of legs.
- Carapace width 2 to 2.5 times larger than length.
- 2 long rays at right and left sides.
- 8 side rays beginning from sides to eyes.
- Body surrounded with exoskeleton of calcium-rich chitin.
- Eyes on top of a short stick-like form, have independent motion
- Various colors on carapace from dark green to brownish green.

2.3. Reproduction

Blue crabs reproduce by sexual reproduction (Figure 2). Males reach sexual maturity when they are smaller in size than females but keep growing. Females reach sexual maturity in 12 to 14 months and mate only once in a year while males can mate several times. Mating generally takes place in brackish waters and only when the carapace of the female is still soft before and after molting, during which period it is protected by the male, ascertaining it can receive the sperms.



Figure 2. Male and female blue crab

The male delivers the spermatozoa to the seminal receptaculum of the female. Female can maintain the sperms in her body over one year if the spawning delays, and during that period she can mate once more. Female blue crab would spawn in 1 or 9 months after mating depending on the water temperature. Eggs are fertilized as they pass through the seminal receptaculum. In this period the female is called a sponge crab and can carry over 2 million eggs inside her crescent-shaped apron abdomen.

Although blue crabs live in brackish waters, females migrate deeper since the eggs can hatch only in high salinity. The color of the egg changes gradually from yellow-orange to brown and black depending on ovulation (Figure 3). In the two weeks following fertilization the egg becomes freely floating zoea larvae which are very fragile but tolerant to salinity and temperature changes. Zoea undergoes 7 or 8 complex molting phases before they become lobster-like crabs called “megalopa” in 31 to 49 days. Megalopa becomes a crab in 20 days depending on the salt and temperature conditions (Figure 4). Maturity is reached in brackish waters in 12-18 months from hatching. From zoea to maturity, females molt 18-20 times and males molt 25 times (Türeli,1999).

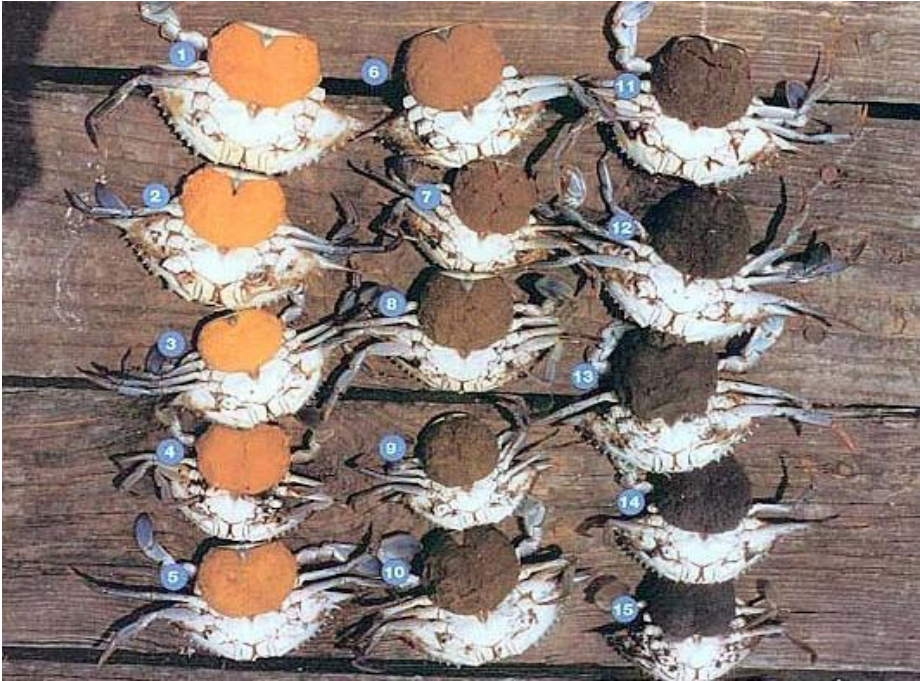


Figure 3. Ovulation phases of blue crab (1-5 days: yellow-orange; 6-10 days: brown; 11-15 days: black) (www.bluecrab.info).

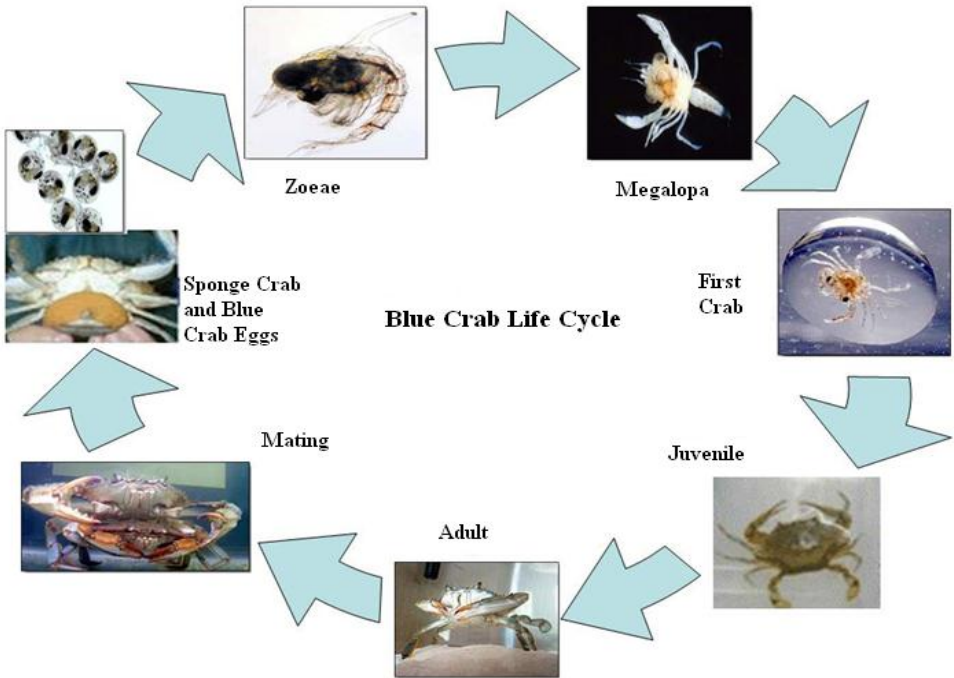


Figure 4. Life cycle of blue crab (www.bluecrab.info)

2.4. Feeding

Blue crab has a diet of wide variety, from living or dead herbal and animal material. Although they are known as scavengers, they prefer fresh food. They feed on bivalvia, fish, crustacea, gastropoda and vegetal organisms. They catch small fish and crush young oysters and bivalves with their pincers (Türeli, 1999).

In identification studies on its feeding habits carried in Northern Florida, blue crab has been found to be omnivorous and detritic as well as cannibal, with bivalves as primary food. Gastral examinations revealed that they feed on fish wastes, gastropoda, vegetal wastes, ostracoda, amphipoda, crustacea, foraminifera, invertebreta eggs, beetle larve, mysid, polychaeta and shrimp (Roger A.L. 1982).

2.5. Habitat

Blue crabs live in the salty waters of mild and tropic seas; they can be seen in waters with 0 to 90% salinity. Only females migrate.

Blue crab is a species of Atlantic origin, observed mostly in Chesapeake Bay, Atlantic and the Gulf beach of Florida. It is also seen in France, Denmark and Mediterranean, especially abundant in Israel, Nile Delta of Egypt and South American coasts (Figure 5).

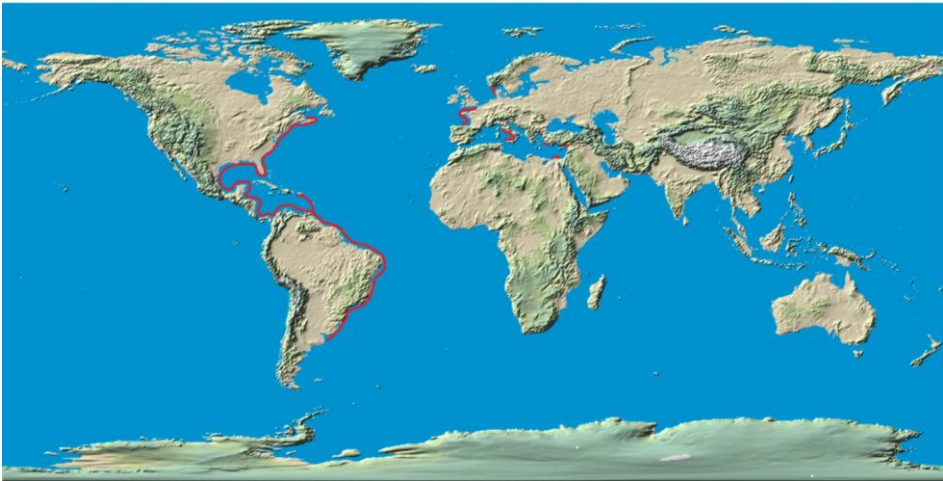


Figure 5. Global Distribution

2.6. Distribution in Turkey

Blue crab is quite big in size and has high commercial value in North America and Canada where it originates. It was firstly brought to the brackish waters of North Aegean lagoons, especially the lakes in Enez region and later to

Köyceğiz and Güllük lagoons along the Aegean coast. Currently it is abundant in Yumurtalık, Beymelek and the Taşucu Karadeniz lagoons (Figure 6).

Blue crab has not completely adapted in these waters where it was brought rather by force. Evidently the species has started to migrate south since 1963. Although for some authorities the reason for the migration is over fishing in the region, but at least in Turkish lagoons blue crab is not caught in such large extent. The reason should be sought in more natural causes that prevent settling in those particular regions. Blue crab is considered a harmful and unwanted species by the fishermen since some attempts to commercialize blue crab have proven unsuccessful and for its cannibalistic nature.



Figure 6. Distribution in Turkey

3. Catching Methods

Blue crab *Callinectes sapidus* (Rathbun 1896) is abundant in southern and western coasts of Turkey and in lagoons has an increasing economic value. Especially in the recent years, the growing demand in touristic summer seasons, it holds greater part in the coastal and lagoon fisheries. Blue crabs are primarily caught by traps, gill and trammel nets, pots and fishing lines but they are a bycatch in trawling and coastal towing methods.

3.1. Catching by hand (without gear)

Blue crab is generally found in shallow waters, often hiding under rocks or plant roots. Catching is done by practically searching the areas by hand and scaring it out for collection. Then the crab is stored live in tanks. Sometimes the catching is done by luring the crab to bait nearby and again collecting by hand (Figure 7).



Figure 7. Catching by hand

3.2. By wire

Blue crabs are in the habit of grasping any approaching object to both protect themselves and scare off the enemy. Catching by wire is mainly taking advantage of this habit. Catching can be done in two ways; One way is by moving the wire closer to the crab to provoke it to grasp the wire. When the crab has grasped the wire, it has to be taken out of the water into a scoop or the boat quickly since it can drop back in the water. Occasionally fowl wastes are used in catching by wire to attract the crab. Another way is to bend the wire in a U shape to serve as a hook to cling the joints and pincers of the crab (Figure 8).



Figure 8. Catching by wire

3.3. Fishing line

Blue crabs generally feed on dead organisms. The fishing line method involves using squids and fowl wastes (wings, lungs, gizzards etc.) besides dead fish. Putrefying the bait beforehand greatly increases the efficiency and will attract the crab better. Covering a plastic pipe of 3-4cm long above the scimitar pin will prevent the line from being cut by the crab. Metal short lines could also be used.

3.5. Gill and trammel nets

Gill and trammel nets are pelagic, semi-pelagic and demersal nets. Demersal gillnets used for demersal target species also catch blue crabs. Especially trammel nets for red mullet and sole have higher rate in catching blue crabs, as they feed on dead organisms, they are attracted to the fish already caught in the nets (Figure 9).



Figure 9. Blue crab catching with Gillnet

3.6. Lagoon traps

Weirs where fresh water and sea water meet are convenient zones for most of marine species for feeding, mating and sheltering. During the glut period when the species rush back to the sea, blue crabs are caught in a fixed trap set by barring the openings of the weir, known as lagoon traps (Figure 10). Besides target species such as sea bass, sea bream etc., blue crabs are also caught and actively collected by landing nets.



Figure 10. Blue crab catching in lagoon traps (Original)

3.7. Fyke net

Fyke nets are fixed traps composed of two intertwined conical nets and metal or wooden frames attached to them (Figure 11). They can have single or double openings. Used with a fence, fyke nets can be useful to increase efficiency. Fyke nets can also be laid successively and left in the sea bed overnight. Fyke nets have proven to be a better method in terms of collection amount than traps (Atar *et al.*, 2002).



Figure 11. Fyke nets

3.8. Pot

Pots are passive gears with single-opening (Figure 12). Baits can also be used at the bottom of the pot to which the crab is attracted and entrapped. Since this method is known to cause eutrofication, baitless pots are preferred in lagoon areas.



Figure 12. Pots designed for blue crab catching (Gökçe, 2011)

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FISHING OF MEDITERRANEAN MUSSEL (*Mytilus galloprovincialis*, Lamarck, 1819) IN THE ISTANBUL STRAIT

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1. Introduction

Mytilus galloprovincialis, known as mediterranean mussel or black mussel is a bivalve species. The common name “mussel” is used for members of several different families of clams or bivalve molluscs. Marine mussel species that belong to the family Mytilidae, in the order Bivalvia, live in intertidal and subtidal areas along coastlines worldwide.

The genus *Mytilus* belonging to the family Mytilidae, includes a complex of two sibling species, *Mytilus edulis* (blue mussel) and *Mytilus galloprovincialis*. Both species are now globally widespread. *M. edulis* (Linnaeus, 1758) and *M. galloprovincialis* are the most closely related species according to genomic DNA (Martinez-Lage *et al.*, 2002) and mtDNA analysis (Hilbish *et al.*, 2000). The genetic identity has been discussed in details and the mussel species living in the seas of Turkey has been demonstrated as *M. galloprovincialis* (Uzonur, 2005). Another genetic study about *M. galloprovincialis*; Kurtuluş 2009, eight localities extending from the Black Sea to the Sea of Marmara were analysed. In total, nine haplotypes were found, and the most common haplotype with almost 90% frequency, was shared among the Sea of Marmara, the Bosphorus and the Black Sea. There is no genetic grouping among geographical regions and Istanbul Strait is a corridor to gene flow for the Mediterranean mussel, *Mytilus galloprovincialis*.

The Mediterranean mussel, *M. galloprovincialis*, is native to the Mediterranean coast, Black Sea and Adriatic, and was introduced to South Africa, east and west North America, Hawaii, and north-eastern Asia (Branch and Steffani, 2004). In Turkey, this species occurs from the Aegean Sea to the Black Sea and the species also extends, though less abundantly, throughout the coastal areas of the East Mediterranean Sea probably due to extreme salinity and temperature (Çevik and Sarıhan, 2004; Uysal, 1970). Even though Mediterranean mussel is fished from Izmir to the Black Sea, the fisheries usually carry out in bosphorus (Alpbaz, 2000).

The Mediterranean mussels are filter feeders, with gills that filter plankton and other microscopic sea creatures found in seawater. They contribute to improve water quality by filtering sediments, organic matter, and pollutants through their bodies (Lök, 2000).

Temperature, current and salinity are the primary controllers of their growth. The bottom layer of water exposed to strong currents causes the abundance of detritus and plankton. For mussels, optimum water temperature between 8-26 °C, salinity is between 15-25 ‰. The Istanbul Strait and Black Sea provide favorable habitats (Bilecik, 1989).

2. Mediterranean Mussel Fishing

Mediterranean mussels are mostly fished by boats (registered to Rumeli Kavagi) in the northern parts of the Istanbul Strait. Currently, there are 20 mussel fishing boats registered in Rumeli Kavağı. (Table 1)

Table 1. Fishing Boat Length (m) and horse power (Hp) of Mussel fishing Boats.

Number of fishing boats	Length (m)		Horse power (Hp)	
	Min	max	min	max
13	8,5	10	80	100
7	10	13	90	130
Total: 20	Total fishing power (Hp): 1640			

Mediterranean mussel fishing is carried out by the boats for 200-250 days a year. Among them ten boats carry out bluefish and Atlantic bonito fishing from October to January.

Mediterranean mussels are caught by using dredging as the common method. A dredge is 1.5-2 m wide and about 1 m high. The dredges are fitted with steel wire with a thickness of 4mm and the mesh size should be a minimum of 40 mm. If the mesh size is smaller than 40 mm, unwanted materials like small mussels, gravel and stones are caught in the net as well. Catches by using dredges are sorted on deck. Each towing is about 15 minutes in duration at a speed of 1.5-2 nmiles. Sacks of 4-5 mussels are obtained at the end of each tow, each sack can hold 20-25 kg of mussels.

Each boat catches about 100 sacks of mussels per day, depending on the weather conditions. Though mussel fishing can be carried out up to 60 m depth, the fishermen prefer depths between 10-15 m.

The price of a sack of mussels varies between 7 and 25 TL, which depends on the mussel size. The buyers prefer mussels larger than 7 cm (Öztürk 1986). Each boat uses 250 TL worth of fuel per day. In a boat, 3 to 4 people are responsible for cleaning the mussels. There are about 90 fishermen engaged in fishing mussels. An estimated of 350 people, mostly women, are engaged in cleaning mussels, which are.

Mussels can be caught on sandy, muddy and flat substrates. Mussel beds are formed if mussels are able to hold on to each other on the flat substrates at the base of a cliff. This allows large mussel colonies to establish.

Mussel beds are more productive in the areas where there is a stronger current. However, their productivity decreases below 15-20m. Also mussel productivity increases more from Yeniköy towards the Black Sea.

The main areas of mussel fishery in the Istanbul Strait are: Paşabahçe, Beykoz, Yeniköy, Kireç Burnu, Sarıyer, Umur Yeri, Rumeli ve Anadolu Kavağı, Fil burnu, Büyük Liman, Rumeli Feneri and Anadolu Feneri (Figure 1). In addition, some fishermen catch mussel by diving near the Eşek Island, Princes' Islands and the rocky areas of the Istanbul Strait. (Uysal 1970).

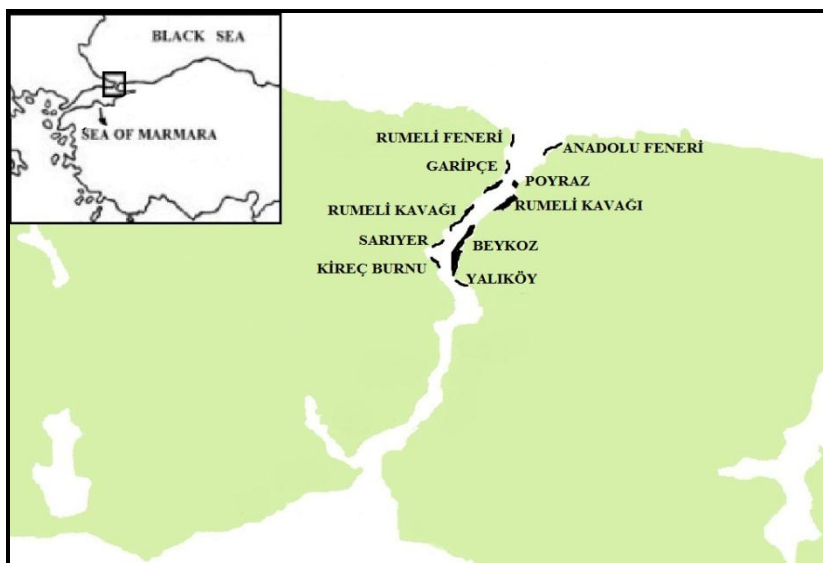


Figure 1. The main areas of mussel fishing in the Istanbul Strait (Black parts shows fishing areas in the Istanbul Strait)

Prohibition of place and time for mussel fishing

According to Turkish fishery regulation circular (TFRC), the seasonal closure for mussel fishery is between May 1-June 30 in all of Turkish territorial waters.

For the Istanbul Strait

Mussel fishery is prohibited in the area between the line connecting Ahırkapı (41° 00' 27" N - 28° 95' 05" E) and, Kadıköy (Inci Burnu) (40° 59' 05" N - 29° 00' 52" E) and the line connecting Yeniköy (41° 07' 01" N - 29° 04' 18" E) and Paşabahçe lighthouse (41° 06' 57" N - 29° 05' 23" E).

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SPINY LOBSTER (*Palinurus elephas* Fabricius, 1787) AND COMMON LOBSTER (*Homarus gammarus* Linnaeus, 1758) FISHING IN THE NORTHERN AEGEAN SEA

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1. Introduction

Spiny Lobster (*Palinurus elephas*, Fabricius 1787) has a wide distribution in the East Atlantic, from Norway to Morocco, except in the eastern Mediterranean (Holthuis, 1991). Excessive harvesting of spiny lobsters has been carried out in Ireland, England, France, Spain, Italy, Greece and Turkey. The lobsters prefer to live among rocks, in small caves with coralligenous beds at the depth between 0 and 200 m. Mature individuals are found as a pair or in small groups. The lobsters are active at nights, but do not move except for feeding and reproductive activities. They are omnivorous, feeding on mollusca, echinodermata and crustaceas (Goni and Latrouite, 2005).

Common lobster (*Homarus gammarus* Linnaeus, 1758) has a wide distribution in the world seas. They are found in the coasts of Britain, Sweden, Denmark as well as from Morocco to the north of Norway in the Atlantic Ocean. In the Mediterranean they are found in the coastal and island areas. They are also reported in the western Black Sea and Istanbul Strait (Bosphorus) (Holthius, 1991). Common lobsters generally prefer the depth shallower than 150 m. They are active at night, feeding on mussels, crabs and polychaeta. They reach sexual maturity at 5 to 8 years depending on temperature. They are sedentary organisms and they migrate for 2-10 km to reproduce and feed (Prodöhl *et.al.* , 2006).

2. Lobster Fishing

Boats registered to Cakil village of Bandırma catch spiny lobsters and common lobsters in the northern Aegean Sea for two months every year (Öztürk, 2011). According to the Turkish fishery regulation circular (TFRC), it is forbidden to fish spiny lobsters and common lobsters except 15th April – 15th June in all of the Turkish territorial waters. However, they can fish out of the Turkish territorial waters by permission from Turkish Ministry of Food, Agriculture and Animal Husbandry. Besides, it is not allowed to catch spiny lobsters and common lobsters within the 1,5 miles territorial water in the north of Gökceada Island, between Kömür Cape and Kaskaval Cape; and within 3 miles in the south.

These boats catch spiny lobsters and common lobsters between Saros Bay and Babakale, in the south of Limni Island and 50-150 m depth in the northern Aegean Sea (Figure 1). Furthermore, two boats are reported fishing spiny lobsters in Foça (Central Aegean Sea) (Tokaç *et.al.*, 2010). It is reported that spiny lobsters and common lobsters were caught by the nets for dentex (*Dentex dentex*) in Datca- Bozburun Semi Island (Southern Aegean Sea) (Akyol and Ceyhan, 2007).

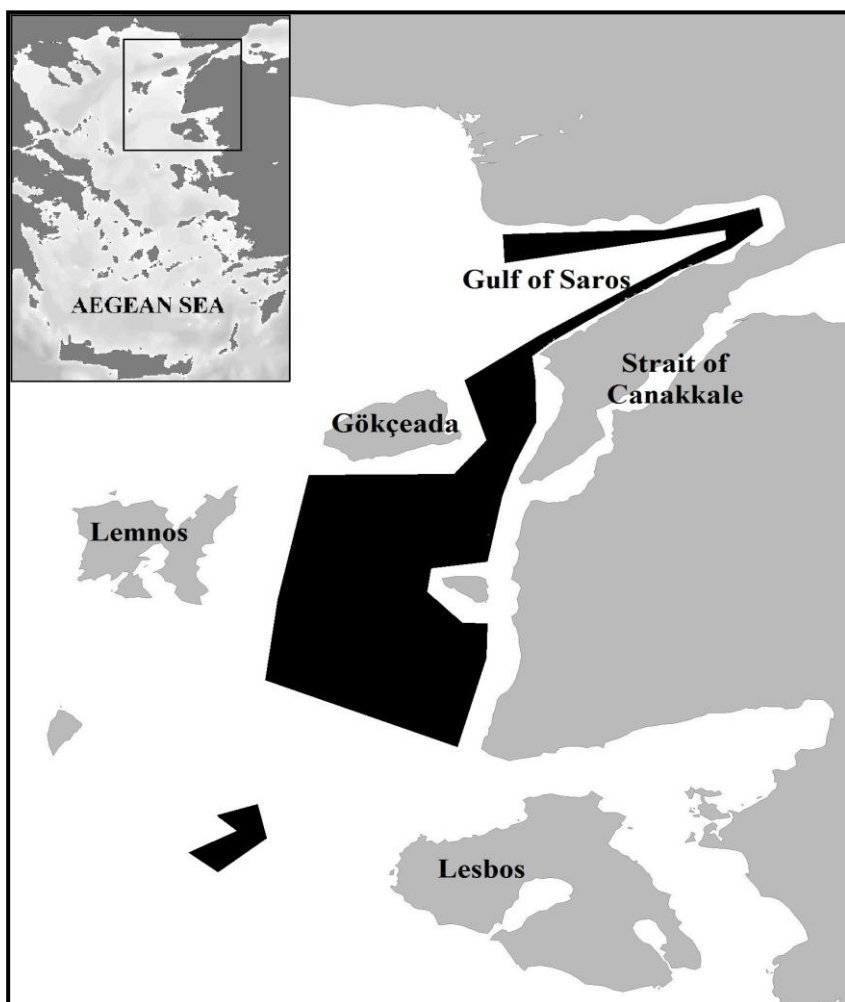


Figure 1: The main areas of lobster fishing in the Northern Aegean Sea (Black color)

Turkey's fishing fleet catch the fish of the Aegean Sea is widespread stretching from the north to the south. Main fishing ground in the Aegean Sea off-shore area which are used by Turkish fishermen (Öztürk *et.al.*, 2002) (Figure 2)

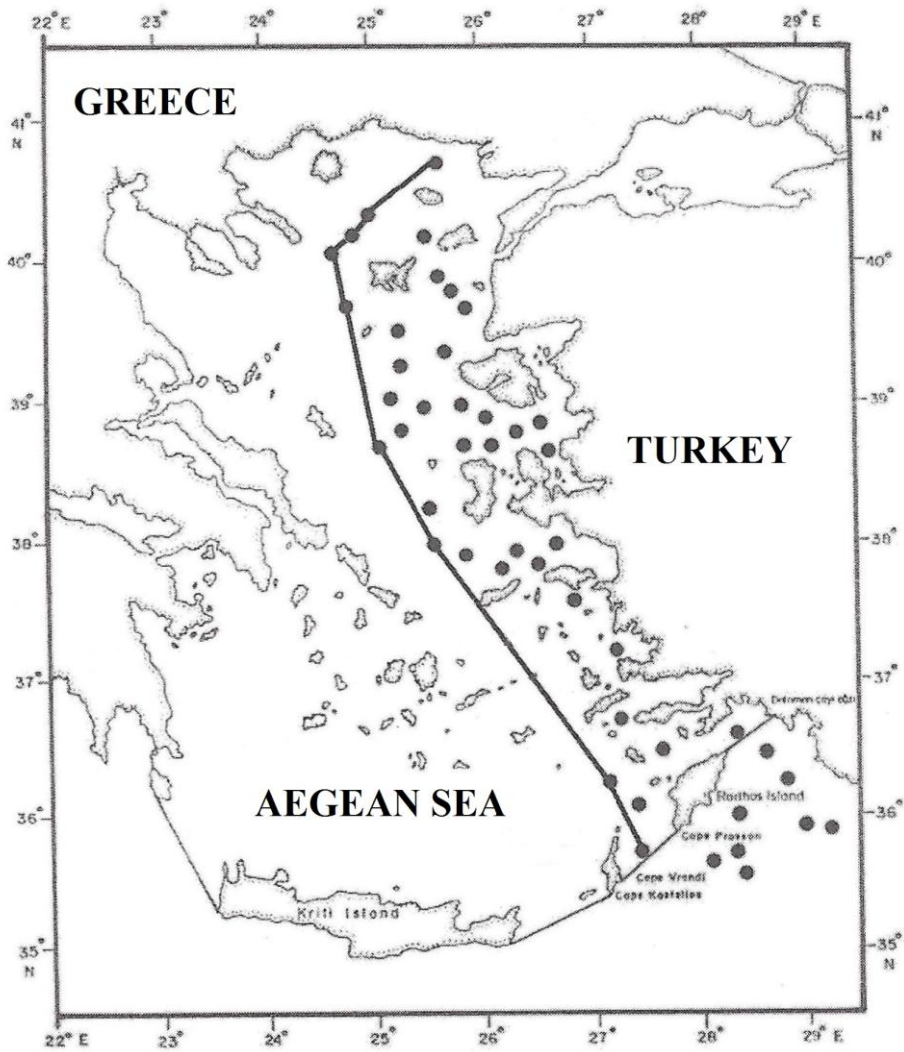


Figure 2: Main fishing off-shore area of the Turkish fishermen in the Aegean Sea

Fishing boats set lobster-trammel nets in the evening and haul in the following morning. Mesh size is between 85 mm and 170 mm, the depth for net is 9-12 m and the nets contain (PA) 210d/9. A float line consists of 157 floats (size 2), a leaded braid consists of 157 lead 50 g. The hanging ratio (E) is between 0.5 (float line) and 0.52 (leaded braid). A floatline is made of PP 4 mm, a lead line PP 3,5 mm twisted braid (Figure 3).

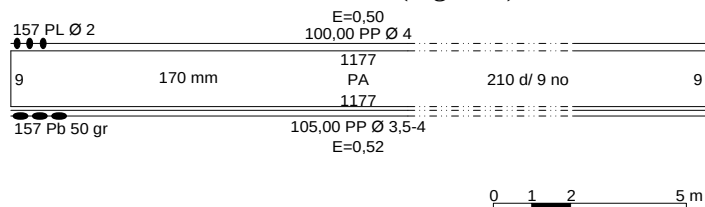


Figure 3: Lobster trammel net

Trammel nets are often rent and lost because they are used at the base of rocks and boulders. The major cause of gear loss is dragging on bottom structures. There are serious problems with losing their gears and recovering them from the reef areas where the fishery is intense. Lost trammel and gillnets are the cause of ghost fishing (Ayaz *et.al*, 2010). Approximately, each fishing boats set 6000 m of trammel nets in the area and haul every other day. The length of fishing boat is between 20 and 25 m. Some features of the fishing boat are given in Table 1.

Table 1: Length of fishing boats (m) and horsepower (Hp)

Number of fishing boat	Length (m)		Horse power (Hp)	
	min	max	min	Max
8	15	20	100	150
4	21	25	130	220
Total: 12	Total fishing power (Hp): 1640			

Monthly earnings of fisherman is about 2000 €. On average five persons work on a boat and one of them is a cook. The total sale of spiny lobsters and common lobsters at the end of the season, after subtraction of the ship's stores and fuel cost, the 50 % of remaining amount and the rest of the amount are given to the boat owner and fishermen, respectively.

Because of the large mesh size opening, discard and non-target species are caught in small amount. However, fish, such as scorpionfish (*Scorpaena scrofa* Linnaeus, 1758), Black bellie dangler (*Lophius budegassa* Spinola, 1807), Blackhand sole (*Pegusa nasuta*, Pallas 1814), are sometimes caught by the lobster nets.

The fishermen remarks overfishing and that trawlers catch lobsters, but in the meantime trawlers catch fish illegally and this causes unfair competition. Some fisherman who used to catch 12 kg of lobsters years ago now can catch only 1-2 kg. Even prices in the best season do not exceed 35 € per kilogram. Table 2 shows the catches of spiny lobster and common lobster, 2001 – 2010

Table 2: Total capture of spiny lobster and common lobster in Turkey (ton) (TUIK, 2010)

	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
SpinyLobster	18	19	11	22	30	42	14	20	26	26
Common lobster	10	9	25	15	13	18	8	15	8	7

Conclusion

The catch of both spiny lobsters and common lobsters in Turkey has been decreasing in recent years due to overfishing. The continuation of heavy fishing pressure will deplete the whole lobster stocks in the near future.

One of our recommendations is not to license boats which are greater than 50 gross tons for lobster fishing. Boats licensed as purse seiners should fish only by purse seines, those licenced as trawlers should fish just by trawlers. In addition, these fishing boats must comply with the prohibition of place and time. Spiny lobster and common lobster fishing has been special artisanal fishing for years and it should be supported for sustainable fisheries.

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SET GILL NET AND TRAMMEL NET SELECTIVITY

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Summary

The set gill net selectivity studies in Turkey have been carried out for the last fifteen years, although these studies have been investigated in the world by numerous researchers since 1948. The studies focused on the set gill net selectivity have reached forty studies so far. The most of the studies were carried out in Aegean Sea, although the studies were available in the Black sea, the Marmara Sea, the Mediterranean, lakes and dam lakes in fresh water. In this book chapter, the gill and trammel net selectivity studies in Turkey are summarized.

1. Introduction

The total fishery production of the World rose rapidly by using of synthetic fiber in fishing gear in 1950s (Sahrhage and Lundbeck 1992). This increase in production started to put fish stock in danger and revealed the necessity of some measures for sustainable use of resources. One of the most important measures was the usage of selective fishing gear. The selective fishing gear reduced the by-catch species and unwanted fishing mortalities. Indeed, the discarded catch of total fishery production of the world seas was estimated 27 million tons per year in the early 1990s (Alverson *et al.*, 1994). It was reported that this catch reduced 7.3 million tons in 2005 (Kelleher, 2004). It was pointed out that the usage of selective fishing gears played a role in this reduction (Zeller and Pauly, 2005).

Not only gill nets are widely used all over the world due to the ease of use and construction (Kara, 1992; Metin *et al.*, 1998) but also gill nets are defined as the most selective fishing gears because that they catch the species and size range being targeted depend on the mesh size (Balık, 1999a; Hameed and Boopendranath, 2000; Hamley, 1975; Holt, 1963; Metin *et al.*, 1998; Özekinci, 1997; Petrakis and Stergiou, 1995; Reis and Pawson, 1992).

The net selectivity is defined as the probability that a fish of certain species and size is retained encountering a fishing gear (Kitahara, 1971). It is the first time gill net selectivity studies have been started by Baranov (1948). Baranov asserted the principle of geometrical similarity, which based on the relationship between the circumference or length of the fish and the mesh size

of the gear, acknowledging that fishing power was the same for all mesh size. The selectivity curve of mesh sizes are same shape each other because of the fact that k is a constant (Hamley, 1975).

The theory of geometric similarity is described by the following expression:

$$s(l,m) = s(kl, km)$$

Where s is the selectivity, m is the any combination of mesh size, l is the fish size and k is a constant.

The selectivity methods were developed by different researchers in subsequent studies after Baranov's geometric similarity (Gulland and Harding, 1961; Holt, 1963; McCombie and Fry, 1960; Regier and Robson, 1966; Sechin, 1969). Hamley (1975) reviewed selectivity methods and tried to make a deduction which methods are the best. The SELECT (Share Each LENGTH's Catch Total), widely used so far today, had been developed in 1990s (Millar, 1992; Millar and Fryer, 1999; Millar and Holst, 1997). Hovgard and Lassen (2000) prepared a technical paper for FAO, contains selectivity estimation for gill net and long line gears.

The factors affecting selectivity are fish size and shape and mesh size, twine thicknesses of the net, hanging of the net, fishing methods, elastic stretching of the net and behavior of the fish (Clarke, 1960; Hamley, 1975). Because the main factor is mesh size of the net (von Brandt, 1975), the vast majority of selectivity studies focused on this factor (Askey *et al.*, 2007; Fabi *et al.*, 2002; Fonseca *et al.*, 2005; Fujimori and Tokai, 2001; Karunasinghe and Wijeyaratne, 1991; Lucena and O'Brien, 2001; Madsen *et al.*, 1999; Moth-Poulsen, 2003; Park *et al.*, 2004; Park *et al.*, 2011; Pet *et al.*, 1995; Petrakis and Stergiou, 1995, 1996; Psuty and Borowski, 1997; Purbayanto *et al.*, 2000; Revill *et al.*, 2007; Santos *et al.*, 1995; Santos *et al.*, 1998; Van Densen, 1987). There are few studies about other factors such as twine thickness (Holst *et al.*, 2002; Yokota *et al.*, 2001), hanging ratio (Gray *et al.*, 2005; Sulaeman *et al.*, 2000), maturation (Santos *et al.*, 1998) and fish shape (Carol and Garcia-Berthou, 2007; Reis and Pawson, 1999).

The selectivity studies in Turkey started in the early 1990s although the studies in the world commenced in 1940s. The sufficient importance has not been given by scientist and fisheries managers since the studies concerned with the fisheries started in the early 1990s and there has still been no coherent fisheries management policies in Turkey. However, the reductions in fish populations and the necessities for protection of juvenile fish species have caused to start the set net selectivity studies focused on the certain species. In this book chapter, the gill and trammel net selectivity studies in Turkey are summarized.

2. The Set Gill Net Selectivity Studies in Turkey

The first set gill net selectivity study was conducted as a review by Sari (1995), focused on disclosure of Holt's (1963) and Sechin's (1969) methods. After this study, Seventhesis, four scientific projects, twenty-one scientific articles and six proceedings related with set net selectivity have been conducted so far in Turkey. The studies are given in Table 1.

Table 1. The studies related with the set net selectivity in Turkey

Resaercher	Study area	Species	Selectivity Methods	StudyType
SARI (1995)	-	-	Holt–Sechin Review	Proceeding
ÖZEKINCI (1995)	Aegean Sea	<i>Mullus barbatus</i> , <i>Diplodus annularis</i> , <i>Spicara flexuosa</i>	Holt	MScThesis
ÇETINKAYA et al. (1995)	Lake Van	<i>Chalcalburnus tarichi</i>	Holt	Research article
AYDIN et al. (1997)	Black Sea	<i>Merlangius merlangus</i>	Holt-Sechin	Proceeding
ÖZEKINCI (1997)	Aegean Sea	<i>Mullus barbatus</i> , <i>Diplodus annularis</i>	Holt	Proceeding
SARI (1997)	Lake Van	<i>Chalcalburnus tarichi</i>	Holt	Proceeding
ATAR (1998)	Mediterranean	<i>Mugil saliens</i> , <i>Mugil auratus</i>	Holt	PhDThesis
METIN et al. (1998)	Aegean Sea	<i>Diplodus annularis</i> , <i>Spicara flexuosa</i>	Holt	Research article
BALIK (1999a)	Lake Beyşehir	<i>Cyprinu scarpio</i>	Holt	Research article
BALIK (1999b)	Lake Beyşehir	<i>Stizostedion lucioperca</i>	Holt	Researcharticle
SARI and GÜVEN (2000)	-	-	Holt	Proceeding
KINACIGİL et al. (2000)	Aegean Sea	<i>Diplodus. annularis</i> , <i>Diplodus vulgaris</i> <i>Mullus surmuletus</i> <i>Spicara maena</i> <i>Spicara smarıs</i> <i>Serranus scriba</i>	Holt	Project
BALIK and ÇUBUK (2001)	Lake Beyşehir	<i>Stizostedion lucioperca</i> <i>Tinca tinca</i>	Holt	Research article
KARA and ÖZEKİNCİ (2002)	Aegean Sea	<i>Sardina pilcardus</i>	Holt	Research article
KARA (2003a)	Aegean Sea	<i>Diplodus annularis</i>	Holt	Research article
KARA (2003b)	Aegean Sea	<i>Sardinella aurita</i>	Holt	Research article

Table 1. Continued

ÖZEKINCI et al. (2003)	Keban Dam Lake	<i>Capoeta capoetaumbla</i> , <i>Capoeta trutta</i>	Holt	Research article
SÜMER (2003)	Black Sea	<i>Mullus barbatus</i>	Baranov (1948)	MScThesis
BAHAR (2004)	Black Sea	<i>Mullus barbatus</i>	Holt	PhDThesis
DEVAL et al.(2004)	Marmara Sea	<i>Merluccius merluccius</i>	Holt	Research article
KARA et al. (2004)	Black Sea	<i>Scophthalmus maeoticus</i>	Holt	Project
İLKYAZ (2005)	Aegean Sea	<i>Mullus barbatus</i> <i>Diplodus annularis</i> <i>Pagellus acarne</i> <i>Spicara flexuosa</i>	Direct estimationm ethod	PhDThesis
ÖZEKINCI (2005)	Aegean Sea	<i>Diplodus annularis</i>	Sechin (1969)	Research article
ÖZYURT and AVSAR (2005)	Seyhan Dam Lake	<i>Cyprinus carpio</i>	Holt	Research article
YALÇIN (2006)	Dam Lake	<i>Cyprinus carpio</i>	Holt	Proceeding
AYDIN and DÜZGÜNEŞ (2007)	Aegean Sea	<i>Diplodus annularis</i> , <i>Sardinella aurita</i> <i>Serranus cabrilla</i> , <i>Boops boops</i>	Sechin (1969)	Proceeding
ÖZEKINCI et al. (2007)	Lake Atikhisar reservoir	<i>Leuciscus cephalus</i>	Holt	Research article
ÖZTEKIN (2007)	Aegean Sea	<i>Sarpa salpa</i>	Holt	MScThesis
SÜMER et al. (2007)	Black Sea	<i>Mullus barbatus</i>	Baranov (1948)	Research article
DINCER and BAHAR (2008)	Black Sea	<i>Mullus barbatus</i>	SELECT	Research article
KALE (2008)	Aegean Sea	<i>Boops boops</i>	Holt	MScThesis
KARAKULAK and ERK (2008)	Aegean Sea	<i>Boops boops</i> , <i>Diplodus annulari</i> <i>Mullus surmuletus</i> <i>Pagellus acarne</i> <i>Spicara maena</i>	SELECT	Research article
AYAZ et al. (2009)	Aegean Sea	<i>Boops boops</i>	SELECT	Research article
ÖZEKINCI et al. (2009)	Aegean Sea	15 fishs pecies	SELECT	Project
AKAMCA et al. (2010)	Mediterranean	<i>Sparus aurata</i>	SELECT	Research article
CEYHAN et al. (2010)	Aegean Sea	<i>Mustelus mustelus</i>	SELECT	Research article
AYAZ et al. (2010a)	Aegean Sea	<i>Diplodus annularis</i>	SELECT	Research article

Table 1. Continued

AYAZ et al. (2010b)	Aegean Sea	14 Fish Species, selectivity parameters of hanging ratio and twinethicknessfor three species	Holt	Project
AYDIN and SÜMER (2010)	Aegean Sea	<i>Dentex dentex</i>	Sechin (1969)	Research article
ÖZYURT et al. (2011)	Seyhan Dam Lake	<i>Sander lucioperca</i>	SELECT	Research article

The most of the studies were carried out in Aegean Sea, although the studies were available in the Black Sea (five studies), the Marmara Sea (one study), the Mediterranean (two study), lakes and dam lakes in fresh water (ten studies). The studies are mainly focused on size selectivity of the fish species. The mullets (*M. barbatus* and *M. surmuletus*), annular sea bream (*D. annularis*), bogue (*B. boops*), blotched picarel (*S. maena*) and round sardinella (*S. aurita*) have been the most studied species in the Turkish coast. In addition, carpio (*C. carpio*) and pike perch (*S. lucioperca*) have been studied in the fresh water (Table 1.).

There are only three study related to other factors affect the selectivity (Ayaz *et al.*, 2010a; Ayaz *et al.*, 2010b; Balik and Çubuk, 2001). The main methods used in the studies are Holt (used in the majority of the studies), SELECT (eight studies), Sechin's (four studies) and direct estimation method (only one) (Table 1).

3. The Selectivity Methods

The set gill net selectivity methods used in Turkey depend mainly on Holt's method (1963), SELECT method (developed *by Millar*(1992), Millar and Holst (1997)and Millar and Fryer (1999)), and the Sechin's method (1969).

3.1. Holt Method

Holt's method (1963) is one of the most widely used methods for estimating set gill nets selectivity in Turkey. This method is preferred by Turkish researchers because it is easy to understand and simple. It is assumed in this method that Fish length increases linearly with natural logarithm of ratio of the fish caught by large mesh to small mesh. This method based on comparison of the length-frequency distribution of fish caught by two different mesh sizes. Sparre et al. (1989) modified this method for three or more mesh size. Martins et al. (1990) developed formulas to determine spread of the selectivity curve.

The Holt's method is estimated by the following procedure; the length-frequency distributions of fish caught by larger mesh size are divided into the distributions caught by small mesh size and are estimated the natural logarithm of the results.

$$y = \ln\left(\frac{C_2}{C_1}\right) = bL + a$$

Where C_1 and C_2 are number of fish caught per length group, L is the fish length, a is the intercept and b is the slope of regression equation.

The optimum lengths for mesh size (Lm_1 and Lm_2), standard deviation (sd) and the selection factor (sf) are determined from following formulas,

$$Lm_1 = \frac{-2a.m_1}{b.(m_1 + m_2)}$$

$$Lm_2 = \frac{-2a.m_2}{b.(m_1 + m_2)} = \frac{Lm_1 \times m_2}{m_1}$$

$$sd = \sqrt{\frac{-2a(m_{i+1} - m_i)}{b_i^2(m_i + m_{i+1})}}$$

$$SF = -(2a)/b(m_1 + m_2)$$

Where m_i is the mesh size. If the number of mesh size are more than two mesh size, the common selection factor and standart deviation must be calculated with following equations (Sparre *et al.*, 1989).

$$SF = -2 \left[\sum_{i=1}^{n-1} (a_i / b_i)(m_i + m_{i+1}) \right] / \left[\sum_{i=1}^{n-1} (m_i + m_{i+1})^2 \right]$$

$$sd = \sqrt{\left(\frac{1}{n-1} \right) \left(\sum_{i=1}^{n-1} \frac{-2a_i(m_{i+1} - m_i)}{b_i^2(m_i + m_{i+1})} \right)}$$

Where n is the number of the mesh size. Optimum length (Lm_i) for mesh size (m_i) is calculated from following formula,

$$Lm_i = SF \times m_i$$

The probability of capture P for each length classes L in the used mesh size is estimated from the following equation (Holt, 1963):

$$P = \exp \left[- \left(\frac{L - L_{m_i}}{2(sd)} \right)^2 \right]$$

The minimum and maximum catch length ($Lmin$ and $Lmax$) for each mesh size m_i are calculated as follows (Martins *et al.*, 1990).

$$L \min = Lm_i - \sqrt{(-\ln(0.5) \times 2 \times sd)}$$

$$L \max = Lm_i + \sqrt{(-\ln(0.5) \times 2 \times sd)}$$

3.2. Sechin Method

This method, developed by Sechin's(1969) and Kawamura (1972) and modified by Reis and Pawson(1992), is one of the selectivity method used slightly in Turkey. The selectivity is estimated by using operculum and maximum girth lengths of the fish species, provided that gilling or wedging are main means of capture and the analysis is independent of size distribution data for gill net catches (Sbrana et al., 2007).The selectivity curve is estimated from following equation:

$$S_j = \Phi\left(\frac{2M - Gh_j}{\theta h}\right) \left[1 - \Phi\left(\frac{2M - Gmax_j}{\theta max}\right) \right]$$

Where Φ is the cumulative function of the normal distribution; M is the stretched mesh size, G_{hj} and G_{maxj} are estimated mean of the operculum and maximum girth lengths per j^{th} length class; θ_h and θ_{max} are mean standard deviation of the operculum and maximum girth lengths; S_j ranges between 0 and 1; it is 0 when the j^{th} length class is not caught and 1 when it is probability of catch is %100. G_{hj} and G_{maxj} are determined by linear regression (Fabi et al., 2002; Sbrana et al., 2007).

3.3. SELECT (Share Each Length's Catch Total) Method

The SELECT (Share Each LENGTH's Catch Total) method has been started to use in recent years in Turkey. The SELECT model is described by the following expression:

$$n_{lj} \approx \text{Pois} (p_j \lambda_l r_j(l)),$$

where n_{lj} is the number of fish of length l caught in mesh size j , p_j is the fishing intensity, λ_l is reflecting the abundance of the length class l , $r_j(l)$ indicates the retention probability of length l fish in the j 'th mesh size.

The log likelihood of the model is as:

$$\sum_l \sum_j \{n_l \log [p_j \lambda_l r_j(l)] - p_j \lambda_l r_j(l)\}$$

Five different models, normal location, normal scale, log-normal, gamma, and bi-normal scale were calculated from following equations(Millar, 1992; Millar and Fryer, 1999; Millar and Holst, 1997):

$$\exp\left(-\frac{(L - k.m_j)^2}{2\sigma^2}\right) \text{ for normal location shift in which means is proportional to mesh size,}$$

$$\exp\left(-\frac{(L-k_1.m_j)^2}{2k_2^2.m_j^2}\right) \text{ for normal scale,}$$

$$\frac{1}{L} \exp\left(\mu + \log\left(\frac{m_j}{m_1}\right) - \frac{\sigma^2}{2} - \frac{\left(\log(L) - \mu - \log\left(\frac{m_j}{m_1}\right)\right)^2}{2\sigma^2}\right) \text{ for log-normal,}$$

$$\left(\frac{L}{(\alpha-1).k.m_j}\right)^{\alpha-1} \exp\left(\alpha-1-\frac{L}{k.m_j}\right) \text{ for gamma, and}$$

$$\exp\left(-\frac{(L-k_1.m_j)^2}{2k_2^2.m_j^2}\right) + c.\exp\left(-\frac{(L-k_3.m_j)^2}{2k_4^2.m_j^2}\right) \text{ for bi-normal scale,}$$

Where L is the total length in cm, m_1 is the smallest mesh size, m_j is the mesh size j , μ is the mean size (length) of fish caught, σ is the standard deviation of the size of fish, and k is a constant. Decision on the most appropriate model fitting the data was evaluated by comparing the deviances of each model and by examining their residual plots.

4. The Impact of Selectivity Studies on Turkish Legislation

The by-catch rate is very high in Turkish set net fisheries so Turkey seas have rich fish biodiversity. The using selective fishing gear is a way to reduce the by-catch rate. Although a considerable number of set net selectivity studies have been conducted in Turkey since the studies were started in 1995, there are two set net selectivity regulations in Turkish legislation related to grey mullets and flat fish. However, there is no study on these species. Despite the fact that the striped and red mullets are the most studied species; there is no regulation on this species. This is quite a strange situation. There is also no demand for determination of selectivity from fisheries management authorities in Turkey. The researchers have studied the most abundant fish and widely used set nets by fishermen.

5. Conclusion

Most of the set net selectivity studies in Turkey include the selectivity parameters for only one species and recommend the regulations for this species, ignoring the other species caught in the same fishing operation. The restriction of mesh size recommended for a species may cause in danger for sustainability of the other species. While a researcher recommend a restriction related to

selectivity for a mesh size of the net, the arrangement must be covered as much as possible for all species caught in the nets.

The set nets are the most widely used in Turkey seas and their size selectivity must be known to protect juvenile fish per species. Besides, fishery managers should take into account these studies and the results of the studies should be included in the legislation. There's a huge need for selectivity studies in Turkey seas and fresh waters.

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SURVIVAL STUDIES: INVESTIGATING THE SURVIVAL OF FISH ESCAPING FROM THE CODENDS OF BOTTOM TRAWLS

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1. Introduction

Bottom trawling is one of the most effective fishing methods for catching demersal fish worldwide. However, aside from the landed catch, this fishing gear can inflict considerable fishing mortality upon exploited stocks that is unaccounted for (Suuronen 2005). Many experiments conducted in the last two decades have shown that at least some fish do not survive the rigours of capture even if they ultimately escape from the gear. Improving the selectivity of trawls is an important conservation tool for minimising discards of unwanted and undersized fish and ensuring that fish reach their optimal size before harvesting (Main and Sangster 1990).

A considerable amount of studies of escape mortality have been conducted over the past two decades in the northwest coast of Scotland, the North Sea, the northern Baltic Sea and the Barents Sea (Main and Sangster 1990, Sangster *et al.*, 1996, Suuronen *et al.* 1996, Broadhurst *et al.*, 2006, Ingólfsson *et al.*, 2007). The most studied group of fish are gadoids and in particular cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*) and whiting (*Merlangius merlangus*) (Main and Sangster 1990, Sangster *et al.*, 1996, Suuronen *et al.*, 2005, Ingólfsson *et al.*, 2007). Most important factors, summarised by Suuronen (2005), such as species related mortality, effects of fish size, mesh size and shape, water temperature, and codend catch may cause variant mortalities of fish escaping from demersal trawl codends. However, until now, there have been only a few studies (Düzbastılar *et al.*, 2010a,b, Metin *et al.* 2004, Tokaç *et al.* 2006) investigating the survival rates of fish escaping from trawl codends in the Mediterranean.

2. History of Survival Studies in the Mediterranean

Demersal trawling in Turkish Coasts is performed on grounds where more than 50 species encounter the gear (Tosunoğlu *et al.*, 2003). Poor selectivity of trawl codends has been an important issue in Turkish fisheries since the mid 1980s. There are many selectivity studies carried out in the Mediterranean Sea to improve selectivity some modifications of the codend (Metin *et al.*, 2005, Bahamon *et al.*, 2006, Aydın *et al.*, 2008).

Survival studies to investigate mortality of red mullet (*Mullus barbatus*) after escape from trawl a 40 mm PE codend have been started since 2000s in the

west coasts of Turkey (Metin *et al.*, 2004). However, information on the survival of released fish is limited for the Mediterranean. Information on survival rates is only available for red mullet (*Mullus barbatus*) (Metin *et al.*, 2004), annular seabream (*Diplodus annularis*) (Düzbastılar *et al.*, 2010a, Tokaç *et al.*, 2006), black goby (*Gobius niger*) (Düzbastılar *et al.*, 2010a), brown comber (*Serranus hepatus*) (Düzbastılar *et al.*, 2010a,b) and blotched picarel (*Spicara maena*).

3. Research on Escape Mortality in Turkey

Survival experiments were conducted out of Yassica Island in İzmir Bay between the years of 2001 and 2009. A research vessel, R/V EGESÜF (26.8 m length, ~500 HP engine) was used for trawling operations. Two different tow durations (5 and 15 min) were performed to find appropriate sampling time which may affect on the survival probability of fish in the experiments. The towing speed varied from 2.0 to 2.6 knots and a constant towing duration of 15 min was used for most of hauls. The trawl began fishing in water depths of approximately 30 m and then the operation was terminated in a depth of between 10-20 m.

Fishing gears were a conventional bottom trawl with 600 meshes around the mouth and a tailored bottom trawl with 700 meshes around the fishing circle. Survival of fish escaping from 40 mm square (100 bars around circumference and 5 m in length) and 40 mm diamond mesh polyethylene (PE) codends (200 meshes around the circumference and 5 m in length) were studied. Codend covers were constructed to retain escaping fishes. 24 mm mesh size knotless PE netting was used as a codend cover. It was supported by two High Density Polyethylene (HDPE) hoops in 1.6 m diameter. A 1 m long zip was mounted on the cover netting between the two large hoops, to collect the mortalities from the cages and to feed the survivors.

The trawl codend was left open to collect control fishes (Figure 1a). Thus, the fish that entered the codend also entered the cover without having to penetrate the codend meshes. In the test hauls the cod line was tied as in the commercial practise, so all the escapees in these hauls had to penetrate the codend meshes (Figure 1b). At the end of each tow, the covers were detached (Figure 1c) from the codends and horizontally deployed to sea bottom by divers to be used as observation cages at shallow depths. The anchoring depths allowed the divers to monitor the cages securely and with a long bottom time for sampling. To prevent anoxia by providing maximum possible cage volume, the cages were stretched from one end to the other using ropes and wooden rods by divers. The cages were observed by divers three times a day; live fish were fed and the dead individuals were collected during the study period. At the end of the observation period (6-8 days), the cages were retrieved. The fishes were counted and their total and standard lengths were measured.

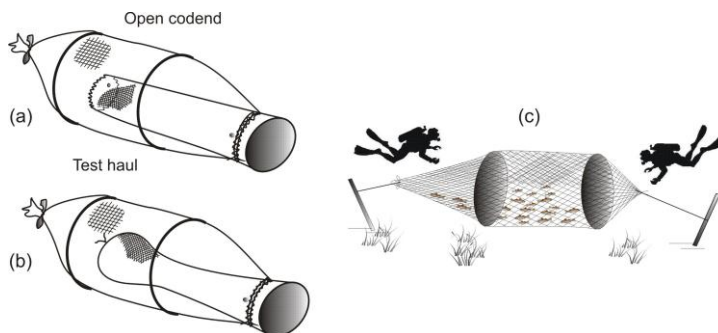


Figure 1. (a) Open codend (b) Test haul (c) Installing the cover

3.1. Effects of Water Temperature

The study was carried out to determine the seasonal variation on survival rates of the brown comber (*Serranus hepatus*) after escape from a 40 mm stretched diamond mesh (DM) PE codend. Two experiments were conducted out of Yassica Island in İzmir Bay during the periods 29 January-5 February 2007 (water temperature; 13°C), and 11-18 September 2008 (water temperature; 24°C). The mortality of brown comber (2.2% for 2007 and 1.9% for 2008) in the test cages (DM1, DM2, and DM3) for two experiments was very low and survival probability was unrelated to the seasonal variation ($p>0.05$) (Figure 2).

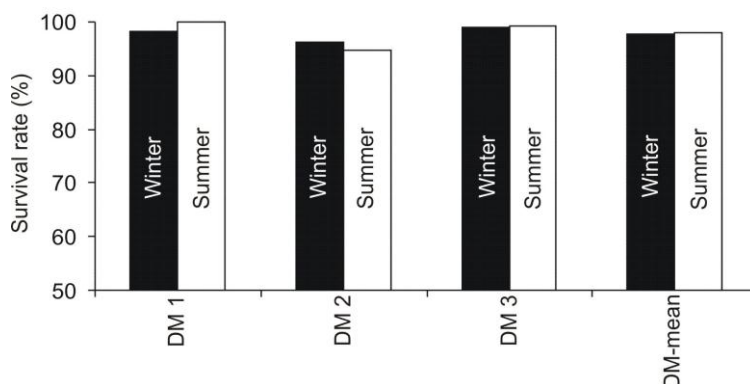


Figure 2. Survival rate of brown comber escape from diamond mesh (DM) test codends in the 2007 and 2008 experiments

3.2. Effects of Mesh Size and Shape

The survival of red mullet (*Mullus barbatus*), annular seabream (*Diplodus annularis*), blotched picarel (*Spicara maena*), brown comber in the Aegean Sea escaping from 40 mm square (SM) and 40 mm diamond mesh codends was investigated between 2001 and 2009. For red mullet, survival rates were found as 93.9, 94.7 and 90.8% in the three DM test cages in the

September, 2001 experiments (Metin et al. 2004). The proportion surviving of red mullet in the open codend (OC) cage was 77.4%. In the October, 2009 experiments, survival rates of red mullet varied between 71% and 95% in the three DM test cages (Figure 3). The survival rates for the three SM test cages varied between 94% and 96%. Survival rates among the observation cages showed insignificant difference ($p>0.05$).

Overall, it was noted that the mortalities were generally smaller than the survivors in the cages (Figure 4). The sizes of the mortalities in the square mesh codend cages were between 6.5 and 11.0 cm.

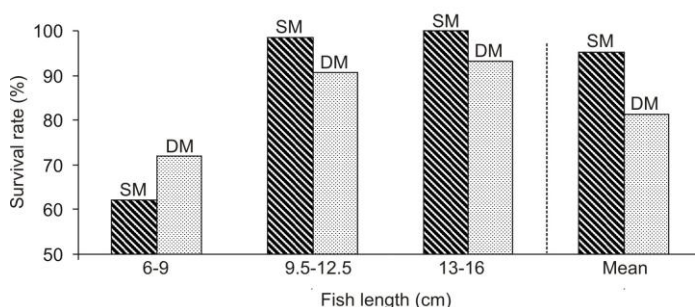


Figure 3. Survival rate of red mullet that escaped from the square (SM1, SM2 and SM3) and diamond (DM1, DM2, and DM3) mesh codends in relation to three length categories and mean survival rate between 6 and 16 cm fish length

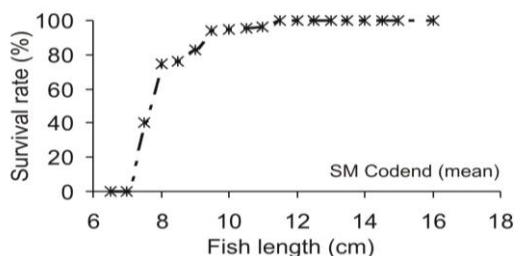


Figure 4. The survival percentages of red mullet in the square (SM1, SM2, and SM3) mesh codend cages are positively associated with fish length (October, 2009).

For brown comber in the September 2007, survival rates were 100, 96.7 and 98.3% in the three diamond mesh codends (Düzbastılar *et al.*, 2010a). The mean survival rate of the three open codend cages was 97%. In the September 2008, survival rates of brown comber were 93.1, 81.4, 74.3, 100, 94.8 and 99.3% in the three square and diamond mesh codends, respectively (Düzbastılar *et al.*, 2010b) (Figure 5). In the study, the proportion surviving of brown comber in the open codend cage was 92%. The diamond test cages had greater the mean survival rate (98.1%) than the square test cages (82.9%). There was no

significant difference in survival rates between the square test cages and the diamond test cages ($p>0.01$).

All the escaping annular seabream individuals from both the square and diamond mesh codends showed 100% survival in most of the survival experiments (2001, 2007, 2008 and 2009 experiments) (Tokac *et al.*, 2006; Duzbastilar *et al.*, 2010a).

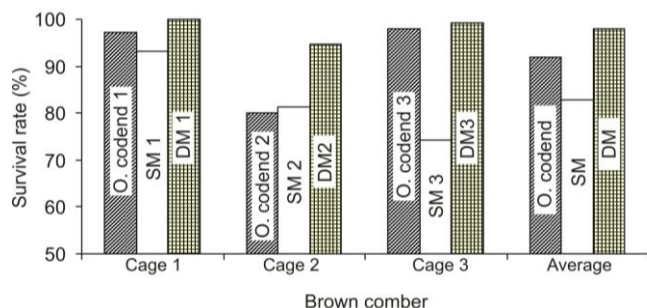


Figure 5. Survival rate of brown comber from the observation period in the survival experiment (summer 2008) for open codend, square (SM1, SM2, and SM3) and diamond (DM1, DM2, and DM3) mesh codends

In the 2009 experiments, survival percentages of the blotched picarel escaping from diamond mesh codend in three tows were 80.4, 98.9, and 94.4 resulting in a mean value of 91.2%. These values for the square mesh codend were 96.4, 96.3 and 96.7% (mean 96.5%). In 2007 experiments, survival percentages of black goby varied between 58% and 87%, and 47% and 80% for the test cages (DM) and open codends, respectively (Duzbastilar *et al.*, 2010a).

4. Conclusions

This chapter reports the first experiments on the survival ratios of five fish species escaping from diamond and square mesh codends in the Mediterranean. The methodology used in those experiments has been developed in early 2000s by the same team (Ege University, Faculty of Fisheries and Centre of Underwater Research and Application) after several captivity arrangements were tested and preliminary results were obtained (Metin *et al.*, 2004). It was considered that the best results could be obtained by 15 min tows to require an acceptable catch size. In this chapter, results show that mortalities vary with the different fish species, although the exact causes of variation have not yet been explained. Species-specific variation in escape mortality has been reported by several researchers (Broadhurst *et al.*, 2006, Ingólfsson *et al.*, 2007). Some fishes have been reported to have a greater capacity (Ryer *et al.*, 2004) such as brown comber and annular seabream in our studies to survive under many different conditions (skin damage, captivity stress, etc.). However, this issue could not be investigated in our experiments due to time constrain and remains to be studied in future studies. Furthermore, our results may have not been entirely representative of commercial fishing condition. On the other hand,

we concluded that the survival data of five fish species, resulted in various escape mortalities, will obtain useful information for commercial bottom trawling fisheries in the Mediterranean Sea.

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ARTIFICIAL REEF RESEARCHES AND APPLICATIONS IN TURKISH SEAS

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1. Introduction

An artificial reef is a structure placed in the sea, either to protect or enhance the existing habitat or to create a new type of habitat for marine animals and plants (Collins and Jensen, 1996). Older artificial reef deployment practices were including artisanal commercial and recreational fishing. Newer practices include aquaculture, recreational diving, submarine diving for nature-based tourism, protection and restoration of habitats and environmental mitigation (Seaman, 2002).

Artificial reef applications have very short history in Turkey. The first scientific artificial reef project, conducted by the Ege University Faculty of Fisheries, was started in Hekim Island, Izmir Bay, in 1991. The perceived success of this project resulted in increased interest in reef technology and new cooperative projects were started among local governments, fishery cooperatives, and universities. Local governments provided financial support, universities provided scientific and technical knowledge, and fishery cooperatives provided practical information on local conditions.

The main aims of reef deployment in Turkey are: (1) to create new sites for recreational fishing and diving, (2) to improve small-scale fisheries, (3) to protect fish-spawning and nursery areas (e.g. *Posidonia* meadows) from illegal trawling, and (4) to conduct scientific experiments.

2. Researches

The researches on artificial reefs had focused on fisheries, biological and engineering issues.

Fisheries and biological studies consist of;

- determination of marine fauna and flora on and around artificial reefs,
- seasonal changes of abundance, biomass and biodiversity of fauna around artificial reefs and FADs,
- the effects of deployment depth and habitats on fauna,
- species specific artificial reef design for octopus,
- FADs design,
- determination of CPUE of small-scale fishing methods around FADs,

The results of some studies which listed above are given below.

The first scientific artificial reef project, conducted by the Ege University Faculty of Fisheries, was started in Hekim Island, Izmir Bay, in 1991. Thirty cubic concrete blocks were assembled in six pyramids (four blocks forming the base, with one on top). According to result of this study (Lök and Gül, 2005), fish family and species numbers increased approximately three times after 8 years and individual number increased two times in the same period (Table 1).

Table 1. The change of fish community structure by time in Hekim Island artificial reef site

Mean number of	Before reef deployment	After 1 year	After 8 year
Family	5	9	14
Species	8	10	22
Individual	116.4	218.5	225.8

A long term study to determine of fish assemblages and their changes by seasonally, had conducted at four artificial reef sites Hekim Island, Dalyanköy, Ürkmez and Gümüldür between 2001 and 2005. A census was performed on fish populations at artificial reef sites to record species richness, abundance and length estimates for biomass calculation (Lök and Gül, 2005; Lök *et al.*, 2006). In total, 64 species belonging to 24 families were recorded. Labridae, Sparidae and Serranidae were the dominant families at all reef sites. Bilecenoğlu *et al.* (2002) have recorded 331 fish species at Aegean Sea coast of Turkey, Identified 64 species at artificial reefs compose almost %20 of Aegean Sea fish species.

Fish assemblages at artificial reef sites varied significantly daily, seasonally and annually. The highest records in terms of fish species richness and biodiversity were found in both autumn and spring seasons, for instance at the Gümüldür artificial reef site as shown in Figure 1. We found that fish abundance and biomass peaked in summer and winter, respectively (Gül, 2008; Lök *et al.*, 2006; Lök and Gül, 2005). Biodiversity changes depend on the presence of fish schools, especially during spawning periods.

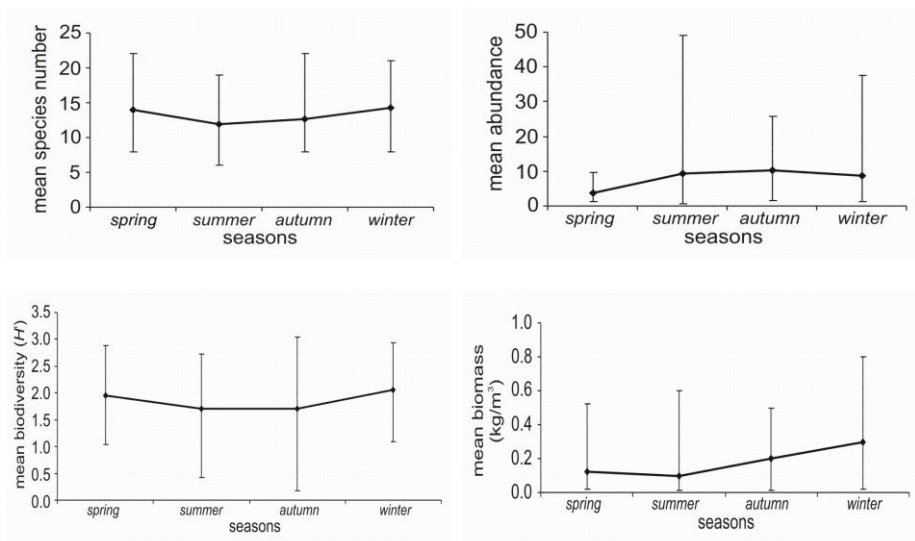


Figure 1. Seasonal changes of fish community at Gümüldür artificial reef site

Although fish aggregation devices (FADs) have been used around of the world for many years, their use in the context of fishing on the coasts of the Aegean Sea or eastern Mediterranean has not been reported. So, this study represents the first such research effort in these regions. Samples were collected with small-scale fishery techniques and acoustic surveys with scientific echo sounder (*Biosonics DT-X*) around FADs and control sites throughout one year periods. Underwater visual observations were also conducted to obtain qualitative information on the spatial distribution of fish populations.

A total of 1478 fishes were sampled, comprising 27 species belonging to 20 families around of FADs. By far the most frequently observed family was Carangidae (4 species); we also observed Scombridae (3 species) and Sparidae (3 species). *Seriola dumerili*, *Trachurus mediterraneus*, *Coryphaena hippurus*, and *Balistes capriscus* were the species most frequently observed beneath FADs. The number of species associated with FADs was significantly peaked in the autumn and the spring. The number of individuals/FADs peaked in the autumn, and then declined throughout the winter.

Two buoys as FADs were constructed and moored in 50 and 100 m deep of water in the Aegean Sea to support recreational fisheries. FAD units consisted of a steel buoy that was 2.25 m in diameter and HDPE (high density poly ethylene) buoy that was 1.20 m in diameter which were moored with multifilament polypropylene ropes ($\varnothing$ 16 mm), and chain ($\varnothing$ 13 mm) with anchor weighing approximately 2.5 t. FAD units were also equipped with flashlights to prevent sea accidents (Figure 2; g and h). FADs were moored over 1.1 nautical miles and 3 nautical miles from the coast respectively. The distance

between FADs was approximately 2 nautical miles. When performing the FAD design, wave, current and wind effects were evaluated using the stability equation before deploying the FADs. The interaction between the forces of wave and current and FADs in those waters was investigated. In the experiment, all forces (drag force, buoyancy force etc.) acting on FADs were calculated. Hardware and connections of FADs, ropes, mooring calculation and anchor design were made before FADs deployment.

Data were analyzed by station as well as according to experimental fishing method. A 259 fish and 74.4 kg were caught beneath FADs. Fish abundance at FADs was greater than that at control stations in terms of number of fish and total weight. Besides, FAD-50 has number of fish than FAD-100 but FAD-100 has more fish biomass than FAD-50. Especially, *Xiphias gladius* was recorded around FADs for the first time in Mediterranean waters; this species has economic value for commercial fisheries. Notwithstanding trolling was an important fishing method for game or sports fisheries. Horizontal longlines were more productivity method for professional fisheries but also gillnet is not useful methods for FADs fisheries.

Engineering studies consist of;

- local scour
- stability

problems of artificial reef units due to internal waves and related currents in shallow waters.

While designing the reefs, environmental effects such as wave and current conditions, distribution of bottom material around the reef blocks and deployment depths are particularly important (Nakamura, 1985). Consideration of local scour and loss of stability together has indicated that shallow waters are likely to have a very limited service life for artificial reefs in the Black Sea. Result of hydraulic studies had showed that a minimum deployment depth should be 20m in Black Sea (Düzbastılar *et al.*, 2006). Furthermore, to improve reef design, numerical modeling studies which using empirical data from monitored reef sites started (Düzbastılar and Şentürk, 2009). This kind of studies should be made for all Seas.

3. Applications

The term of “application” in this part of the text was used for “artificial reef projects supported by municipalities or civil organizations without a scientific purpose”.

The success of research projects resulted in increased interest in reef technology and new cooperative projects were started among local governments fishery cooperatives, and universities. Local governments provided financial

support, universities provided scientific and technical knowledge, and fishery cooperatives provided practical information on local conditions. There are 24 artificial reef project in 16 locality in Turkey (Figure 2).



Figure 2. The map of artificial reef areas in Turkey

Different artificial reef designs had used in these projects (Figure 3).

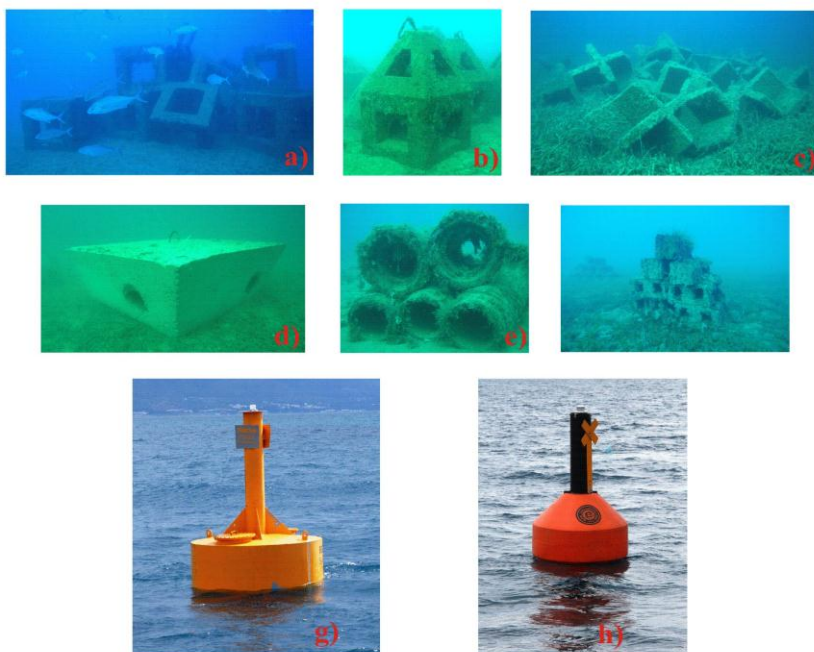


Figure 3. Artificial reef designs in Turkey

4. National Programme

The Ministry of Agriculture and Rural Affairs decided to prepare a National Artificial Reef Program in 2008. This meeting was attended by decision-makers and scientists. The first discussion was performed to describe the purposes of the program. Potential artificial reef grounds and projects to be conducted at these sites were discussed according to the stated objectives:

- To create new fishing grounds in minimally productive muddy areas in order to promote small-scale fisheries
- To conserve biodiversity in the littoral zone

Three provinces on the Black Sea coasts and all provinces on the Aegean Sea and the Mediterranean Sea coasts were included in the program during its first stage due to the importance of small-scale fisheries.

Scientific studies were planned in two stages before reef deployment. In the first stage, information on small-scale fishery structure and hydrographic characteristics (bottom type, slope, etc) were determined for 10 provinces (three on the Black Sea coast, four on the Aegean Sea coast and three on the Mediterranean coast) between September 2008 and March 2009. Two provinces on the Black Sea coasts were excluded after data analysis because of very soft sea bottom and high sedimentation rate due to large rivers. Eight provinces remained after the first selection. The second stage of the evaluation is currently

ongoing and includes the collection of data related to biology, oceanography, fisheries techniques and socio-economics for one year prior to deployment.

Monitoring studies of at least two years that cover biological, physicochemical, fishery and socio-economic parameters are planned for the period after the deployment of each artificial reef site.

The National Program will be finished in 2020. This date depends on the future status of the Turkish national economy because the program's funding is provided entirely by the national budget.

5. Overview

One of the important issues related to artificial reef in Turkey is limited scientific research effort versus big application effort. The main reason of this is lack of research team in universities and national institutes. The National Program seems to big chance to solve this problem. If there will be a future for artificial reefs in Turkey, it should be depend on the results of scientific research.

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GHOST FISHING

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Summary

Ghost fishing is to continue catching organisms after the fishing gears or their scraps are lost or abandoned in the aquatic environment with any reason. These fishing gears both catch organisms and make the habitat useless by covering it. All fishing gears have the potential of being lost, but there has not been strong evidence that the active fishing gears like trawl and purse seine nets cause ghost fishing. So all studies in the world have focused on traps and set nets which their ghost fishing effect was proven. It is aimed to review the problem of the ghost fishing in this book chapter.

1. Introduction

Lost fishing gear and their scraps are one of the most dangerous types of marine debris (Laist, 1995). That dangerous effects of these fishing gears have occurred in the last years has elevated increasingly anxieties about this issue all around the world.

After the discovery of synthetic materials in 1930s, most synthetic materials started to be used in the trap making within ten years. Pelagic gillnets, trawls and drag-nets followed traps. In 1950 the first gillnet made of polyamide monofilament material was produced and in the beginning of 1960s all nets started to be produced from synthetic material and reached their today's situation (Sarhage and Lundbeck, 1992).

Synthetic materials are resistant to against tough conditions such as water, sun light and breaking of. Due to this feature, the synthetic materials have been widely used in different areas of fishery industries. However, some fishing gear such as traps, gill and trammel nets causes unexpected effects to the aquatic environment after being lost because of its resistant structure. One of the unexpected effects is ghost fishing.

Ghost fishing is an unwanted fishing situation that caused by lost, discarded or abandoned fishing gears, which continue to catch aquatic organism (Smolowitz, 1978b; Breen, 1990; Kaiser *et al.*, 1996; Erzini *et al.*, 1997; Ayaz, 2003; Matsuoka *et al.*, 2005; Brown and Macfadyen, 2007). While lost fishing gears continue their catching activities on the target species, the caught fishes attract the predators and make them caught by the lost gear. This situation can continue until the fishing gears completely destroyed in water. As a consequence of cannibalism the occurring odor in some traps can attract species

into the trap, and this species cannot exit and die in the trap. In addition to that, some species use the trap as a nest, but cannot exit too. Both of these issues make the trap baited again and causes ghost fishing continuously (High and Worlund, 1979; Von Brandt, 1984; Breen, 1987, 1990).

All fishing gears have the potential of being lost, but there has not been strong evidence that the active fishing gears like trawl and purse seine nets cause ghost fishing. So all studies in the world have focused on traps and set nets which their ghost fishing effect was proven. Recent studies demonstrate that passive fishing gear caught significant amount of the aquatic organism for certain time (Carr *et al.*, 1992; Erzini *et al.*, 1997; Bullimore *et al.*, 2001; Ayaz, 2003; Humborstad *et al.*, 2003; Sancho *et al.*, 2003; Santos *et al.*, 2003b; Tschernij and Larsson, 2003; Al-Masroori *et al.*, 2004; Ayaz *et al.*, 2006a; Ayaz *et al.*, 2010).

The reasons of the loss of the passive fishing gear have been stated as bad weather conditions (storms, currents and ice movements), bottom obstacle and structure (ship wrecks and rocks), shipping activities, fishing gear conflict, human error (not well tied up main buoys), effects of sea birds, sea mammal and other big marine creatures (buoy ropes cut by sea birds and the nets being drifted away by big marine creatures when they are entangled to them), vandalism among fishermen and nets being drifted by currents to territorial waters of neighboring countries (Bowen, 1961; Smolowitz, 1978a; Sutherland *et al.*, 1983; Von Brandt, 1984; Breen, 1987, 1990; Laist, 1995; Ayaz, 2003; Ayaz *et al.*, 2010).

The first scientific studies concerning ghost fishing started in 1970s but first global discussions realized in the meeting of the 16th Fishing Committee made in FAO in April 1985 (Brown and Macfadyen, 2007; Baeta *et al.*, 2009). Studies about this issue started in 1970s in the world, unfortunately the studies do almost not exist in Turkey. It is the first time a PhD Thesis has been carried out in İzmir Bay (Ayaz, 2003). That date to the present, two master thesis and five scientific article and a proceeding have been conducted (Ayaz ve Acarlı, 2002; Ayaz *et al.*, 2004; Ayaz *et al.* 2006a; Ayaz *et al.* 2006b; Taşlıel, 2008; Yıldız, 2010; Ayaz *et al.*, 2010). It is aimed to review the problem of the ghost fishing in this book chapter.

2. First Scientific Studies of Ghost Fishing in the World

The first scientific studies concerning ghost fishing started to carry out in early 1970s although the issue was first recognized in gill net fisheries in FAO meeting in Roma in 1960 (Smolowitz, 1978b). Demory (1971) retrieved 117 Dungeness crab (*Cancer magister*) traps, which had been lost at least 6 weeks and declared that there were 3629 live crabs inside them. Ghost fishing in traps was first proven with a study carried out in 1975. In two years of the observation period by hauling and scuba diving, 98 American lobster (*Homarus*

americanus) traps were deployed, 35 of them were unbaited and the rest was baited. It was reported that 12-18 % of lobsters caught by traps were death in the study (Sheldon and Dow, 1975). Somolowitz (1978b) declared that he found 24 (70.8 kg) lobster inside 18 live American lobster traps, which became lost for about 9 weeks.

The ghost fishing issue in set nets, similar to traps, was proven with spoiled, dead and live fish met on the nets retrieved. Way (1977) found a gillnet used in Cod catching by grappling devices, declared that there were live fish and crabs on it and concluded that the net continued to ghost fishing in decreasing ratio. Degange and Newby (1980) reported finding a drifting pelagic 3.5 km gillnet loss for more than a month and indicated that the net included 99 birds and 78 fish. They concluded that the net were going on catching from the fresh fish and live birds.

3. Extent of the Ghost Fishing Problem

The ghost fishing problem covers all countries their fishermen use set nets and traps while the extent of the problem is not known exactly in the world. The result of the research conducted by the European Union countries found that the lost nets were not a problem in the shallow waters (Pawson, 2003; Revill and Dunlin, 2003; Sancho *et al.*, 2003; Santos *et al.*, 2003b; Tschernij and Larsson, 2003), but set nets may hang on the rocks with three-dimensionally, maintain initial magnitude and continue to ghost fishing for a long period of time, even after badly fouled (Matsuoka *et al.*, 2005). As noted in recent studies, the lost nets wash ashore by the current or collapse on the bottom due to over bio fouling or retrieve (Carr *et al.*, 1992; Erzini *et al.*, 1997; Pawson, 2003; Revill and Dunlin, 2003; Brown and Macfadyen, 2007; Large *et al.*, 2009). However in rocky grounds, to recover the lost nets can be hauled only by SCUBA diving limited to 30 meters. Therefore, especially for countries such as Turkey, the coastline of which are covered with reef areas, ghost fishing is a serious threat for both organisms and ecosystem in the area where water depth is deeper than 30 m. In Aegean Sea, there is a major concern about ghost fishing among the local fishermen, because lobster (*Homarus gammarus*) and spiny lobster (*Palinurus vulgaris*) fishing by using the bottom set gill and trammel net are widely used in natural reef areas. They claim that large amount of the net has been lost in deeper than 50 m depth in lobster and spiny lobster fishing by these nets.

There is no study related with ghost fishing in fresh water all over the world and Turkey (river and lake except estuary and lagoon), however it is known by the public that ghost fishing is occurred especially in Turkey. They told that fishing gear being called “TIRIVIRI”, widely used in the river, has been lost.

4. Amount of Lost Fishing Gears

Passive fishing gears (set nets and traps) are widely used fishing in the world because of their low cost and ease of use (Breen, 1990; Kara, 1992; Metin *et al.*, 1998). The amount of these fishing gears used all around the world is not known completely. That 1.6 million km pelagic squid gillnet was used by Japan, Korean and Taiwanese fishers in 1986 (Coe, 1986 in Breen, 1990) is an example that how much set nets are widely used all over the world. That one million lobster traps were used in the northwest of Hawaiian Islands (Landgraf *et al.*, 1989 in Parrish and Kazama, 1992), that 72000 blue crab (*Callinectes sapidus*) traps by 150 ships in New England Lobster fishing (Smolowitz, 1978a) and 560000 by 2800 ships in Louisiana state of the USA (Guillory, 1993) were used are dramatic examples that how effectively trap fishing is used. The passive fishing gear such as the widely used around the world, the rate of the lost fishing gears is not known exactly.

A one percent loss rate for gillnet fisheries has been declared (Natural Resources Consultants, 1990; Laist, 1995) but studies suggest that there might be higher than the stated estimates according to fishing features of the region where nets are used. On the coasts of Algarve in Southern Portuguese, lost rates of set nets were reported 3.2, 5.1 and 7.4 % for local, coastal and hake depth, respectively (Santos *et al.*, 2003a). In Turkey, the loss rates of the set nets totally used were declared 14.5 and 2,28 % in İzmir and Gökova Special Environmental Protection Area (SEPA), respectively (Ayaz *et al.*, 2004; Ayaz *et al.*, 2010). In addition, it was reported that a total of 226 km deep set net were lost in a fishing season (2006-2007) by the fishermen on the coasts of İskenderun, Karataş and Yumurtalık (Taşlıel, 2008). Lastly, it was designated that 229.48 km set nets were lost on the coasts of İstanbul in 2008 (Yıldız, 2010).

An overall loss ratio for the trap fishery has not been reported yet. The studies carried out show the regional loss rates. These values vary between 10-30 % (Laist, 1995). Muir (1984) reported 18 % trap lost rate in Dungeness crab trap fishing in Columbia river (USA), Breen (1987) declared 11 % for the same species in Fraser river (British Columbia) and notified 10-20 % in the King crab (*Paralithodes camtschaticus*) fishing in Bering Sea (Stevens *et al.*, 1993 in Laist, 1995). In New England (USA), the loss rates of the crab traps were estimated between 20 and 30 % of totally used (Smolowitz, 1978a). A 20 % loss rate in the fish traps used in Oman Gulf (Al-Masroori, 2002 in Al-Masroori *et al.*, 2004) and an 8.47 % lost rate in a study fulfilled in İskenderun Bay in Turkey were reported (Özyurt *et al.*, 2008).

5. Dangerous Life of Lost Fishing Gears

Effective fishing time of lost fishing gear shows difference from the sea to the sea. It is known that they continue to ghost fishing for a long time especially when they have stayed hanging on the reefs as three-dimensional (Matsuoka *et al.*, 2005). Thusly, it was observed that the halibut (*Reinhardtius hippoglossoides*) gillnets continue to ghost fishing eight years after being lost (Humborstad *et al.*, 2003). In the ghost fishing studies, it was reported that a quick algal development was observed on the nets after being lost and the nets continued to catch fish for a certain time although the nets' fish catching decreased due to the increased visibility (Carr *et al.*, 1992; Kaiser *et al.*, 1996; Erzini *et al.*, 1997; Ayaz, 2003). Sometimes, fishermen abandon or discard at sea the nets after badly fouled due to the various influences such as strong currents and wind. Figure 1 shows that how the abandoned gill net affects the crustaceans even after badly fouled.

In Norwegian halibut fishing, it was declared that the ghost gill net catching efficiency decreased about 20-30 % of that of nets used in the commercial fishery at the end of the 45 days (Humborstad *et al.*, 2003). It was declared that the catching capacity of the gillnets deployed to the open ground in of UK coastal waters decreased in more than 50 % during the first few week immersions and washed ashore in the 58th day while wreck net remained in situ and continued to ghost fishing, in spite of with decreasing capacity, over two years (Revill and Dunlin, 2003). It was determined that lost gillnets used in Hake (*Merluccius merluccius*) fishing off the coast of Algarve Gulf offing in Southern Portuguese had three months of life (Santos *et al.*, 2003b); reported that ghost fishing by gill and trammel net continued to catch the organism for 15-20 weeks in a study carried out in 15-18 m depths on the same fishing ground, and again in this country in a study conducted, it was found that the lost trammel nets made ghost fishing for 10-11 months in rocky grounds and for eight months in sandy grounds (Baeta *et al.*, 2009). It was declared that gillnets used in monkfish (*Lophius* spp.) fisheries in Cantabrian Sea in Spain continued to capture effective for 135 until 224 days (Sancho *et al.*, 2003). It was reported that the catching efficiency of lost cod gillnets in Baltic Sea decreased in 80 % in three months (Tschernij and Larsson, 2003). It was determined that multifilament and monofilament gillnets didn't catch the organism after 106 and 112 days, respectively (Ayaz *et al.*, 2006a). In Gökova Bay, it was determined that a dentex (*Dentex dentex*) trammel net known as lost for more than a year continued to capture fish (Ayaz *et al.*, 2010). The lost common dentex trammel net shows in Figure 2 in Gökova Bay.



Figure 1. A abandoned gill net in the Strait of Çanakkale

It was declared that the fishing life of Crustacean traps could be between two weeks and 15 years depending on their construction materials (Smolowitz, 1978a; High and Worlund, 1979; Breen, 1987). Although studies carried out in this issue are less, it is seen that the estimates may be true. As a result of a one-year study in Canada British Columbia Fraser River Estuary, it was reported that crab traps were in good condition and continued ghost fishing (Breen, 1987). Bullimore *et al.* (2001) in the study they carried out on the coast of Wales in England, stated that traps continued to fishing for two years and the catching could go on for long time. While the situation in Crustacean traps was in that way, that the ghost fishing life of fish traps varied between one month, and one year was observed in the less numbers of studies carried out (Al-Masroori *et al.*, 2004; Ayaz *et al.*, 2006b).



Figure 2. The skeletons of white grouper (*Epinephelus aeneus*) lying nearby a lost trammel net in Gökova Bay

6. Effects of Lost Fishing Gears on Aquatic Life and Environment

There are estimations for some marine areas although there is no general estimation about ghost fishing mortalities all over the world. It was detected that 0.5 % of the total catch of hake (*Merluccius merluccius*) fishing on the coast of Algarve in Southern Portuguese (Santos *et al.*, 2003b) and 1.46 % of the total catch in Cantabrian sea Monkfish fishing in Southern Spain (Sancho *et al.*, 2003) were for ghost fishing. The problem is the same for the trap fishery. It was indicated that 7 % of total catch of dungeness crab (*Cancer magister*) in Fraser River estuary (British Columbia, Canada) (Breen, 1987), 5 % of the total catch in New England lobster trap fisheries (USA) and 7.5-30 % of the total catch sable fish trap fishing (British Columbia, Canada) (Scarsbrooke *et al.*, 1988) were caught by lost traps.

The number of species affected by the lost fishing gears and their scraps in the world was declared as 267. This list includes 86 % of the sea turtles in the world, 44 % of the sea birds, 43 % of the sea mammals, and so many fish and crustacean species (Laist, 1997; Anonymous, 2004). A lost gill net scrap shows in figure 3 in Gökova Bay.



Figure 3. A lost gill net scrap caught a common dentex (*Dentex dentex*) in Gökova Bay

Lost fishing gear affects the benthic habitat negatively as well as aquatic life (Brown and Macfadyen, 2007). They especially cover on the reef areas and make them useless and destroy organisms remaining under them. The lost net covering on the reef area shows in Figure 4 in Gökova Bay (Ayaz *et al.*, 2010). They move with currents and harm to organisms by removing them from their location (Ayaz, 2003).



Figure 4. The lost net covering on the reef area in Gökova Bay

7. Measures Against Ghost Fishing

A part of studies conducted towards the reduction of ghost fishing has been completed and some of them continue. The aim of the prevention of ghost fishing, in a study, researchers were investigated make the lost set nets remain in catching position collapsed on the bottom rigging the yarn made of bio-degradable material on the float line (Carr *et al.*, 1992). Moreover, the use of cotton material is tried to be developed instead of synthetic materials used in the set nets manufacture (Matsushita *et al.*, 2008). However, those bio-degradable materials have short fishing life prevent a widespread use of a fishery. In an application made in Japan, the radar reflector is attached to the drift nets against the probability of being lost (Breen, 1990). Besides, attaching the flags in the day and light in the night on the set nets was made to be connected to prevent ghost fishing in many countries (Anonymous, 2004; Ayaz *et al.*, 2004).

In trap construction, that a certain section of the trap equipped with degradable material to provide the escape of the harvest from the trap and to make the opening mechanisms (time-release) to provide the harvest in the trap to escape within a certain time is one of the measures taken to eliminate ghost fishing by making the lost traps unusable (Breen, 1990; Laist, 1995). It's been stated that; addition of vent to traps derives prevention of catching the species under minimum landing size and allays biomass in the trap, as a consequence reduces ghost fishing effect (Smolowitz, 1978a).

In some seas legal reforms have become valid for preventing ghost fishing. These reforms became valid in areas which loss of gear rate is high and also for fishing gears that have high risk of getting lost. Thus result of two projects supported by European Commission stated that ghost fishing pose a threat in deep water (Large *et al.*, 2009) and fishing with gill nets deeper than 200 m of depth was prohibited since 1st of February 2006 (Brown and Macfadyen, 2007).

It is known that the set nets cause the ghost fishing in Turkey's seas data from a few scientific studies, but there is no restriction on ghost fishing in the seas. Although there is no scientific study on effect of "TIRIVIRI" in the fresh water, but the using of this gear has been banned by Turkish legislation.

One of the most effective actions to be taken against ghost fishing is removing the abandoned fishing gears. Thus studies and suggestions support the idea of removing abandoned gears. It is suggested to start campaigns for removing abandoned gears from the place they were tangled with scuba divers in rocky surfaces as possible as can be and removing them with graps in flat surfaces (Cooper *et al.*, 1988; Guillory *et al.*, 2001; Ayaz *et al.*, 2004; Brown and Macfadyen, 2007; Large *et al.*, 2009; Ayaz *et al.*, 2010).

8. Conclusion

As a conclusion, ghost fishing is a significant danger that threatens the marine ecosystem. Concerns about this issue rise globally day by day. Education is one of the most significant ways of solving this problem. Main reason of ghost fishing in less developed countries, especially which has uneducated fishermen is loss of fishing gears by using them in inadequate areas (e.g. in reefs) to save the day and illegal fishing. Similar problems may be encountered in Turkey too. Serious problem encounter for blue spotted bream (*Dentex gibbosus*), common dentex (*Dentex dentex*) and lobster (*Homarus gammarus* and *Palinurus vulgaris*) fishing with trammel nets in Aegean Sea. Teaching courses by experts of ghost fishing issue specially would be the solution of allaying this problem. Radical reforms have to become valid for illegal fishing to support these teaching courses. There's a huge need for scientific surveys to determine the situation of the problem and to allay. Countries have to take actions globally against this problem urgently.

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