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RESEARCH PAPER

Dynamics of the Romanian Sprat (*Sprattus Sprattus*, Linnaeus 1758) Fishery between Evolution of the Fishing Effort and the State of the Environmental Conditions

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Abstract

Sprat is one of the fish species with special commercial importance in the Romanian marine area, but its share in the catches of the recent years has significantly diminished. The paper is a synthesis of long-term observations on catches of sprat in the Romanian area considering the evolution of fishing effort by both active and passive gears and considering the state of environmental conditions in the period. The main elements analysed are: dynamics of sprat catches and its share on fishing gears; evolution of fishing effort; sprat stock status and fishing agglomerations biomass; environmental conditions influence on the status and distribution of fishing agglomerations; evolution of biological parameters of the sprat.

Keywords: Romanian Black Sea area, catch, fishing effort, biomass, environmental conditions.

Introduction

Dynamics of the Romanian sprat fishery from 1950 to nowadays can be correlated with the evolution of the Black Sea ecosystem as a characteristic of the inland seas, subject of land-based pollutions and other human influences (Radu *et al*., 2011a; Radu *et al*., 2011b). In these conditions, the fishery was the most affected sector by the important changes of the Black Sea ecosystem, but the fishing activities contribute themselves to the worsening of the ecological situation and for the depletion of the fish stocks. The recent studies have shown that the fishing affects not only fish stocks, but also lower trophic levels, the ecosystem and the quality of marine environment through trophic cascades and top-down driven regime shifts (Daskalov *et al*., 2007a; Daskalov *et al*., 2007b; Daskalov *et al*., 2008; Porumb, 1998).

The composition of the Black Sea ichthyofauna has changed in response to the alterations of the living conditions in the sea. Some of the changes had an impact on coastal and shelf waters, others on the pelagic zone, affecting common and rare species, juveniles and adults, commercial and non-commercial species (Zaitsev and Mamaev, 1997).

Material and Methods

The paper includes data about dynamics of sprat catches and its share on fishing gears, evolution of fishing effort, sprat stock status and fishing agglomerations biomass, distribution of fishing agglomerations under the influence of environmental conditions and evolution of biological parameters.

The source of the information is represented by the papers published by some authors, such as: Cautis, 1976; Daskalov *et al*., 2007a; Parcalaboiu, 1977; Porumb, 1996; Radu *et al*., 2011b; Radu, *et al*., 2015 and others. Also, most of data come from Fisheries Reports of the National Institute for Marine Research "Grigore Antipa" (NIMRD). After EU accession of Romania, data are obtained from Annual Reports realised also by the NIMRD in the frame of National Program for Collection of Fisheries Data 2008-2010 and 2011-2014 and STECF/EWG – BS stock assessment Reports (2009-2014).

Results and Discussions

Dynamics of Sprat Catches and Its Share on Fishing Gears

In the 1930-1950s the small pelagic fish, anchovy and sprat, made up 35% of the total catch at Black sea level; the rest being composed of large pelagic, fish estuarine and demersal species (Cautis, 1976; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; Zaitsev and Mamaev, 1997).

Inputs of nutrients from the Black Sea catchment basin increased dramatically since the 1950s, increasing primary production, and also zooplankton abundance. Increasing loads of nutrients from rivers caused on overproduction of micro-phytoplankton, which in turn blocked the light reaching the sea plants and algae, essential components of the sensitive ecosystem of the North-Western shelf. The entire ecosystem began to collapse (Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011b; Zaitsev and Mamaev, 1997).

The huge quantities of agricultural fertilizers discharged in the coastal Black Sea waters, beginning in the middle of '60s, which produced the phenomenon named "eutrophication", constituted the stimulus of the severe disturbances, cascade-like, from the marine ecosystems, similar with a reaction chain as follows: Increasing of phytoplanktonic global quantities, chronicisation and succession, more and more frequent and ample of "bloom" events of waters. In 1951-1956, blooms of waters were registered in the North-western part of the Black Sea, in front of Danube Delta and Dniester and Dnieper rivers mouths. After 1970, the number of blooms increased 10-30 times comparatively with 1950-1969 (Nesterova, 1979).

This problem coupled with pollution and irrational exploitation of fish stocks, triggered a sharp decline in the fishery resources (Daskalov *et al*., 2007a; Daskalov *et al*., 2007b; Daskalov *et al*., 2008).

Predator control by large pelagic fish and marine mammals was removed with their stock depletion, and in combination with increased zooplanktonic food, small pelagic fish expanded in stock size.

Thus in 80's, the marine fish such as mackerel, bonito, bluefish disappeared from commercial catches achieved by Bulgaria, Romanian and Ukraine proving the increasing disturbance of environmental conditions in the western part of the Black Sea but also in Bosporus Strait (Radu *et al*., 1996-1997; Radu *et al*., 2011b). The environmental disturbances together with the overexploitation constituted the major issues also in Marmara Sea, which constituted the main migration route for valuable species such as bonito, mackerel, bluefish; these species were migrating into Black Sea for feeding in spring, then returning for spawning in Marmara Sea, in winter (Unluata *et al*., 1990).

Also, the decline of the predatory fish species was determined by the over-fishing of the migratory fish at some point in their migration route and by the environmental degradation affecting the behavioural responses of migratory fish.

The dramatic depletion of Black Sea catches after 1989, in fact the depletion of fish stocks, were produced by the severe degradation of environmental conditions, at which there were added the overwhelming developments of the exotic species ctenophore *Mnemiopsis leidyi* after 1980, as well as the overexploitation of resources (Radu *et al*., 1996-1997; Radu *et al*., 2011b).

To make matters worse, in the mid of the 1980's, a jellyfish - like species (*Mnemiopsis leidyi*), which was accidentally introduced from the ecosystem seaboard of America in the ballast water of a ship, invaded the Black Sea. Its diet included fish larvae and the tiny animals small fish feed upon (Zaitsev and Mamaev, 1997).

Heavy fishing activities on small pelagic fish predominantly by the Soviet Union, and later also by Turkey, was carried out in a competitive framework without any agreement between the countries on limits to fishing. Depletion of the small pelagic stock appears to have led to increased opportunities for population explosion of planktonic predators (jelly fish and ctenophores) which have competed for food with fish, and preyed on their eggs and larvae.

Decreasing of zooplanktonic quantities with dominance of more tolerant species, especially gelatinous planktonic forms, such as the cystoflagelat *Noctiluca scintillans* or jellyfish *Aurelia aurita*, the last one being replaced in time by newcomer *Mnemiopsis leidyi*. The mass development of the gelatinous organisms is a feature of zooplanktonic biocoenosis under eutrophication conditions (Zaitsev and Polishchuk, 1984).

Comparatively with the 1950-1979 period, when former USSR prevailed the catches obtained in the Black Sea, beginning in 1980 the Turkey begun to have the greatest importance in fisheries, with catches of 180,000 (1991) and 482,500 t (1988), representing 52-89% from the whole Black Sea catch (Porumb, 1977; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011b).

Between 1980 and 1990, the total Black Sea catch ranged from 210,453 (1991) and 812,341 t (1988), represented especially by the pelagic species; after 1970, the pelagic species participated with percentage of 90 in total catch, excepting 1990, 1991 and 1992. The catch of the Black Sea countries increased until 1985-1989 after which a sharp decline occurred (Radu *et al*., 1996-1997; Radu *et al*., 2011b).

The sprat catch, oscillated from 1700 tons in 1955; 40,900 (1983) and 105,200 tons (1989) (Figure 1; 2) (Radu *et al*., 1996-1997; Radu *et al*., 2011b; STECF/BS-EWG, 2009-2014).

For the period 1993 to 2013 catches of sprat in the Black Sea increased steadily from a low level of about 17 thousand tons in 1993 to a first peak level of about 72 thousand tons in 2002, and a subsequent peak of almost 121 thousand tons in 2011. Catch during 2013 was only 27 thousand tons (Figure 2) (Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; STECF/BS-EWG, 2009-2014). Most of the reported landings of sprat since 2004 for Black Sea were taken by Turkey (47%) (STECF/BS-EWG, 2009-2014).

Consequently after 1995 the catches increased to levels comparable to the 1980s: 2001-2005 ~70 000 t. Landings have initially (in 2001-2005) reached the levels comparable to the 1980s but dropped again in 2006-2007. In 2008 the landing started to increase again due to expending Turkish fisheries that corresponded to a rise in fishing mortality, but in 2012 and 2013 decreased again (STECF/BS-EWG, 2009-2014).

At national level, sprat was and remains one of the main species in the catches on the Romanian seaside.

If, during the 1950-1959 interval, the multi-annual total catch on the Romanian coast was 4,410 t, the following three decades it increased intense, reaching a maximum value of 12,964 t (1980-1989), 16000 t in 1986 (Figure 3, 4) (Cautis, 1976; Parcalaboiu, 1977; Porumb, 1977; Porumb, 1996; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA - NIMRD, 2008-2014). In the following decade (1990-1999), the multi-annual catch declined by about four times the previous one and, in the last decade (2000-2014), it fell to 1,575 t (Figure 4) (Cautis, 1976; Parcalaboiu, 1977; Porumb, 1977; Porumb, 1996; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA-NIMRD, 2008-2014).

In the same interval, 1950-2014, for the main pelagic species (sprat), the same differences in terms of multi-annual catch were found. Thus, although the dominant species in catches on the Romanian coast, the multi-annual catch of sprat increased in the first decade, reaching a maximum of 5,841 t (1980-1989), maxim 9500t in 1987 then, in the next decade, fell to half that amount, reaching a minimum in the last decade (Fig. 3; 4) (Cautis, 1976; Parcalaboiu, 1977; Porumb, 1977; Porumb, 1996; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA-NIMRD, 2008-2014).

Meanwhile, Romanian catch for sprat in the area ranged from total catch of sprat in the Black Sea level with percentages between 40-50% in the years 1953-1961, dropping below 1% in recent years (Fig.1, 2).

Compared with the total Romanian catch, the sprat catch had percentages ranged between 20-40% by 1979, increasing to 76-86% in percentage in 1995-1997, then to decrease to 4% (Figure 5, 6).

Between 1950-1979, fishing on the Romanian coast was done with pound-nets, trap-type tools installed perpendicular to the shore, from Sulina to Mangalia (Cautis, 1976; Parcalaboiu, 1977; Porumb, 1977; Porumb, 1996; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA-NIMRD, 2008-2014). The main target of pound-net fishing was represented especially by: anchovy, shads, horse mackerel, sprat and small quantities of blue mackerel.

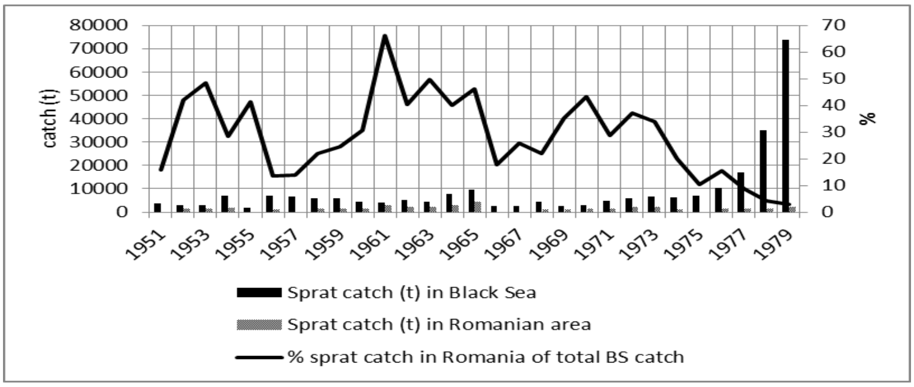

Figure 1. Romanian catch for sprat compared with the catch of sprat for entire Black Sea, 1951-1979.

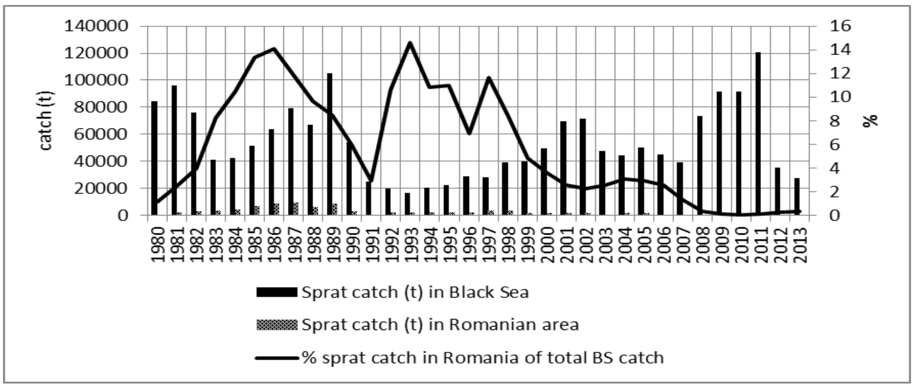

Figure 2. Romanian catch for sprat compared with the catch of sprat for entire Black Sea, 1980-2013.

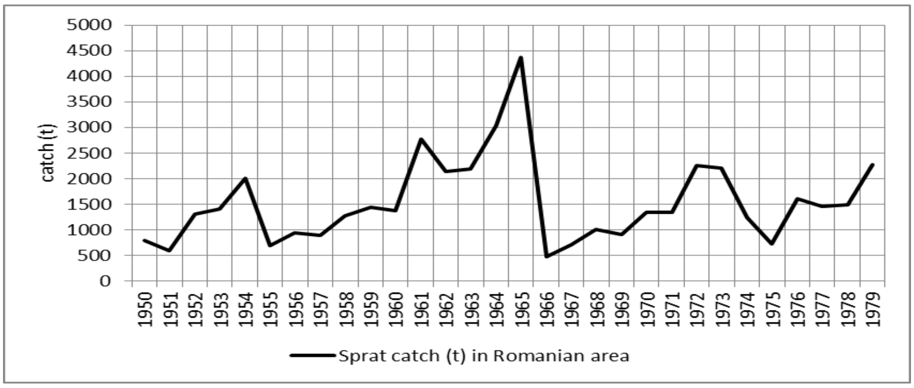

Figure 3. Dynamics of the sprat catches in the Romanian Black Sea area, 1950-1979.

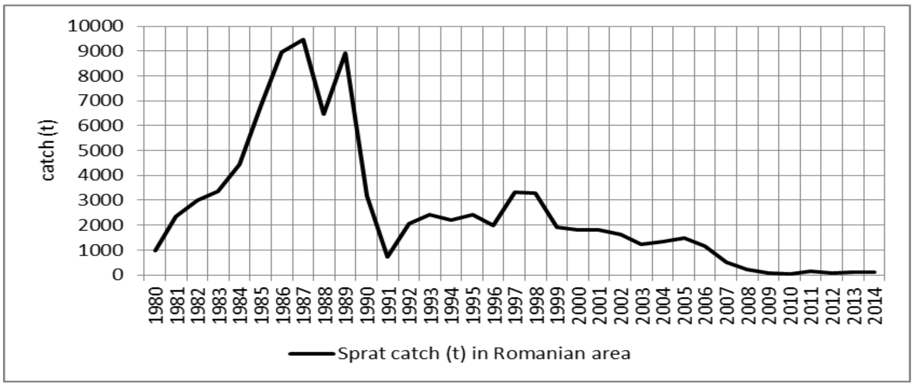

Figure 4. Dynamics of the sprat catches in the Romanian Black Sea area, 1980-2014.

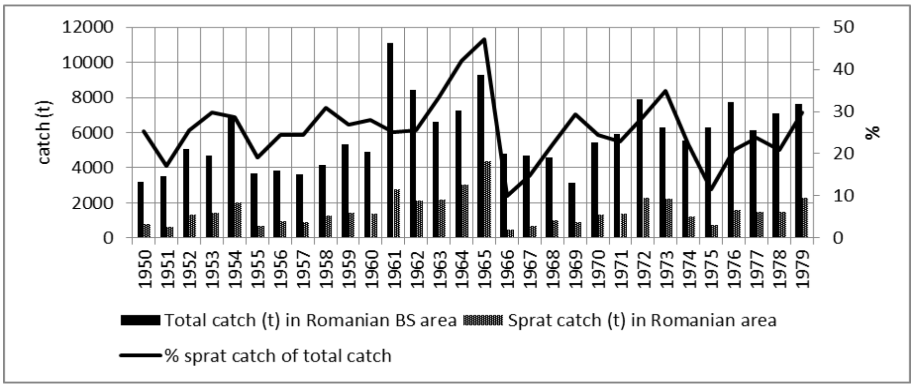

Figure 5. Romanian catch for sprat compared to the total catch in the Romanian Black Sea area, 1950-1979.

Pound-nets made annually up to 70% of the total amount of catches, during a time when specialized fishing with other tools was also undertaken, either for mullet (1953-1955), or turbot (1953-1956) and blue mackerel and bonito (1954-1958).

Between 1980-1990, catches were more significant for trap-nets (53-100%), except for 1989, when stationary fishing was only 37% of the total catch. In the early years of the following decade (1991-2000), fixed gear fishing remained prevalent (42-83% in the years 1991-1995), while, in the last decade (2001-2014), active fishing clearly exceeded the results of stationary fishing, except for 2009 (Figure 7; 8) (Radu *et al*., 1996-1997; Radu *et al*., 2011b). Sprat catch to the pound nets had a percentage that reached up to 47% (1965) and 55% (2006), (Fig. 7, 8).

In actively fishing, the main fishing species continues to be sprat, along with sporadically occurrences, in the summer months, of anchovies and horse mackerel, and blue fish late in the season (September-October) (Figure 9). Thus, sprat catches in active fishing, between 1981-2009, ranged from 77 t (1981) and 7,053 t (1989), contributing to the total catch obtained with trawlers with 63 percent (1983) to 96 (1982, 2002 and following years (Fig. 9).

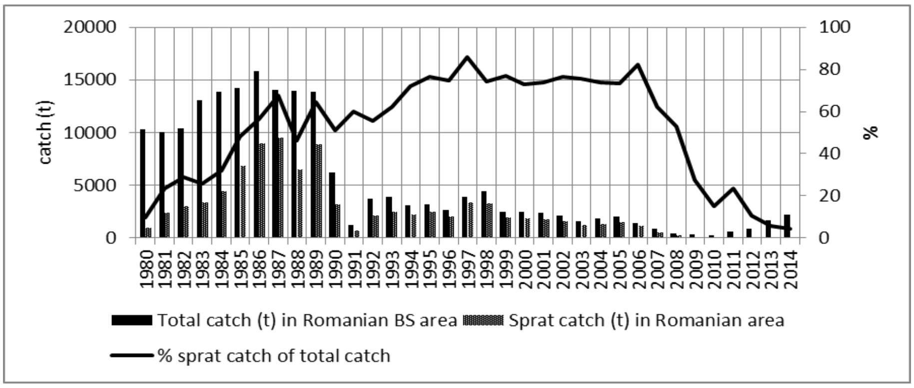

Figure 6. Romanian catch for sprat compared to the total catch in the Romanian Black Sea area, 1980-2014.

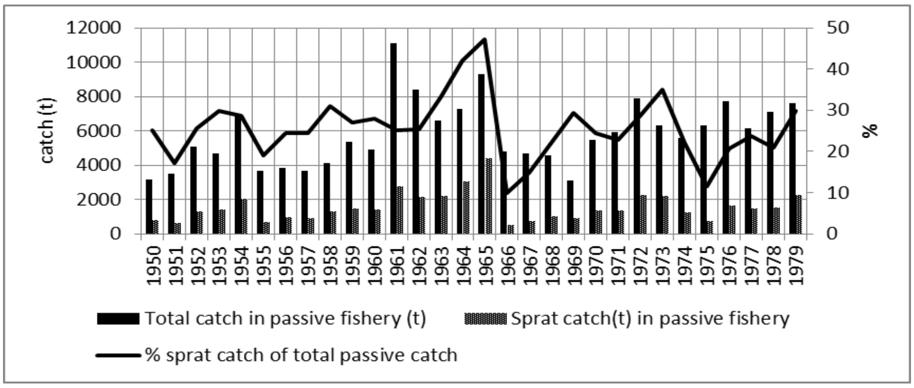

Figure 7. Romanian catch for sprat in the passive fishing compared to the total catch in passive fishing for the Romanian Black Sea area, 1950-1979.

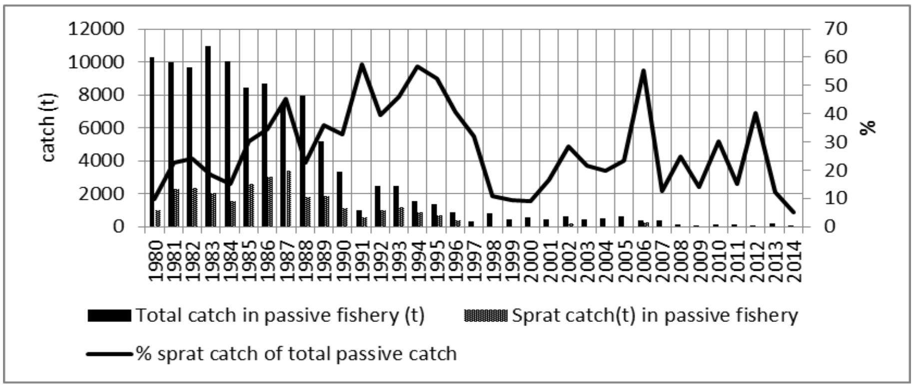

Figure 8. Romanian catch for sprat in the passive fishing compared to the total catch in passive fishing for the Romanian Black Sea area, 1980-2014.

In active fishing sprat percentage was extremely high, overcoming most often 80-90% of the total catch (Fig. 9).

Evolution of Fishing Effort

In the sprat fishery there are two type of fishing gears used for the active and passive fishery practised in Romanian Black Sea area, in the inshore and offshore coastal fishery.

The passive fishing gears include the equipment for catching in general the fish migrating for spawning and feeding in shallow waters, namely sea pound nets. Their number has dropped from a peak of 140 units in 1965 to 15 units in 2011 (Figure 10, 11) (Cautis, 1976; Parcalaboiu, 1977; Porumb, 1977; Porumb, 1996; Porumb, 1998; Radu *et al*., 1996-1997; Radu *et al*., 2011a; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA-NIMRD, 2008-2014). In 2014 there were 21 pound nets.

In the early '80s, a small tonnage trawler fleet was established. This coastal fishing fleet suffered

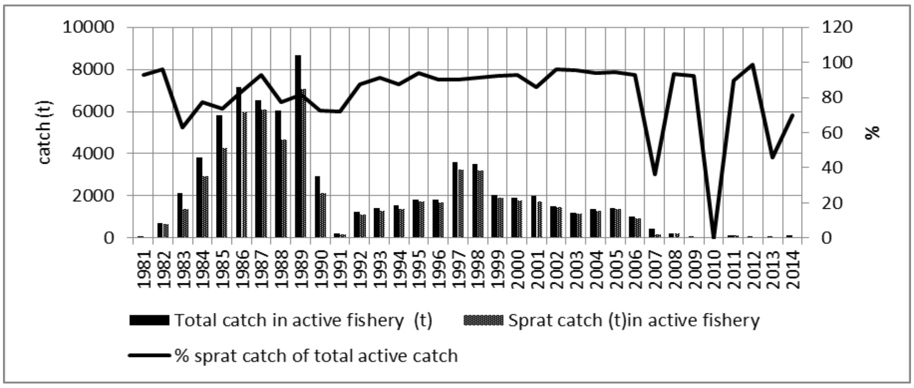

Figure 9. Romanian catch for sprat in the active fishing compared to the total catch in active fishing for the Romanian Black Sea area.

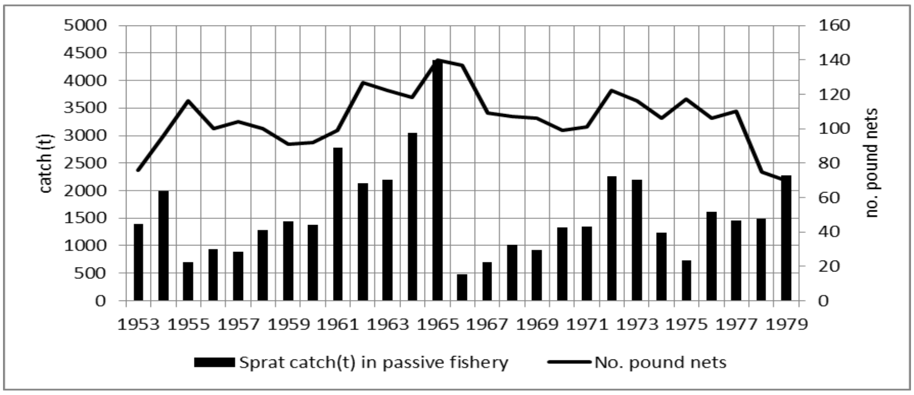

Figure 10. Sprat catch in the passive fishing and number of pound nets, 1953 – 1979.

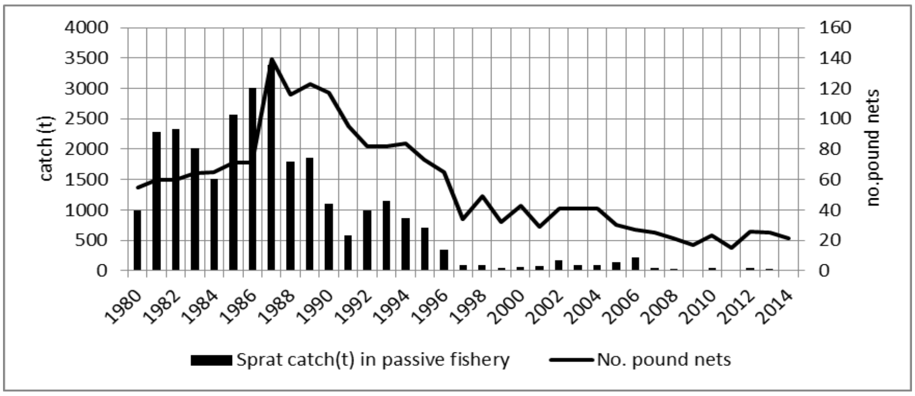

Figure 11. Sprat catch in the passive fishing and number of pound nets, 1980 – 2014.

drastic transformation, yearly fishing gradually decreased, reaching in 2012 of more than 20 ships in the vessels register, only one inshore trawler (FLAMINGO 4) to conduct an active fishing for sprat (Figure 12). Default and catches of these vessels fell from about 7000tons/year to less than 100 tonnes in recent years (Fig. 12) (Radu *et al*., 1996-1997; Radu *et al*., 2011b; NIMRD, 2000-2014; NAFA-NIMRD, 2008-2014). In the Figure 13 is presented CPUE for sprat in the passive and active fishing.

Sprat Stock Status and Fishing Agglomerations Biomass

The biomass of sprat stock shows cyclic dynamics with lows and highs over decades. Maxima of recruitment and biomass occurred in the mid 1970s and mid 1980s. Maximum catch was recorded in 1989, leading to highest fishing mortality after that the stock collapsed. The combination of low recruitment and excessive over-fishing was claimed to be the main cause of the collapse. The collapse has been indicated by the drop in catches, survey abundance indices and commercial CPUE, and age and size composition (STECF/BS-EWG, 2009-2014).

In the mid of 1990s the sprat stock started to recover and reached previous peak-levels recorded in the 1980s, but catches stayed relatively low because of the stagnated economies of Bulgaria, Romania and Ukraine (Figure 14, 15) (Radu, *et al*., 2015; STECF/BS-EWG, 2009-2014).

The year with relatively strong recruitment were followed by years of low to medium recruitment which leads to a relative decrease of the Spawning Stock Biomass (SSB) (Fig.14; 15) (Radu, *et al*., 2015; STECF/BS-EWG, 2009-2014).

In the recent period SSB has again decreased due to lower recruitment and high fishing mortality. A certain coincidence between growth of the fish juveniles and the growth of the trophic plankton sometimes constitute one of the most important factors which determine respective generation (Radu, *et al*., 2015; STECF/BS-EWG, 2009-2014).

On Romanian shelf, the swept area method was used for evaluation the biomass of fishing

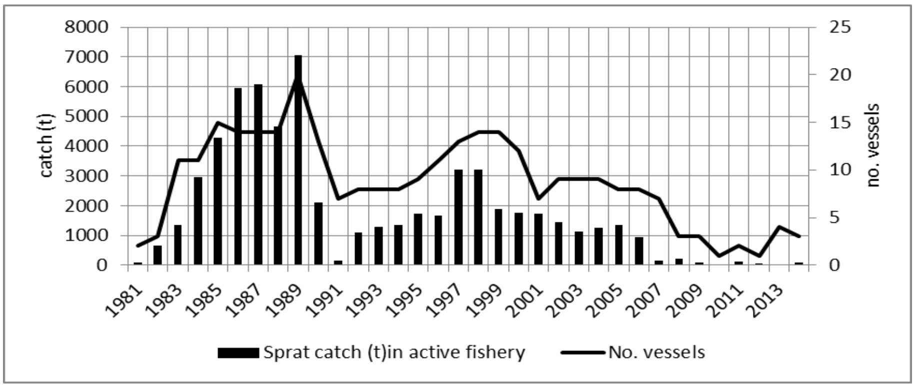

Figure 12. Sprat catches in the active fishing and number of vessels, 1981-2014.

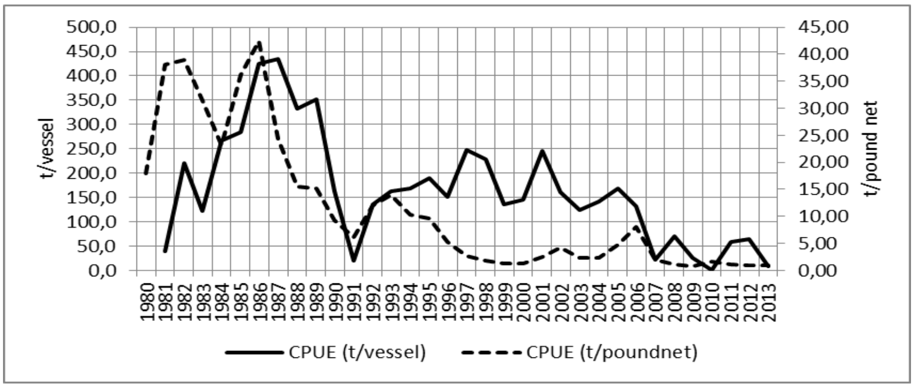

Figure 13. CPUE for sprat in passive and active fishing.

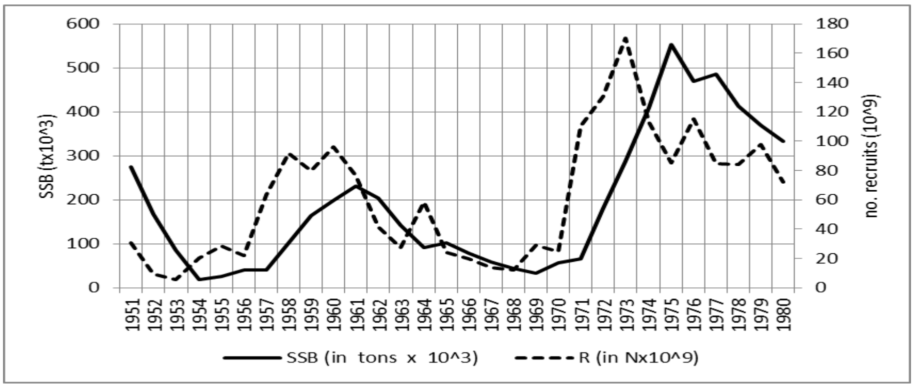

Figure 14. The relationship recruitment - spawners biomass in the Black Sea (STECF/BS-EWG, 2009-2014).

agglomerations of sprat, pelagic species but during the day is quartered above the bottom and can be successfully used this method of assessment. Meanwhile was assessed the biomass of the jellyfish agglomerations in the sprat distribution area.

The sprat agglomeration biomass ranged in the last 15 years between 30,000 - 60,000 tons (Figure 16). In the spring period, the calculated biomass for sprat oscillated between 30917 tons (2008) and 68887 tons in 2012 (Fig. 16) (Radu *et al*., 2013a; Radu *et al*., 2013b; Radu *et al*., 2013c; Radu, *et al*., 2015; NIMRD, 2000-2014; STECF/BS-EWG, 2009-2014).

Distribution of Fishing Agglomerations under the Influence of Environmental Conditions

In April 2006 sprat catch ranged between 20 kg and 200 kg/trawling, being smaller comparatively with jellyfish catch (Figure 17). Sprat biomass, on the surveyed area, was assessed at 3,763 tons, extrapolated to 10,380 tons for shelf area up to 50 Nm from seashore (Table 1). The obtained biomass has values of tree-four times less than former years. The situation can partially explained through extreme jellyfish agglomerations that removed sprat from area.

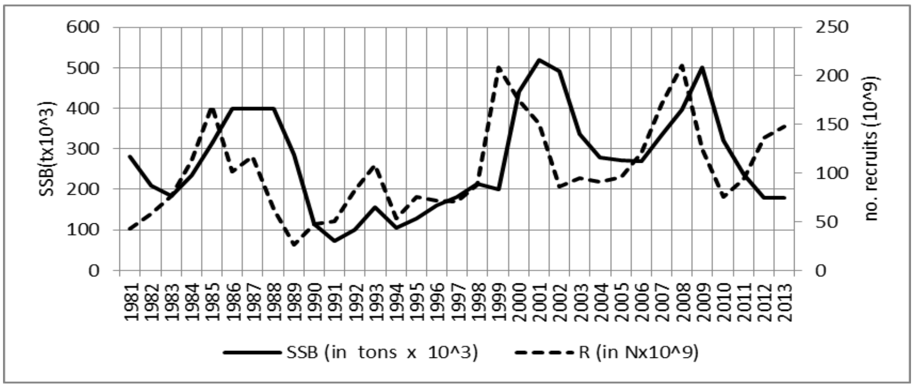

Figure 15. The relationship recruitment - spawners biomass in the Black Sea(STECF/BS-EWG, 2009-2014).

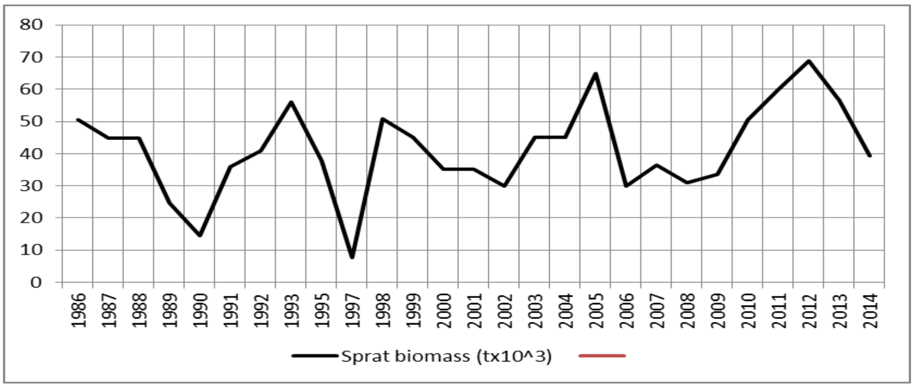

Figure 16. The sprat biomass in the Romanian marine area calculated with swept area method.

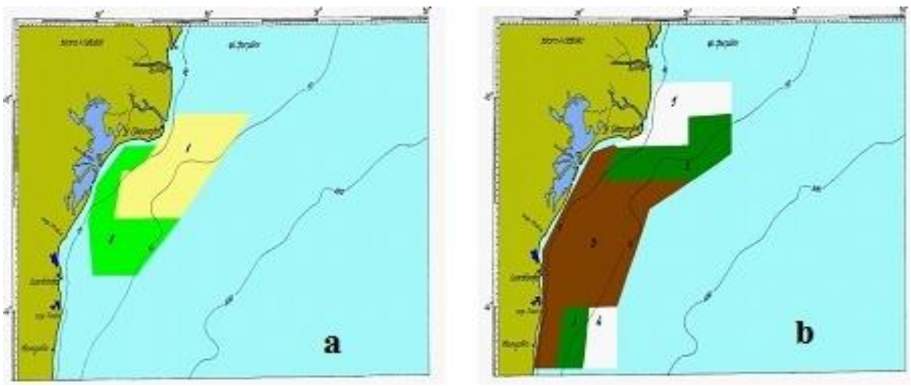

Figure 17. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, April 2006.

Jellyfish biomass computed for the area surveyed was estimated to 102,625 tons, extrapolated to 143,115 tons for shelf area up to 50 Nm from seashore (Table 1).

Colours of the maps in Figures 17 to 23 have different meanings depending on the biomass per unit area (g/m^2) as follows:

0	0.01-0.4	0.5-1.0	1.0-5.0	5.0-10.0	10.0-20.0	20.0-100.0

In May 2006, the situation remained enough difficult from fishery point of view, however observing a slight improvement given the previous month (Figure 18, Table 1). Given the period 2006, in May 2007 the fishing agglomerations were influenced considerable less by the jellyfish agglomerations. Jellyfish was located especially in the area Zatone from Biosphere Reserve Danube Delta. The density was only of 3.58t/Nm^2 given the previous year when the density was of 11.74 t/Nm^2 (Figure 19, Table 1). In May 2008, the jellyfish hampered again the fishing activity (Figure 20; Table 1). Distribution and abundance of the sprat are correlated with jellyfish distribution and abundance by simply graphical overlap.

In the summer period, in July 2006, the phenomenon repeated, the situation being almost same as in May (Table 1; Figure 21).

In the following maps (Figure 22,26, and Table 1) are presented data from the following years, 2008, 2010, 2012 and 2013, from which is clear that where there are significant agglomerations of jellyfish, sprat is removed, fishing activities are much more difficult.

Evolution of Biological Parameters of the Sprat

The sprat has lengths comprised among 40 and 130 mm, the highest frequency pertaining to the individuals of 70-100 mm lengths (Figure 27). The age corresponding to these lengths was 0+ - 4; 4+, the ages 2:2+ - 3; 3+ having a significant participation. By 1982, the age classes 4; 4+ years had a share of 34% from the catch of this species, then the percentage continually decreased up to 1995 when

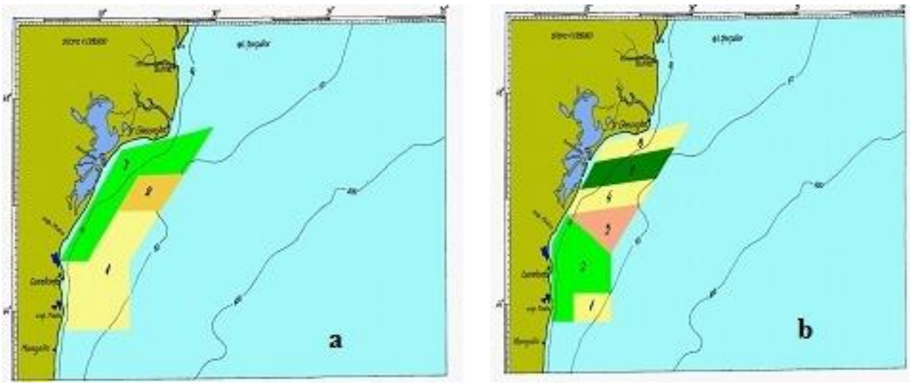

Figure 18. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, may 2006.

Table 1. Sprat and jellyfish biomass

Analyzed period	Sprat		Jellyfish	
	Biomass in surveyed area (t)	Total biomass (t)	Biomass in surveyed area (t)	Total biomass (t)
April 2006	3,764	10,380	102,625	143,115
May 2006	6,791	19,240	19,957	57,292
May 2007	3,275	30,567	522	4,872
May 2008	1,488	9,285	2,744	17,313
July 2006	5,900	14,750	11,475	28,670
July 2007	5,455	20,828	274	1,046
August 2008	30,917	58,439	818	1,546
June-July 2010	28,002	59,643	5,203	13,343
June-July 2012	49,798	68,887	11,196	18,156
June-July 2013	18,057	56,428	59,045	184,517

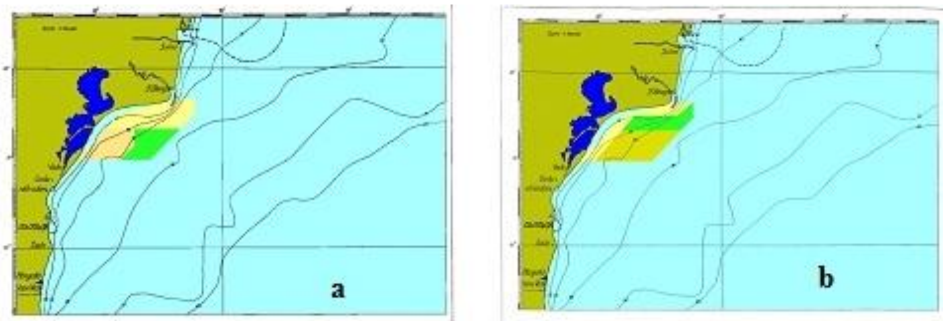

Figure 19. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, May 2007.

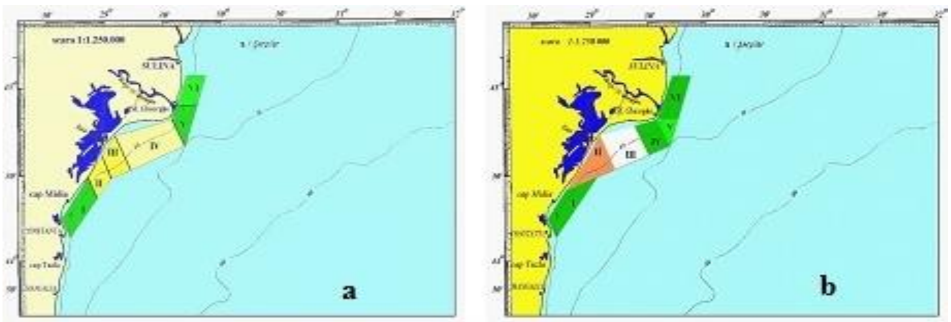

Figure 20. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, May 2008

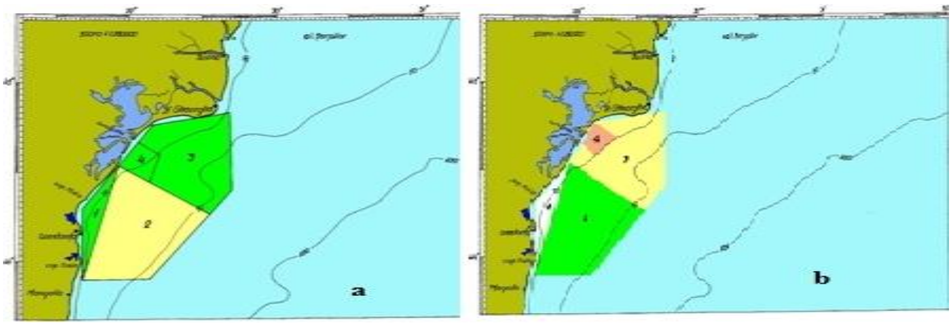

Figure 21. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, May 2006.

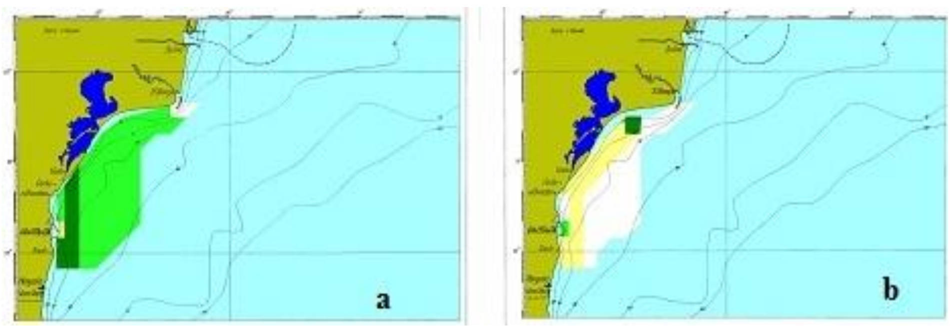

Figure 22. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, July 2007.

this age was not signalled, meaning the increase of the pressure through fishing exerted on the populations. While the share of this age decreased, the prevalence of 0+ especially 1; 1+ ages became increased (Fig. 27). (Radu *et al*., 1996-1997; Radu *et al*., 2011b; Radu *et al*., 2013a; Radu *et al*., 2013b; Radu *et al*., 2013c; Radu, *et al*., 2015; NIMRD, 2000-2014; STECF/BS-EWG, 2009-2014).

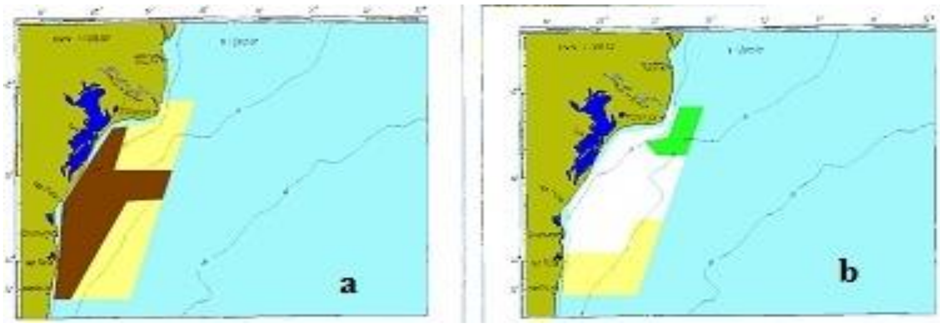

Figure 23. Distribution and abundance of the sprat (a) correlated with jellyfish (b) distribution and abundance, August 2008.

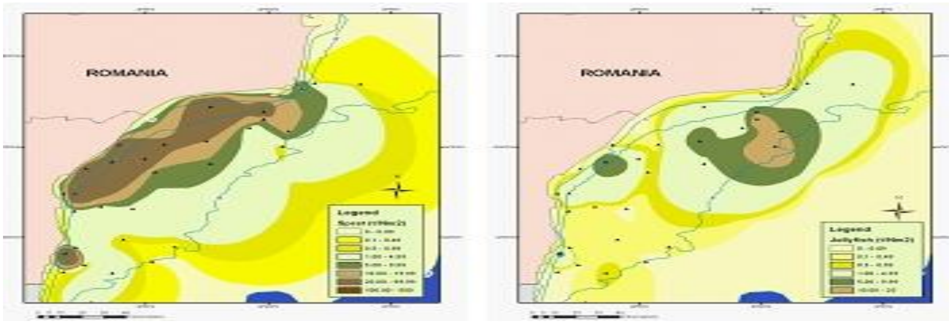

Figure 24. Distribution and abundance of the sprat correlated with jellyfish distribution and abundance, June-July 2010.

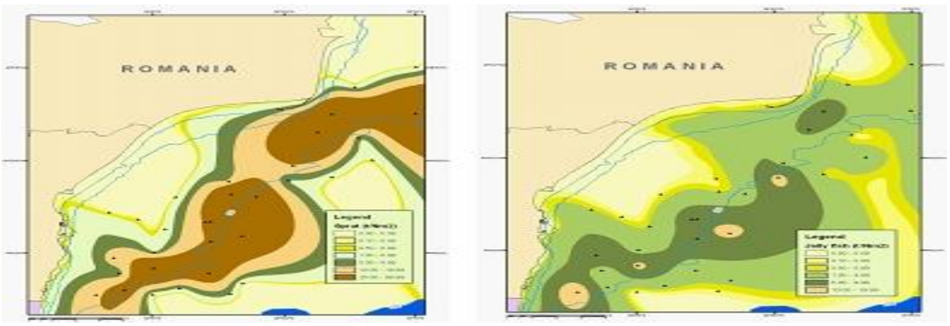

Figure 25. Distribution and abundance of the sprat correlated with jellyfish distribution and abundance, June-July 2012.

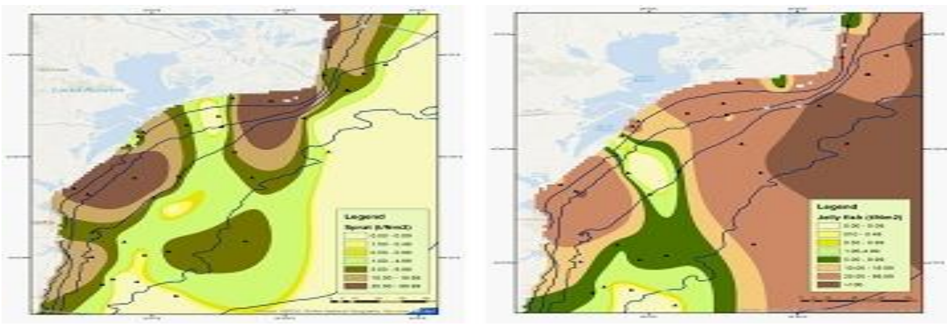

Figure 26. Distribution and abundance of the sprat correlated with jellyfish distribution and abundance, June-July 2013.

Causes that Determined the Evolution of the Sprat Fishery

In summary, the main causes responsible for decline of marine living resources were generated by: eutrophication (sources from agriculture, municipal waste, industry, etc); harmful substances (sources from agriculture, industry, municipal waste, etc);

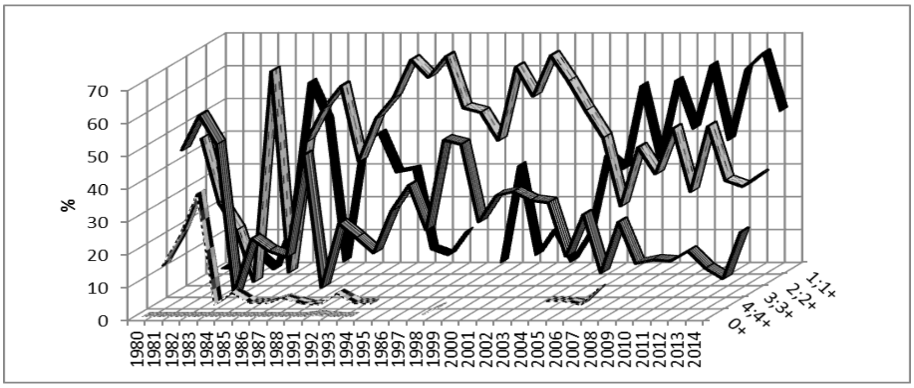

Figure 27. Structure on age classes of the sprat at the Romanian marine area.

hydraulic works; commercial fisheries; alien species; climatic changes;

Eutrophication

- Alteration of ecological state in rivers, lagoons/limans and shelf areas;
- Mass development of phytoplankton;
- Mass mortalities of demersal species;
- Disturbance of fish behaviour, mainly by keeping of fish shoals away from shallow waters.

Hydraulic Works

- Loss of valuable habitats for spawning and feeding habitats of fish due to transforming of lagoons/limans in freshwater reservoirs;
- Affecting the shelf habitats important for spawning and feeding of living resources through siltation from building of port dams or civil coastal defence works;
- Changing of fish behaviour in coastal areas due to modification of water currents by building of big ports.

Alien Species

- Outbreak of some alien species (such as *Mnemiopsis leidyi*) multiplied the ecological disturbance, especially at the food chain level of marine living resources and on fish behaviour.
- Increase the natural sensitivity of the Black Sea ecosystem.

Commercial Fisheries

- Using of non-selective fishing gears allowing catching of non-target species (some of them endangered) and/or having undersize length;
- Increasing of catches and fishing effort which permits exploitation of stocks outside safe biological limits;
- Illegal fishing amplifies the effect of overfishing

So, the causes of this situation are multiple, the independent effect of each being very difficult to be assessed:

- The high value of the percentage of the species sprat and their constancy within the catches explain the high oscillations of the annual catches on the Romanian coast. These oscillations occur even more as the fishing is done in a restricted area of coast where the conditions of maintaining fish shoals are extremely variable.
- The passive fishery uses pound nets and has suffered the strongest impact due to the change of the ecological conditions near the coast zone. Moreover, there are observations attesting the fish migration routes changed during the last 6-7 years. The fish has the tendency to remain in the offing, at a certain distance from the coast zone with the isobaths of 5-13 m where the pound nets are located.
- The environmental conditions existing to the Romanian littoral allowed formation and maintaining of very large agglomerations of gelatinous species, especially jellyfish. Jelly fish and ctenophore agglomerations making difficult the trawl fishery on all hauling level in some years and periods.
- Heavy fishing on small pelagic fish predominantly by the Soviet Union, and later also by Turkey, was carried out in a competitive framework without any agreement between the countries on limits to fishing. Depletion of the small pelagic stock appears to have led to increased opportunities for population explosion of planktonic predators (jelly fish and ctenophores) which have competed for food with fish, and preyed on their eggs and larvae.
- The reduction of the fishing effort as a consequence of the economic changes occasioned by the transformation of the state capital into private capital;
- The limitation of market demands for some periods of the year, mainly amplified by the fact that more than 90% of the production was delivered as salted fish;
- The free market and imported products have caused the limitation of the traditionally prepared products and the reduction of their price until the limit of the profitableness.

Conclusions

- For majority of pelagic species from Romanian littoral setting up of the fishing agglomerations and availability for fishing are strong influenced by the environmental conditions variation;

- The environmental conditions existing to the Romanian littoral allowed formation and maintaining of very large agglomerations of gelatinous species, especially jellyfish;

- On the other hand, fishing activities contribute themselves to the worsening of the ecological situation and for the depletion of the fish stocks through: open access resources management regime applied individually by each coastal country; overfishing and illegal fishing; and the use of destructive harvest technique.

- The Black Sea ecosystem has proven, however, to be very fragile, especially when stressed simultaneously by several factors at once (heavy fishing on several species, nutrient discharge, invasive species, climate change, etc.).

- Small-sized species like sprat that have been in previous years the main target of fisheries engaged on the Romanian Black Sea coast have experienced significant fluctuations in catches, with the obvious trend of regression or dramatic decreases.

- Sprat is an object of both artisanal and commercial mid-water trawl fisheries.

- The biomass of sprat stock shows cyclic dynamics with lows and highs over decades.

- The Romanian catch in the last decade is regionally almost insignificant, having a very low contribution at depletion of the stocks.

- In the transboundary context, it still requires strengthening and regional harmonization of the regulatory and legal framework especially in regard to the conservation and protection of the migratory and shared marine living resources.

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