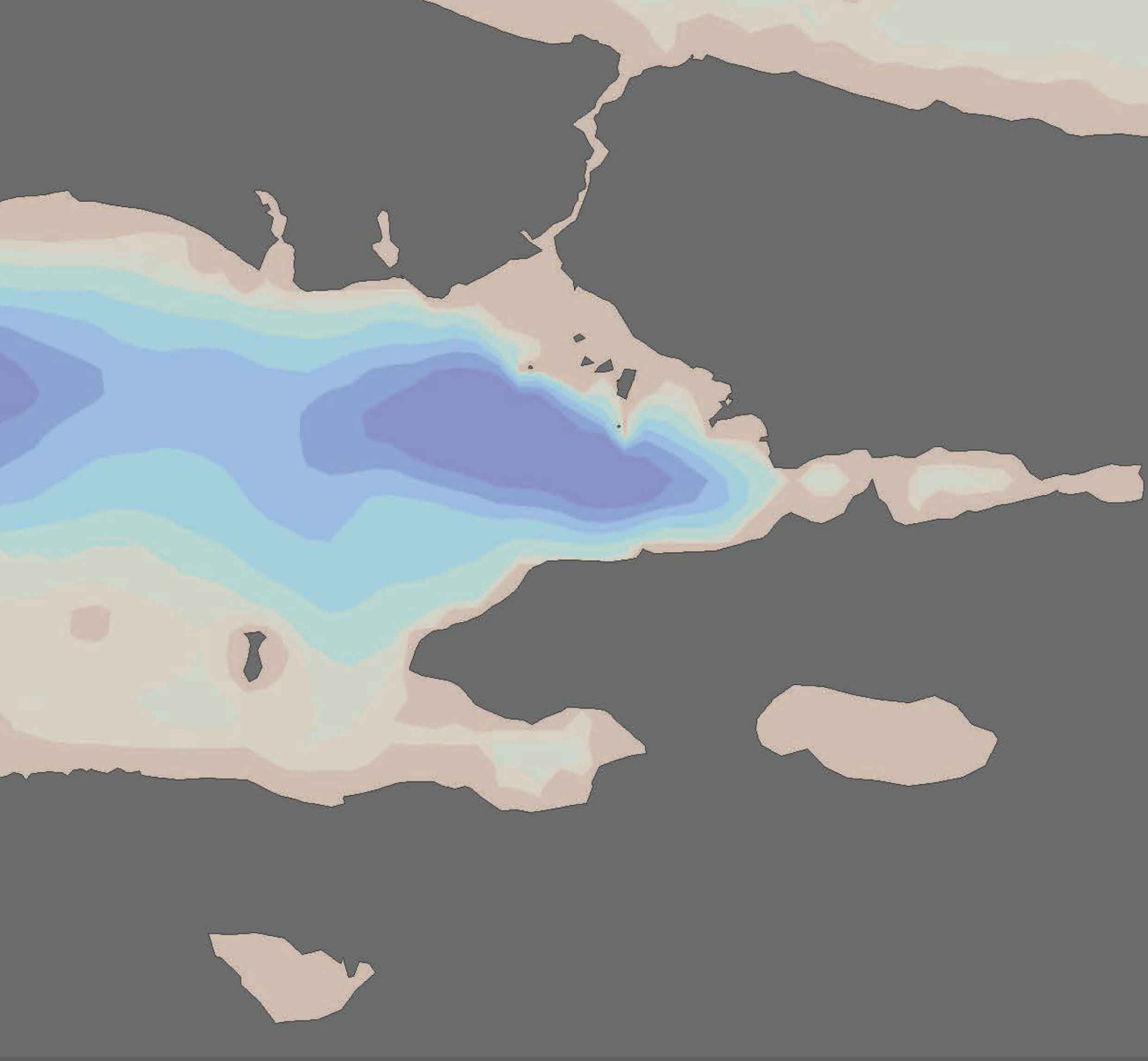

THE SEA OF MARMARA

MARINE BIODIVERSITY, FISHERIES, CONSERVATION AND GOVERNANCE

EDITORS: Emin ÖZSOY, M. Namık ÇAĞATAY,
Neslihan BALKIS, Nuray BALKIS, Bayram ÖZTÜRK

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STATUS OF SMALL PELAGIC FISHES IN THE SEA OF MARMARA

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1. Introduction

The first research on fish biodiversity of the Sea of Marmara was performed around 70 years ago by Erazi (1942) with reported 181 fish species. Since then a few number of other researches were also reported 135 species (Slastenenko 1965), 175 species (Geldiay 1969) and in the most recent research with 257 species (Bilecenoğlu *et al.* 2014) in the Sea of Marmara which represents half of the recorded ichthyofauna in Turkish seas (see Appendix Table 1). Of the 257 species, 36 of them are cartilaginous species including 21 sharks, 14 rays and 1 chimeras. The great majority of total fish species are constituted by ray-finned fishes namely teleosteans or bony fishes over 80% percent and chondrosteans namely sturgeons with 5 species.

The term “small pelagics” defines the species live in coastal pelagic zone of the marine environment with schooling behaviour in huge number. Small pelagics are very important component of the marine life with th e close relation to upper and lower trophic levels (Palomera *et al.* 2007). Anchovy, sardine, sprat and herring are the main small pelagic fishes which are the most important for commerical interest around the world.

According to FAO latest review of world fisheries, global capture database includes 1600 harvested species, and only 25 genera including 14 small pelagics represent about 40% and 23% of the total marine catch respectively (Table 1). Those small pelagics widely used as raw material in reduction to meal and oil, and are of low commercial value. The fishery industries of developing countries rely heavily on developed countries both as outlets for their exports and as suppliers of their imports for local consumption (mainly low-priced small pelagics as well as high-value fishery species for emerging economies) or for their processing industries (FAO 2016).

Catch statistics of small pelagics show significant decline for 50 years. In 1960’s, small pelagics constituted 69% percent total catch while it was reported 23% in 2014. Especially the situation in the Mediterranean and Black Sea is alarming as catches have dropped by one-third since 2007, a decrease mainly in small pelagics such as anchovy and sardine but one that has also affected most species groups. The Mediterranean and Black Sea had 59 percent of assessed stocks fished at biologically unsustainable levels and 41 percent fully fished to under fished in 2013 (FAO 2016).

As a global scale, the key responsibility of states was recognized to preserve or rebuild healthy ecosystems for the wellbeing of current and future generations under the subject of conservation of biological diversity (CBD 1992). One of the central themes in this context is the preservation of the marine environment and implementation of precautionary rules for the exploitation of living marine resources (UNFSA 1995).

This chapter, put an effort to understand current situation of small pelagic fishery in the Sea of Marrmara. Catch statistics in years, fishing effort, fish regulation and previous studies for small pelagic fishes have been summarized.

Table 1. Marine captures of major species and genera (FAO 2016).

Scientific name	**FAO English name**	**2003-2012**	**2013 (Tonnes)**	**2014**
Theragra chalcogramma	Alaska pollock (= walleye pollock)	2860840	3239296	3214422
Engraulis ringens	Anchoveta (= Peruvian anchovy)	7329446	5674036	3140029
Katsuwonus pelamis	Skipjack tuna	2509640	2974189	3058608
Sardinella spp.1	Sardinellas nei	2214855	2284195	2326422
Scomber japonicus	Chub mackerel	1804820	1655132	1829833
Clupea harengus	Atlantic herring	2164209	1817333	1631181
Thunnus albacares	Yellowfin tuna	1284169	1313424	1466606
Decapterus spp.1	Scads nei	1389354	1414958	1456869
Scomber scombrus	Atlantic mackerel	717030	981998	1420744
Engraulis japonicus	Japanese anchovy	1410105	1329311	1396312
Gadus morhua	Atlantic cod	897266	1359399	1373460
Trichiurus lepturus	Largehead hairtail	1311774	1258413	1260824
Sardina pilchardus	European pilchard (= sardine)	1088635	1001627	1207764
Dosidicus gigas	Jumbo flying squid	778384	847292	1161690
Micromesistius poutassou	Blue whiting (= poutassou)	1357086	631534	1160872
Scomberomorus spp.1	Seerfishes nei	834548	941741	919644
Illex argentinus	Argentine shortfin squid	446366	525402	862867
Nemipterus spp.1	Threadfin breams nei	536339	581276	649700
Cololabis saira	Pacific saury	465032	428390	628569
Portunus trituberculatus	Gazami crab	356587	503868	605632
Acetes japonicus	Akiami paste shrimp	580147	585433	556316
Strangomera bentincki	Araucanian herring	580805	236968	543278
Sprattus sprattus	European sprat	611525	394405	494619
Clupea pallasii	Pacific herring	330017	510025	478778

Gadus macrocephalus	Pacific cod	373547	464367	474498
Total 25 major species and genera		**34232526**	**32954012**	**33319537**

2. Catch Statistic (Landings) of small pelagic fishes in the Sea of Marmara

The Sea of Marmara forms the transitional environment between the Black Sea and the Mediterranean Sea. This unique marine environment exchanges waters with the Black Sea through the Istanbul Strait (Bosphorus) and with the Mediterranean Sea through the Dardanelles Strait. In the Bosphorus, this exchange of water is achieved by a surface current entering from the Black Sea and a deep current flowing from the Mediterranean towards the Black Sea (Beşiktepe *et al.* 1994).

Kocatas *et al.* (1993) defined the Sea of Marmara as an enclosed basin where Atlanto-Mediterranean originated commercial pelagic fishes spawn while migrating from the Mediterranean and Aegean Sea to the Black Sea. Besides the well-established importance of the Black Sea fisheries for Turkey, the catches from the Sea of Marmara, despite its small surface area (11,111 km^2), constitute a significant fraction of catches in Turkey through 1980's (7%), 1990's (14%) and 2000's (10%). However, dramatic declines in catches were recorded for total fish production in 2015 (8%) for the Sea of Marmara (TÜİK 2015) (Table 2).

Table 2. Decadal changes in annual fish production in Turkish waters and in the Sea of Marmara since 1970.

Years	Sea of Marmara (t)	Turkey (t)	%
1970	17448	166080	10.5
1980	30365	392196	7.74
1990	42064	297123	14.15
2000	46137	441690	10.44
2010	36529	399656	9.14
2015	29337	345765	8.48

The catch statistics of the Sea of Marmara have been started to collect since 1967 by Turkish Statistical Institute (formerly known as State Institute of Statistic). The contribution of the Sea of Marmara to the total marine landing of Turkey increased in 39% percent in a decade between 1980 and1990. Increasing of total fish production was mainly the results by new regulations such as high promotion to fishermen provided extending the fishing fleet, by demographic changes and increased population in the Marmara region and industrial development with the establishment of fish meal and fish oil factories in the region. The changes in catch of small pelagics for 50 years period can be seen in Table 3.

Table 3. Small pelagic catches (tonnes) in the Sea of Marmara between the years 1967 and 2015.

Years	Anchovy	Small horse mackerel	Horse mackerel	Sardine	Sprat
1967 - 1970	1960	925	434	1111.3	-
1970 - 1979	5439	2100	570	980.8	-
1980 - 1989	10258	6641	1728	2330.1	-
1990 - 1999	14857	2242.6	2276	6482	297.2
2000 - 2009	21591	5907	2846.4	4576	346.1
2010 - 2015	18249	2735.1	1972.1	7209	93.5

Small pelagics constitutes a high percent of (68%) total fish production in Turkey and any fluctiations in small pelagics catched directly affected Turkish fish production. This fluctuation pattern and its direct effect can be seen clearly in Figure 1.

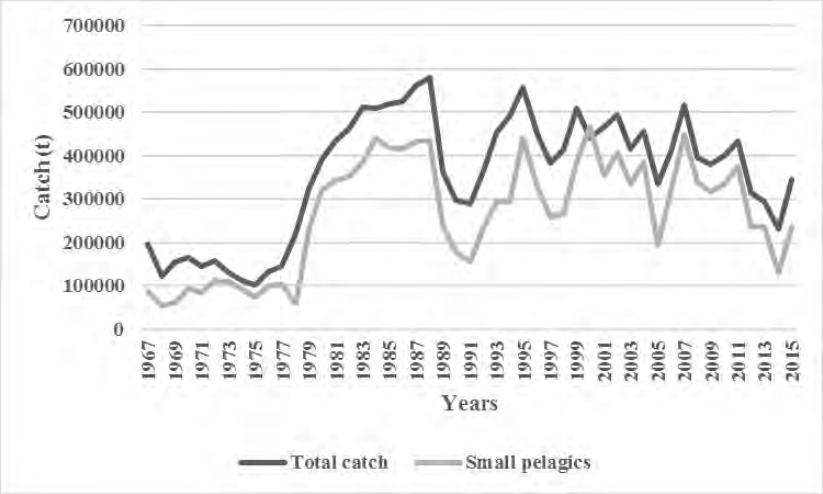

Figure 1. Annual total fish production and small pelagics catch statistics in Turkish waters between the years 1967 and 2015 (TUIK 2015).

Fish production in the Sea of Marmara corresponds 8% percent of total fish production in Turkey while 10% percent of small pelagics catch was obtained from this small sea according to the recent catch statistics (TÜİK 2015) (Figure 2). In other words, the fisheries of the Sea of Marmara is mainly dominated by small pelagics. Commercially exploited small pelagic fish species in this sea are: *Engraulis encrasicolus* (anchovy), *Trachurus mediterraneus* (Mediterranean horse mackerel), *Trachurus trachurus* (Atlantic horse mackerel), *Sardina pilchardus* (sardine) and *Sprattus sprattus* (sprat).

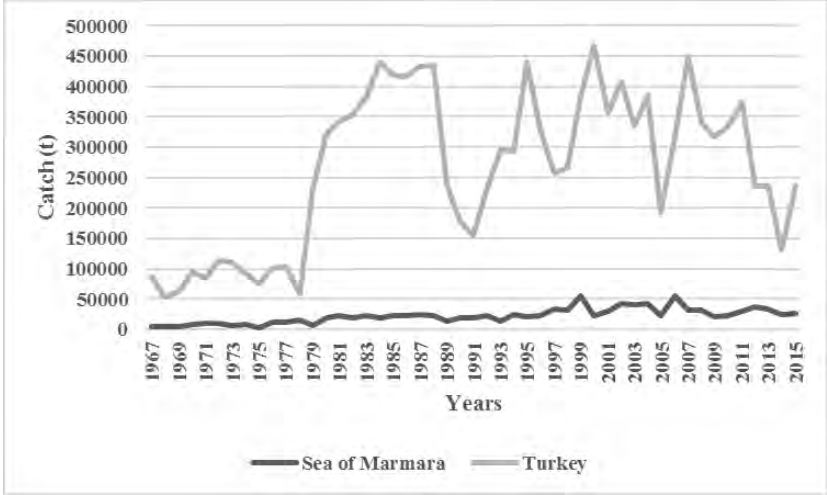

Figure 2. The annual small pelagics catches in the Sea of Marmara and in Turkish waters between the years 1967 and 2015.

Anchovy, the most important species of small pelagic fishing, accounts for approximately 61% of the Sea of Marmara fisheries. This commercially important fish species is sensitive to environmental conditions and any fluctuations in its population directly affect commercial fishing in the Sea of Marmara. Anchovy fisheries can be addressed as a good indicator of the chancing environment in the Sea of Marmara due to various reasons such as demographic changes in the region, urbanization and eutrophication, increased fishing activity, alien species in the past 50 years.

Early 1980s, an Atlantic originated ctenephore species *Mnemiopsis lediyi* has been transported via ballast water and widespreaded in the Black Sea before the late 1980s. Dramatic changes in Black Sea anchovy fisheries were observed in 90's due to *Mnemiopsis leidy* invasion. (Kıdeyş 2002). In 1991 the first observation of the invasive ctenophore species was observed in the Sea of Marmara (Artüz 1991). Average abundance of *Mnemiopsis leidy* was determined 4.2 $kg.m^{-2}$ in the surface water of the Sea of Marmara in October 1992 (Shinagova *et al.* 1995). A sharp decline in anchovy catch was recorded in 1993 with only 709 tonnes while it was recorded 13971 ton already in previous year 1991 (TUIK 1992; 1993) (Figure 3).

The latest considerable environmental change was mucilage event in the Sea of Marmara. Mucilage formation was first observed in the Sea of Marmara in October 2007 and dozens of square kilometers area of the sea surface was covered by. It has been caused not only visual pollution also economical damage on fisheries by decreasing fishing production as well as clogging the fishing nets and causing discards.

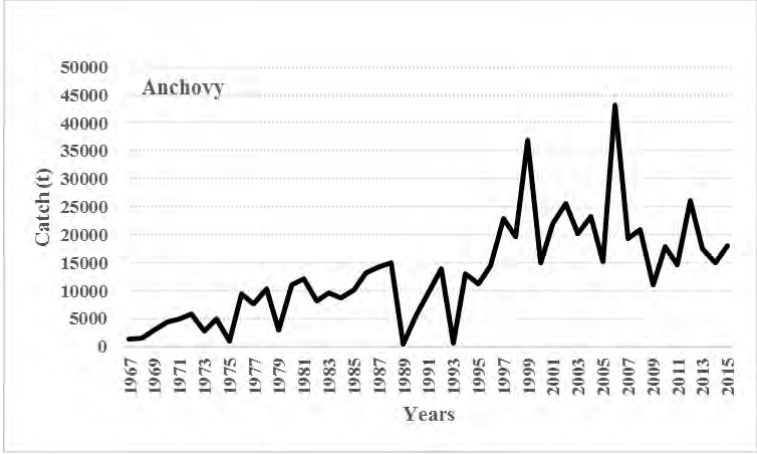

Figure 3. The annual anchovy catch statistics in the Sea of Marmara between the years 1967 and 2015.

The other important small pelagic fish species in the Sea of Marmara are Mediterranean horse mackerel and Atlantic horse mackerel. The production of those species were recorded 2256 tonnes for Mediterranean horse mackerel and 794 tonnes for Atlantic horse mackerel in 2015 (TUIK 2015). There is a significant declining trend in horse mackerel productions in the last decade (Figure 4). However, likewise the anchovy fisheries there are no stock assessment studies on those species and poor knowledge on stock status makes it difficult to evaluate maximum sustainable yield, biological reference points and overfishing activity on horse mackerel fisheries both in the Sea of Marmara and in Turkish waters.

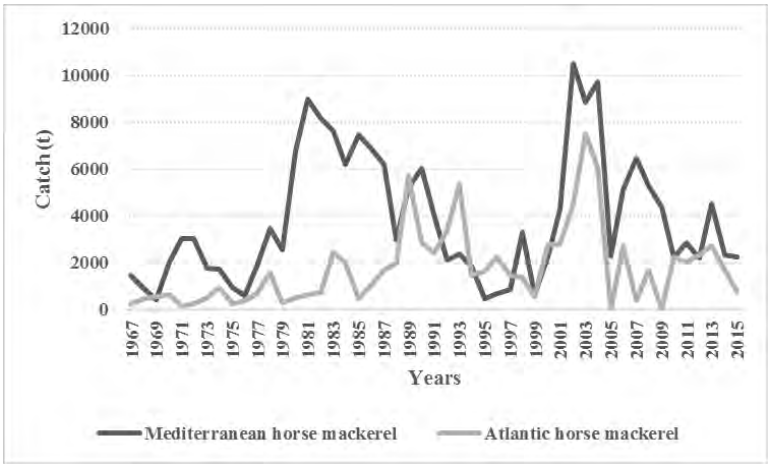

Figure 4. The annual Mediterranean horse mackerel and Atlantic horse mackerel catch statistics in the Sea of Marmara between the years 1967 and 2015.

Sardine is one of the other commercially important small pelagic fish in the Sea of Marmara. Especially in recent years, an increase in the catch of sardines has been observed (Figure 5). The lowest catch was recorded 163 tonnes in 2001 since then sardine fishery shows high fluctuation with the second highest catch in 2011. In order to consider last 5 years catch statistics of sardine, the average annual catch is 7209 tonnes.

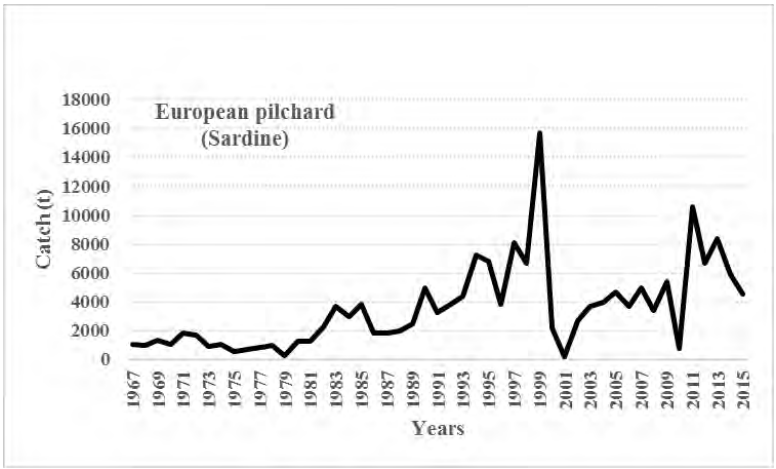

Figure 5. The annual sardine catch statistics in the Sea of Marmara between the years 1967 and 2015.

The sprat fishery has been included fish statistics of the Sea of Marmara since 1993 and this small pelagic fish has the less contribution in the area with the obtained 265.3 tonnes catch during the 22 years. Sprat catch statistics present high fluctiations in the Sea of Marmara (Figure 6). Its lowest production was recorded 5 tonnes in 2013, while the amount of the highest production was 662 tonnes in 1996.

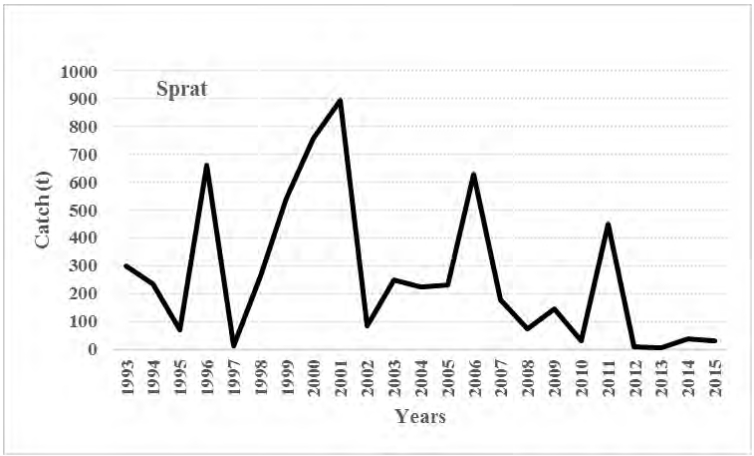

Figure 6. The annual sprat catch statistics in the Sea of Marmara between the years 1993 and 2015.

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

Small pelagics are schooling species and spent their lifes near the surface marine waters. Fishing activity on small pelagics are mainly performed by surrounding the schools of fish which is known seine fishing with the common type of seine called as purse seine.

The schooling pelagic fishes are very important in fisheries, and because of their economic importance, pelagic fisheries became an industrialized activity in the world. Industralization has been launched with the increasing the engine power of the fishing boats and their catch capacity, development of high-tech fish finder devices such as echo-sounder and sonars and their extending usage by state-funds (Hoşsucu 2010). Since 1970, easy findable of schooling fishes, even determination of species level by acoustic methods has been very common in fishing activity (Reid and Simmonds 1993). It is obvious to say that those innovations on fishing methods are the main contribution on increased fishing pressure on the small pelagic fish stocks.

Nowadays, most of the purse seine boats are equipped echo-sounder and sonar devices in the world. A total of 454 purse seiner boats are recorded in Turkish waters, 90% percent of them are equipped with echo-sounder and while 80% percent were with sonar devices. Considering the Sea of Marmara, %12 and 49.3% percent of registered fishing boats have been equipped sonar and echo-sounder respectively (TUIK 2015) (Figure 7).

The Ministry of Food, Agriculture and Livestock is the main state organization responsible for fisheries (including aquaculture) administration, regulation, protection, promotion and technical assistance. All activities in fisheries and aquaculture are based on the Fisheries Law No. 1380, enacted in 1971 (Düzgüneş and Erdoğan 2008). Small pelagic fishing are usually performed by purse seines and mid-water trawls in our country. According to abovementioned fiheries law, it is prohibited fishing by purse seine and trawling in all of our sea between April 15 to August 31.

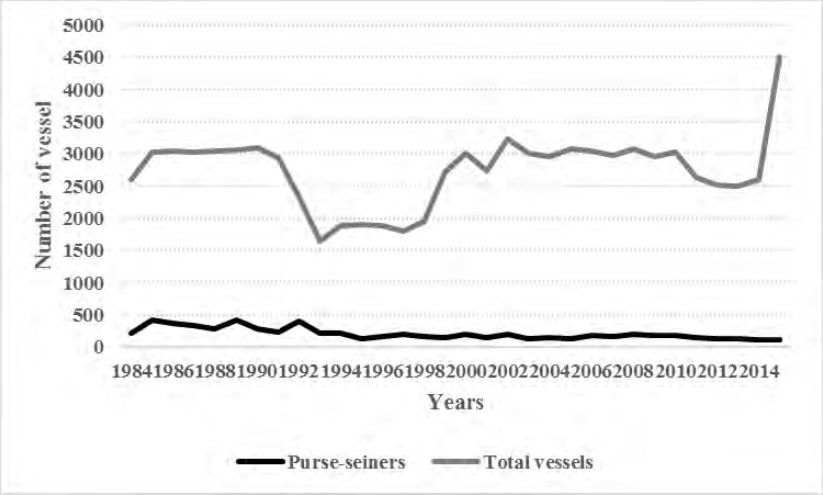

Figure 7. Changes in the registered total number of fishing vessels and purse seiners in the Sea of Marmara between the years 1984 and 2015.

4. The European Anchovy (*Engraulis encrasicolus* L.,1758) in the Sea of Marmara

Anchovies, the genus *Engraulidae*, are the most important marine fish species with high economic value both in our country and in the world. Anchovies are widely distributed around the world, and their production capacity is very high. Anchovy species with the highest biomass around the world are Peru anchovetta (*Engraulis ringens*, Mysak, 1986), South African anchovy (*Engraulis capensis*, Hampton, 1996), European anchovy (*Engraulis encrasicolus*) and the Black Sea anchovy (*Engraulis encrasicolus ponticus*) (FAO 2016).

Anchovy is a planktivorous species mainly feed on copepods and cirripeds and in a big competition with the other small pelagic species such as sprat, shad, sardine as well as ctenophors and jellyfishes for the food resources (Bingel and Gücü 2010). Anchovy is the fast-growing species with short life-span and it is highly sensitive to the environmental changes (Prodanov *et al.* 1997).

Anchovy reaches sexual maturity at the age 1+, usually between 9 and 12 total lengths. Spawning period is reported from May to August (Demir 1959). As a batch spawner, according to Owen (1979) anchovy spawns 9-12 times while Lisovenko (1985) reported 50 times for the Black Sea.

There are very limited study on the biology and stock of anchovy in the Sea of Marmara. Azgider (2016) performed a detailed study on biology of anchovy from the northerneast part. The results of mortality rates were stated Z=1.37 y^{-1}, M=0.38 y^{-1},

F=0.99 y^{-1} and estimated exploitation rate was E= 0.72 with the indication of high fishing pressure (Azgider 2016). Zengin *et al.* (2015) investigated a comparative study on morphometric characteristic and otolith shapes anchovy in Black Sea and in the Sea of Marmara. Their results indicated there are statistical differences in the measurements of individiual belongs to diffferent seas. Although, it is still an ongoing discussion, those results are supported the idea that anchovy caught in the Sea of Marmara forms a separate stock from the Black Sea (Gücü 2013).

5. Mediterranean Horse Mackarel (*Trachurus mediterraneus*, Steindachner, 1868) in the Sea of Marmara

The Mediterranean horse mackerel, *Trachurus mediterraneus* (Steindachner, 1868), is distributed in the temperate waters of the Atlantic Ocean (from Mauritania to the Bay of Biscay), the Mediterranean Sea, and the Black Sea. The habitat of this species includes a wide range of water types such as marine, brackish waters and the pelagic ocean (Froese and Pauly 2016). Mediterranean horse mackerel constitutes one-fourth of the total marine fish catch of Turkey (TÜİK 2015) and also provides income for the fishermen, who use simple fishing methods such as setlines, long lines, and gillnets. Additionally, it is the most common recreational fish for anglers and small-scale fishermen around the Istanbul region throughout the year. Especially in the summer season, Istanbul residents cluster around both sides of the Istanbul Strait and the entrance of the Golden Horn Estuary in order to angle. It is prohibited by Turkish fishery law to use any fishing gear or methods except angling in the Golden Horn Estuary.

Many marine fishes are classified as visitors when they randomly appear in estuaries (McLusky and Elliott 2004). Mediterranean horse mackerel was also evaluated as an irregular visitor to the Golden Horn Estuary of Istanbul metropolitan area; thus, no spawning or nursery dependency should be ascribed to this species (Demirel and Yüksek 2014).

First studies on biology of *Trachurus* species in the Sea of Marmara was performed by Neumann (1956) and Demir (1958). Additionally, Demir (1961) pointed out eggs and larvae distirbution of *Trachurus mediterraneus* in the Sea of Marmara. Kukul (1987) was studied first maturity size and distributional pattern on 737 individual of *Trachurus mediterraneus* in the Strait of Istanbul. It was determined that first maturity size of this species was 13.5 cm at the age of 2+.

Demirel and Yüksek (2013a) reported that spawning of this species starts in May, peaks in July–August and ends in September but the spawning season extended to October for males according to results of gonad histology and gonadosomatic index values (Figure 8). Females reach maturity at smaller sizes than males. Sizes at 50% maturity in females were reported 12.2 cm and in males were 12.5 cm.

Oocyte development in *T. mediterraneus* was determined to be asynchronous with indeterminate fecundity (Demirel and Yüksek 2013b). Observations of all stages of oocytes, with a continuous size distribution and no distinct hiatus in the pre-spawned ovaries were defined as asynchronous ovarian organization and indeterminate fecundity type (Hunter *et al.,*1985; Murua *et al.* 2003).

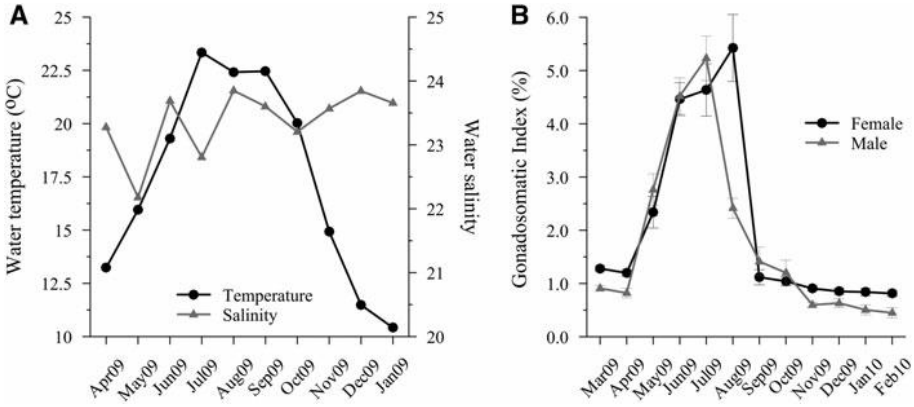

Figure 8. Hydrographical conditions and mean gonadosomatic index values in the northern part of the Sea of Marmara. (A) Monthly distribution of water temperature and salinity; (B) monthly changes of mean gonadosomatic index (GSI%) for female and male (Demirel and Yüksek 2013a).

6. Conclusion

Significant decline in small pelagics statistics of the Sea of Marmara display an urgent action for the fishery regulation and management. In this context, the question should be: "How successful is management based on such simple harvest control rule, if compared with management informed by full stock assessments?" Gücü (2013) stated that increasing eutrophication in the Sea of Marmara once helped small pelagics to built up their carrying capacity, however this turn to a challenge quickly and environmental changes such as mucilage event abruptly decrease the small pelagic stocks.

Good fishery management should consider well-designed national stock assessment programme with sub-indicators and reference points by international agreement (MSFD 2008) such as:

1. Spawning stock size (SSB) relative to the stock size (SSBmsy) that can produce the maximum sustainable yield.
2. Fishing mortality (F) relative to the natural mortality (M).

3. Mean length (Lmean) in commercial catches relative to the mean length where 90% of the females have reached sexual maturity (Lm90).
4. Abundance measured as catch-per-unit-effort (CPUE) relative to the mean CPUE in the time series.

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APPENDIX

Table 1. Checklist of fish species in the Sea of Marmara (Bilecenoğlu *et al.* 2014).

Species	Species
Hexanchus griseus (Bonnaterre, 1788)	*Myliobatis aquila* (Linnaeus, 1758)
Carcharodon carcharias (Linnaeus, 1758)	*Chimaera monstrosa* Linnaeus, 1758
Lamna nasus (Bonnaterre, 1788)	*Acipenser gueldenstaedtii* Brandt & Ratzeburg, 1833
Alopias superciliosus Lowe, 1841	*Acipenser nudiventris* Lovetsky, 1828
Alopias vulpinus (Bonnaterre, 1788)	*Acipenser stellatus* Pallas, 1770
Galeus melastomus Rafinesque, 1810	*Acipenser sturio* Linnaeus, 1758
Scyliorhinus canicula (Linnaeus, 1758)	*Huso huso* (Linnaeus, 1758)
Scyliorhinus stellaris (Linnaeus, 1758)	*Anguilla anguilla* (Linnaeus, 1758)
Galeorhinus galeus (Linnaeus, 1758)	*Muraena helena* Linnaeus, 1758
Mustelus asterias Cloquet, 1821	*Conger conger* (Linnaeus, 1758)
Mustelus mustelus (Linnaeus, 1758)	*Alosa fallax* (Lacepede, 1803)
Prionace glauca (Linnaeus, 1758)	*Alosa caspia* (Eichwald, 1838)
Dalatias licha (Bonnaterre, 1788)	*Alosa maeotica* (Grimm, 1901)
Oxynotus centrina (Linnaeus, 1758)	*Alosa tanaica* (Grimm, 1901)
Centrophorus granulosus (Bloch & Schneider, 1801)	*Clupeonella cultriventris* (Nordmann, 1840)
Centrophorus uyato (Rafinesque, 1810)	*Sardina pilchardus* (Walbaum, 1792)
Squalus acanthias Linnaeus, 1758	*Sardinella aurita* Valenciennes, 1847
Squalus blainville (Risso, 1827)	*Sprattus sprattus* (Linnaeus, 1758)
Echinorhinus brucus (Bonnaterre, 1788)	*Engraulis encrasicolus* (Linnaeus, 1758)
Squatina oculata Bonaparte, 1840	*Argentina sphyraena* Linnaeus, 1758
Squatina squatina (Linnaeus, 1758)	*Maurolicus muelleri* (Gmelin, 1789)
Torpedo nobiliana Bonaparte, 1835	*Argyropelecus hemigymnus* Cocco, 1829
Torpedo marmorata Risso, 1810	*Stomias boa* (Risso, 1810)
Torpedo torpedo (Linnaeus, 1758)	*Benthosema glaciale* (Reinhardt, 1837)
Dipturus batis (Linnaeus, 1758)	*Hygophum benoiti* (Cocco, 1838)
Dipturus oxyrinchus (Linnaeus, 1758)	*Lampanyctus crocodilus* (Risso, 1810)
Leucoraja naevus (Müller & Henle, 1841)	*Myctophum punctatum* Rafinesque, 1810
Raja asterias Delaroche, 1809	*Notoscopelus elongatus* (Costa, 1844)
Raja clavata Linnaeus, 1758	*Trachipterus trachypterus* (Gmelin, 1789)
Raja miraletus Linnaeus, 1758	*Nezumia aequalis* (Günther, 1878)
Raja montagui Fowler, 1910	*Nezumia sclerorhynchus* Valenciennes, 1838
Raja radula Delaroche, 1809	*Gadiculus argenteus* Guichenot, 1850
Dasyatis pastinaca (Linnaeus, 1758)	*Merlangius merlangus* (Linnaeus, 1758)
Gymnura altavela (Linnaeus, 1758)	*Micromesistius poutassou* (Risso, 1827)

Table 1. Continued

Species	Species
Trisopterus minutus (Linnaeus, 1758)	*Scorpaena scrofa* Linnaeus, 1758
Gaidropsarus biscayensis (Collett, 1890)	*Dactylopterus volitans* (Linnaeus, 1758)
Gaidropsarus mediterraneus (Linnaeus, 1758)	*Chelidonichthys cuculus* (Linnaeus, 1758)
Gaidropsarus vulgaris (Cloquet,1824)	*Chelidonichthys gurnardus* (Linnaeus, 1758)
Merluccius merluccius (Linnaeus, 1758)	*Chelidonichthys lastoviza* (Bonnaterre, 1788)
Ophidion barbatum Linnaeus, 1758	*Chelidonichthys lucernus* (Linnaeus, 1758)
Ophidion rochei Müller, 1845	*Lepidotrigla cavillone* (Lacepède, 1801)
Parophidion vassali (Risso, 1810)	*Lepidotrigla dieuzeidei* Blanc & Hureau, 1973
Carapus acus (Brünnich, 1768)	*Trigla lyra* Linnaeus, 1758
Lophius budegassa Spinola, 1807	*Peristedion cataphractum* (Linnaeus, 1758)
Lophius piscatorius Linnaeus, 1758	*Dicentrarchus labrax* (Linnaeus, 1758)
Apletodon dentatus (Facciolà, 1887)	*Anthias anthias* (Linnaeus, 1758)
Diplecogaster bimaculata (Bonnaterre, 1788)	*Epinephelus marginatus* (Lowe, 1834)
Lepadogaster candolii Risso, 1810	*Serranus cabrilla* (Linnaeus, 1758)
Lepadogaster lepadogaster (Bonnaterre, 1788)	*Serranus hepatus* (Linnaeus, 1758)
Atherina boyeri Risso, 1810	*Serranus scriba* (Linnaeus, 1758)
Atherina hepsetus Linnaeus, 1758	*Apogon imberbis* (Linnaeus, 1758)
Scomberesox saurus (Walbaum, 1792)	*Pomatomus saltatrix* (Linnaeus, 1766)
Belone belone (Linnaeus, 1761)	*Echeneis naucrates* Linnaeus, 1758
Hirundichthys rondeletii (Valenciennes, 1847)	*Remora remora* (Linnaeus, 1758)
Zeus faber Linnaeus, 1758	*Lichia amia* (Linnaeus, 1758)
Gasterosteus aculeatus Linnaeus, 1758	*Naucrates ductor* (Linnaeus, 1758)
Hippocampus guttulatus Cuvier, 1829	*Trachurus mediterraneus* (Steindachner, 1868)
Hippocampus hippocampus (Linnaeus, 1758)	*Trachurus trachurus* (Linnaeus, 1758)
Nerophis maculatus Rafinesque, 1810	*Boops boops* (Linnaeus, 1758)
Nerophis ophidion (Linnaeus, 1758)	*Dentex dentex* (Linnaeus, 1758)
Syngnathus abaster Risso, 1827	*Dentex gibbosus* (Rafinesque, 1810)
Syngnathus acus Linnaeus, 1758	*Diplodus annularis* (Linnaeus, 1758)
Syngnathus phlegon Risso, 1827	*Diplodus puntazzo* (Cetti, 1777)
Syngnathus schmidti Popov, 1927	*Diplodus sargus* (Linnaeus, 1758)
Syngnathus tenuirostris Rathke, 1837	*Diplodus vulgaris* (Geoffroy St. Hilaire, 1817)
Syngnathus typhle Linnaeus, 1758	*Lithognathus mormyrus* (Linnaeus, 1758)
Helicolenus dactylopterus (Delaroche, 1809)	*Oblada melanura* (Linnaeus, 1758)
Scorpaena notata Rafinesque, 1810	*Pagellus acarne* (Risso, 1827)
Scorpaena porcus Linnaeus, 1758	*Pagellus bogaraveo* (Brünnich, 1768)

Table 1. Continued

Species	Species
Pagellus erythrinus (Linnaeus, 1758)	*Symphodus tinca* (Linnaeus, 1758)
Pagrus pagrus (Linnaeus, 1758)	*Thalassoma pavo* (Linnaeuus, 1758)
Sarpa salpa (Linnaeus, 1758)	*Xyrichtys novacula* (Linnaeus, 1758)
Sparus aurata Linnaeus, 1758	*Gymnammodytes cicerelus* (Rafinesque, 1810)
Spondyliosoma cantharus (Linnaeus, 1758)	*Echiichthys vipera* (Cuvier, 1829)
Spicara flexuosa Rafinesque, 1810	*Trachinus araneus* Cuvier, 1829
Spicara maena (Linnaeus, 1758)	*Trachinus draco* Linnaeus, 1758
Spicara smaris (Linnaeus, 1758)	*Trachinus radiatus* Cuvier, 1829
Argyrosomus regius (Asso, 1801)	*Uranoscopus scaber* Linnaeus, 1758
Sciaena umbra Linnaeus, 1758	*Tripterygion tripteronotus* (Risso, 1810)
Umbrina cirrosa (Linnaeus, 1758)	*Clinitrachus argentatus* (Risso, 1810)
Mullus barbatus Linnaeus, 1758	*Aidablennius sphynx* (Valenciennes, 1836)
Mullus surmuletus Linnaeus, 1758	*Blennius ocellaris* Linnaeus, 1758
Chromis chromis (Linnaeus, 1758)	*Coryphoblennius galerita* (Linnaeus, 1758)
Cepola macrophthalma (Linnaeus, 1758)	*Microlipophrys adriaticus* (Steindachner & Kolombatović, 1883)
Chelon labrosus (Risso, 1827)	*Parablennius gattorugine* (Linnaeus, 1758)
Liza aurata (Risso, 1810)	*Parablennius incognitus* (Bath, 1968)
Liza haematocheila (Temminck & Schlegel, 1845)	*Parablennius sanguinolentus* (Pallas, 1814)
Liza ramada (Risso, 1810)	*Parablennius tentacularis* (Brünnich, 1768)
Liza saliens (Risso, 1810)	*Parablennius zvonimiri* (Kolombatović, 1892)
Mugil cephalus Linnaeus, 1758	*Paralipophrys trigloides* (Valenciennes, 1836)
Oedalechilus labeo (Cuvier, 1829)	*Salaria pavo* (Risso, 1810)
Coris julis (Linnaeus, 1758)	*Callionymus fasciatus* Valenciennes, 1837
Ctenolabrus rupestris (Linnaeus, 1758)	*Callionymus lyra* Linnaeus, 1758
Labrus bergylta Ascanius, 1767	*Callionymus maculatus* Rafinesque, 1810
Labrus merula Linnaeus, 1758	*Callionymus pusillus* Delaroche, 1809
Labrus mixtus Linnaeus, 1758	*Callionymus risso* LeSueur, 1814
Labrus viridis Linnaeus, 1758	*Aphia minuta* (Risso, 1810)
Symphodus cinereus (Bonnaterre, 1788)	*Chromogobius quadrivittatus* (Steindachner, 1863)
Symphodus doderleini Jordan, 1890	*Deltentosteus quadrimaculatus* (Valenciennes, 1837)
Symphodus mediterraneus (Linnaeus, 1758)	*Gobius auratus* Risso, 1810
Symphodus melanocercus (Risso, 1810)	*Gobius bucchichi* Steindachner, 1870
Symphodus ocellatus (Forsskål, 1775)	*Gobius cobitis* Pallas, 1814
Symphodus roissali (Risso, 1810)	*Gobius cruentatus* Gmelin, 1789
Symphodus rostratus (Bloch, 1791)	*Gobius geniporus* Valenciennes, 1837

Table 1. Continued

Species	Species
Gobius niger Linnaeus, 1758	*Lepidorhombus boscii* (Risso, 1810)
Gobius paganellus Linnaeus, 1758	*Lepidorhombus whiffiagonis* (Walbaum, 1792)
Knipowitschia caucasica (Berg, 1916)	*Scophthalmus maximus* (Linnaeus 1758)
Lesueurigobius friesii (Malm, 1874)	*Scophthalmus rhombus* (Linnaeus, 1758)
Mesogobius batrachocephalus (Pallas, 1814)	*Zeugopterus regius* (Bonnaterre, 1788)
Neogobius melanostomus (Pallas, 1814)	*Arnoglossus imperialis* (Rafinesque, 1810)
Ponticola syrman (Nordmann, 1840)	*Arnoglossus kessleri* Schmidt, 1915
Pomatoschistus adriaticus Miller, 1973	*Arnoglossus laterna* (Walbaum, 1792)
Pomatoschistus bathi Miller, 1982	*Arnoglossus thori* Kyle, 1913
Pomatoschistus marmoratus (Risso, 1810)	*Platichthys luscus* (Pallas, 1814)
Pomatoschistus minutus (Pallas, 1770)	*Buglossidium luteum* (Risso, 1810)
Zosterisessor ophiocephalus (Pallas, 1814)	*Dicologlossa cuneata* (Moreau, 1881)
Sphyraena sphyraena (Linnaeus, 1758)	*Microchirus ocellatus* (Linnaeus, 1758)
Auxis rochei (Risso, 1810)	*Microchirus variegatus* (Donovan, 1808)
Euthynnus alletteratus (Rafinesque, 1810)	*Monochirus hispidus* Rafinesque, 1814
Katsuwonus pelamis (Linnaeus, 1758)	*Pegusa impar* (Bennett, 1831)
Sarda sarda (Bloch, 1793)	*Pegusa nasuta* (Pallas, 1814)
Scomber colias Gmelin, 1789	*Pegusa lascaris* (Risso, 1810)
Scomber scombrus Linnaeus, 1758	*Solea solea* (Linnaeus, 1758)
Thunnus alalunga (Bonnaterre, 1788)	*Synapturichthys kleinii* (Risso, 1827)
Th nnus thynnus (Linnaeus, 1758)	*Balistes capriscus* Gmelin, 1789
Xiphias gladius Linnaeus, 1758	*Stephanolepis diaspros* Fraser-Brunner, 1940
Capros aper (Linnaeus, 1758)	*Lagocephalus spadiceus* (Richardson 1845)
Citharus linguatula (Linnaeus, 1758)	*Mola mola* (Linnaeus, 1758)