| Dynamics of Fish and Marine Mammal Populations at the Romanian Black Sea Coast in the Past 10 Years and their Evolution Trends *(Valodia Maximov, Simion Nicolaev, Eugen Anton, Gheorghe Radu, George Țiganov, Cristian Danilov, Magda Nenciu, Madălina Galațchi* | **"Cercetări Marine" Issue no. 48**<br><br>**Pages 26-49** | **2018** |
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# DYNAMICS OF FISH AND MARINE MAMMAL POPULATIONS AT THE ROMANIAN BLACK SEA COAST IN THE PAST 10 YEARS AND THEIR EVOLUTION TRENDS

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## ABSTRACT

The last-decade changes in the Black Sea ecosystem have contributed to the deterioration of the structural and functional components of the marine ecosystem, which has had direct repercussions on reducing biodiversity and productivity, affecting the ecological balance and quality of life. These changes are mainly caused by the intensity of eutrophication, pollution of the sea and the over-exploitation of its natural resources. Fisheries resource management is an integrated process of gathering information, analyzing, planning, consulting, decision-making, allocating resources, and formulating and implementing regulations or rules governing fisheries to ensure the continuity of resource productivity and revenue and other objectives. This paper presents the dynamics of fish and cetacean populations on the Romanian Black Sea coast in the last decade (2008-2017). For most fish species on the Romanian seaside, the formation of fish aggregations and the availability of fish for fishing are strongly influenced by the variation in environmental conditions.

**Key-Words:** vessels, fishing effort, catch, population, length, age, cetaceans, biomass

## AIMS AND BACKGROUND

The authors of this study have proposed, on the basis of their own research, to contribute to the development of the scientific support needed to develop a strategy for the management of living aquatic resources in the Romanian Black Sea sector (Nicolaev et al., 2016). In order to meet the proposed goal, the work was structured in the following directions:

- quantitative and qualitative catch and effort determination;
- study of fish and marine mammals populations, as well as their distribution areas;

- study of biological parameters and growth parameters;
- determination of the current state of stocks;
- developing measures and recommendations for a sustainable management of resources.

## EXPERIMENTAL

The methodology and techniques used to collect, verify, process and analyze data, as well as to assess fish stocks are those generally accepted for the Black Sea basin and in line with the international methodology. The qualitative and quantitative composition of fish catches and fishing effort was obtained from the data of economic operators collected by the inspectors of the National Agency for Fisheries and Aquaculture (NAFA). The data serve to evaluate the exploitable biomass and allowable catches. For studying fish populations, we used the method of studying randomized samples, which are a part of the population, but provide enough information to characterize the entire population.

Catches of industrial fishing were the main source of material for establishing the qualitative and quantitative structure of fish populations and biological parameters. Samples were also taken from the survey trawler hauls conducted with NIMRD's research vessel "R/V Steaua de Mare 1". For the study of the biological parameters of the main fish species, samples were taken for each species analyzed in the laboratory, with the following being studied: structure by length classes, mass and age, elements necessary for the estimation of the growth parameters. Biometric measurements were made for total length (Lt), being read at intervals of 5 mm (sprat) and 30 mm (turbot) and centralizations at the lower centimeter. The weight was obtained in grams with an accuracy of ± 1 g. Age readings were made on otoliths and radii (Radu & Maximov, 2006).

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## RESULTS AND DISCUSSION

***The main fishing grounds at the Romanian coast***

Marine fishing practiced along the Romanian coast is limited to areas up to the 60-70 meter isoline, as a consequence of the characteristics of the fishing vessels and their limited autonomy. Traditionally, fishing in the Romanian marine area has been achieved in two ways:

* with coastal trawlers equipped with pelagic trawls and turbot gillnets, activating at depths greater than 20 m (Fig. 1). In 2013, according to Ord. 1696/11.07.2013, the activity using the beam trawl started, this fishing gear being fitted on vessels over 12 m long. During the fishing season, a vessel may alternate the use of fishing gears, such as pelagic trawl, beam trawl or turbot gillnets (Maximov et al., 2016).

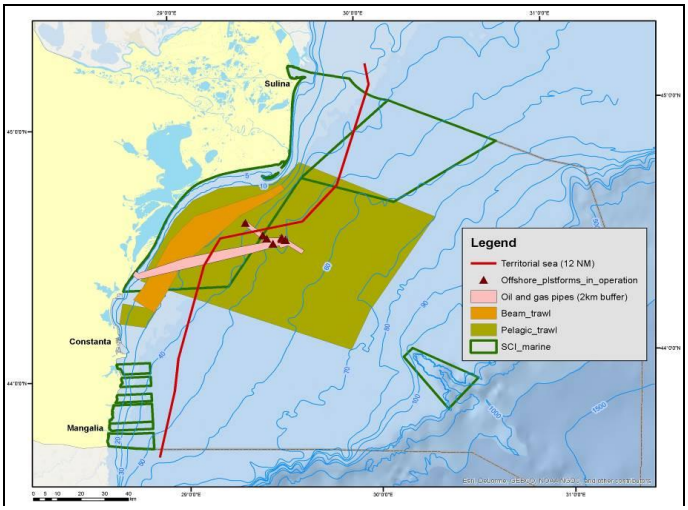


**Fig. 1.** Trawling area at the Romanian Black Sea coast (pelagic + beam trawl).

* Fishing practiced along the coast, in 12 fishery points, situated between Sulina and Vama Veche (Fig. 2), on depths of 3-11 m, with fixed tools (hand lines, long lines, goby cages, beach seines, pound nets and gillnets) and up to the 40-60 m isoline, with gillnets and longlines, especially for turbot, common stingray, thornback ray and dogfish (as by-catch) (Maximov & Stroie, 2017).

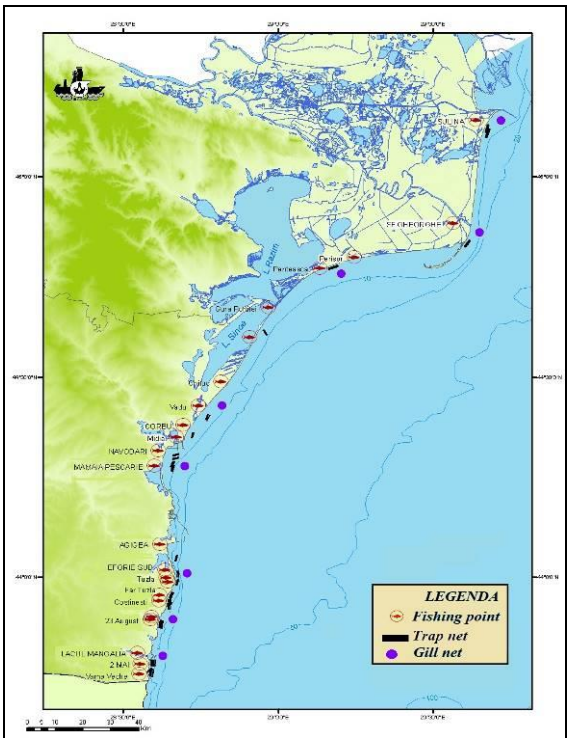


**Fig. 2.** Distribution of fishing points at the Romanian Black Sea coast.

### *Fleet, gears and fishing effort*

In the last 10 years, in the light of the new conditions of fishing with the reduction of state subsidies and the principle of economic competitiveness, there have been radical changes in the conditions for national fisheries. Year after year, coastal fishing activity declined gradually to the point where, in 2017, of the 500 ships registered in 2008, there were only 155 boats left, of which only 135 active boats (Maximov & Tiganov, 2018 a and b) (Fig. 3 and Fig. 4).

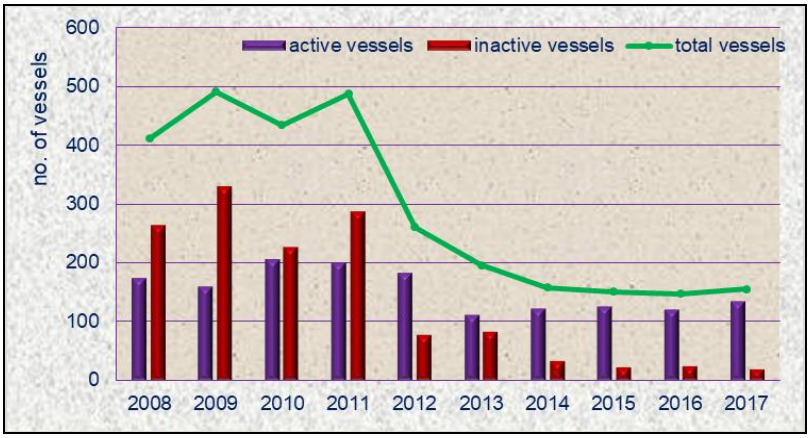


**Fig. 3.** Romanian fleet segmentation during 208-2017 (active and inactive vessels).

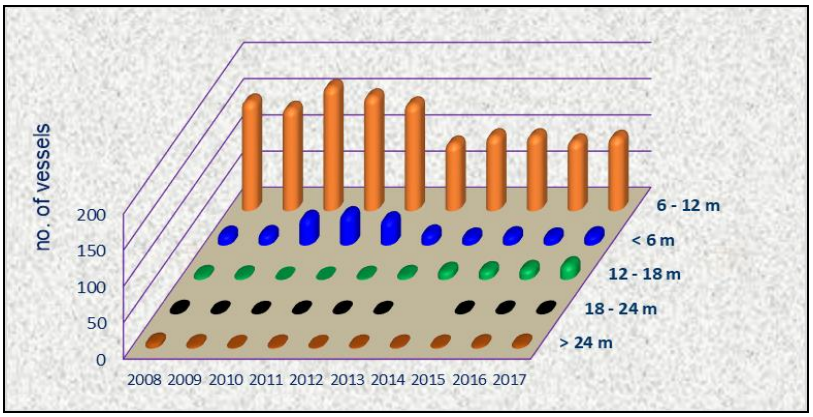


**Fig. 4**. Fishing vessels' structure on length classes during 2008-2017.

### *Catch, fishing effort and C.P.U.E. (Catch Per Unit Effort)*

At the Romanian coast, catch levels and fishing efficiency fluctuated from one year to another, depending on the fishing effort (number of vessels, number of trap nets, number of actual fishing days etc.), the evolution of hydro-climatic conditions, stock status of the main species and the anthropogenic factors. At the same time, the catches were dependent on the type of activity and the technology used in fishing. The level of catches over the period 2000 to 2013, with the exception of the years 2001 and 2002, when over 2,000 tonnes were obtained (2,431

to and 2,116 to, respectively), was quite low, ranging from 1,390 tonnes / 2006 to 1,940 tonnes / 2005, after which it fell sharply to 435 t / 2007, 177 t / 2008, 331 t / 2009 and 258 t / 2010 (Romanian Technical Reports, 2009-2017).

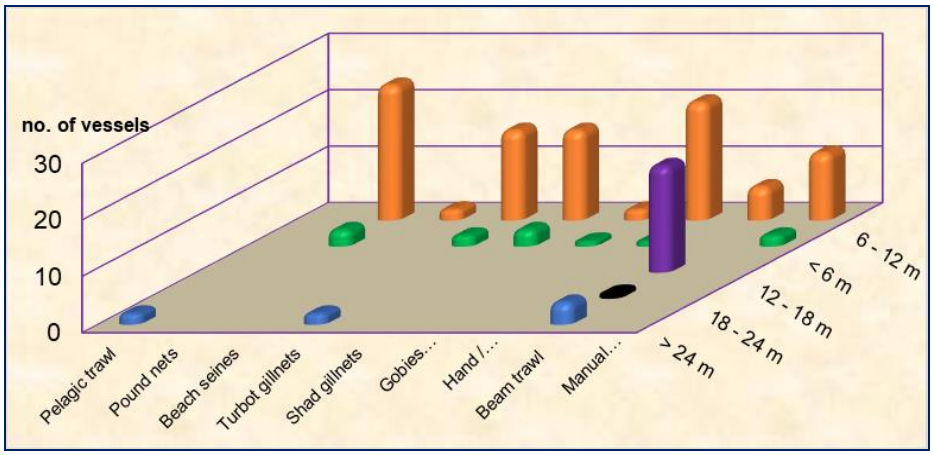


**Fig. 5.** Fishing vessels' structure on length classes and fishing gears, 2017.

Over the past five years, catches have had an increasing trend, from 1,711 tonnes / 2013 to 2,231 tonnes / 2014, 4,847 tonnes / 2015 (double compared to 2014), 6,839 tonnes in 2016 (higher than in the previous year by 41.1%) and 9.553 to 2017 (higher by 71.59% than in 2016) (Fig. 6). The increasing trend of catches over the past six years was not due to the fish fauna itself, but to the interest of economic operators in manual and beam trawl harvesting of *Rapana venosa*, which increased from one year to another from about 65% / 2012 to 98.6% / 2017 of the total catch achieved at the Romanian Black Sea coast.

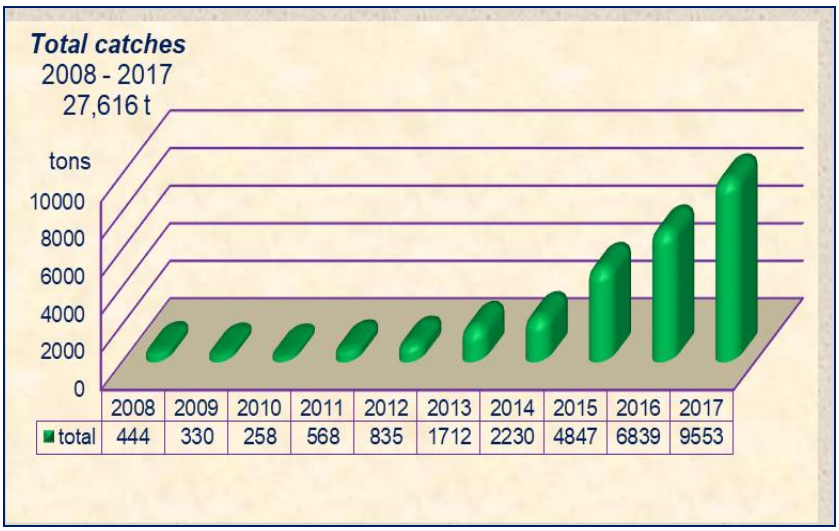


**Fig. 6.** The total catch (t) made in the Romanian Black Sea sector, during 2008 - 2017.

The fishing effort and the CPUE (Catch Per Unit Effort) resulting from fishing in the Romanian coastal area in 2017 were as follows:

**Using fixed gears**:

***Boats < 6 m:***

- ***pound net***: 1,060.16 kg/pound net: 289.13 kg/month, namely 56.79 kg/day and 19.393 kg/hour, for a fishing effort of 3 pound nets, 11 months, 56 days, 164 hours and a catch of **3,180.5** kg;
- ***turbot gillnet***: 1,617 kg/boat, 20.21 kg/gillnet; 323.4 kg/month; 134.75 kg/day; 31.70 kg/hour, for a fishing effort of 1 boat, 80 gillnets, 5 months, 12 days, 51 hours and a catch of **1,617** kg;
- ***shad gillnet***: 288.14 kg/boat, 29.66 kg/gillnet; 155.153 kg/month; 59.32 kg/day; 22.66 kg/hour; for a fishing effort of 7 boats, 68 gillnets, 13 months, 34 days, 89 hours and a catch of **2,017** kg;
- ***goby gillnet***: 131.25 kg/boat, 15.44 kg/gillnet; 131.25 kg/month; 24.2 kg/day; 9.55 kg/hour, for a fishing effort of 4 boats, 34 gillnets, 4 months, 14 days, 38 hours and a catch of **525** kg;
- ***longlines***: 363 kg/boat, 72.6 kg/longline; 72.6 kg/month; 49.56 kg/day; 21.43 kg/hour, for a fishing effort of 1 boat, 5 longlines, 5 months, 15 days, 34 hours and a catch of **363** kg;
- ***manual rapa whelk harvesting***: 4,761.8 kg/boat, 2,645.44 kg/diver; 2,164,45 kg/month; 384.02 kg/day; 87.53 kg/hour, for a fishing effort of 5 boats, 9 divers, 11 months, 61 days, 272 hours and a catch of **23,809** kg;

***Boats 6 - 12 m:***

- ***pound net***: 667.71 kg/boat, 790.66 kg/pound net: 167.94 kg/month, namely 23.085 kg/day, 6.15 kg/hour for a fishing effort made by 28 boats, 24 pound nets, 113 months, 882 days, 3.083 hours and a catch of **18,976** kg;
- ***turbot gillnet***: 1,120.94 kg/boat; 22.47 kg/gillnet; 296.72 kg/month; 164.04 kg/day; 45.34 kg/hour, for a fishing effort of 18 boats, 898 gillnets, 68 months, 123 days, 445 hours and a catch of **20,711** kg;
- ***shad gillnet***: 157.06 kg/boat; 15.51 kg/gillnet; 102.57 kg/month; 41.54 kg/day; 17.88 kg/hour; for a fishing effort of 32 boats, 324 gillnets, 49 months, 121 days, 281 hours and a catch of **5,026** kg;
- ***goby gillnet***: 288.33 kg/boat; 37.61 kg/gillnet; 55.81 kg/month; 29.83 kg/day; 10,57 kg/hour; for a fishing effort of 6 boats, 46 gillnets, 14 months, 58 days, 162 hours and a catch of **1,730** kg;
- ***dogfish gillnet***: 365.0 kg/boat; 26.54 kg/gillnet; 243.33 kg/month; 162.22 kg/day; 38.42 kg/hour; for a fishing effort of 4 boats, 55 gillnets, 6 months, 9 days, 38 hours and a catch of **1,460** kg;
- ***goby longlines***: 114.6 kg/boat, 30.16 kg/longline; 63.66 kg/month; 27.28 kg/day; 9.55 kg/hour, for a fishing effort of 5 boats, 19 longlines, 9 months, 21 days, 60 hours and a catch of **573** kg;
- ***beach seine***: 55.0 kg/boat; 55.0 kg/beach seine; 27.5 kg/month; 18.33 kg/day; 4.58 kg/hour, for a fishing effort of 2 boats, 2 beach seines, 4 months, 6 ays, 24 hours and catch of **110** kg;
- ***beam trawl***: 100,833.5 kg/boat; 50,416.75 kg/beam trawl; 19,516.16 kg/month;

2,200.0 kg/day; 458.68 kg/haul, 372.31 kg/hour; for an effort of: 6 boats, 12 beam trawls, 31 months, 275 days, 1,319 hauls, 1,625 hours and a catch of **605,001** kg;

- ***manual rapa whelk harvesting***: 69,970.46 kg/boat; 11,891.12 kg/diver; 21,404.02 kg/month; 2,667.66 kg/day; 463.61 kg/hour; for an effort of 26 boats, 153 divers, 85 months, 682 days, 3,926 hours and a catch of **1,819,232** kg;
- ***hooked lines***: 212.38 kg/boat; 47.44 kg/hooked line; 40.93 kg/month; 11.96 kg/day; 2.90 kg/hour, for an effort of 21 boats, 94 hooked lines, 109 months, 373 days, 1,537 hours and a catch of **4,460** kg;
- ***handlines***: 58.75 kg/boat; 32.5 kg/handline; 22.94 kg/month; 7.65 kg/day; 2.18 kg/hour, for an effort of 16 boats, 24 handlines, 34 months, 102 days, 357 hours and a catch of **780** kg;

**Using active gears**:

***Vessels 12 - 18 m:***

- ***turbot gillnet***: 1,629.09 kg/vessel, 12.77 kg/gillnet; 471.58 kg/month; 308.97 kg/day; 50.55 kg/hour, for a fishing effort of 11 vessels, 1,403 gillnets, 38 months, 58 days, 358 hours and a catch of **17,920** kg;
- ***dogfish gillnet***: 140.0 kg/vessel; 46.66 kg/gillnet; 70 kg/month; 70 kg/day; 28.0 kg/hour; for a fishing effort of 1 vessel, 3 gillnets, 2 months, 2 days, 5 hours and a catch of **140** kg;
- ***shad gillnet***: 116.0 kg/boat; 5.8 kg/gillnet; 116.0 kg/month; 29.0 kg/day; 3.14 kg/hour; for a fishing effort of 1 vessel, 20 gillnets, 1 month, 4 days, 37 hours and a catch of **116** kg;
- ***beam trawl***: 253,496.64 kg/vessel; 126,748.42 kg/beam trawl; 40,137.0 kg/month; 5,140.277 kg/day; 468.161 kg/haul, 412.477 kg/hour, for a fishing effort of: 19 vessels, 38 beam trawls, 120 months, 937 days, 10,288 hauls, 11,677 hours and a catch of **4,816,440** kg.

***Vessels 18 - 24 m:***

- ***beam trawl***: 382,233 kg/vessel, 191,166.5 kg/beam trawl; 47,791.63 kg/month; 3,748.36 kg/day; 170,138.18 kg/haul, 378,137.34 kg/hour, for an effort of 1 vessel, 2 beam trawls, 8 months, 102 days, 445 hauls, 989 hours and and catch of **382,333** kg;

***Vessels 24 - 40 m:***

- ***pelagic trawl***: 8,930 kg/vessel; 2,551.43 kg/month; 1,050.59 kg/day, 241.351 kg/haul, 223.25 kg/hour, for a fishing effort of 2 vessels, 7 months, 17 days, 74 hauls and 80 hauling hours and a catch of **17,860** kg;
- ***turbot gillnet***: 1,264.5 kg/vessel; 8.43 kg/gillnet; 361,28 kg/month; 229.90 kg/day; 41.46 kg/hour, for an effort of 2 vessels, 300 gillnets, 9 months, 11 days, 61 hours and a catch of **2,529** kg;
- ***beam trawl***: 399,360.75 kg/vessel; 199,680.37 kg/beam trawl; 55,084.44 kg/month; 4,248.52 kg/day; 464.508 kg/haul, 372.451 kg/hour, for an efort of: 4 vessels, 8 beam trawls, 29 months, 376 days, 3,439 hauls, 4,289 hours and a catch of **1,597,443** t.

**Species composition of catches**

The population structure shows the presence of a larger number of species (over 20) in catches, of which both small species (sprat, anchovy, whiting, horse mackerel, gobies) and larger (turbot and shad) were dominant. While the dominance in catches during 2008-2013 was mainly held by *Sprattus sprattus* / sprat (62.3-78.8%), followed by traditional species: *Merlangius merlangus euxinus* / whiting (2.9-6.4%), *Engraulis encrasicolus* / anchovy (1.6-10.4%), *Psetta maxima maeotica* / turbot (1.8-12.9%), *Trachurus mediterraneus ponticus* / horse mackerel (0.6-1.73%), *Squalus acanthias* / dogfish (0.1-2.1%), Gobiidae / gobies (3.5-4.6%), Mugilidae / mullets (0.1-1.2%), Alosae /shads (2.7%) and other species (0.55-3.0%), **over the past six years, catches of mollusks have increased the commercial value** by catching large amounts of rapa whelk (*Rapana venosa*).

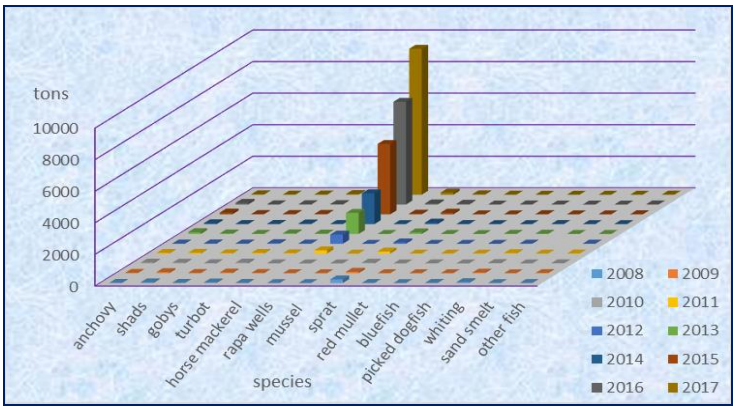


**Fig. 7.** Catch structure (t) of the main fish species caught in the Romanian marine sector during 2008 - 2017**.**

The main species in the catches of 2017 were: rapana - 9,244.3 t; mussels (67 t); anchovy (102 t), sprat (28.738 t); horse mackerel (34.569 t); turbot (42.616 t); shads (9.208 t) and red mullet (4 t) (Fig. 6). In addition to these species, the following also appeared in the catches: sand smelt (0.085 t), flathead gray mullet (0.647 t), golden gray mullet (1.212 t), gobies (18.853 t), knout goby (1.695 t), Azov shad (5.457 t), Danube shad (8.326 t), bluefish (8.042 t), garfish (2.486 t), thornback ray (0.312 t), bonito (0.295 t) and common stingray (0.509 t).

**Biological parameters and distribution area of the main fish species**

**TURBOT** / *Psetta maxima maeotica* (Pallas, 1811), marine benthic species, characteristic for soft bottoms. The juveniles are found in the vicinity of the shore, on sandy beaches, and as they grow they retreat to greater depths. Adults are found in winter at depths of 60-70 m, in the phaseolinoid facies area. In spring (March-April), turbots approach the shore, up to a depth of 18-30 m, where they form spawning agglomerations. After spawning, they disperse and retreat back to greater depths. During the analyzed period, the catches made were within the TAC approved by the STECF/European Commission, ie around 43.2 tonnes per year (Fig. 8). The exception was made in the years 2015 and 2016, when catches were around 30 tonnes per year (Maximov et al., 2013).

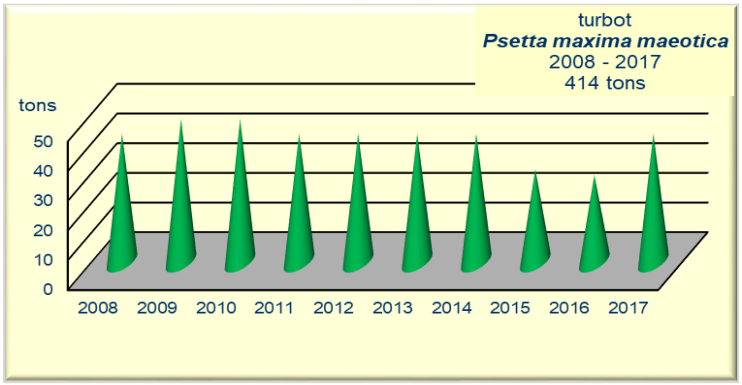


**Fig. 8. Total catch (tonnes) of turbot during 2008 - 2017.**

The analysis of the structure on length and mass classes of the turbot shoals from 2008 to 2017 highlighted the presence of mature specimens and a high homogeneity of the shoals. The length and weight ranges of the turbot individuals varied from 7 to 82.0 cm / 257 - 9,850 g, with the classes 43.0 - 61.0 cm / 950 - 3.550 g being dominant (Fig. 9). The sex ratio indicates a clear dominance of females (58.77%) compared to males (41.23%). The average length of the body was 47.06 cm and the average weight was 2.015 g.

The age composition of turbot catches indicates the presence of specimens from 1 to 8 years old, the basis for catches being 3-year olds (29.5% of all specimens analyzed), 4 years (27.83%), and 5 years (18.76), followed by 2 years (10.77%), 6 years (9.56%), 7 years (3.01%) and less than 1%, those of 1 year and 8 years old (Maximov et al., 2016 a and b) (Fig. 10).

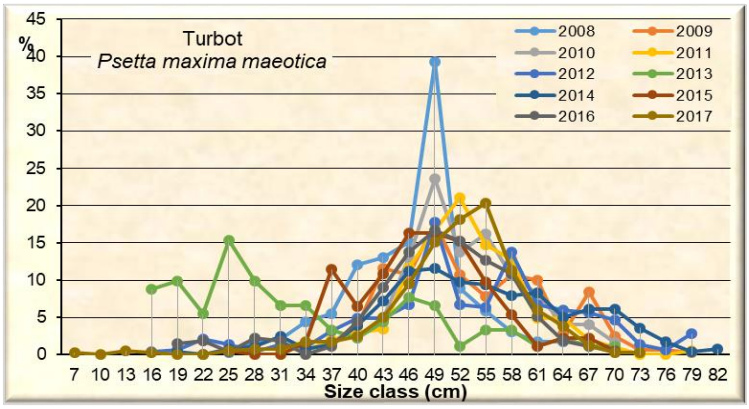


**Fig. 9. Length class structure (cm) for turbot (*Psetta maxima maeotica*) caught during 2008 - 2017.**

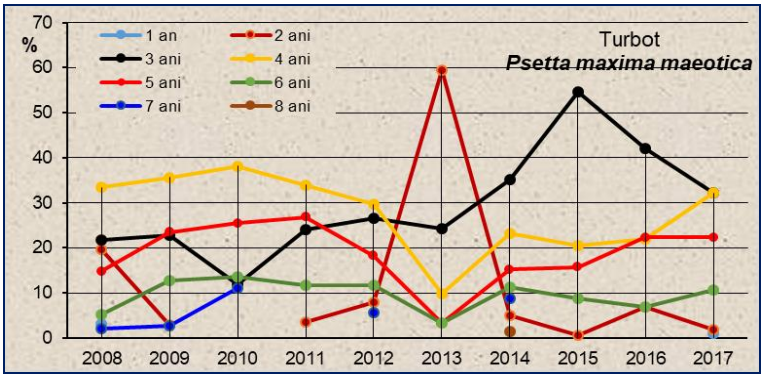


**Fig. 10.** Age class structure (years) for turbot (*Psetta maxima maeotica*) caught during 2008 - 2017.

**SPRAT /** *Sprattus sprattus* (Linnaeus, 1758), pelagic fish species that prefers cold water, does not run long migrations, but only movements between the coast and offshore waters at certain times of the year or between surface and deep horizons. Sprat's movements are mainly determined by the water temperature, taking place in three main periods of the year: autumn-winter-spring. Sprats carry diurnal migrations, both larvae, juveniles and adults are maintained during the day in the layers above the bottom and at night they rise up into the surface water layers. Sprat is an essential species in active fishing with coastal trawler vessels. During 2008 - 2017, sprat represented approximately 62.29% of the total annual catch (Fig. 11) (92.6% of trawler vessels' catches and 55.5% of pound net catches) (Maximov et al., 2017).

The analysis of the structure by length and weight classes revealed the presence of specimens of 50 - 130 mm / 1.47 - 14.00 g, ng the classes 70-100 mm / 2.23-6.66 g being dominant (Fig. 12). The ratio of females to males is 58.39% compared to only 41.61%. The average length of the body was 79.02 mm and the average mass was 3.2 g. The age composition of sprat catches showed the presence of 1 to 3 year olds, the basis for catches being 1 year olds (56.08%). and 2 year year olds (35.06%), plus the 0 year olds (8.86%) individuals belonging to the new generations (Maximov & Tiganov, 2016) (Fig.13).

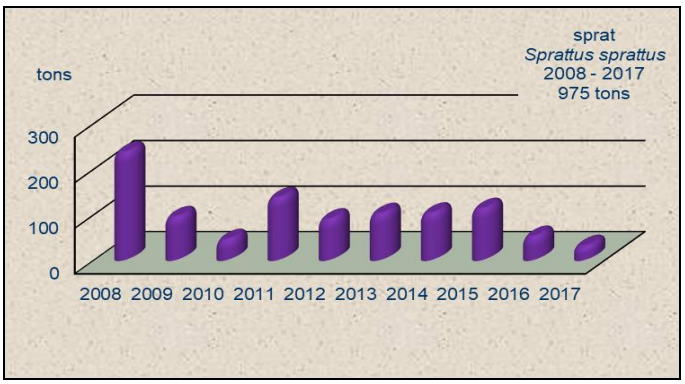


**Fig. 11.** Total catch (tons) of sprat during 2008 - 2017.

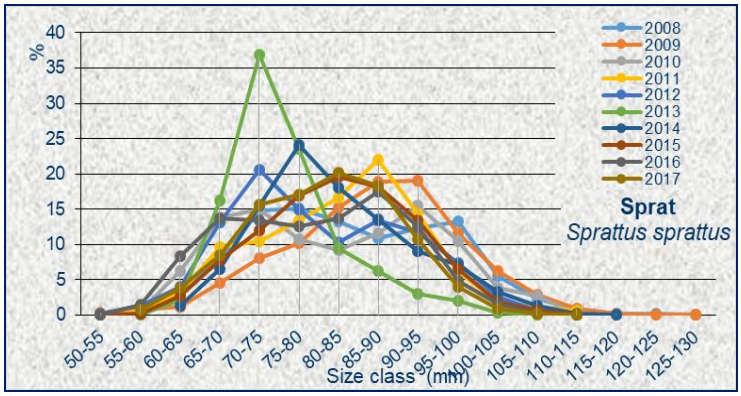


**Fig. 12.** Length class structure in sprat (*Sprattus sprattus*) caught during 2008 - 2017.

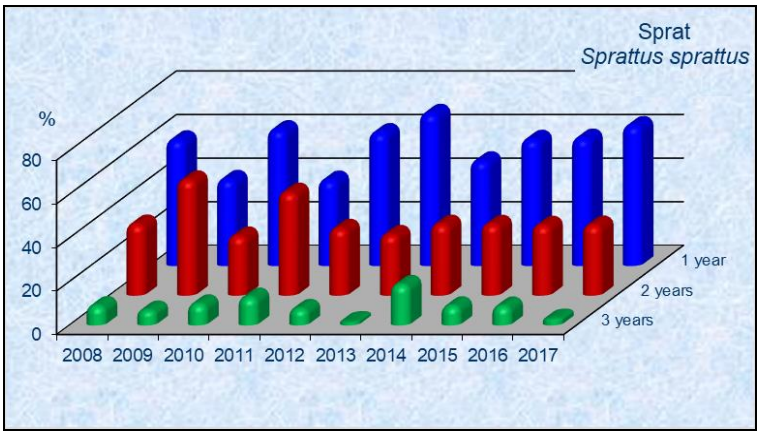


**Fig. 13.** Age class structure (years) in sprat (*Sprattus sprattus*) caught during 2008 - 2017.

**ANCHOVY /** *Engraulis encrasicolus* (Linnaeus, 1758), pelagic gregarious species, spread throughout the Black Sea. It winters in large dense shoals on the coasts of Anatolia, Crimea and Caucasus, at depths of 20-80 m. At the beginning of April, it migrates to the north, on the west and east coast, where it feeds intensely. The return migration begins in October and follows the same route.

90-95% pf anchovy is caught at the Romanian coast with stationary pound net gears (marine trap nets) installed on depths of 5-12 m, representing about 50% of the total pound net catch. In large-scale fishing with trawler vessels (active fishing), especially in the summer season (June-August), its presence is also reported at depths of over 20 m, but anchovy is not a target species for active fishing. The catch during 2008-2017, approximately 600 tonnes, oscillated between 15 tons / 2008 and 117 t / 2013, and in the last years it became the basic species in stationary fishing (pound nets) (Fig. 14).

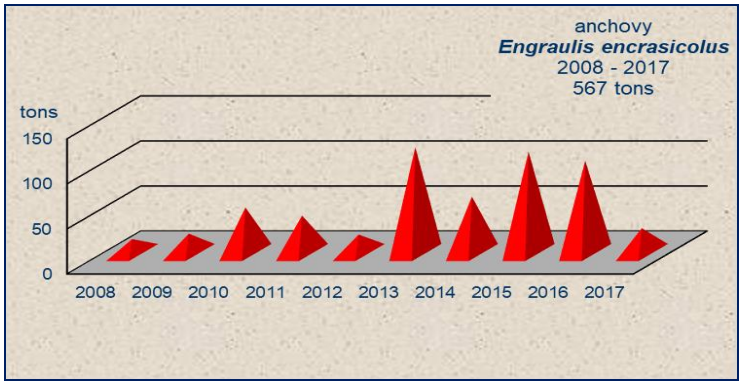


**Fig. 14.** Total catch (tons) of anchovy caught during 2008 - 2017.

During 2008-2017, 57,584 specimens of anchovy (59.41% females and 40.59 males) were examined, with a total length ranging from 45.11 mm to 145.88 mm and a mean weight ranging between 3.79 g and 14.56 g, the dominant classes being 70-115 mm / 3.23-7.87 g (Fig. 15). The average length of the body was 91.51 mm and the average weight was 4.99 g. In the catches, specimens belonging to the age group 0-4 years occurred, the groups 1 and 2 year olds being dominant, as a consequence of the pressure exerted by fishing for the species, especially in the wintering areas (Fig. 16).

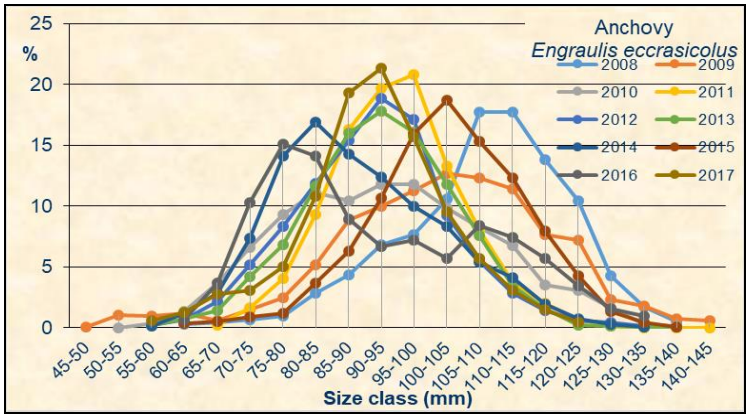


**Fig. 15.** Length class structure in anchovy (*Engraulis encrasicolus*) caught during 2008 - 2017.

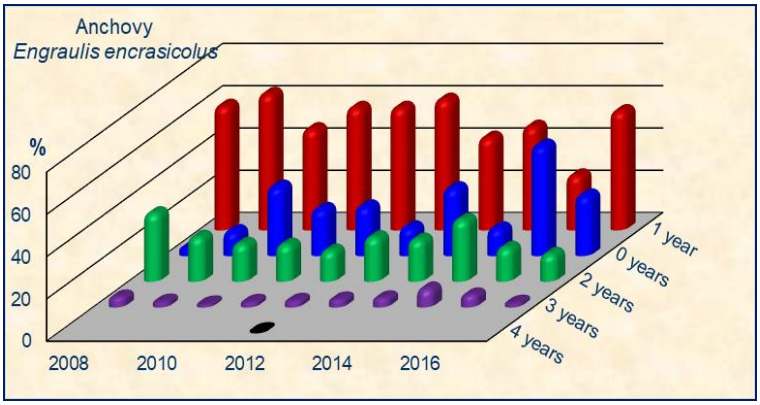


**Fig. 16.** Age class structure (years) in anchovy (*Engraulis encrasicolus*) caught during 2008 - 2017.

**HORSE MACKEREL** / *Trachurus mediterraneus ponticus* (Aleev, 1956), pelagic gregarious species, with a high degree of thermophilia. Spread in the Black Sea, the Azov Sea (except its freshwater parts), the Marmara Sea (especially in winter) and also in the Eastern Atlantic. On the Black Sea coast it is spread mostly in the northern part, wintering in the eastern and southern parts of the sea at depths of 80-100 m. In spring, it leaves the wintering grounds and goes to the feeding grounds. In summer, horse mackerel runs irregular migrations from the offing to shore and vice versa depending on water temperature, wind, salinity. Horse mackerel shoals are maintained in the upper horizons of the water up to a depth of 25 m. The first agglomerations appear at the Romanian coast in May, large quantities being fished in August-October. The horse mackerel catch between 2008 and 2017 varied between 7 tonnes / 2010 and 35 tonnes / 2017 (Fig. 17). Aggolmerations were formed from both young and mature specimens, the length and weight spectrum ranging between 35-175 mm / 3.05 - 44.17 g, ages between 1; $1^+$ and 5; $5^+$, the classes 80-145 mm / 13.10-30.30 g, aged 2, $2^+$ and 3, $3^+$ years old being dominant (Fig. 18 and 19).

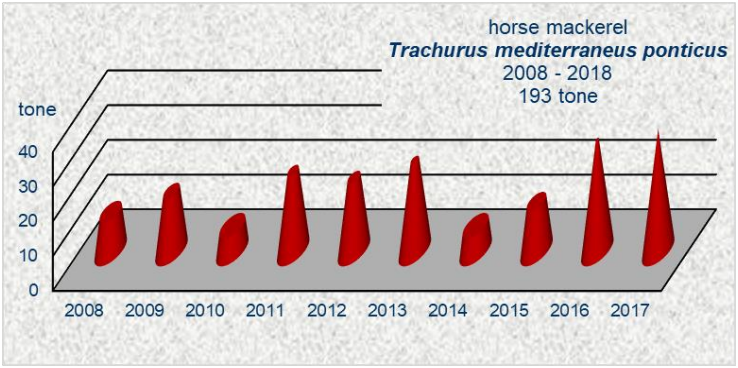


**Fig. 17.** Total catch (tons) of horse mackerel caught during 2008 - 2017.

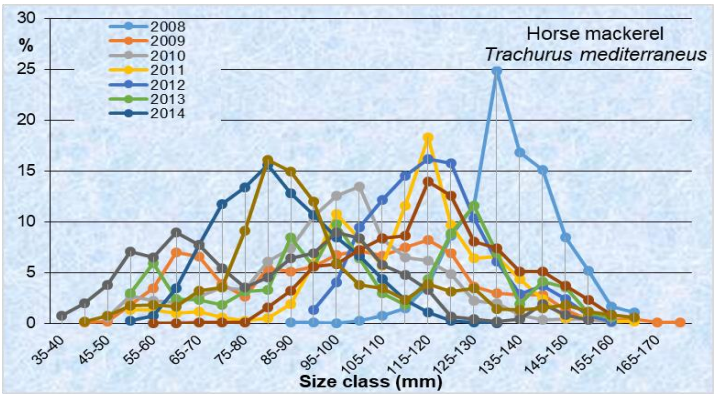


**Fig. 18.** Length class structure in horse mackerel (*Trachurus mediterraneus*) caught during 2008 - 2017.

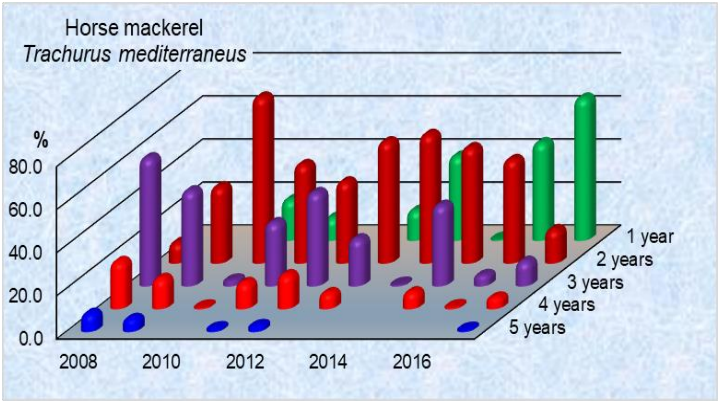


**Fig. 19**. Age class structure (years) in horse mackerel (*Trachurus mediterraneus*) caught during 2008 - 2017.

**WHITING**/ *Merlangius merlangus euxinus* (Nordmann, 1840), cold water demersal species, it is found in the vicinity of the shore on sandy bottoms, both in autumn and spring, but often in summer in the mussel and phaseolin mud areas, at depths of 30-120 m. During the cold season of the year (spring and autumn), whiting is found near the shore, and in the warm season (summer) it retreats to the offing and approaches the coast with the cold water counter-currents. Spawning takes place almost all year round, but with maximum intensity in November - March. Although a basic species in fishing with coastal trawler vessels and pound nets, its share has recently declined to 7.69% / 2014, after which, due to the poor quality of the meat and the lack of market demamd, no more catches have been reported (Fig. 20).

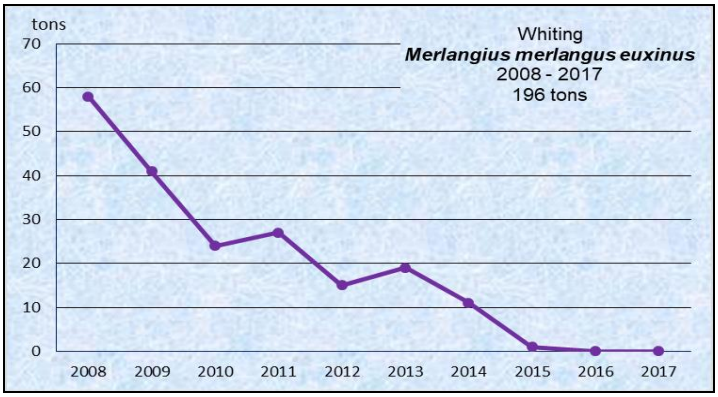


**Fig. 20.** Total catch (tons) of whiting during 2008 - 2017.

Overall, during 2008-2017, the whiting population on the Romanian coast was homogeneous, the length and weight spectrum ranging from 45-275 mm / 0.67-165.25 g, the 90- 140 mm / 6.05-15.47 g class being dominant (Fig. 21).

The sex ratio indicates a net dominance (60.46%) of females. The average length of the body was 107.45 mm and the average weight was 10.58 g. The analysis of age composition over the whole analyzed period revealed the occurrence of 1 to 5 year olds, dominated by 1 year olds (48.62%) and 2 year olds (43.05%) (Fig. 22).

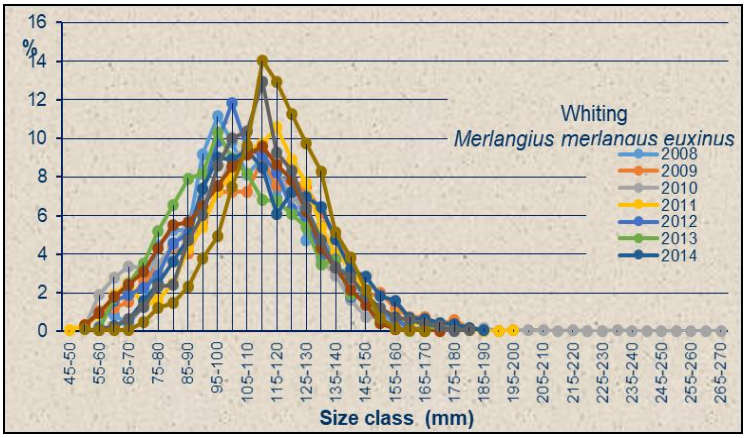


**Fig. 21.** Length class structure in whiting (*Merlangius merlangus euxinus*) caught during 2008 - 2017.

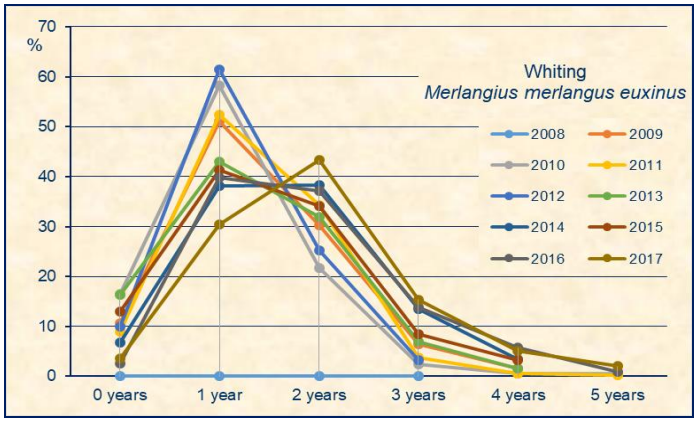


**Fig. 22.** Age class structure (years) in whiting (*Merlangius merlangus euxinus*) caught during 2008 - 2017.

**SPINY DOGFISH** / *Squalus acanthias* (Linnaeus, 1758), marine benthic pelagic species, solitary, it only aggregates during spawning. It approaches the shore at the beginning of spring (March-April) until the end of November. It is usually found between 50-70 m in the mitiloid-phaseolinoid area. It is an open water species, good swimmer, which generally lives isolated, gathering in small groups only during spawning. In the Romanian coastal area, spiny dogfish catches did not exceed 15 tonnes per year, most of them under 5 tonnes/year, being considered as a by-catch species in industrial fishing (Fig. 23).

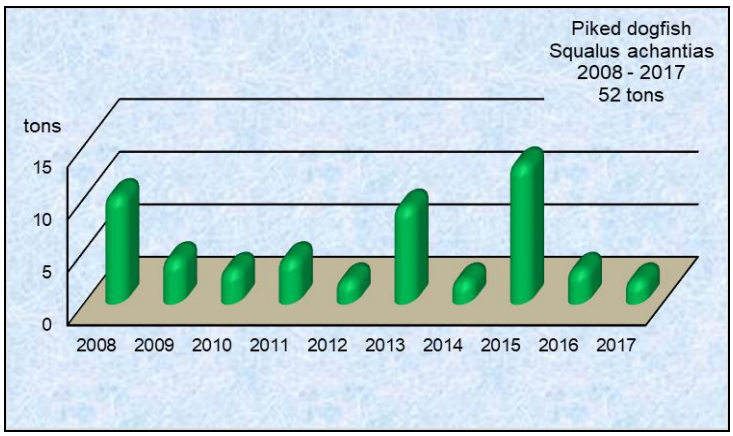


**Fig. 23.** Total catch (tons) of dogfish during 2008 - 2017.

In the Romanian coastal area, the spectrum of lengths and weights ranged from 30-145 cm / 280-15,800 g, the classes 108-123 cm / 4,775-7,000 g being dominant (Fig. 24). The sex ratio shows a net dominance (80.46%) of males. The average length of the body was 107.91 mm and the average weight was 5,329.73 g. The analysis of age composition over the whole analyzed period revealed the occurrence of 11-18 year olds, dominated by 14 year-olds (28.0%), 15 year olds (26.1%) and 14 year olds (Fig. 25).

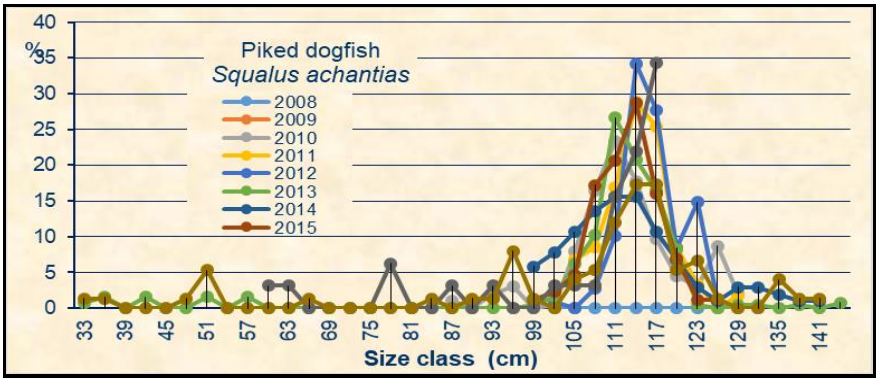


**Fig. 24.** Length class structure in spiny dogfish (*Squalus acanthias*) caught during 2008 - 2017.

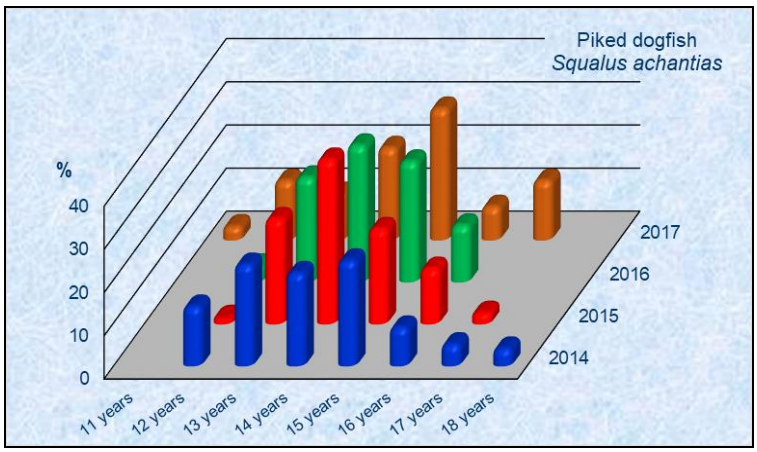


**Fig. 25.** Age class structure (years) in spiny dogfish (*Squalus acanthias*) caught during 2008 - 2017.

**RED MULLET** / *Mullus barbatus ponticus* (Essipov, 1927), benthic, thermophilic (preferring cold waters) marine species, it is found along the Black Sea and Azov coasts, where it lives in small shoals above the sandy bottoms. Spawning takes place between June and July at a temperature of 19-23ºC. Rarely, the period extends until the early days of September. This demersal marine species is very representative in catches at pound nets located in the Mamaia Bay - Vama Veche sector. It presented a homogeneous size, ranging from 45-170 mm / 0.8-55.1 g, the 85- 125 mm / 7.1 - 21.6 g class being dominant (Fig. 27).

The sex ratio was slightly dominated by females (56.08%), compared to males (43.92%). The average length of the body was 93.88 cm and the average mass was 9.87 g. The age analysis indicated the presence of specimens aged between 0 and 3 years. Those aged $1^+$ years (26.76%), with average lengths and masses of 93.27 mm, respectively 8.44 g, and 2 years (48.82%, mean length and weight 115.83 mm and 16.09 g), formed the base of catches of red mullet, followed by the group of 3 year olds, with 15.29% (average length and average weight 133.31 mm and 25.42 g, respectively) (Fig. 28).


**Fig. 26.** Total catch (tons) of red mullet during 2008 - 2017.

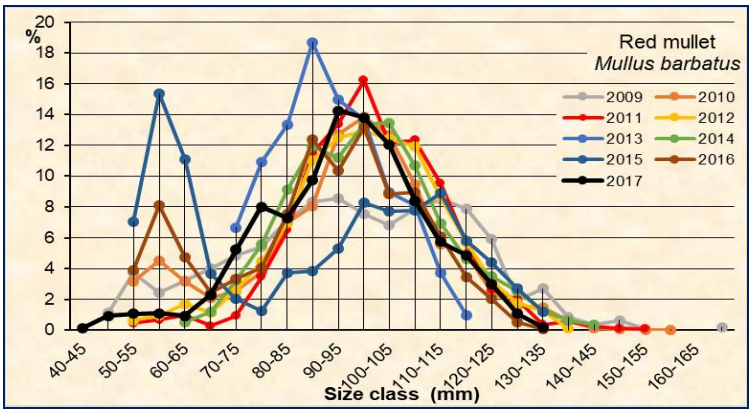


**Fig. 27.** Length class structure in red mullet (*Mullus barbatus*) caught during 2008 - 2017.

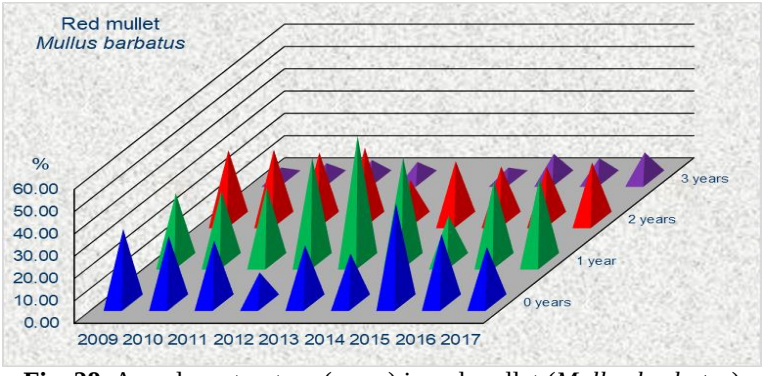


**Fig. 28.** Age class structure (years) in red mullet (*Mullus barbatus*) caught during 2008 - 2017**.**

**Marine Mammals**

Marine mammals at the Romanian coast, represented by the three dolphin species - *Delphinus delphis ponticus*, *Tursiops truncatus ponticus* and *Phocoena phocoena relicta* - are extremely vulnerable to threats from various human activities. These threats are more severe in the Black Sea due to the character of this semi-enclosed sea, the demographic density and the intensity of anthropogenic activities, especially in the coastal area.

The three species of dolphins in the Black Sea experienced a dramatic decline during the 20$^{th}$ century, as a result of their direct capture in the past, accidental catches in fishing nets (Fig. 29), as well as the reduction of fish stocks that constitute their food and the degradation of the marine environment.

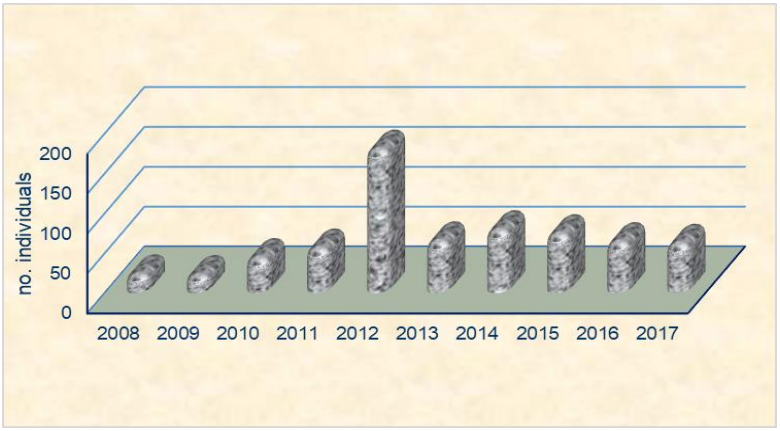


**Fig. 29.** Marine mammal by-catches at the Romanian Black Sea coast during 2008-2017.

In disrupting population interrelations systems, human influence can be greater than that of predators and parasites, through excessive fishing that aims to obtain maximum production quantities from ecosystems. The research carried out by NIMRD's experts to date has focused on the distribution of the three marine mammal species, as well as the oversight of incidental dolphin catches in the Romanian Black Sea area.

All dolphin species are migrating in search of food, with no special area dedicated to them. Therefore, the signaling of dolphin pods at the Romanian coast was recorded in all surveys at sea, organized by NIMRD "Grigore Antipa" Constanta and distribution maps were drawn up for all three dolphin species (Fig. 30).

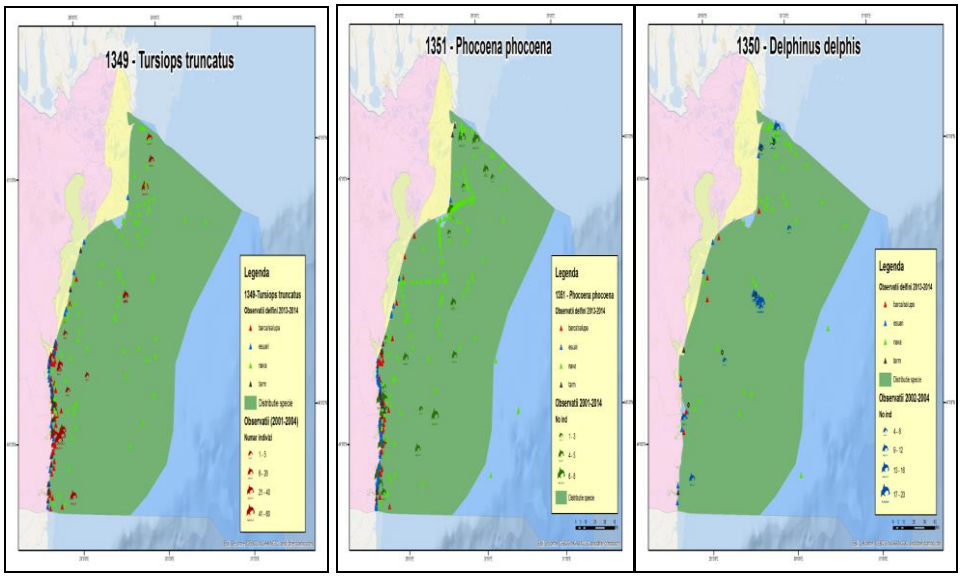


**Fig. 30.** Distribution areas of the marine mammal species at the Romanian coast: *Tursiops truncatus ponticus, Phocoena phocoena relicta* and *Delphinus delphis ponticus.*

**Assessing the Fishable Agglomerations**

For the estimation of the biomass of fishable agglomerations of the main fish species of commercial interest, surveys were made on the Romanian continental shelf. The evaluation of a part of the stock of sprat and turbot was done by the sample trawl holistic method, which can be applied in restricted areas, without taking into account the whole stock distribution area and which uses as parameters: the speed of the vessel, the horizontal opening of the trawl and trawling time.

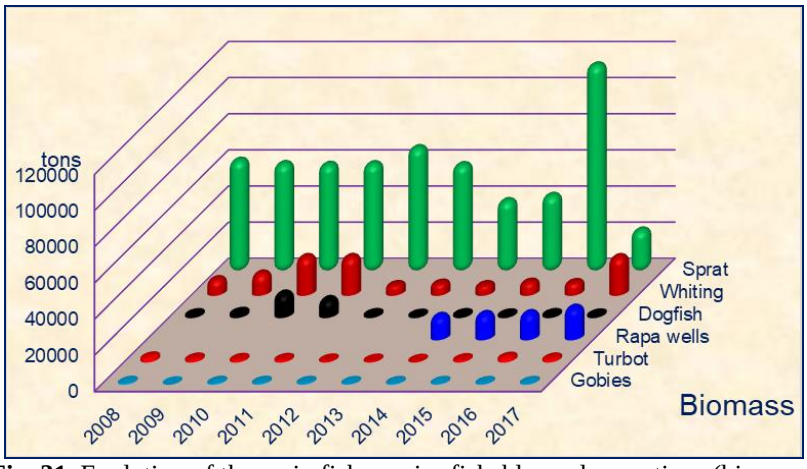


**Fig. 31.** Evolution of the main fish species fishable agglomerations (biomass) during 2008-2017.

The estimated biomass for the pelagic and demersal main species at the Romanian coast during 2008-2017 ranged between: 39,600-114,653 tons for **sprat**; 5,650-21,000 tons for **whiting;** 291-2,117 tons for **turbot**, 300- 600 tons for **gobies**, 1,223 - 10,000 tons for **spiny dogfish** and 13,000-17,500 tons for ***Rapana venosa*** (Fig. 31).

**Fish Stocks Evolution Trends**

For the Black Sea, it is estimated that the **sprat** Spawnig Stock Biomss (SSB) is 460,298 t, which is one of the greatest estimates of all times. The recruitment was lower during 2009 to 2011, but increased starting from 2012 and the current exploitation rate (E = 0.36, corresponding to a Fishing Mortality F = 0.54) is lower than the $E_{MSY}$ (exploitatble Maximum Sustainable Yield) (0.40 corresponding to F = 0.64), indicating that the sprat of GSA 29 is fished under $E_{MSY}$. It is recommended that, at the level of the entire Black Sea basin, sprat catches should not exceed 91,852 tons, corresponding to the $E_{MSY}$ level (0,40).

The **turbot** stock in the Black Sea is estimated to have been unsustainably exploited in recent years and remains at the risk of collapse. The SSB declined from a peak in the period from 1977 to 1982 to the minimum observed in 2013 (1,528 t), which represents less than 43% of the $B_{lim}$ (limit reference point for spawning stock biomass - SSB) estimate (3,535 t). Fishing mortality has steadily increased since the early 1990s, reaching a peak in 2001 (F = 1.22) and in 2013 F = 1.08. F has a value of 0.82, more than three times higher than $F_{MSY}$ (0.26), indicating that the turbot in the GSA 29 area is overfished.

For **horse mackerel**, an F=1.42 was estimated, which corresponds to an exploitation rate of 0.78, almost double than the recommended rate for small pelagic species of 0.4. The SSB declined from a peak in 2007 (about 50,000 tons) to a minimum in 2014 (about 12,000 tons). Recruitment has a fluctuating trend, with peaks in 2006, 2010 and 2014. F has risen over the years, reaching a peak in 2013 (F = 2.0). The current exploitation rate (E = 0.71, corresponds to F = 0.98) is higher than the $E_{MSY}$ (0.40), indicating that the horse mackerel in the GSA 29 area is fished above the $E_{MSY}$ limit.

For anchovy, the XSA (extended survivor analysis) estimates for 2017 have resulted in a fishing mortality of F = 1.2, which corresponds to an exploitation rate of 1.01, being higher than the precautionary threshold of 0.49. Experts believe that, although the stock has been unsustainably exploited in recent years, it has been found that the fishing mortality rate has fallen in recent years over the 2010-2012 period. Reproduction stock biomass peaked in 2011 and subsequently fell to around 400,000 tons.

If the estimated values of spiny dogfish biomass in the period 2008-2011 were quite high (10,000-13,000 t/year), in the last five years (2014-2017), they have fallen sharply from 750 t to 1,550 t. Although considered to be by-catch, the fishing mortality rate was estimated at F = 0.24 / 2015, which is very high compared to the exploitation rate $F_{MSY}$ = 0.08. The very small (reported) catches lead to the conclusion that the stock seems to be seriously depleted. For precautionary reasons, it is advisable to reduce catches to a value of less than 13.5 t, spiny dogfish being a

long-lived species, and the recovery of the populations takes longer.

Taking into account the diversification of fishing methods and gears, as well as the results of recent years estimations, it is necessary to limit **goby** catches to 30 t/year and to introduce a prohibition period in the peak spawning season.

***Special Recommendations:***

* Returning to the sea turbot, sturgeon and spiny dogfish juvenile specimens caught in beam trawls and fish with legal size during the prohibition period;
* Returning to the sea of fish juveniles and specimens under the legal size, caught in the pelagic trawl, fixed gillnets and pound nets;
* launching an impact assessment program on demersal habitats and demersal species using destructive fishing methods, in particular beam trawls. On the basis of the results obtained, it will be possible to recommend the most effective measures to eliminate the possible negative impact on habitats and benthic marine species;
* expanding the stock assessment program for other fish and mollusk species;
* regulating fishing in Community waters of Romania and Bulgaria (Zaharia et al., 2014).

## CONCLUSIONS

The main conclusions concerning the dynamics of fish and marine mammal populations at the romanian black sea coast in the past 10 years and their evolution trends can be summarized as follows:

- non-uniform distribution of the fishable agglomerations of the main fish species along the Romanian coast, both in the area of action of pound nets, at depths of 3-11 m, as well as in the activity area of the trawler vessels at depths of 20-68 m;
- Dominance in passive fishery catches was held by traditional species: anchovy, whiting, Azov shad, sprat, sand smelt, gobies, along with a large number of other species and a net decrease of sprat in active fishing, followed by whiting and other species (anchovy, horse mackerel and bluefish);
- Demersal species are the most important segment of regional fisheries potential in terms of commercial interest and demand on the domestic and international market. The main species of interest are: *Psetta maxima maeotica* (turbot), *Squalus acantias* (spiny dogfish), Gobiidae (gobies) and Mullidae (red mullet);
- Changes in fish behavior are noted, by the removal of fish agglomerations from areas close to the coast and a more pronounced dynamism of the formation and dispersion of these agglomerations, both in the shallow area (3.0-11.0 m) and in the offshore area (20-80 m);
- The study of fish populations at the Romanian coast was carried out by biometric, gravimetric and age measurements of over 100,000 specimens;
- The qualitative and quantitative structure of catches made at the Romanian coast had a variable evolution depending on the state of the fish populations, the fishing effort deployed, the type of gear used and the

conditions for the formation and maintenance of the fish agglomerations, especially in the coastal zone;

- The state of stocks of the main fish species of commercial interest in the Romanian Black Sea sector is quite different, with a clear recovery trend for anchovy and a slight recovery for bluefish, mullets and horse mackerel. Sprat is the only species that exhibited an almost normal natural fluctuation and a relatively good stock;
- sprat has formed in the last years agglomerations at the Romanian coast estimated at about 39,832 - 114,652.7 tons, the formation and dispersion of the fish aggregates being very strongly influenced by the oceanographic conditions (wind direction and force, the presence of the thermocline, marine currents, jellyfish agglomerations);
- although in the period 2010-2014, the biomass of turbot in the Romanian coastal area has been drastically reduced, being estimated at values not exceeding 500 t/year, being mostly composed of non-mature specimens, in the last years (2015-2017), turbot presented relatively stable agglomerations, estimated at 1,000 t in 2016 and 2,117 t in 2017;
- given the low fishing capacity for species such as **anchovy** and **horse mackerel**, we consider that the total allowable catches are not required for the Romanian marine sector, but the minimum size allowed for fishing for these species is required to protect them.

**ACKNOWLEDGEMENTS**

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