United Nations Environment Programme
Mediterranean Action Plan
Regional Activity Centre For Specially Protected Areas

UNEP

MAP

RAC/SPA

ADRIATIC SEA:

STATUS AND CONSERVATION OF FISHERIES

With financial support of the European Commission

RAC/SPA – Tunis, 2015

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This document has been prepared in the framework of the project MedOpenSeas for supporting the establishment of MPAs in open seas, including deep seas; with financial support of the European Commission.

The original version of this document was prepared for the Regional Activity Centre for Specially Protected Areas (RAC/SPA) by: Henri FARRUGIO and Alen SOLDO, RAC/SPA Consultants. Under the supervision of: Dr. Daniel Cebrian, RAC/SPA. Edited by Cebrian, D. and Requena, S.

The draft document was submitted for revision to the expert representatives of the following Parties to the Barcelona Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean: Albania, Croatia, Italy, Montenegro, Bosnia-Herzegovina and Slovenia.

For bibliographic purposes this document may be cited as:

UNEP-MAP-RAC/SPA. (2015). *Adriatic Sea: Status and conservation of fisheries*. By Farrugio, H. & Soldo, A. Edited by Cebrian, D. and Requena, S., RAC/SPA, Tunis; 58 pp.

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1. Brief introduction to the Adriatic Sea

The Adriatic Sea is a semi-enclosed basin within the larger semi-enclosed sea constituted by the Mediterranean, it extends over 138000 and is characterised by the largest shelf area of the Mediterranean, which extends over the Northern and Central parts where the bottom depth is no more than about 75 and 100 m respectively, with the exception of the Pomo/Jabuka Pit (200-260 m) in the Central Adriatic. The Southern Adriatic has a relatively narrow continental shelf and a marked, steep slope; it reaches the maximum depth of 1223 m

In the Adriatic Sea all types of bottom sediments are found, muddy bottoms are mostly below a depth of 100 m, while in the Central and Northern Adriatic the shallower sea bed is characterized by relict sand. The Eastern and Western coasts are very different; the former is high, rocky and articulated with many islands, the Western coast is flat and alluvional with raised terraces in some areas. The hydrography of the region is characterized by water inflow from the Eastern Mediterranean (entering from the Otranto channel along the Eastern Adriatic coast) and fresh water runoff from Italian rivers. These features seasonally produce both latitudinal and longitudinal gradients in hydrographic characteristics along the basin (32, 33).

For the purpose of fisheries management the fisheries of the Adriatic basin are divided in two Geographical Sub-Areas (GSA): the GSA 17 (North and Central Adriatic) and the GSA 18 (Southern Adriatic). Croatia, Bosnia-Herzegovina, Italy and Slovenia border the GSA 17 (North and Central Adriatic), Albania, Italy (South-Eastern coast) and Montenegro are included in the GSA 18 (fig. 1).

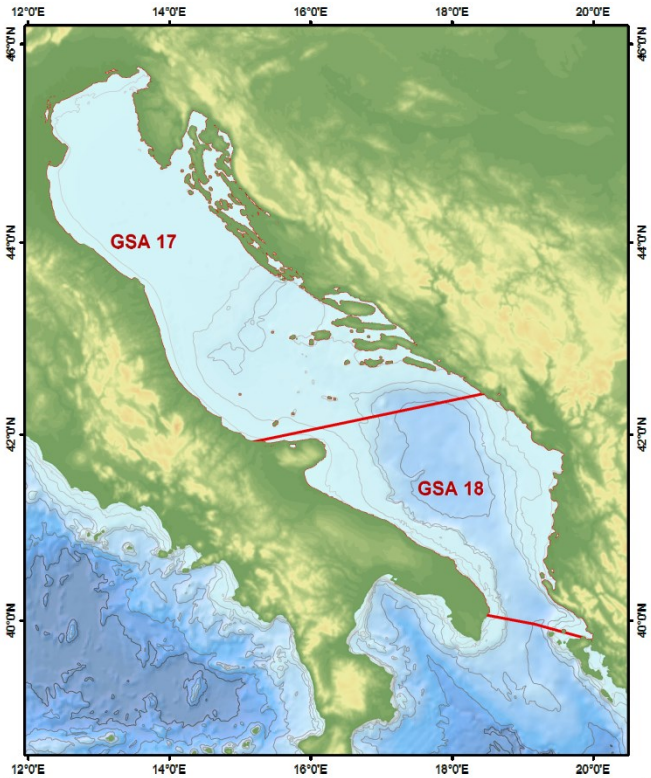


Figure 1. Bathymetry of the Adriatic sea and boundaries of the GFCM GSA's

2. Fisheries activities conducted within the area

2.1. Fishing gears

Two kind of fishing gears are currently used to catch the small pelagic species (mainly anchovy and sardine) in the Adriatic Sea: the most used by the Italian fleet is the “volante” a mid-water pelagic trawl net towed by two vessels, mostly operated in the northern and central areas. Average size of volante vessels is 50 GRT while average engine power is about 400 HP. These vessels fish only by daytime and land their product every evening: the fishing trips last about 11-14 hours. Catches up to 15 tons per couple of boats per day have been recorded in the late seventies and early eighties and at present, maximum catches are about 4 tons per day.

Until the mid-sixties the main gear which was used to catch small pelagic species was light attraction purse seine and is still in use in the Gulf of Trieste and south of Ancona on the Western side and it is the main gear used in Slovenia, Croatia, Montenegro and Albania. The Italian purse seine vessels have an average dimension of 85 GRT and an average engine power of 300 HP; they operate mainly in the central Adriatic and in the Gulf of Trieste; they fish by night in good weather conditions attracting fish with lights. Their activity is often, but not always, suspended during the colder months. In Croatia there is a fishing ban from 15th December till 15th January.

Classical bottom trawls are used to fish demersal species like red mullets, octopus, sepias or squillas, while another bottom gear, the «rapido» is used for the demersal fishery. This gear is a dredge composed by an anterior rigid metallic framework, a wooden table acting as depressor and maintaining the mouth in close contact with the sea bottom, and a series of iron teeth that penetrate in the sediment. Rapido is used to catch flatfishes and Norway lobsters; this gear is used offshore to fish mainly clams and other mollusks. Bottom trawls and Rapido trawls induce severe sub-lethal and lethal damages on non-target species. Along the Croatian coast bottom trawl fisheries is mainly regulated by spatial and temporal fisheries regulation measures and about 1/3 of territorial sea is closed for bottom trawl fisheries over whole year. Also bottom trawl fishery is closed half year in the majority of the inner sea. In Croatia rapido trawl is allowed only to catch mollusks (Pectinidae).

Offshore purse-seine fishing activities concerning the bluefin tuna are a very important part of the pelagic fishery within the Adriatic Sea. In Croatia, purse seine is a principal fishing gear used for its capture. The principal fishing grounds for Croatian bluefin tuna purse-seiners are the offshore waters of the central part of the Adriatic Sea. After capture, they are transferred into floating towing cages. This is done in the open sea where the catch has occurred, by simply joining both nets under the sea surface. Once the cages are filled with the right number of tuna they are slowly towed by a tugboat towards the farming locations. The distance between the fishing ground and the farming location can vary from a few to several hundreds of miles (if the fish catch occurs outside the Adriatic Sea).

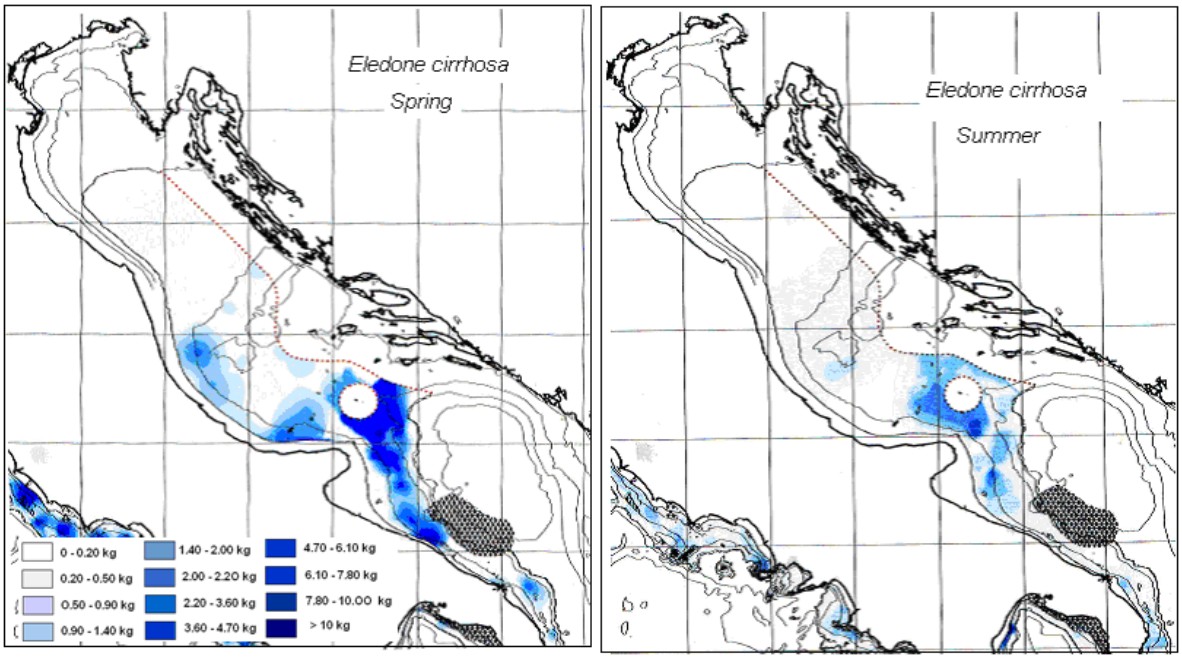
2.2. Fishing sectors

The Adriatic Sea is one of the largest areas of occurrence of demersal and small pelagic shared stocks in the Mediterranean.

The main small pelagic species are sardine (*Sardina pilchardus*), anchovy (*Engraulis encrasicolus*), horse mackerel (*Trachurus spp.*) and mackerel (*Scomber spp*.). In the northern area, sprat (*Sprattus sprattus*) is found, although it was more abundant during the 1960s and 1970s than nowadays.

On the continental shelf from 10-50 m depth, the dominant fish species in terms of biomass are red mullet (*M. barbatus*), poor cod (*Trisopterus minutus*), various species of triglids, sole (*Solea solea*), various species of flatfishes, gobies and pandoras (*Pagellus spp*.). From 50 to 100 m deep, anglerfish (*Lophius spp*.), European hake (*Merluccius merluccius*), greater forkbeard (*Phycis blennoides*) and red bandfish (*Cepola rubescens*) are also abundant, as well as blue whiting (*Micromesistius poutassou*) at 100 to 200 m deep.

The continental shelf of the Adriatic Sea is also rich in invertebrate fauna, where some of the most abundant species are cuttlefish (*Sepia officinalis* and *S. elegans*), octopuses (*Eledone moschata, Eledone cirrhosa* and *Octopus vulgaris*), squids (*Loligo vulgaris* and *Alloteuthis media*), mantis shrimps (*Squilla mantis*), shrimps (*Solenocera membranacea* and *Parapenaeus longirostris*), Norway lobster (*Nephrops norvegicus*) and scallops (*Pecten jacobaeus* and *Chlamys opercularis*).



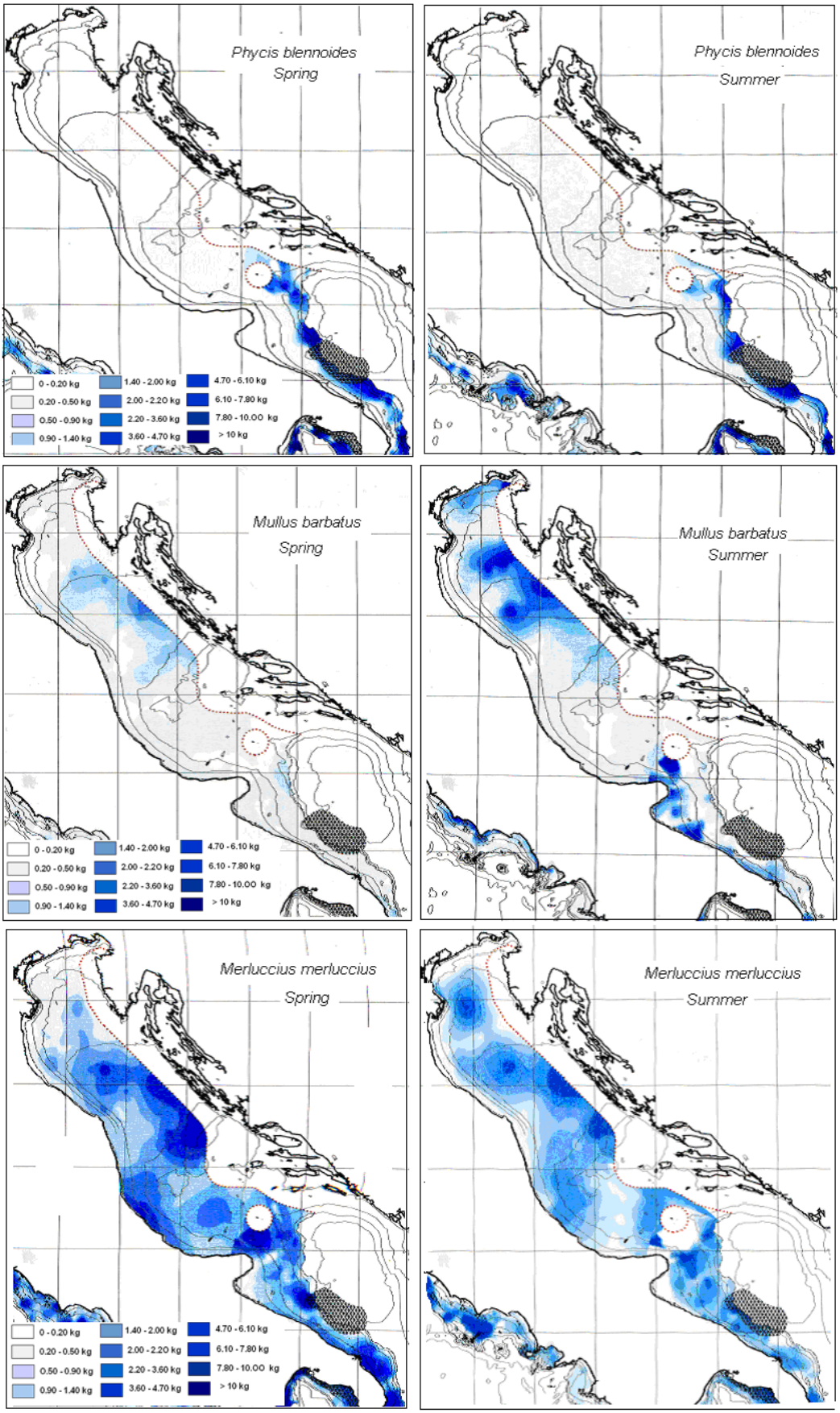


Fig.2 Geographical distribution of some main species fished in the western Adriatic (4)

Evidence of the transboundary and straddling nature of some important resources may be drawn from the geographical occurrence pattern of several stocks which are high-value stocks targeted by the Adriatic demersal fishery (fig. 3). In fact beyond the 12 miles zone all the resources are potentially shared among the national fleets that operate in international sea.

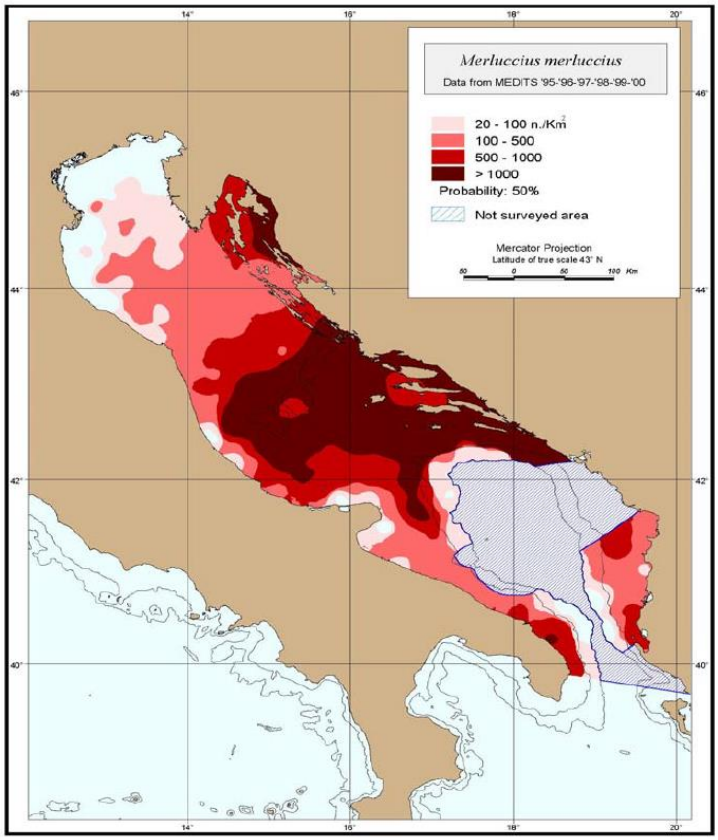


Fig.3 Frequency distribution of the hake *Merluccius merluccius:* data from Medits surveys 1995, 96,98,99,2000 (33)

In the subsequent three maps from 2004 densities at sea are plotted taking into account different length ranges (increasing in the maps from left to right). In particular, individuals with length lower than 12 cm are concentrated in the southern part of the GSA 17. The individuals with length between 12 and 20 cm display the same pattern but are more diffuse; the same pattern is observed also for the individuals with length larger than 20 cm, but they are more abundant on the eastern side of the Adriatic (fig. 4, 5).

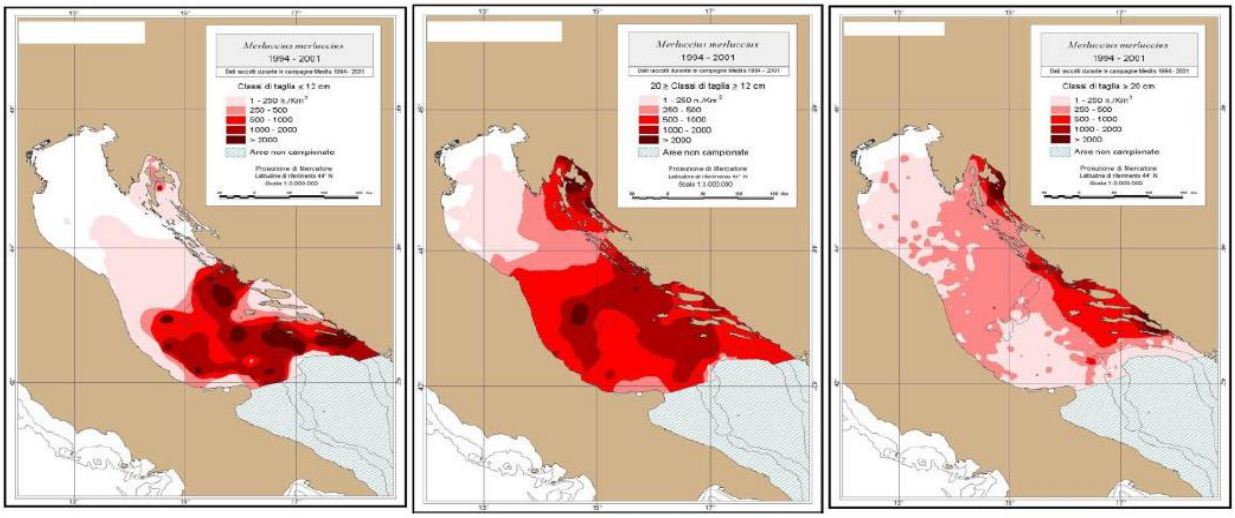


Fig. 4 Distribution of the hake *(Merluccius merluccius)* in the Adriatic Sea. Data from Medits surveys (41).

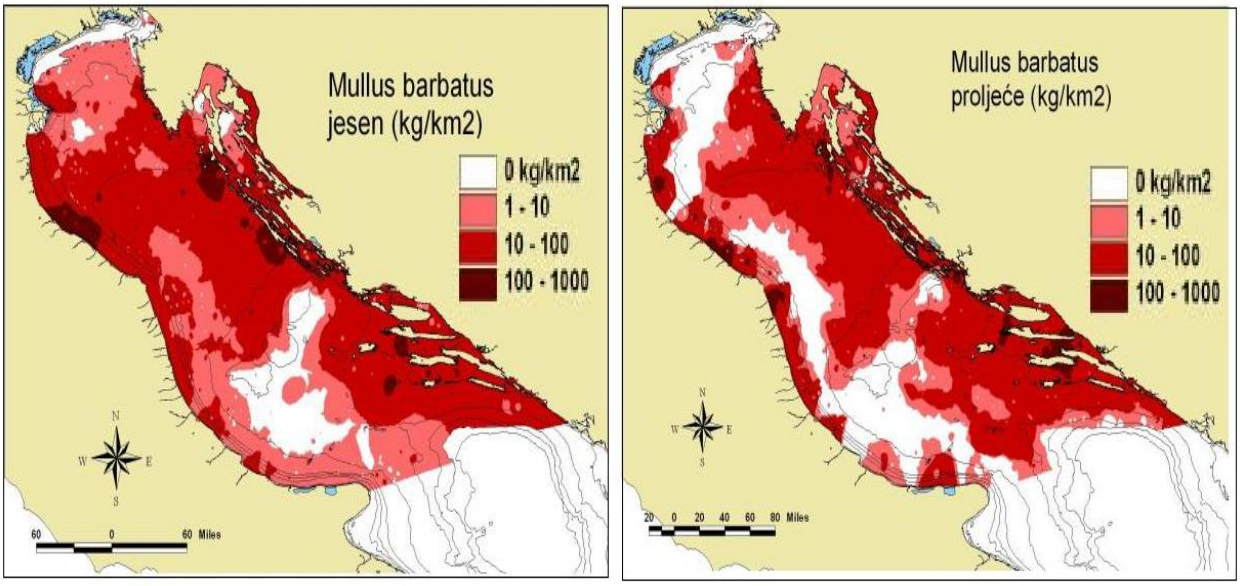


Fig. 5 Distribution of red mullet in the autumn –spring period (data from AdriaMed Trawl Survey + GRUND surveys).

The highest densities of Norway Lobster are in the Pomo Pit and in other areas deeper than 100 meters. Low densities but bigger size/faster growing individuals are found in muddy bottom shallower than 100 metres in Central Northern Adriatic (fig.6). Intermediate densities are also found around and between the above two areas, (4, 33b)

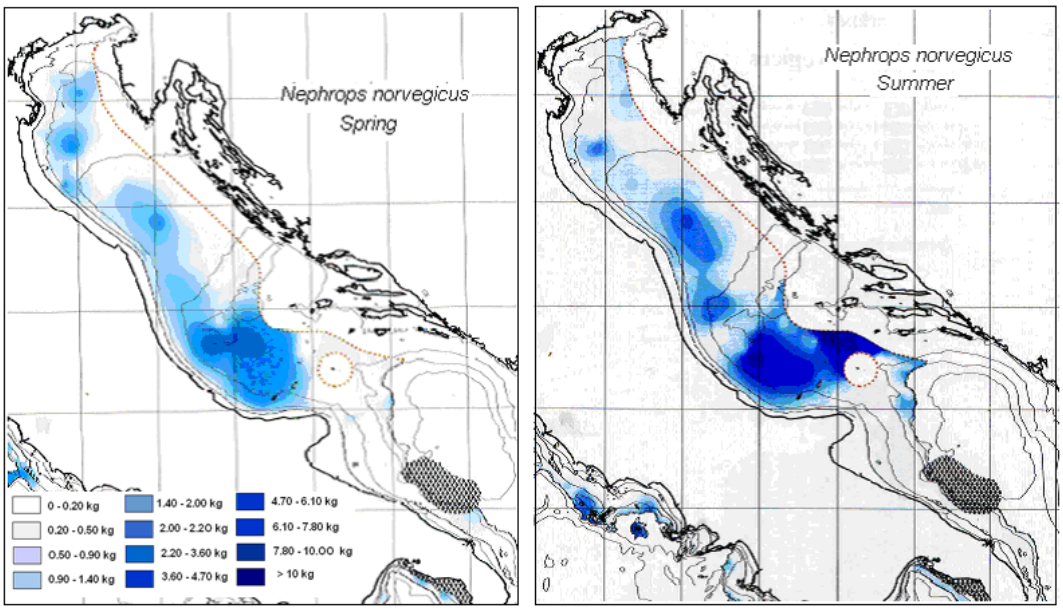


Fig. 6 Distribution of Norway lobster in the spring–summer period (data from AdriaMed Trawl Survey + GRUND surveys).

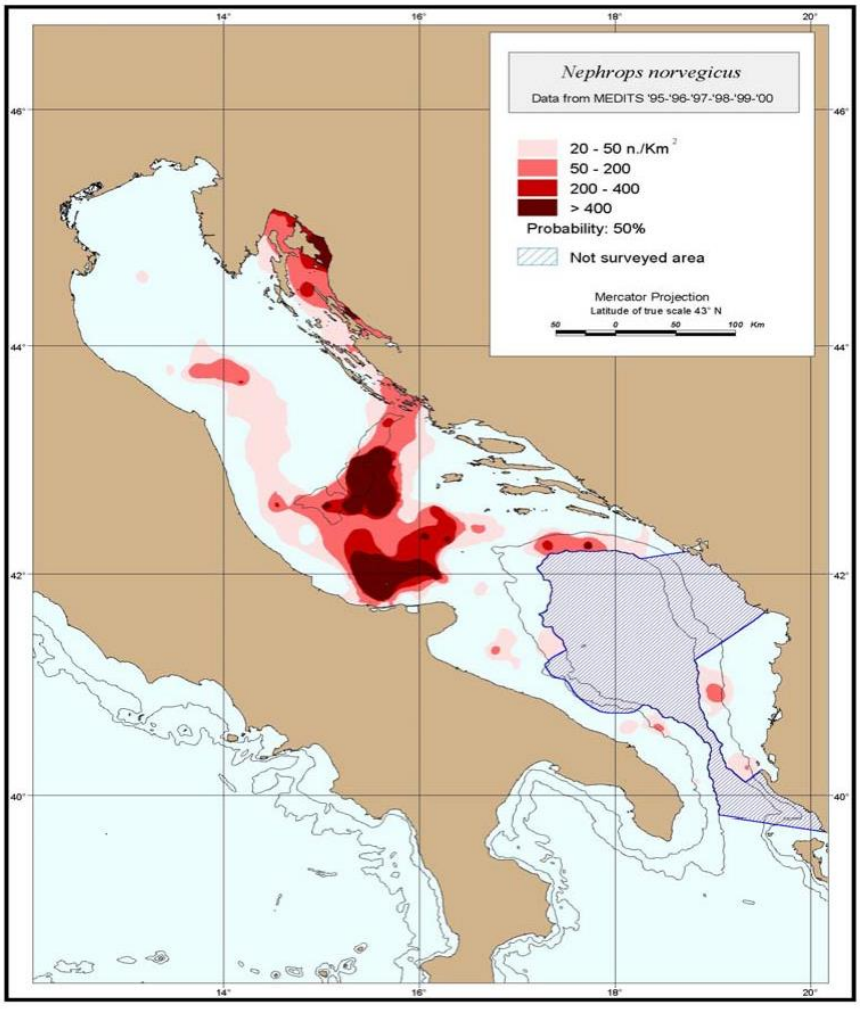


Fig. 7. Distribution of N. norvegicus in the Adriatic Sea: indicator kriegiung representation. Data from Medits surveys (Gramolini et al., in press)

The Pomo Pit (also called Jabuka Pit) is one of the most important habitats for some shared demersal stocks of the Adriatic Sea. Although it covers less than 10% of the total surface of the Adriatic Sea, it is one of the most important fishing grounds especially for the bottom trawl fishery which apply a high fishing pressure on the resources of the area. The bottom of the Pomo pit is characterized by 2 contiguous areas (fig.8). The “fossa centrale” or Pomo/Jabuka Pit) of more than 200 meters deep, which is largely situated within the Croatian territorial waters. Towards the Italian coast there is a second depressed area (the Western Pomo Pit, with depths greater than 200 meters, called "the fondaletto" and separated from the Pomo pit by a sill. Jabuka/Pomo Pit has been the subject of numerous scientific investigations on both sides of the Adriatic; it is a region were cold nutrient reach waters from Northern Adriatic flow near the bottom and get trapped by the bottom shape. It has thus waters with more nutrients near the bottom than near surface waters. These conditions encourage a high abundance of fish and shellfish and the area has long been known as a productive fishing ground, due to the high presence of some species whose stocks are commercially important like hake, shrimps, Norway lobsters and cephalopods. In addition, the Pomo Pit is an important (or the main) nursery area for for many demersal species and in particular for the stock of hake in the northern and central Adriatic. It is distant 40 nautical miles from the Italian coast and it extends inside the Croatia territorial waters. The area is easily reached by fishing vessels from Italian fishing ports between Ancona and Termoli and Croatian ports between Zadar and Makarska.

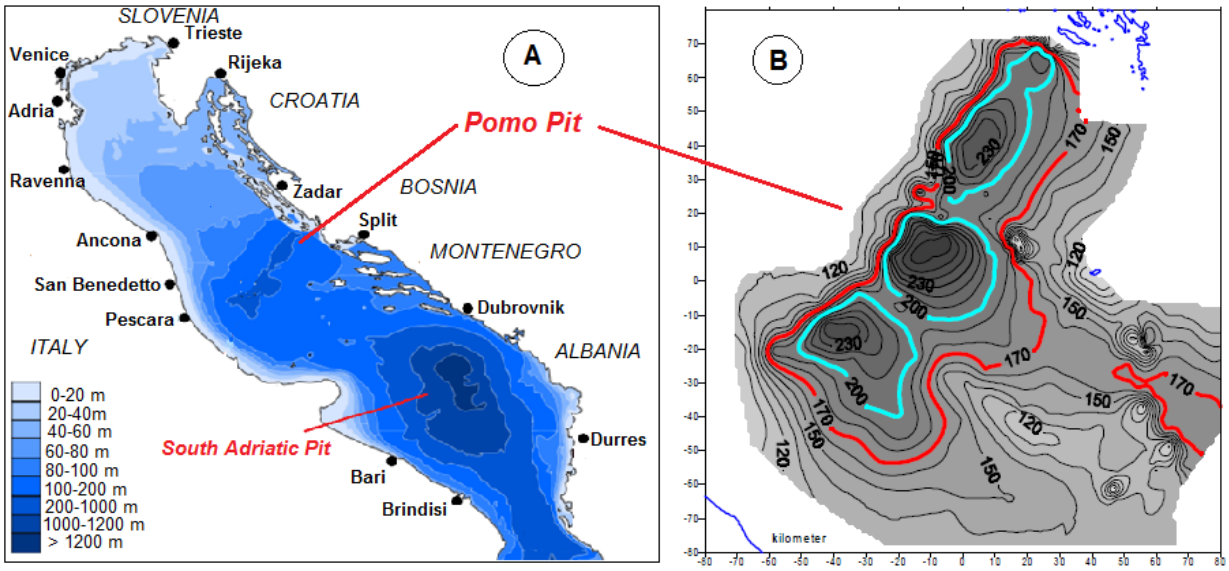


Fig. 8 Bathymetry of the Pomo Pit

Mollusks fishery production in Adriatic area

According to the FAO FISHSTAT database, bivalve mollusks fishery seems to be quite significant in the Adriatic area, especially in the North West basin where best edaphic and trophic conditions for propagation of these species are met. Major rivers flowing into this part of the Adriatic Sea, together with extended lagoons along the coast and muddy and sandy bottoms characterized by minor slopes, are the main factors that make this area rich in biocenosis with important bivalve mollusks species. It is worthwhile to cite the presence of extended *Anadara inaequivalvis* beds, an allochthonous species involuntarily introduced in

Adriatic towards the end of the '60s, that now proliferate between 1 and 10 miles from the coast, and has yet not found valuable market utilization.

Mussels are usually harvested (collected) by hand and less frequently, where rich mussels beds on lagoon bottoms are present, through bottom trawl fishery. The most exploited areas are the ones close to the rocky coastal parts, among which Conero promontory in the Marche region stands out. Equally important are the quantities collected on methane-producing platforms during cleaning and maintenance activities.

Clams are usually caught by vessels equipped with a hydraulic dredge. In 2000, out of 728 dredge boats registered in Italy, 685 were operative along the Adriatic coast. This fishery system operates on sandy bottoms within 1 mile from the coast. Normative applied to this capture system contains the following indications: gears dimensions, catches limit, vessels dimensions, engine power, clam size. Fishing areas are managed by compartmental management consortiums to which all fishermen are affiliated. Some of these vessels are used or other bivalve mollusks fisheries as well, such as smooth callista (*Callista chione*) and razor-clams (*Solen* spp. e *Ensis* spp.). Production is around 30.000 tons per year (see Froglia paper)

Eastern coast clams production (stripped venus) is only reported for Albania referring to the period 1987–1996. The trend shows a progressive decrease from the initial amount of 700 t (FAO Fishstat). Although reduced clam beds are present along the northern coast of this country, collection of any kind is not allowed.

In Croatia, particularly in the northern Adriatic area, along Istrian penninsula coast, *Pecten jacobaeus* is a very important species targeted by a good part of the fleet using dredges. In other areas the capture fisheries of Pectinidae (scallops and queen scallops) has nowadays become marginal. In the past Pectinidae species were collected in the northern Adriatic with bottom trawl gears called “rapidi”, vessels equipped with fixed dredges originally constructed for flat fish fisheries (35).

Natural harvesting of Japanese littleneck clams (*Tapes semidecussatus*) an introduced species in Northern Adriatic lagoons is very developed and yielding about 30.000 tons of clams, it can be practiced according to gear, quota and area regulations in specific areas, identified by hygienic and sanitary parameters.

2.3. Fleets operating in the area

The regional fleet including all fleet segments, i.e. from small-scale fishery vessels to large trawlers reached its maximum numerical size between the 1990s and the year 2000. However, since the 1980s two trends appear to have taken place: the number of fishing vessels has been decreasing along the Italian coast and in Montenegro (small-scale fishing vessels not included) while the opposite has been observed in the cases of Croatia and Albania. The size of the Adriatic fishing fleet (Albania, Croatia, Italy and Slovenia) in 2001, on the basis of official and semi-official sources, was about 10000 registered/licensed fishing vessels, although the number of small artisanal units was certainly under-reported.

Most of the small scale fixed gear fishery is performed by small units of less than 12 m and most polyvalent vessels fall within the small vessel class. Most demersal and pelagic

trawlers, purse seiners and tuna vessels belong to the medium-size category (12-24 m) even though they are also present with various percentages in the small vessels segment. Lastly, consistent percentages of pelagic trawlers, tuna vessels, purse seiners and demersal trawlers in decreasing order of occurrence within each vessel/gear group, belong to the large vessels category (length above 24 m).

According to the GFCM task 1 data the Italian fleet was composed in 2011 of 136 pairs of mid-water trawlers and about 45 purse seiners (with quite different tonnage), with the former being predominant on the latter ones.

The main Italian *rapido* trawl fleets are sited in GSA17 in the following harbours: Ancona, Rimini and Chioggia. In 2011 the Italian artisanal fleet in GSA 17, accounted for around 500 vessels widespread in many harbours along the coast.

The small scale fishery use gill net or trammel net especially from spring to fall and target small and medium sized sole (usually smaller than 25 cm TL).

The Italian pelagic fleet is distributed in ports along the Adriatic coastline from Trieste to Vieste (2) and operates in GSA 17 and 18. The fleet is composed primarily of 'lampara' vessels (purse seiners operating at night with the use of light attraction) and midwater pelagic pair trawlers ('volante'), which were introduced in 1959 and presently is the dominating fleet (38). As of 2010 the fleet was composed of 131 mid-water pair trawlers (operating in pairs) and about 49 purse seiners. The actual number of vessels authorized to potentially be operative to use these gears in the fleet register through the fishing license is much higher. Total catches (not discriminated by species) of purse seiners in 2010 were 5,747 tons (65% in GSA 17) and of mid-water pair trawlers 44,393 tons (80% in GSA 17).

A "bianchetto" (fry) fishery, targeting juvenile clupeid fishes, had also some importance in Italy, being concentrated in the Apulian coast (Gulf of Manfredonia). The fishery had a long tradition with products fetching high prices in domestic markets (38). The fishery was conducted mainly with bottom trawls with fine cod-end meshes (5 mm). About 200 vessels were involved in this fishery in early 1990s, with catches in the order of 6 tons per day (38) for a fishing season of approximately two months. The magnitude of catches was uncertain.

In Albania the fishing fleet is composed mainly by bottom trawlers (168 fishing vessels), followed by trammel and gillnetters (32), hooks and lines (30), and purse seiners (15). There are also 7 Albanian pelagic vessels which are active during 3 to 5 months during the year. The Albanian registered fishing fleet consists of 245 boats located in four ports: Durres, Vlora, Shengjin and Saranda. Durres is the most important port with a fishing fleet consisting mainly of trawlers and some entangling and gillnetters. It is followed by Vlora and Shengjin that have fleets with a majority of trawlers and Saranda which fleet is dominated by entangling and gillnetters. Vessels from the Durres port have an average length of 19 metres, followed by Shengjin (18 metres), Vlora (15 metres), and Saranda (11 metres).

According to the most updated data (2011) on the fleet provided by the National Focal Point of Albania, the fleet is currently made up of purse seiners (7), seiners and seven multipurpose vessels, being seiners with less than 12 meters, the dominating fleet segment (Annex 1). The number of fishers directly employed in these fisheries is about 100. Catch data is also not available (including in FAO FishStat), but it is likely to be about 800 tons per year.. In 2004 the total catches of sardine from purse seiners operating from the port of Vlora

was about 40 tons (Albanian Fishery Policies Directorate, AdriaMed, MedFisis. 2006).

In Croatia, small pelagic (mainly sardine) are fished by purse seiners. In 2011there were 39 purse seine vessels with less than 12 meters and 209 vessels with more than 12 meters (Annex 1). The fleet operates year round (with the exception of the closed period between 15 December and 15 January) in GSA 17. Sardine is the main species in the catches, with recorded landings of 44 614 tons in 2011. Anchovy landings were 14 163 tons in 2011. The larger purse seiners accounted for more than 99% of the reported catches of both species.

In Montenegro most of the catches are originated from small-scale beach seine fisheries in the Boka Kotorska Bay and from the fishery with small purse seiners in coastal waters (< 70 m depth). These fisheries target both sardine and anchovy but the catches are poor, probably because of lack of experience of the crew and some technical problems.. Common associated species include *Atherina hepsetus, Boops boops, Trachurus sp., Scomber sp, Sarda sarda, Argenthina sphyrena* and *Spicara sp*. The small-scale beach seine fishery, present in several parts of the Eastern Adriatic coast, is traditional for centuries in the Boka Kotorska Bay. Montenegrin industrial fishing of sardine and anchovy is still undeveloped; the three existing large purse seiners are currently not active due to market constrains and lack of skilled fishers. Likewise, the only pelagic trawler is also inactive. Total catches of sardine and anchovy in recent years has been at about 32 tons/year and 12 tons/year, respectively. At an average ex-vessel price of 4 Euro/kg for sardine and 3 Euro/kg for anchovy, the total annual value of the catches is in the order of 164 000 Euro. Participate in the fishery a total of 181 fishers, including those involved in the large purse seine and pelagic trawler fisheries currently out of activity.

In Slovenia Sardine and anchovy are the dominant fish species landed. Between 2006 and 2010 the total landed catch of these species constituted, on average, 72.8% of the total catch landed in that period (sardine 40.4% and anchovy 32.5%). Until recently a large share of the catches of these two species was made by a pair of fishing vessels that employ a midwater pair trawl. These vessels were responsible for 55.2% of the entire landed catch between 2005 and 2010. Fishing vessels employing purse seines accounted for 24.5% of the total landed catch in the same period. The pair trawlers stopped operation in 2012 as a result of the implementation of the measure for permanent cessation of fishing activities (see Fisheries governance and management section). The current (2012 data) fleet is therefore composed of 4 purse seiners (> 12 m).

The purse seine fleet operates exclusively in shallow waters of the northern part of GSA 17 (most of the fishing areas are shallower than 25 meters). In fact, the operation of this fleet is currently constrained by the Council Regulation (EC) No 1967/2006 provision regarding the size of purse seines and the depth of fishing areas (see section on Main issues affecting the sustainability of the fishery). The demands of the Council Regulation are in practice unachievable by Slovenian purse seiners because of the shallow depth of the fishing areas. The fishery occurs mainly from May to August. Besides anchovy and sardine, the other associated species in the catch include *Mugilidae, Liza aurata, Lithognathus mormyrus* and *Trachurus trachurus*. Purse seine landings in 2012 were in the order of 107 tons, worth 270.000 Euro. The number of fishers employed in the small pelagic fisheries is unknown.

Table 1: synthesis of the Adriatic fleet composition: Btrwl = bottom trawlers, Ptrawl = pelagic trawlers, PSsp = purse seiners for small pelagics

	Btrwl	**Ptrwl**	**PSsp**
Slovenia	20	1	9
Montenegro	30	?	18
Croatia	800	0	400
Italy	1225	136	48
Albania	168	0	15
Total	2243	137	490

Table 2: Italian fleet in GSA 17 (source: GFCM task 1 data)

NORTHERN ADRIATIC ITALY GSA 17	**Nb of vessels**		**Surrounding nets**	**Seine nets**	**Trawls**	**Dredges**	**Gillnets and Entangling nets**	**Traps**	**Hooks and Line**	**Miscellaneous**
A - Polyvalent small-scale without engine <12m										
B - Polyvalent small-scale with engine <6m	**726**	*21,67%*					**514**	**536**		
C - Polyvalent small-scale with engine 6-12m	**1149**	*34,29%*			**4**		**634**	**1157**		**93**
D - Trawlers (<12 m)	**59**	*1,76%*			**55**					
E - Trawlers (12-24m)	**596**	*17,79%*			**556**			**4**		
F - Trawlers (<24m)	**88**	*2,63%*			**91**					
G - Purse seiners (6-12m)		*0,00%*								
H - Purse seiners (> 12m)	**37**	*1,10%*	**37**		**9**					
I - Longliners (> 6m)		*0,00%*								
J - Pelagic trawlers (> 6m)	**102**	*3,04%*			**107**					
K - Tuna seiners (> 12m)		*0,00%*								
L - Dredgers (>6m)	**587**	*17,52%*				**604**				
M - Polyvalent vessels (12m)	**7**	*0,21%*					**7**			
TOTAL	**3351**		**37** 1,10%		**822** 24,53 %	**604** 18,02 %	**1155** 34,47 %	**1697** 50,64 %		**93** 2,78%

Table 3: Italian fleet in GSA 18 (source: GFCM task 1 data)

SOUTHERN ADRIATIC ITALY + ALBANIA GSA 18	Nb of vessels		Surrounding nets	Seine nets	Trawls	Dredges	Gillnets and Entangling nets	Traps	Hooks and Line	Miscellaneous
A - Polyvalent small-scale without engine <12m	**11**	*0,68%*							**11**	
B - Polyvalent small-scale with engine <6m	**384**	*23,78%*		**204**			**103**		**41**	
C - Polyvalent small-scale with engine 6-12m	**377**	*23,34%*		68			**174**		**39**	
D - Trawlers (<12 m)	**40**	*2,48%*			**40**					
E - Trawlers (12-24m)	**546**	*33,81%*			**855**					
F - Trawlers (<24m)	**64**	*3,96%*			**90**					
G - Purse seiners (6-12m)		*0,00%*								
H - Purse seiners (> 12m)	**11**	*0,68%*	**11**							
I - Longliners (> 6m)	**44**	*2,72%*			**8**				**67**	
J - Pelagic trawlers (> 6m)	**34**	*2,11%*			**34**					
K - Tuna seiners (> 12m)		*0,00%*								
L - Dredgers (>6m)	**76**	*4,71%*				**76**				
M - Polyvalent vessels (12m)	**28**	*1,73%*			**28**					
TOTAL	**1615**		**11** 0,68%	**272** 16,84 %	**1055** 65,33 %	**76** 4,71%	**277** 17,15 %	0,00%	**158** 9,78%	

3. Targeted species

The high number of species exploited by the demersal fishery characterizes the Adriatic fisheries (as well as Mediterranean fisheries in general) as remarkably multi-specific. As it has been said before the Adriatic Sea is probably the largest and the best-defined area of occurrence of shared stocks in the Mediterranean. The most important demersal and small pelagic commercial species whose stocks are shared in the Adriatic were identified and agreed upon by regional experts convened by the AdriaMed FAO Regional Project. The recognition of the shared-stock status of the priority species (Table 4) was subsequently proposed to the national management authorities of Albania, Croatia, Italy and Slovenia and then endorsed at the 28th Session of the GFCM in 2003.

Table 4. Relevant common species whose stocks are shared by at least two Adriatic countries

Species	**Area of Occurrence**		
Adriatic Sea basins	Northern Adriatic	Central Adriatic	Southern Adriatic
Geographical Sub-area	**17**		**18**
Eledone cirrhosa		●	●
Eledone moschata	●	●	○
Loligo vulgaris	●	●	●
Lophius budegassa	○	●	●
Lophius piscatorius		●	●
Merlangus merlangus	●	○	
Merluccius merluccius	●	●	●
Mullus barbatus	●	●	●
Nephrops norvegicus	●	●	●
Pagellus erythrinus	●	●	●
Parapeneus longirostris		○	●
Sepia officinalis	●	●	●
Solea vulgaris	●	●	○
Engraulis encrasicolus	●	●	●
Sardina pilchardus	●	●	●
Sprattus sprattus	●	○	
Scomber scomber	●	●	●

●: common occurrence; ○: scarce; blank: negligible. Small pelagic main species. Small pelagic stocks make up most of the landed catch from the Adriatic Sea. Anchovy *(Engraulis enchrasicolus)* and sardine *(Sardina Pilchardus)* fisheries have developed on both side of the Adriatic but as far as anchovies are concerned the Italian fleet has always been responsible for most (about 90%) of the catches.

3.1 Pelagic main species

Small pelagic fish species are widely distributed in the Adriatic Sea and play an important role in the commercial fisheries of all countries located along the coast of the Adriatic Sea. The main species of small pelagic fish are sardine, *Sardina pilchardus*, anchovy, *Engraulis encrasicolus*, Atlantic mackerel, *Scomber scombrus*, chub mackerel, *Scomber japonicus* and sprat, *Sprattus sprattus*. Other species also occasionally caught in small pelagic fisheries in the Adriatic Sea are the horse mackerel *Trachurus trachurus*, Mediterranean horse mackerel *Trachurus mediterraneus*, Mediterranean sand smelt *Atherina hepsetus*, Blotched pickarel *Spicara maena* and bogue *Boops boops*.

Anchovies and sardines are fished by purse seiners, attracting fish by light and pelagic trawlers belonging to Italy, Croatia and Slovenia. The fishery takes place all year round: a closure period is observed for the Italian pelagic trawlers on August, while the closure is from 15th December to 15th January in Croatia (Pelagic fishing fleet activity on the eastern part of the Adriatic has always been directed mostly at sardines and the Croatian catches represent the main part of the total catches).

Small pelagic fishes are the main fisheries resources of the Adriatic Sea, accounting for a large share of the total catches. The group represented approximately 46% of the total marine catches of the Adriatic from 2000 to 2010, being 99% of this total accounted for by sardine and anchovy. Sardine and anchovy are the most abundant and economically important small pelagic species in the Adriatic Sea, with stock regularly assessed by GFCM and FAO-ADRIAMED Working Group on Small Pelagics.

A General overview of capture fisheries landing trends from the Adriatic over 40 years (1970 2011) can be extracted from the open access FAO statistics FishstatJ software. In this database the reliability of Nominal landing can differ greatly between countries and regions and cannot be easily assessed, however these data roughly outline the fisheries production performance of the region.

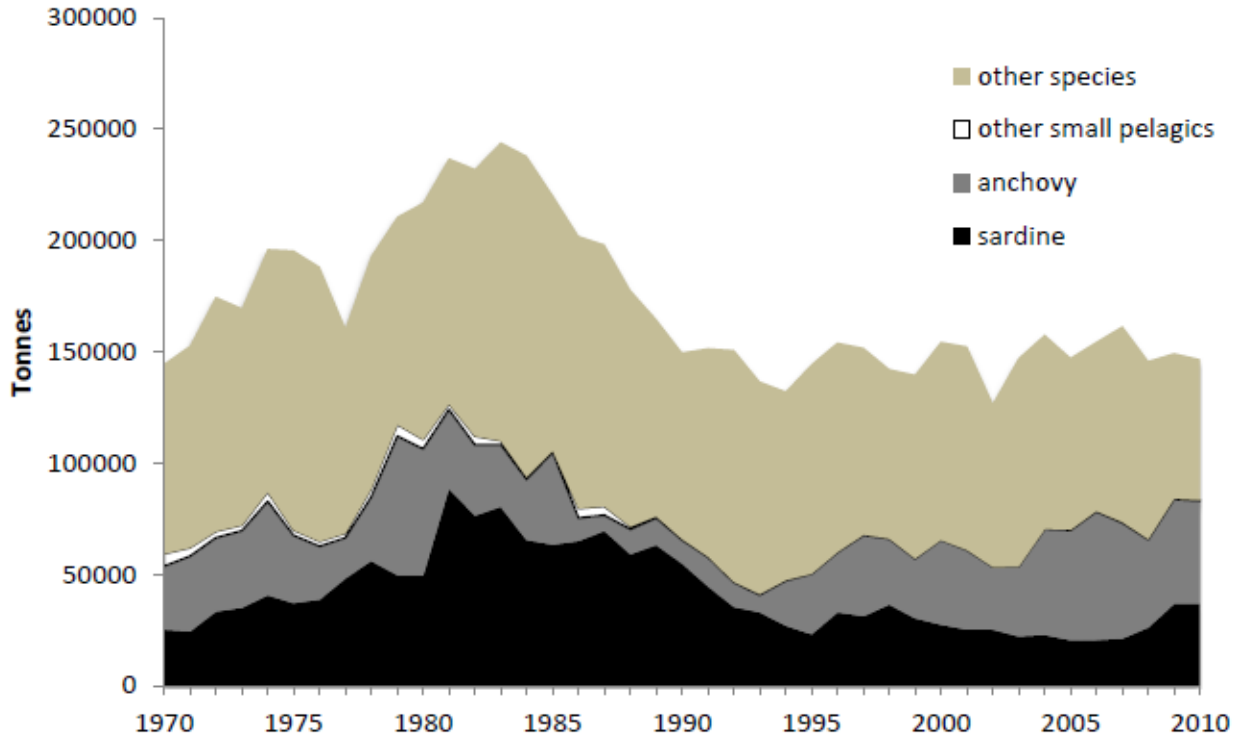


Fig. 9 Catches of marine species in the Adriatic Sea (source FAO FishStat).

Figures 9 and 10 show the trend in reported catches of sardine and anchovy by country in the Adriatic Sea. Historically the eastern Adriatic countries targeted mainly sardine, but since the mid-1990s there has been an increase in anchovy catches in the east, specifically by Croatia.

Total catch of sardine increased steadily between 1970 and 1981 when a maximum was recorded at 88,518 tons. This was followed by a sharp decrease between 1982 and 1995 (the war in the former Yugoslavia from 1990 to 1995 was one important factor that affected the fisheries from eastern Adriatic countries in that period). Catches remained below 40,000 tons since then, with two peaks in 1998 and 2010 of about 36,000 tons. Data from the northern and central Adriatic Sea (GSA 17) for 2011 indicate that catches have continued to increase in more recent years (9). The eastern Adriatic fishery (represented by the Yugoslavian Federal Republic until the independence of Croatia and Slovenia in 1991) experienced a marked decline between 1990 and 1995, followed by a period on increasing catches by Croatia until 2010. Italy accounted for a large share of the catches until the early 1990s, declining in importance since then. In 2010 Italy reported 6,880 tons of sardine, Croatia 29,600 and Slovenia 403 tons. Catches by Montenegro (and Serbia and Montenegro) have been below 100 tons, with Montenegrin catches in 2010 of 35 tons.

Anchovy catches increased between 1970 and 1974, reaching about 42,900 tons, decreased to 18,100 tons in 1977, increasing sharply in the following two years. The fishery attained its maximum historical level in 1979 when 62,462 tons were landed. Catches collapsed afterwards, reaching the historical minimum of 7,055 tons in 1987. The collapse of the fishery was followed by a period of relative stability in catches, which oscillated around 10,000 tons/year from 1988 to 1992. The fishery experienced a recovery since then, reaching a peak of 57,650 tons in 2006. Catches declined after that, being at about 46,000 per year in 2009 and 2010. Data from the northern and central Adriatic Sea (GSA 17) for 2011 indicate that catches have continued to decline in more recent years (10).

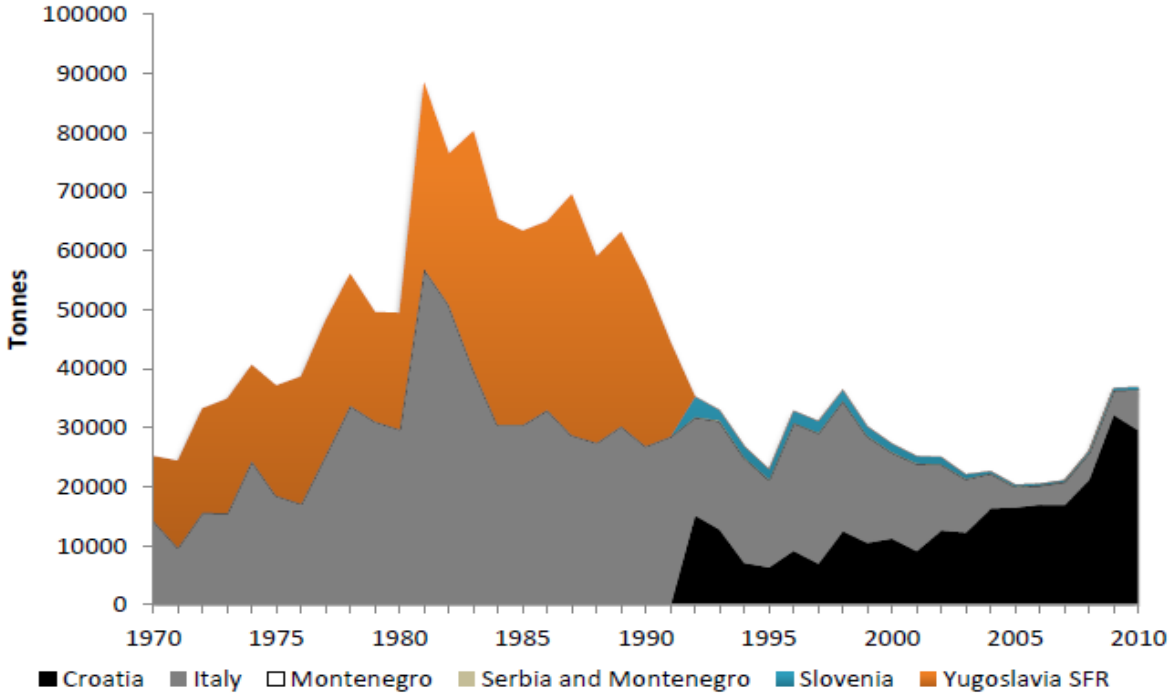


Fig. 10a Catches of sardine by country in the Adriatic Sea (source FAO-FishStat).

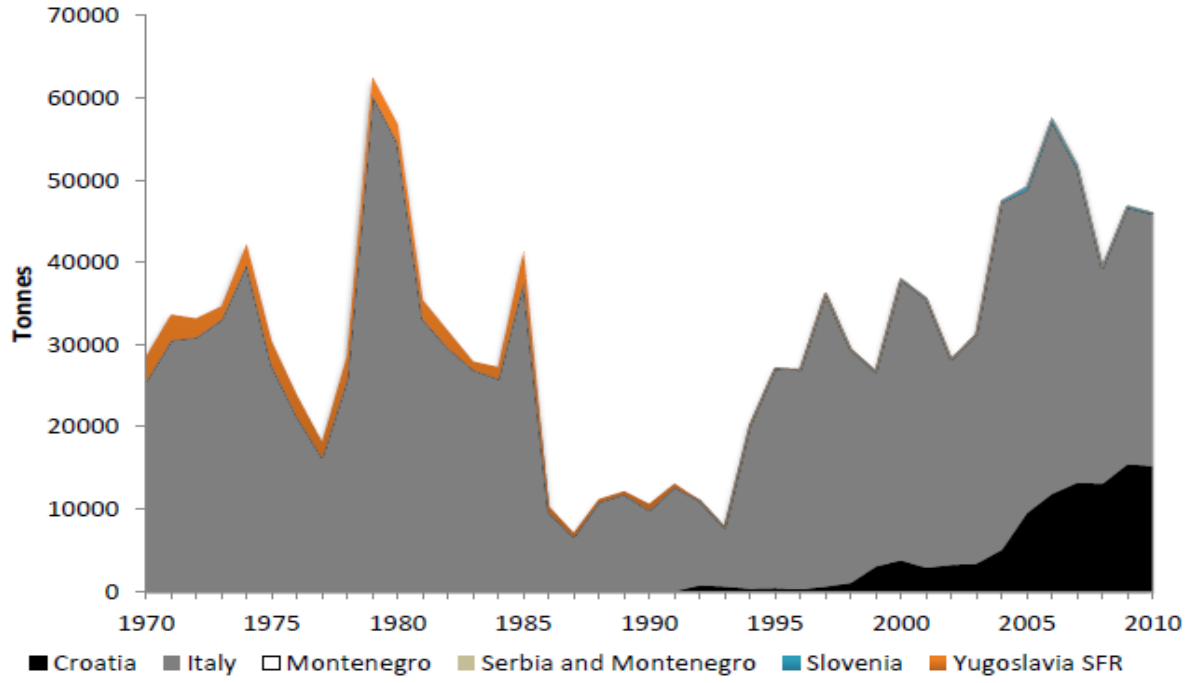


Fig. 10b Catches of anchovy by country in the Adriatic Sea (source FAO FishStat).

In 2011 the closure season for the Italian fleet was extended to 60 days (August and September). Pelagic catch dominated the marine fish landing, particularly in the East Coast fishery, even though from the mid1980s the contribution of pelagics to total fish landings decreased remarkably as a consequence of the successive downsizing of the anchovy and sardine stocks and, more recently, of the economic changes which took place in the eastern coastal countries.

3.2 Demersal main species

In the Adriatic Sea, the demersal fishery takes place on the entire continental shelf and on a part of the continental slope in the southern Adriatic. Most of the fishing activity is carried out by trawlers and the use of fixed gear is usually limited to the area unsuitable for trawling. The demersal fishery is a multispecies fishery and the main target species are: European hake (*Merluccius merluccius*), Red mullet (*Mullus barbatus*), breams (*Pagellus spp*.), Whiting (*Merlangius merlangus*), anglerfish (*Lophius* spp.), flatfish (*Solea vulgaris,Psetta maxima, Scophthtalmus rhombus, Platichys flesus*), *Eledone* spp., Common cuttlefish (*Sepia officinalis*), squids (*Loligo* and *Illex*), Norway lobster (*Nephrops norvegicus*) and Deepwater rose shrimp (*Parapenaeus longirostris*).

The Hake *(Merluccius merluccius)*

The hake *(Merluccius merluccius)* is largely distributed in the Adriatic, excepted in the northern part of GSA 17, north of the mouth of the Po river and coastal shallow waters. The juveniles are concentrated in the middle Adriatic around 150 meters depth, while adult individuals are commonly found at depths greater than 250 meters. This species is mainly caught by trawlers but is also frequently present in the catches of gillnets and entangling nets. In the Adriatic hake spawns throughout the year, but with different intensity (fig. 11).

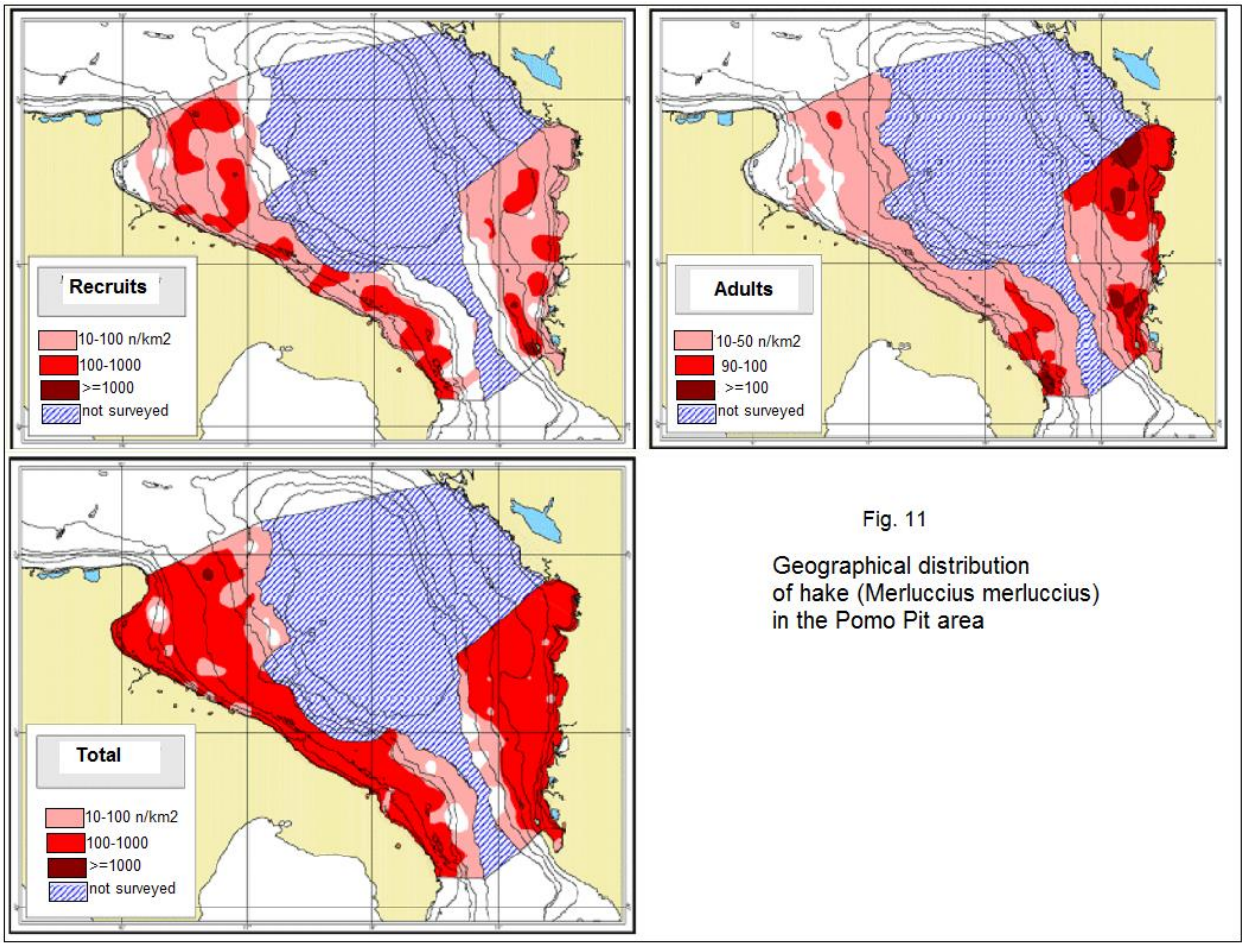


Fig. 11

Geographical distribution of hake (Merluccius merluccius) in the Pomo Pit area

The peak spawning takes place in winter and summer. In the Pomo Pit the first deposition occurs in winter in the deep waters (up to 200 m). In the period between spring and summer, spawning takes place in shallower water. The nursery areas are located on the slopes in areas adjacent to the Pomo pit at depths between 150 and 200 meters.

The Norway lobster *(Nephrops norvegicus)*

The Norway lobster *(Nephrops norvegicus)* is widely distributed in the central and northern Adriatic, at depths of more than 50 meters but the most important densities of this species are located on Pomo pit grounds. Juveniles are concentrated in deep areas, over 200 m. There are substantial differences in average length between the population of the Pomo Pit and those of the rest of the Adriatic. These differences are the result of the diversity of ecological factors, which lead to a reduction in the growth of *Nephrops norvegicus* (and other benthic decapods) in the Pomo Pit.

The Red mullet *(Mullus barbatus)*

The Red mullet *(Mullus barbatus)* is distributed all over the GSA 17 and performs seasonal migrations. The adult population is distributed along the central and eastern part of the Adriatic, while the juveniles are found in the western coastal area, where it remains until the early winter and then moves to the depths of the sea. The species is mainly fished by bottom trawl nets from both Italian and Croatian fleet. Smaller quantities are also caught with Italian trammel nets and gill nets. Slovenian catches are low (only 2 t reported in 2007). A closure of 45 days in late summer has been enforced in 2011 - 2012 for the Italian fleet. Before 2011 the closure period was 30 days in summer.

The common sole (*Solea vulgaris*)

The common sole (*Solea vulgaris*) is distributed In the northern and central Adriatic depending on the age: the adult specimens are present along the coast of the Istrian coast, while the younger ones are present in the Italian coastal waters, especially at the mouth of the river Po. The majority of the population moves from north to south along the Italian coast, and probably from south to north along the eastern coast. The highest catches occur in the fall.

The Deepwater rose shrimp *(Parapenaeus longirostris)*

The Deepwater rose shrimp *(Parapenaeus longirostris)* is an important species in the demersal trawl fishery of the whole Geographical Sub Area 18, as it Is distributed mainly in the southern Adriatic. It is not very abundant In the central. with the exception of Pomo pit, where it is present mainly on muddy bottoms between 130 and 190 feet deep.

The Mantis shrimp (*Squilla mantis*)

The Mantis shrimp (*Squilla mantis*) is distributed over a wide band parallel to the coast between 15 and 70 m depth in the upper and middle Adriatic. In this area, mantis shrimp is exploited by bottom otter trawl, gillnet and rapido trawl. This species is exploited all year round essentially by the Italian trawlers and ranks first among the crustacean landed in the Adriatic ports. The Slovenian annual landings are much lower while in Croatian landings statistics the species is absent. Trawl catch is mainly composed by age 1 and 2 individuals while the older age classes are poorly represented in the catch. As concerns artisanal fisheries, *S. mantis* is an alternate target of gillnetters targeting Solea solea, especially during spring summer seasons in the coastal area. The species is not present in the list of shared stock of GFCM as it is present and commercially fished mainly in the Italian Territorial Waters.

Other demersal species:

Octopus vulgaris, Boops boops, Trachurus trachurus, Octopus Spp, Spicara flexuosa, Arnoglossus spp, Sardina pilchardus, Aristeus foliacea, Aristeus antennatus, Mustelus mustelus, Pagellus bogaraveo, Sparus aurata.

4. The status of the stocks

4.1 Small Pelagic resources

Anchovy (Engraulis encrasicolus) in GSA 17

Main Italian fishing harbours for anchovies in the Adriatic harbours can be considered Trieste, Chioggia, Porto Garibaldi, Cesenatico, Rimini, Cattolica, Ancona, San Benedetto del Tronto and Vieste: in these harbours about 85% of the catch of anchovies is landed. Other important harbours are Grado, Mara no Lagunare, Caorle, Goro, Fano and Giulianova.Anchovy landings during the last thirty years are characterized by two major factors: the landing peak of more than 50000 t in1981 and the subsequent decline to the minimum of 10000 t in 1987, which lasted till the early 1990s (14). Since then yield has been increasing.

Whether anchovy in the Adriatic Sea is part of one or two stocks is uncertain. The hypothesis of two distinct populations is based on morphometric and allozymic differences between northern and southern Adriatic anchovy (7). This hypothesis has not been supported by more recent genetic data (30). For stock assessment purposes, anchovy caught in the northern-central Adriatic (GSA 17) has been considered part of a single stock and has been assessed separately from the stock in GSA 18.

A first attempt to assess the stock of small pelagics (anchovy and sardine) in the whole Adriatic was carried out in 2011 (29). The authors noted however that some work has still to be done in order to make a reliable assessment of the stock in the combined areas, including better information on catches in GSA 18, which are currently considered unrealistic. Therefore the information presented below is based on the last available stock assessment of the species in each GSA.

Stock assessments and biomass estimations of anchovy have been carried out in the last twenty years using direct methods as echo surveys and ichthyoplankton surveys as well as indirect (catch and effort and VPA) methods (fig. 12). In the GSA 17 the trend in biomass of anchovy increased until 2005, then decreases until 2009, and then increases again. The 2011 spawning stock biomass estimate is between 309361 tons and 264565 tons. The current biomass is above the reference points Blim and Bpa proposed by the GFCM. The fishing mortality decreases constantly until 2007 and then increases again, being higher for age 2 and 3.

The stock can be considered as sustainably exploited; the level of abundance is considered intermediate (current biomass = 333404 tons) higher than the proposed Blim (179000 tons) and Bpa (250600 tons) reference points (27a).

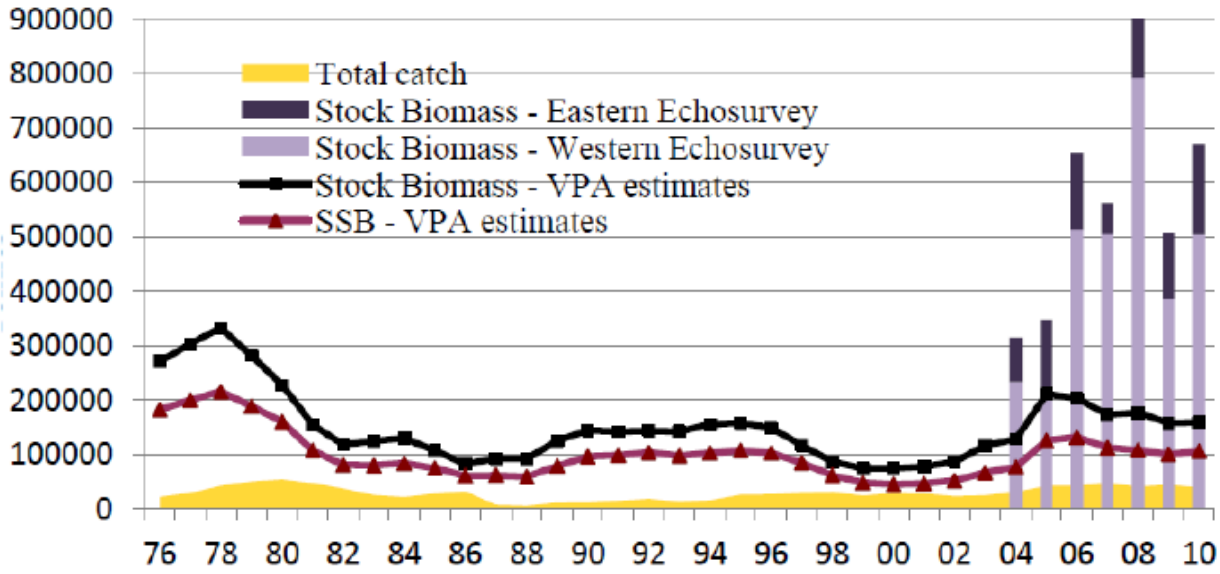


Fig. 12 Trends in population biomass (estimated by acoustic surveys and VPA) and catches of anchovy in GSA 17 from 1976 to 2010. Data in tons.

Since this stock can display large fluctuations associated with analogous fluctuations in recruitment, and since the exploitation rate is equal to the precautionary threshold, the advice is not to increase fishing mortality. Moreover numerous studies have shown that the dynamics of anchovy and sardine populations are strongly influenced by success in the recruitment that is, on the other hand, strongly influenced by environmental conditions.

It has been argued for a long time whether there are two separate stocks of anchovies in the Adriatic one in shallow waters (less than 50 meters of depth) of the northern western Adriatic, and the other in deeper off shore waters of the central southern Adriatic with extensive migrations. The biological basis for this stock differentiation (i.e. spatial and/or temporal separation in spawning) are still to be clarified but it is evident that the spatial distribution of shared stock of anchovy is not limited to GSA17 area only, but it is extended in GSA18 area also. Therefore, future assessments will try to take into account combined data from these two GSAs. It should be noted that Adriatic small pelagic fishery is multispecies and effort on sardine stock cannot be separated from effort on stock of anchovy.

Sardine (Sardina pilchardus)in GSA 17

The Croatian catches of sardine represent the great part of the total catches of the Adriatic Sea. Exploitation is based on all the age classes from 0 to 6+. The current assessments show that the trend in biomass of sardine started a slow but continuous increase since 2000. The 2011 biomass estimation showed rather high values. The current biomass (Between 483369 and 215050 t) is above the reference points Blim and Bpa proposed by the GFCM. The fishing mortality starts to increase in 2007 for all the ages.

Available genetic data indicates that sardine in GSA 17 constitute a single stock (10). The situation in GSA 18 is less clear. Stock assessment of sardine has been done until recently considering stocks in GSA 17 and GSA 18 separately. However in 2012 the Working Group on Stock Assessment of Small Pelagics recognized that spatial distribution of shared stock of sardine is not limited to GSA17 area only, but it is extended in GSA18 area also. The Working Group also noted that an important nursery area of sardine is located in Gulf of Manfredonia (GSA18) where sardine is exploited by a fry fishery.

Biomass of the stocks in GSA 17 decreased continuously from the 1980s to 2000 (Fig. 13). In the most recent years, a moderate recovery of the stock has been observed (Figure 12), accompanied by parallel increases in recruitment and catches (10).

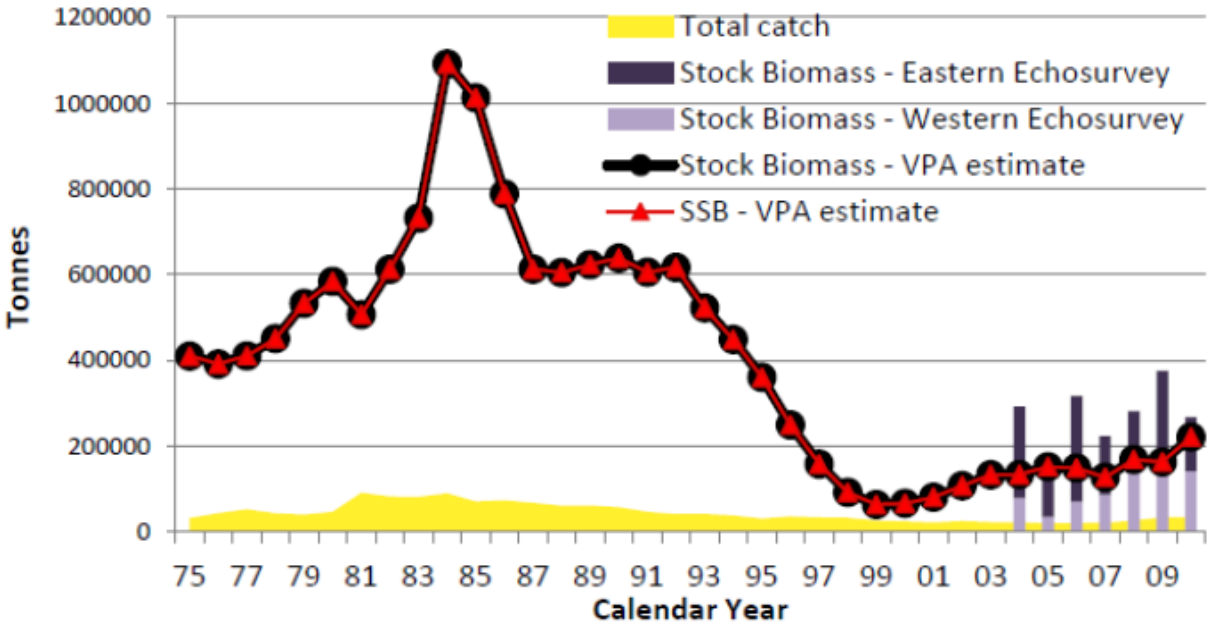


Fig. 13 Trend in catches and biomass of sardine in GSA 17. Source: Santojanni et al. (2011)

The present status of the stock up to 2011 (27a) can be described with high fishing mortality and intermediate abundance (Current biomass higher than Blim and Bpa reference points).Biomass level as well as recruitment level showed a steep increase in 2011. Because of that there are no sign that the stock of sardine in the Adriatic Sea is suffering for high fishing mortality. Nevertheless, since this stock can display large fluctuations associated with analogous fluctuations in recruitment, the GFCM advice is not to increase the fishing effort. Besides, since numerous studies have shown that the dynamics of anchovy and sardine populations are strongly influenced by success in the recruitment, which is, on the other hand, strongly influenced by environmental conditions, like for anchovy. Also the spatial distribution of shared stock of sardine is not limited to GSA17 area only, but it is extended in GSA18 area also. Therefore, WG suggest that future assessments try to take into account combined data from these two GSAs. Moreover, an important nursery area of this stock is located in Gulf of Manfredonia (GSA18) where the sardine stock used to be exploited by fry fishery (the fishery was closed in June 2010).

4.2 Demersal resources

Assessment of demersal resources has been carried out on most species of fishes using mainly trawl surveys and confirming that in late 1980's, the demersal resources were overfished (Tab.5).

Table 5 Trends of abundance from the trawl surveys (no= no trend, > 0= positive trend, 0 < = negative trend).

Species	Trend
Mullus barbatus	no
Nephrops norvegicus	no
Eledone moschata	0 <
Eledone cirrhosa	> 0
Loligo vulgaris	> 0
Illex coindetii	> 0
Sepia officinalis	0 <
Trisopterus minutus capelanus	stable
Pagellus erythrinus	> 0
Zeus faber	stable
Lophius budegassa	> 0
Merlangius merlangus	> 0
Parapenaeus longirostris	0 <
Squilla mantis	> 0

The Adriatic demersal catches are composed mainly of individuals of the age classes 0, 1 or 2. Therefore, trends in abundance reflect more a fluctuation in recruitment than a response to the fishing effort. Also, the landing of some species, for example European hake, has been sustained for a relatively long period in spite of heavy apparently unsustainable exploitation. This could be due to the adult occurrence in deeper waters outside the traditional trawl fishing grounds, as it occurs in the canyons of the Gulf of Lions (GSA 7)

Hake (Merluccius merluccius)

Hake is one of the most important species in the Geographical subarea 18 representing about 20% of landings from trawlers. The nominal landing of the European hake for the whole Adriatic Sea has been increasing since 1984 reaching the maximum of about 7000 t in 1994. Since then, this growing landing trend has reversed sharply declining. In 2011 the landings of hake were about 3,792t in the west side with the higher production from trawlers (3,258 t) followed by longliners (534 t). Along the east side the production from trawlers in 2011 was about 439 t divided by 37 t from Montenegro and 402 t from Albania. The hake is one of the most studied demersal species in the Adriatic Sea, partly due to its substantial impact (due to the species abundance and economic value) on fishery activities in the basin.

The current assessment results show a sharp increase of recruitment in 2005 and thereafter a level similar or higher than the past years. In 2008 a new though lower peak was observed. No trends were detected. Total fishing mortality showed a decreasing trend to 2004 and then an increase in 2005 and 2006. Catches and mortality are dominated by the trawl fishing system.

The stock is in overfishing and thus GFCM recommends considering a considerable reduction of the fishing mortality. Given these results it is necessary to consider that a remarkable reduction of the fishing mortality is necessary (27b). As observed in 2011, the fishing mortality from the Italian bottom trawlers represents about 80% of the total F in the GSA 18 and that of the Italian longlines is accounting for about 9.5%, with an overall percentage of about 90%, while Montenegrin trawlers account only for about 1% of the F exerted on hake in the GSA and Albanian trawlers of about 9.7%. Moreover, the production of hake in GSA 18 is split in 12.5% caught by Italian longlines, 77.2% by Italian trawlers, about 1% by Montenegrin trawlers and about 9.4% by Albanian trawlers.

Common sole (Solea solea) in GSA 17

Rapido trawl landings were traditionally dominated by small sized specimens; they are basically composed by 0+, 1 and 2 year old individuals. Set net fishery lands mostly the same portion of the population, while the otter trawl fishery, exploiting wider fishing grounds, shows a different size distribution of the landings. In the eastern part of the basin common sole is exploited mainly by set netters using trammel net. The catch composition is dominated by adults.

Current assessment results show that the common sole stock in GSA 17 is subjected to overfishing, being the current F (2011) higher than the GFCM reference point (a proxy of FMSY).

A reduction of fishing pressure have been recommended (27b), also taking into account that the exploitation is mainly orientated towards juveniles and the success of recruitment seems to be strictly related to environmental conditions *(GFCM suggests that this could be achieved by a two months closure for rapido trawling inside 11 km (6 nm) offshore along the Italian coast, after the fishing ban)*. Moreover, it is not sure that the adoption of a larger mesh size would correspond to a decrease of juvenile catches. The same uncertainty regards the adoption of square mesh.

Red mullet (Mullus barbatus) in GSA 17

The signals coming from the MEDITS survey are positive, suggesting a stable biomass and a really high recruitment estimated for the 2012. However the current stock assessments show that the estimated fishing mortality for red mullet in 2011 reaches very high value for the Italian fleet in particular for specimens between 15 and 17 cm, while the fishing mortality estimated for the Croatian fleet increases for much bigger individuals (from 17 cm), but still remaining at lower values.

The spawning stock biomass follow a slight decreasing trend starting in 2008 from 9000 t to 6300 t in 2011. Similar considerations can be applied to the trend in total biomass, which decreased by 50% from 2008 (50000 t) to 2011 (25000 t). The current analysis (27b) evidenced the different fishing patterns of the two fleets exploiting the species, which is also determined by the behavior of the species. The Italian fleet is clearly targeting recruitment; besides, the current fishing mortality for the Croatian fleet is low while F for the Italian fleet is above both reference

points, showing a possible situation of growth overfishing. GFCM suggest that It could be wise to reduce the fishing mortality on the recruitment and this could be obtained by a prolongation of the closed season for trawling along the Western Adriatic coast where in autumn age 0 recruits born in summer are concentrated.

Deepwater pink shrimp (Parapenaeus longirostris) in GSA 18

MEDITS trawl surveys data showed that the abundance of this shrimp was steadily growing from1999 to 2005 than a decreasing was observed in 20062007 followed by a new increase in 2008 and 2009, while in 2010 and 2011 the abundance is decreasing again.

Current assessment results by VPA show that the highest fishing mortalities are applied on the age groups 1 and 2. The yield per recruit analysis indicates a current level fishing mortality highest than the target reference point. The main part (71%) of the total F in the GSA 18 is exerted by the Italian fleet, while Montenegrin trawlers account only for about 1.7% of the F exerted on the GSA and Albanian trawlers of about 27.1%. The stock is considered in overfishing and a reduction of the fishing mortality will be necessary to allow the achievement of F0.1. This could be achieved with a multiannual plan based on a reduction of fishing mortality through fishing activity limitations and possibly fishing capacity decreasing (27b).

Mantis shrimp (Squilla mantis) in GSA 17

Current assessment results show that the stock is subjected to overfishing. The Mantis shrimp in GSA 17 is exploited unsustainably, being the current F (2011) estimates with higher than the GFCM reference point (a proxy of FMSY). Moreover decreasing trends have been observed for recruitment and Spawning Stock Biomass in the VPA results and for the relative abundance and biomass in MEDITS trawl surveys. A reduction of fishing pressure is recommended. The relevant fleet effort or catches (demersal otter trawl fishing fleet) should be reduced until fishing mortality is below or at the proposed reference level, in order to avoid future loss in stock productivity and landings. This should be achieved by means of a multiannual management plan taking into account mixed fisheries considerations (27b).

5. Elasmobranch fisheries in the Adriatic Sea

There are several checklists of elasmobranchs in the Adriatic. Most of the lists are reporting more than 50 species, depending on which species status is considered as valid or doubtful. Most recent checklist of elasmobranchs in the Adriatic Sea is reporting total of 53 species, within 28 sharks, 1 chimaera and 24 batoids species have been reported as permanent residents or occasionally visiting species (20).

Table 6 LIST OF SHARKS AND CHIMAREAS OCCURRING IN THE ADRIATIC SEA		
ORDER	**FAMILY**	**SPECIES**
HEXANCHIFORMES	HEXANCHIDAE	*Heptranchias perlo*
		Hexanchus griseus
SQUALIFORMES	ECHINORHINIDAE	*Echinorhinus brucus*
	SQUALIDAE	*Squalus acanthias*
		Squalus blainvillei
	CENTROPHORIDAE	*Centrophorus granulosus*
	ETMOPTERIDAE	*Etmopterus spinax*
	OXYNOTIDAE	*Oxynotus centrina*
	DALATIIDAE	*Dalatias licha*
SQUATINIFORMES	SQUATINIDAE	*Squatina oculata*
		Squatina squatina
LAMNIFORMES	ODONTASPIDIDAE	*Carcharias taurus*
		Odontaspis ferox
	ALOPIIDAE	*Alopias vulpinus*
	CETORHINIDAE	*Cetorhinus maximus*
	LAMNIDAE	*Carcharodon carcharias*
		Isurus oxyrinchus
		Lamna nasus
CARCHARHINIFORMES	SCYLIORHINIDAE	*Galeus melastomus*
		Scyliorhinus canicula
		Scyliorhinus stellaris
	TRIAKIDAE	*Galeorhinus galeus*
		Mustelus asterias
		Mustelus mustelus
		Mustelus punctulatus
	CARCHARHINIDAE	*Carcharhinus plumbeus*
		Prionace glauca
	SPHYRNIDAE	*Sphyrna zygaena*
CHIMAERIFORMES	CHIMAERIDAE	*Chimaera monstrosa*

Table 7 LIST OF BATOIDS OCCURRING IN THE ADRIATIC SEA		
ORDER	**FAMILY**	**SPECIES**
RAJIFORMES	PRISTIDAE	*Pristis pectinata*
	RHINOBATIDAE	*Rhinobatos rhinobatos*
	TORPEDINIDAE	*Torpedo marmorata*
		Torpedo nobiliana
		Torpedo torpedo
	RAJIDAE	*Dipturus batis*
		Dipturus oxyrinchus
		Leucoraja circularis
		Leucoraja fullonica
		Raja asterias
		Raja clavata
		Raja montagui
		Raja miraletus
		Raja polystigma
		Raja radula
		Raja undulata
		Rostroraja alba
	DASYATIDAE	*Dasyatis centroura*
		Dasyatis pastinaca
		Pteroplatytrygon violacea
	GYMNURIDAE	*Gymnura altavela*
	MYLIOBATIDAE	*Myliobatis aquila*
		Pteromylaeus bovinus
	MOBULIDAE	*Mobula mobular*

Most of the elasmobranchs are not target species in the Adriatic Sea but they are caught mainly as bycatch of bottom trawls, gillnets and longlines, as well as by pelagic longlines and other fishing gear used in tuna, small pelagic fish and sword fisheries. Smaller elasmobranchs, especially small sharks, ray and skates are also often and commercially important species of trawls. In certain areas, during some seasons, dogfish and hound sharks are targeted with gillnets (45).

Hence, a part of commercial fishery, during recent decade, sport and recreational fisherman have started to target large sharks in big game fishing (tresher shark, blue shark and porbeagle) (45).

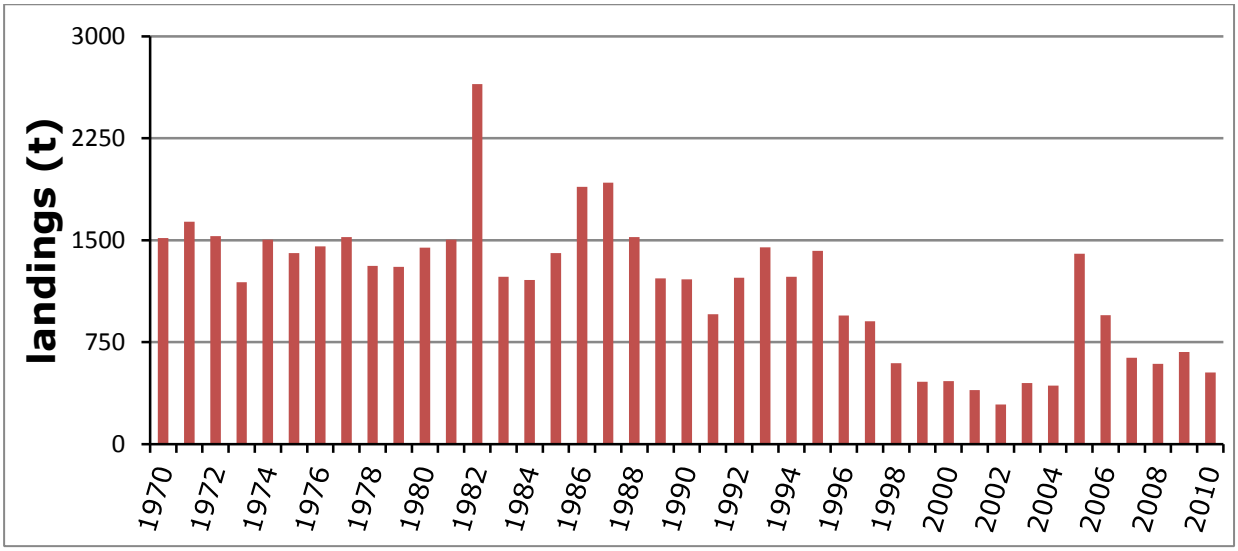


Fig. 14 Landings of „Sharks, rays, chimaeras“ in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

By analyzing FAO statistics on the total landing of the elasmobranch fisheries, reported as „Sharks, rays, chimaeras“ group, in the Adriatic Division 37.2.1 within the period 1970-2010, a 40 year-long period, a maximum of landings has been reached in 1982 with about 2649 t, while minimum landings of 292 t were reported in 2002 (fig.14).

Species-specific statistics of landing does not exist, so only specific data available are on a group level for a „*Squalidae*“, „Rays, stingrays, mantas nei “ and „Smooth-hounds nei“.

Largest landing between these three groups were reported for „Smooth-hounds nei“ group. Analyzing the landings of this group in the 40-years period, from 1970-2010, it can be noticed that this group is responsible for the highest landings of elasmobranchs in 1982, as of total 2649 t, smooth-hounds were represented by 1704 t, or 64,33 %. That year was exceptional, as second highest landings of smooth-hounds were reported in 2005, when 824 t were reported.

Considerable percentage of landings in total catch of elasmobranchs were reported in 1986 and 1987 for „Rays, stingrays, mantas nei“, when this group was represented with 57,95 % or 1097 t and 55,69 % or 1071 t, respectively.

Highest landings of *Squalidae* group were reported in 1993, when 537 t were reported, but only few years after a significant decline of landings was observed, especially in 2003, when only 41 t was reported for a whole Adriatic area.

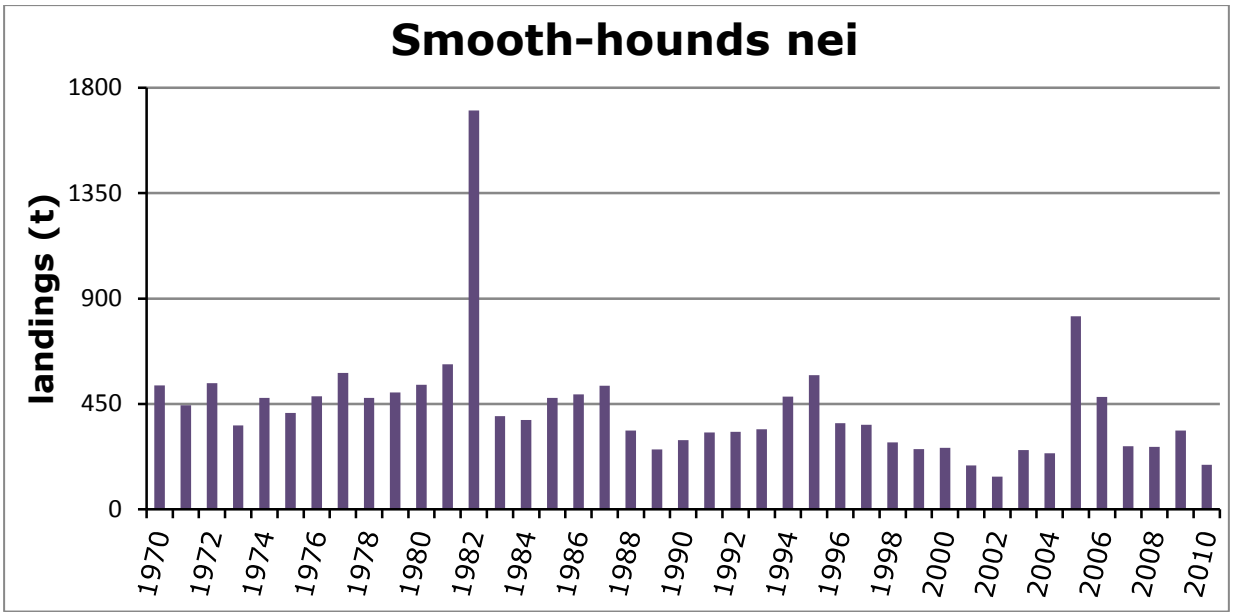


Fig. 15 Landings of „Smooth-hounds nei“ in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

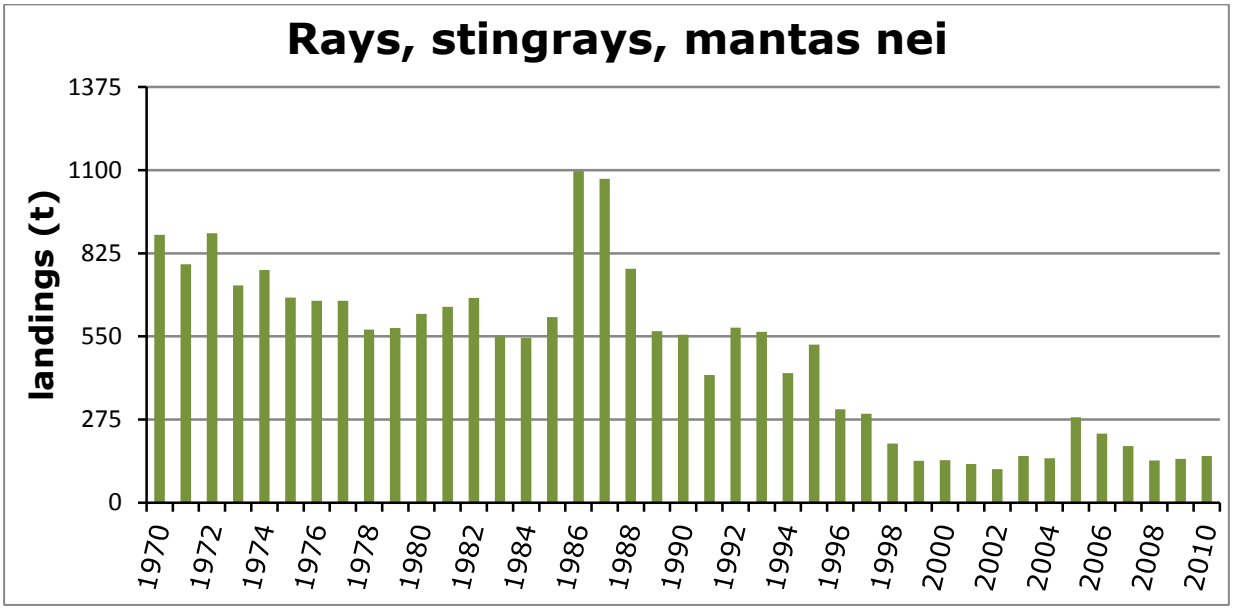


Fig. 16 Landings of „Rays, stingrays, mantas nei“ in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

Within countries that are reporting landings of elasmobranchs in the Adriatic, Italy has a dominant share with the highest landing obtained in 1982: 2222 t or 83,88 of total elasmobranch catch that year. Landings after the peak in 1982 have declined to lowest as 204 t in 2002 and since then are at average of 500 t annually.

Catches of Former Yugoslavia have been reported until 1991 and highest were reported in 1988 when 721 t were reported. After 1991, those catches have been divided between 3 other countries: Croatia, Montenegro and Slovenia. Within these countries Croatia has reported the highest catches with the peak of 811 t in 1993, when that catch represented 56,05 % of the total Adriatic landings. However, after a decline to 64 t in 2003, recent reported landings rarely exceed 100 t.

Other Adriatic countries are not having a significant share of elasmobranch landings, e.g. Montenegro is reporting its landings only since 2006 and the catch was never above 30 t, while Slovenia lately reports 1 to 2 t annually.

In case of Bosnia and Herzegovina, a country that also has a share of the Adriatic Sea, landings of elasmobranchs have never been reported. Bosnia and Herzegovina has only 20 km (12 Nm) of coastline along the Adriatic Sea, situated between Croatian territories/waters. Marine fishery is not developed and data shows that total annual catch of marine organisms is only 1 ton. Fishing fleet is consisted of a few small boats practicing artisanal fisheries, thus, it can be considered that impact of Bosnia and Herzegovina's fisheries on elasmobranch is insignificant.

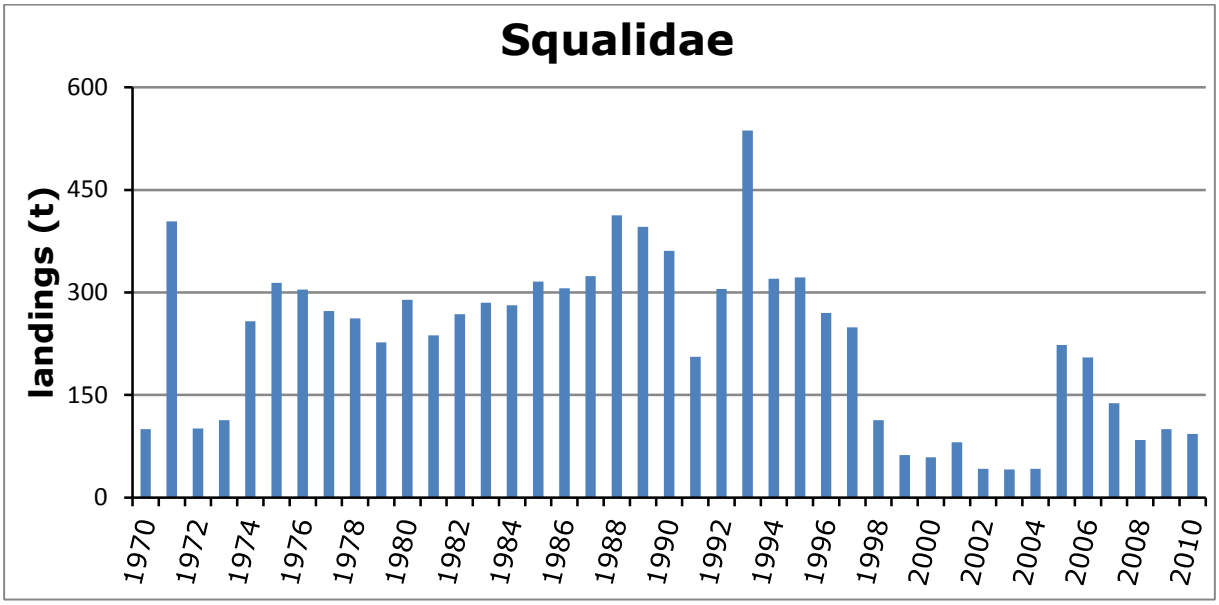


Fig. 17 Landings of „Squalidae" in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

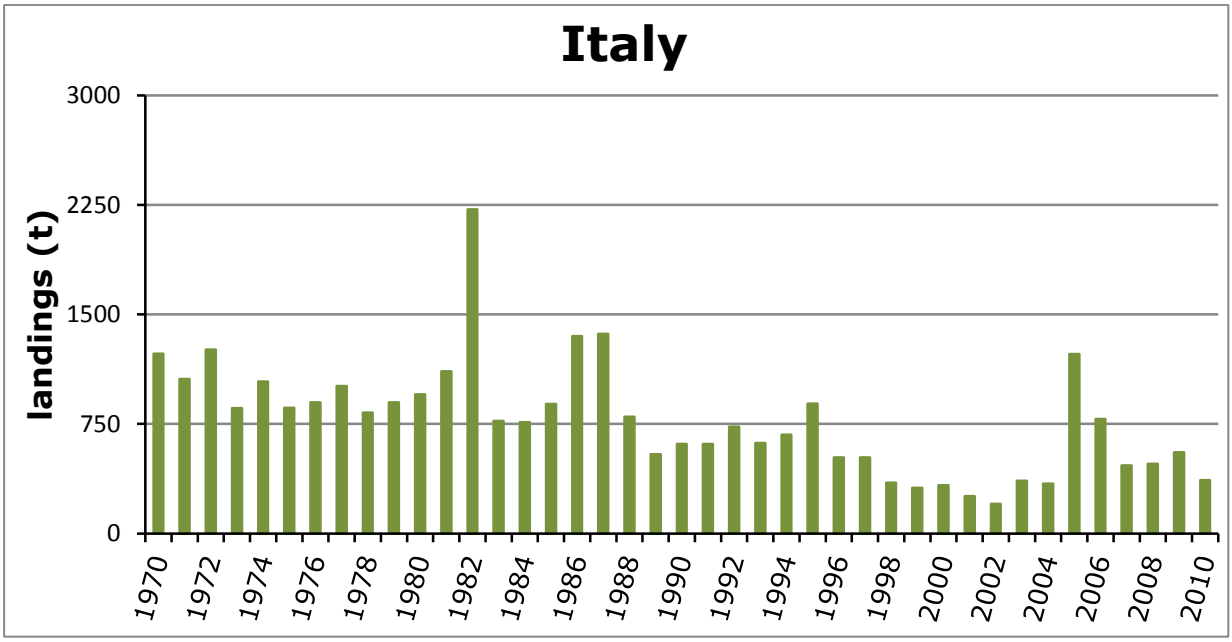


Fig.18 Landings of Italy for „Rays, stingrays, mantas nei" in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

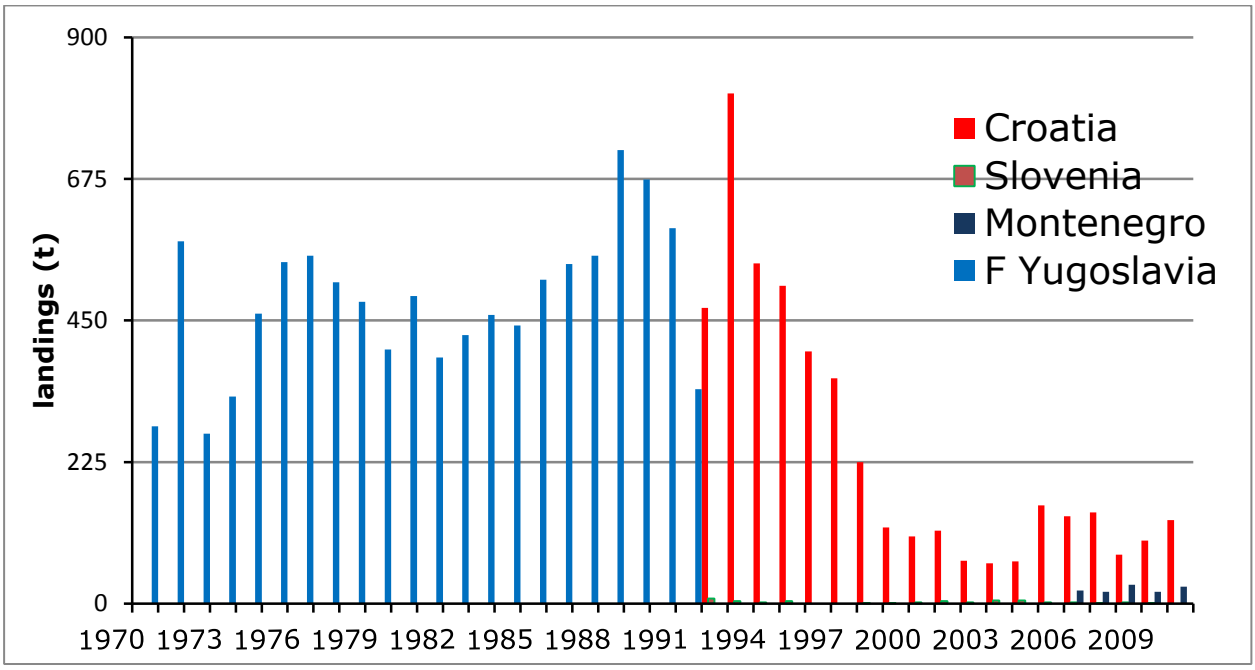


Fig. 19 Landings of other Adriatic countries for „Rays, stingrays, mantas nei“ in the Adriatic area from 1970 to 2010, according to FAO - Fisheries and Aquaculture Information and Statistics Service.

From previous data it is clear that Adriatic countries report general shark statistics without distinction between species. Moreover, the problem of statistics is even worse as most of the species are not recorded at all.

Hence, FAO data only report official landings and therefore bycatch of various fishing gear that is returned to the sea is not included.

Consequently, aggregation of the elasmobranchs landings in just a few groups also make it difficult to identify catch trends for individual species from the official landing data. However, other data exist that can be used for a indication of trends. E.g., analysis of catch per unit of effort data of bottom trawls for elasmobranchs fishes in 1948-49 and 1996-97 and catch percentages change in bottom assemblage structure, within two investigated periods, pointed out that elasmobranchs in 1948-49 were present, on average, with 32,2%. Analysis made in 1996 and 1997 year showed significant percentage decrease of this group, 13.3% and 12.9% respectively (31).

Moreover, the comparison between compared “Hvar 1948” and the “Medits 1998” bottom trawl surveys (31) showed that the main change in composition and distribution of demersal fish resources was the decrease of elasmobranch diversity and frequency. Skates and rays showed the greatest change in biomass percentage. Furthermore, there was a change in community structure: reduction of long lived and slowly growing species. For example, small sized species such as smallspotted catshark (*Scyliorhinus canicula*) and the brown ray (*Raja miraletus*) were frequently collected in both surveys, while some larger sharks and rays species disappeared or were rarely found during Medits survey in 1998.

Species specific data are revealing that for certain species a situation is even much worse. E.g. extracted data for thornback ray, Raja clavata shows that from species with high abundance and widespread distribution throughout whole Adriatic, thornback ray was restricted to small limited area with low abundance (46).

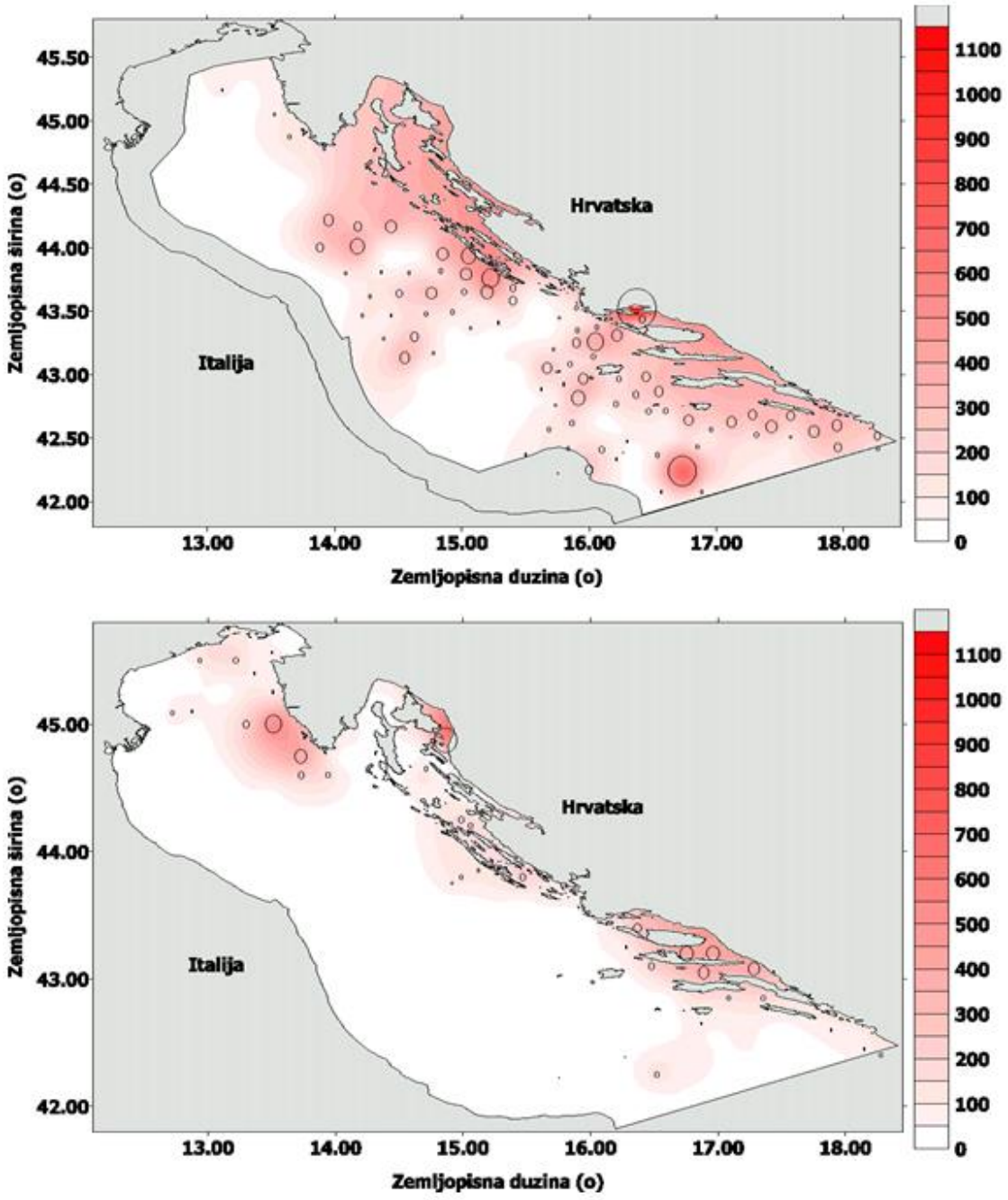


Fig. 20a Abundance and distribution of the bottom elasmobranchs: Hvar expedition (1948/49) - (31)

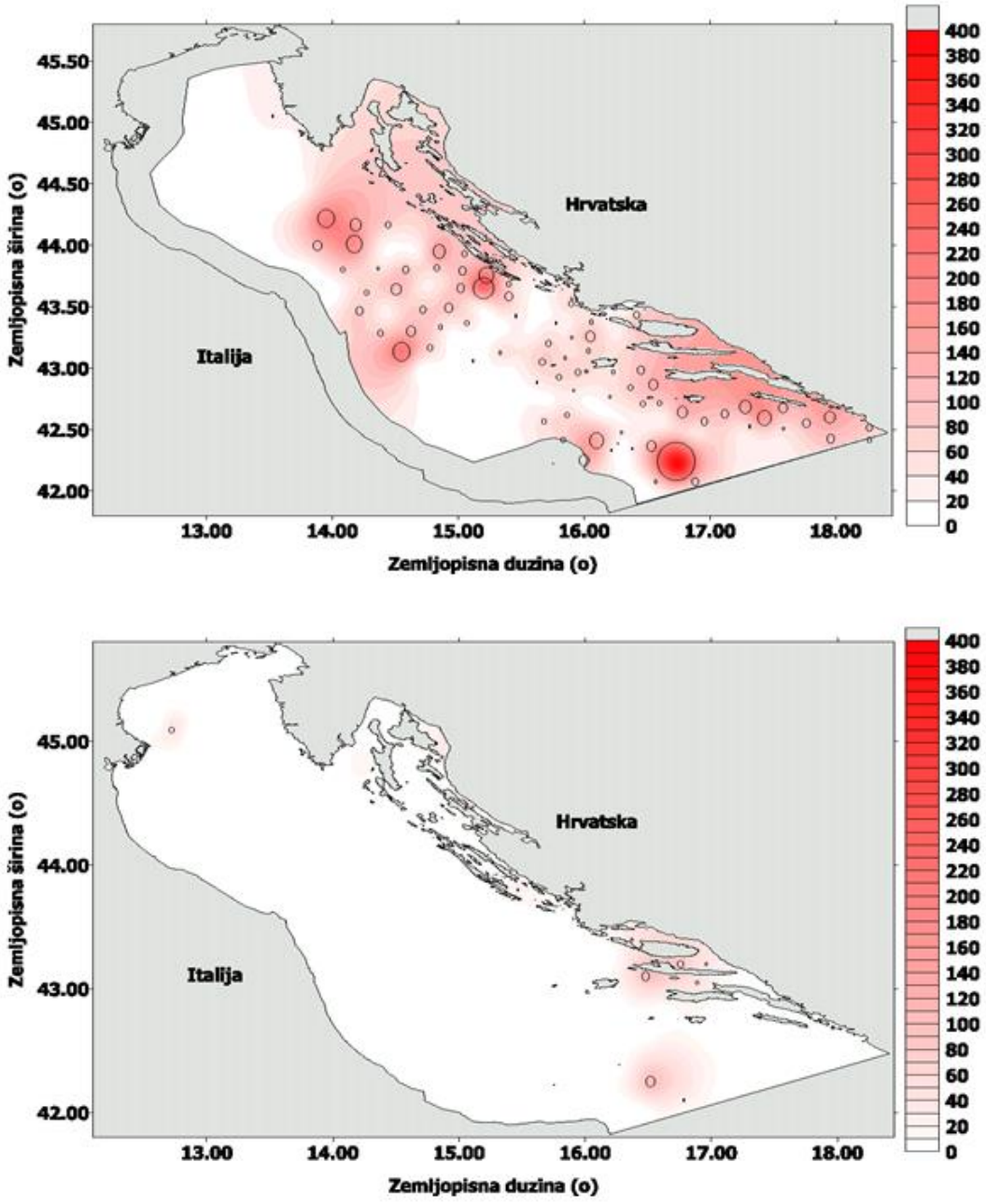


Fig. 20b Abundance and distribution of the bottom elasmobranchs Medits Trawl Survey - (31)

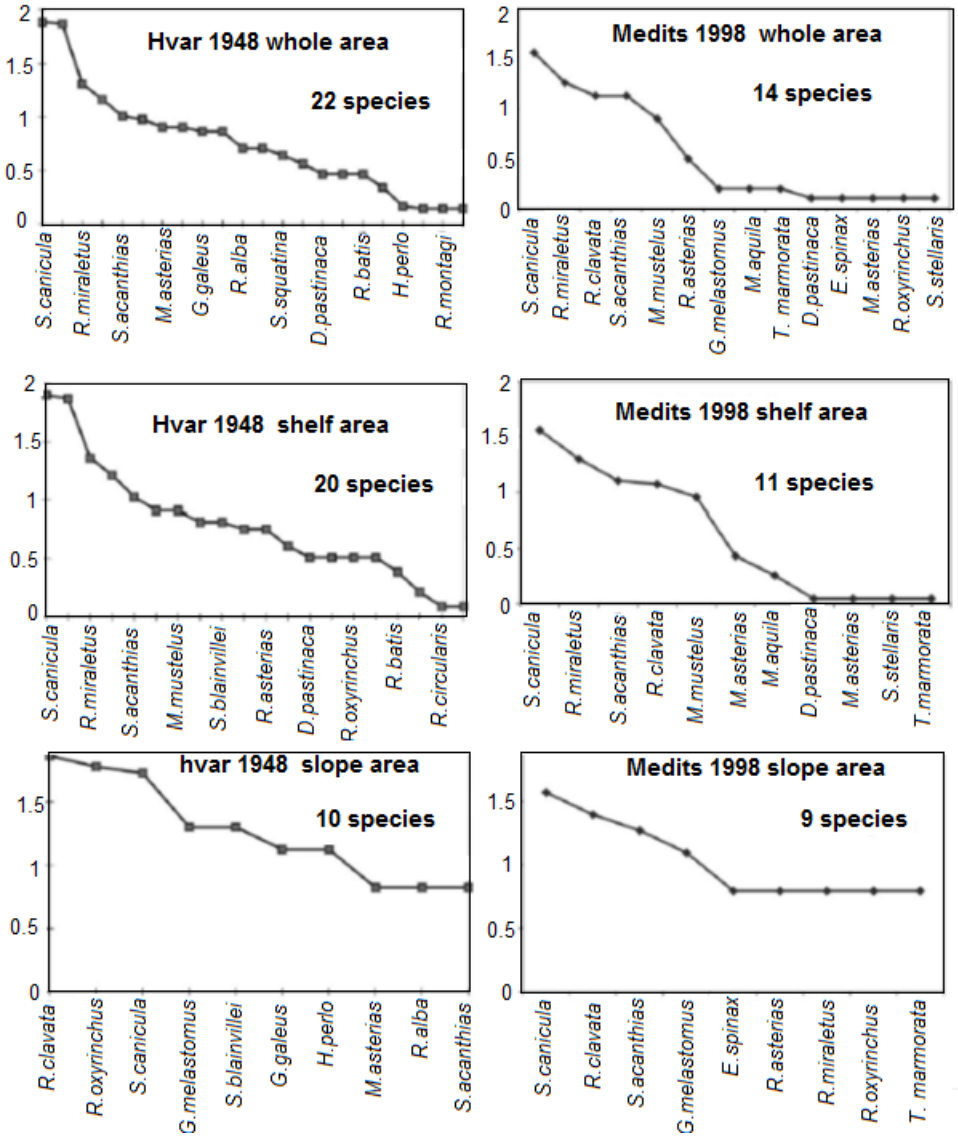


Fig. 21 Occurrence (frequency log-transformed data) of elasmobranchs collected during the bottom trawl surveys “Hvar 1948” and “Medits 1998” (31).

Changes in community structure of the bottom Adriatic elasmobranch can be observed even when analyzing data on change of the percentage of positive sampling stations where elasmobranchs were recorded. Highest decline in the abundance area where observed for smallspotted catshark, *Scyliorhinus canicula* and thornback ray, *Raja clavata* which as 2nd and 3rd most abundant species in 1948 fall to 22nd and 50th place in 1998.

Comparing the abundance data from the stations where elasmobranchs where recorded during both surveys reveals that for the most of the species abundance and distribution were significantly declined (3).

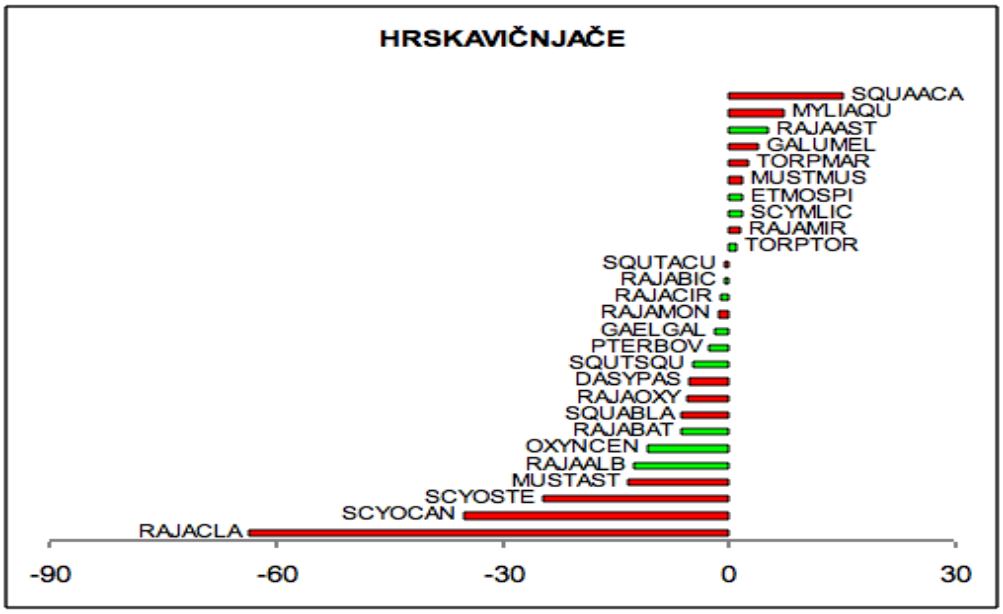


Fig. 22 Change of abundance of the bottom elasmobranchs in percentage of stations where species where recorded during 5 year period (1948-1998) (red colour indicates a species recorded during both surveys, while green colour is indicating species observed only during the first survey) (20).

	TOTAL		TO 50 m		50 - 100 m		100 – 200 m		OVER 200 m	
SPECIES	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**
Dalatias licha	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,12
Dasyatis pastinaca	8,87	0,31	27,00	0,00	11,96	0,86	0,00	0,00	0,00	0,00
Etmopterus spinax	0,00	0,01	0,00	0,00	0,00	0,00	0,00	0,00	0,00	0,10
Gaelorhinus galeus	1,28	0,00	0,00	0,00	0,00	0,00	2,84	0,00	2,33	0,00
Galeus melanostomus	0,12	0,96	0,00	0,00	0,00	0,00	0,00	0,00	1,19	9,43
Mustelus asterias	8,82	0,28	23,64	0,00	1,69	0,77	5,19	0,00	1,73	0,00
Mustelus mustelus	14,16	7,88	95,13	42,88	0,00	1,19	0,75	0,63	0,00	0,00
Myliobatis aquila	0,67	9,98	1,10	57,67	1,35	0,74	0,00	0,00	0,00	0,00
Oxynotus centrina	3,63	0,00	4,24	0,00	6,29	0,00	1,75	0,00	0,00	0,00
Pteromylaeus bovinus	5,78	0,00	34,34	0,00	0,00	0,00	0,00	0,00	0,00	0,00
Raja alba	8,26	0,00	8,85	0,00	16,49	0,00	2,21	0,00	0,00	0,00
Raja asterias	0,00	0,52	0,00	1,75	0,00	0,15	0,00	0,16	0,00	1,13
Raja batis	3,81	0,00	0,00	0,00	2,71	0,00	2,37	0,00	19,21	0,00
Raja bicolor	0,73	0,00	0,00	0,00	0,00	0,00	1,98	0,00	0,00	0,00
Raja circularis	0,20	0,00	0,00	0,00	0,00	0,00	0,55	0,00	0,00	0,00
Raja clavata	65,25	4,48	34,11	0,00	86,03	7,17	63,76	3,83	48,38	4,73

	TOTAL		TO 50 m		50 - 100 m		100 – 200 m		OVER 200 m	
SPECIES	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**	**HVAR**	**MEDITS**
Raja miraletus	2,07	3,49	0,70	0,76	3,58	8,46	1,77	0,83	0,00	0,00
Raja montagui	0,15	0,03	0,00	0,00	0,11	0,00	0,29	0,08	0,00	0,00
Raja oxyrhynchus	2,53	0,12	0,00	0,00	0,00	0,00	1,28	0,00	20,21	1,15
Scyliorhinus canicula	46,99	14,24	25,84	15,00	63,01	23,84	50,41	6,68	12,75	6,20
Scyliorhinus stelaris	8,34	1,91	12,91	0,04	9,61	4,91	7,30	0,35	0,00	0,00
Squalus acanthias	4,01	10,96	8,77	46,10	2,16	6,41	4,76	1,79	0,00	2,19
Squalus blainvillei	1,85	0,32	0,00	0,00	0,00	0,15	3,39	0,00	5,92	2,60
Squatina acuelata	0,01	0,00	0,00	0,00	0,00	0,00	0,03	0,00	0,00	0,00
Squatina squatina	2,61	0,00	0,00	0,00	3,21	0,00	2,68	0,00	4,50	0,00
Torpedo marmorata	0,59	0,09	0,00	0,00	1,62	0,15	0,00	0,09	0,00	0,06
Torpedo torpedo	0,00	0,01	0,00	0,00	0,00	0,01	0,00	0,00	0,00	0,00

Table 8. Landings of the bottom elasmobranchs (kg/km2) during Hvar (1948.-49.) and MEDITS (1996-98.) survey with relation to depth stratums (1).

Comparing biomass indices data of the bottom elasmobranchs with depth stratums reveals that the strongest decline of the bottom elasmobranchs biomass was observed in western Adriatic area (Italian territorial waters) where contribution of the elasmobranchs in total biomass declined from 27 % to 3,12%, then in the open Adriatic area where decline from 29,48% to 9,28% was observed, while the lowest changes were observed in the eastern Adriatic (Croatian territorial waters), with observed decline from 33,58% to 28,64% (20). Hence, within all elasmobranchs stronger decline was observed in the case of Rajiformes group than in Squaliformes group.

Spatial and temporal changes in the Adriatic's elasmobranch community have been studied using data from five different scientific trawl surveys carried out in the Adriatic since 1948

temperature), fishing effort data, and historical fishing information to explain the observed trajectories of population and community changes.

Overall, 33 small, demersal, meso-predatory elasmobranch species were recorded, composed of 12 sharks, 20 rays and one chimaera species. Of these, 11 species ceased to be detected during the period of observation (no more occurrences after the year 2000) while 6, mostly deep-water species and small skates, were only recently detected by the MEDITS surveys which expanded to greater sampling depths. Also, it was detected that over time, moving to the most recent survey, richness and abundance of elasmobranchs decreased toward more flattened and truncated distributions (23).

By analyzing trawl surveys carried out in the area over the last six decades, a structurally depleted elasmobranch community was detected (24). The high elasmobranch abundance and diversity characterizing the central Adriatic during the Hvar survey in 1948–49 disappeared. Yet, species richness and abundance were higher in the eastern coastal areas than elsewhere. Elasmobranch abundance in Croatian territorial waters was almost one order of magnitude higher than in Italian, where sharks and rays were largely absent except for a relatively high-density zone in the upper Adriatic (above the 50 m isobath,) mainly composed of spurdogs, smooth-hounds, and eagle rays. Overall, sharks declined stronger than rays (−95.6% vs. −87.7%), and more shark than ray species recorded significant declines (23).

Although there are no any species specific statistics data for a group of pelagic sharks it is presumed that these species are generally even more endangered in the Adriatic than the bottom ones. Pelagic species occurring in the Adriatic are generally larger than bottom elasmobranchs and exhibit life history traits that confer on most a low intrinsic rate of population increase; they mature late and have long life spans. Hence, after a long gestation period (typically 9–18 months) they give live birth to few well-developed offspring with a relatively high probability of surviving through to adulthood. The slow life-history characteristics and low population growth rates of sharks render them less able to withstand fishing mortality than the earlier-maturing, shorter-lived bony (teleost) fishes with which they are frequently captured as a bycatch. Many of these species are caught regularly as bycatch in widespread longline, purse seine, and gillnet fisheries targeting more productive tuna, swordfish and other billfish, as well as midwater trawl fisheries for small pelagic fish, but never officially reported.

Currently, most of a large pelagic elasmobranch species in the Adriatic have been considered as rare or very rare, although, previously, e.g. great white shark, *Carcharodon carcharias*, and *shortfin mako, Isurus oxyrinchus,* were considered as relatively common species of this area (47). The presence of great white shark in coastal waters of the eastern Adriatic was related with high abundance of tuna in these waters during 19th century and first half of 20th century, which were their major prey (48). The start of intensive tuna fishing in open waters of the Adriatic, especially during the 70's, caused the disappearance of tuna in coastal waters of the eastern Adriatic, and as a consequence the disappearing of the great white shark records in these waters. Data on shortfin mako have showed even more severe decline of its abundance. Of total of 48 records, since 1868, 43 were reported during 19th century and since 1972 there were no more records of this species in the Adriatic (48).

The sand tiger shark (*C. taurus*) and the smalltooth sand tiger (*O. ferox*), were previously reported often, but in recent years there are no records of them (45, 47). The thresher shark

(*A. vulpinus*), was common in the eastern Adriatic and was caught, as bycatch, in purse seines and by tuna longlines, like the blue shark (*P. glauca*). However, although both species were considered as the most common species of large sharks in the Adriatic, latest investigations clearly point out that their status of common species is no longer valid, as their populations are probably more depleted than previously thought. During a large shark research (45) various chum techniques were used for attraction of the sharks, with chum stations sunk to various depths, including below the thermocline. Eight complete 24 hour periods were chummed with eleven further days of chumming activity between 3,5 and 23 hours, producing the total of 308,5 hours of chumming. The research was conducted in the area of Jabuka pit (Blitvenica area), the most important fishing area in the Adriatic and the most popular area for big game fishing and shark encountering. However, only nine records of blue sharks have been reported that were caught and released or sighted round boats, while no other species of sharks have been seen during the entire period of the research (49).

Big game fishing regularly targeted tresher and blue shark, but fishermen involved in that activity have observed rapid decline of those species in their catches during last few years (47).

Similar results for a thresher shark *A. vulpinus* were reported in the northern Adriatic Sea, a decline for recreational catches of about 80,82% over a 11 years period (24).

During the research on the large pelagic sharks caught incidentally in the swordfish and tuna fisheries of the Mediterranean, that was carried out during three year period from 1998 to 2000, relatively large catches of blue shark were reported (1,00 fish / 1000 hooks), but only 8 records of thresher, 2 records of smooth hammerhead *Sphyrna zygaena*, 1 record of a porbeagle *Lamna nasus*, while no records of any other species in the Adriatic Sea (36).

Only in the case of the basking shark, *Cetorhinus maximus*, there has been a notable increase in records reported in the eastern Adriatic since 2000, especially during 2001. This unusual phenomenon was related to changes in zooplankton abundance, mainly of copepod species, with particular emphasis on *Calanus helgolandicus*, on which basking shark prey (50).

It is of great importance to identify critical habitats, namely mating areas, spawning and nursery grounds of all shark species in the Adriatic. The available data suggest that the Adriatic is a nursery and spawning area for many large shark species: C. plumbeus and A.vulpinus in the northern part, for *P. glauca* and *O. centrina* in the central part, and for *L. nasus* in southern/central Adriatic (45,47).

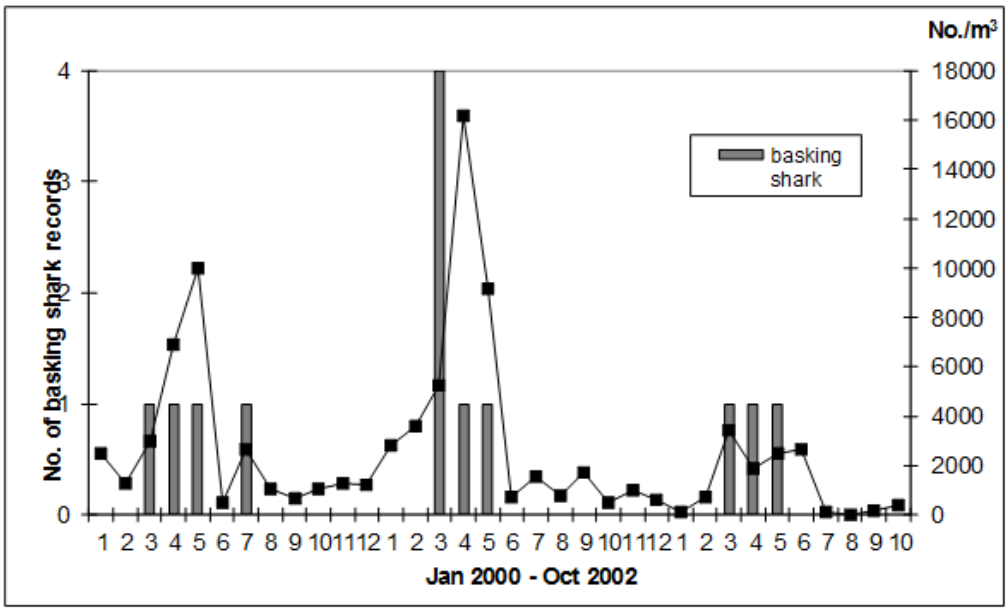


Fig. 23. Monthly occurrence of basking sharks in the northern Eastern Adriatic in relation to mean monthly values of copepods in period January 2000 – October 2002 (50).

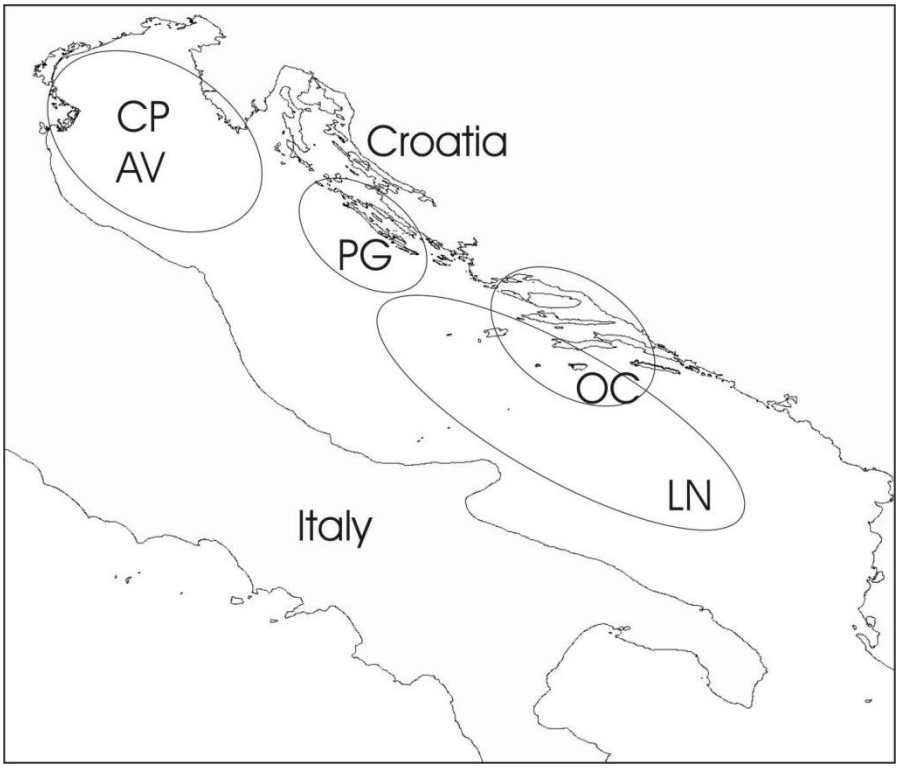


Fig. 24 Possible nursery areas in the Adriatic for *Carcharhinus plumbeus* (CP), *Alopias vulpinus* (AV), *Prionace glauca* (PG), *Oxynotus centrina* (OC), and *Lamna nasus* (LN) (45,47).

It is obvious that bottom trawls used in the Adriatic are absolutely not selective toward any of elasmobranch species. Mesh sizes of codends varies between Adriatic's countries from 40 mm to 50 mm. Consequently, such mesh size is not permitting an escape from trawl to any elasmobranch juvenile, regardless of species. Due to multispecies characteristic of Adriatic bottom trawl fishery it cannot be expected in future a significant increase of a minimum trawl mesh size that will benefit elasmobranch populations. Thus, only option for a enhancement

of a trawl selectivity toward elasmobranch could be a use of Bycatch Reduction Devices, similar to those used for marine turtles - TED (Turtle Excluding Device). Such device could be an effective solution for the escape of unwanted animals, especially elasmobranchs, as it is already used in other areas. On the other side, selectivity of longlines, bottom and pelagic, can be increased by changing of a shape and size of a hooks, reducing setting time (elasmobranchs are attracted by captured prasy), avoiding certain types of bait (sharks are more attracted by squid than fish), determining a proper setting of longline at day and by depth (most of the sharks are caught during the night at surface) etc.

As far as driftnet fishery is concern, this gear known as spadare, essentially used by a Italian fishing fleet, although it is considered as the second most important in the Mediterranean swordfish fishery, is banned by EU. Thus, its use in the Adriatic is forbidden. Various species of elasmobranches are caught by this fishing gear, while the bycatch of three species, the blue shark, the shortfin mako and the thresher shark is estimated at 100,000 individuals each year.

However, although the use of driftnets was banned, fishing with legal driftnet called ferrettara continued and it catches are unknown.

Most of the Adriatic countries have adopted specific legal measures for protecting *Cetorhinus maximus* and *Carcharodon carcharias*, which means that catch, retention on board, transshipment and landings are prohibited. Hence, since 2009 Croatia have granted strictly protected status to 23 chondrichthyan species, which is the highest level of protection, according to Croatian regulations (51).

Carcharhinus plumbeus	*Odontapsis ferox*
Prionace glauca	*Dasyatis pastinaca*
Sphyrna zygaena	*Gymnura altavela*
Galeorhinus galeus	*Mobula mobular*
Heptranchias perlo	*Pristis pectinata*
Hexanchus griseus	*Dipturus batis*
Alopias vulpinus	*Dipturus oxyrinchus*
Cetorhinus maximus	*Rhinobatos rhinobatos*
Carcharodon carcharias	*Oxynotus centrina*
Isurus oxyrinchus	*Squatina oculata*
Lamna nasus	*Squatina squatina*
Carcharias taurus	

Table 9 Species granted by strictly protected status in Croatia.

6. Aquaculture production

Italy

The geographical distribution of the Italian aquaculture areas is characterized by valliculture i.e. aquaculture production inside coastal lagoons. The “valli da pesca” producing sea bass and sea bream are located in confined coastal lagoon environments in Veneto and Emilia Romagna (12).

Valliculture in the Northern Adriatic accounts for 66 percent of the confined wet lands used or fish farming, and 87 percent of the extensive units in Italy supplying about 70 percent of the aquaculture production from coastal lagoons.

The regional distribution of marine species production units shows a greater concentration of land-based farms in the Northern Adriatic (Veneto, Puglia and Friuli Venezia Giulia), while over 60 percent of the cage-based mariculture installations are concentrated in the Southern Adriatic and account for only 35 percent of the total.

A process of conversion to modern mollusk farming practices occurred in the late 1980s with the introduction of a new species, the Manila clam (*Tapes philippinarum*) into the Upper Adriatic lagoon farms, and the development of a new culture technique. During the same period, the introduction of off-shore technologies in mussel farming allowed the open sea areas to be cultured. Shellfish culture is mainly based on mussels (*Mytilus galloprovincialis*) and Manila clams (*Tapes philippinarum*) which has replaced the local clam (*Tapes decussatus*) . Major productive sites are concentrated in the western areas, from Trieste to the Gargano promontory.

Figure 25 shows the geographical distribution of farms. The 323 operational freshwater fish farms are concentrated in the North of the country, prevalently in the Veneto, Friuli Venezia Giulia, Trentino Alto Adige, Lombardy, Emilia-Romagna and Piedmont regions and the following fish are farmed: trout *(Oncorhynchus mykiss, Salmo trutta fario*), char (*Salvelinus spp*.), sturgeon (*Acipenser spp., Huso huso*), and eel (*Anguilla anguilla*).

In Central Italy there are other trout farms, in particular in Umbria and in the Marche regions. Marine farms are distributed along the entire Italian coastline, with a relative concentration in the Upper Adriatic Sea, with the farming stock being mainly sea bream (*Sparus aurata*) and sea bass (*Dicentrarchus labrax*), sometimes associated with other minor species such as meagre (*Argyrosomus regius*).

Shellfish farms are prevalently located in the Adriatic Sea from Grado to the Gargano and in few other specific locations in the South and in Sardinia. The prevalent species are mussels *Mytilus galloprovincialis*) and the Japanese carpet shell (*Ruditapes philippinarum*).

Venetian lagoon pole: Mariculture is practiced in 14 long-line farms for Mediterranean mussel (*Mytilus galloprovincialis*) culture along the coastal strip between the Cavallino-Treporti shoreline and the island of Pellestrina. The estimated production of Mediterranean mussel is about 5,000-6,000 tons/year. Shellfish farming in the Venetian lagoon has recorded an average production in the last 10 years of around 25,000 tons/year for Japanese carpet shell, *Ruditapes philippinarum*, and around 2,000-2,500 tons/year for mussels.

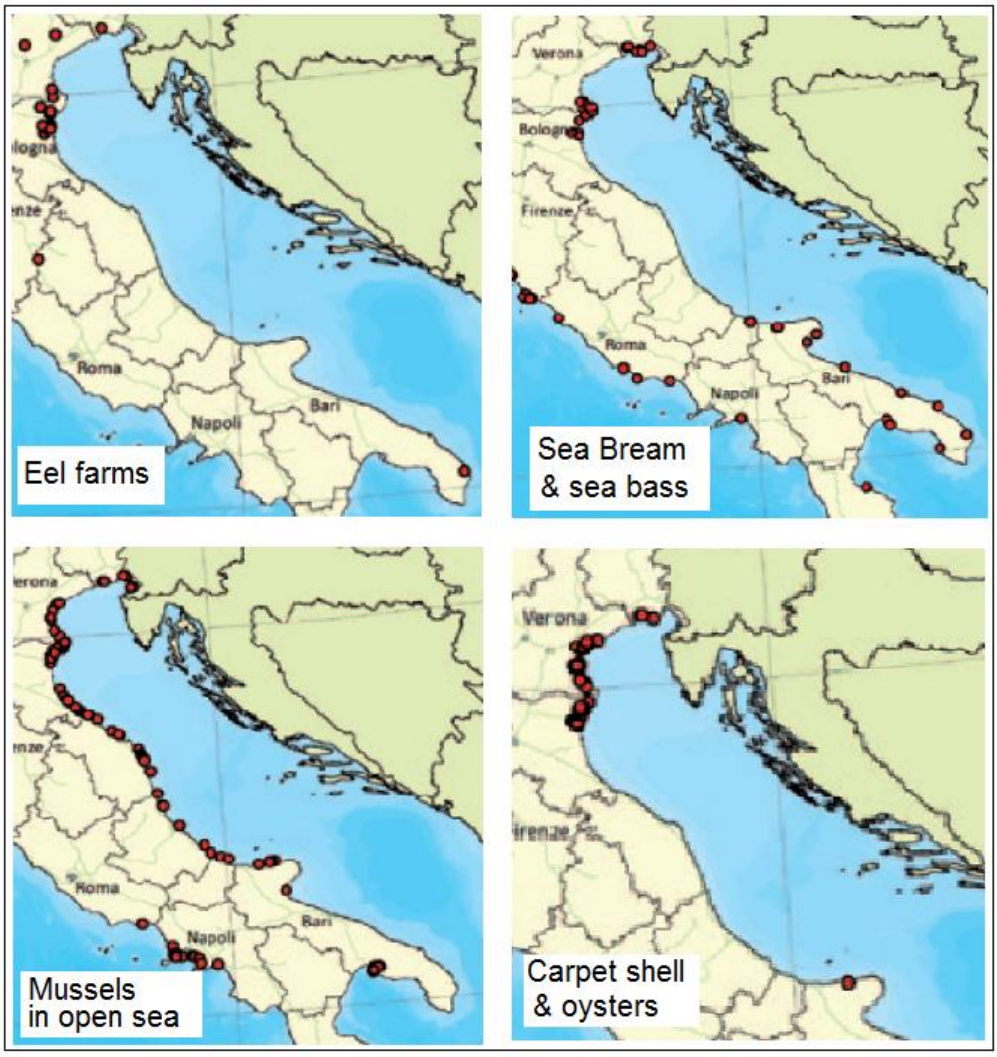


Fig. 25 Geographical distribution of farms (12)

Croatia

Croatian mariculture predominantly includes the production of seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*) in floating cages and bluefin tuna (*Thunnus thynnus*) in offshore floating systems. Seabass and seabream are reared intensively in floating cages, in shore, or semi-offshore. There are four hatcheries producing about 30 percent of the amount needed, and the remaining 70 percent is imported mainly from Italy and France (12).

There is an ancient shellfish culture tradition in this area. The production (*Mytilus galloprovincialis* and oyster *Ostrea edulis)* on long lines is organized mainly on the middle coastal islands and all the Croatian shellfish production is concentrated in the Bay of Mali Ston, the River Krka estuary, and Istria. As mariculture activities have rapidly expanded during the last five years, mainly due to tuna farming, competition with other coastal area users has increased. The main competitor is tourism, followed by the local fishing communities.

Since 1996 the tuna fattening of bluefin tuna *(Thunnus thynnus)* in Croatia has developed rapidly due to the high prices offered by the Japanese market. Bluefin tuna in the Adriatic Sea are mostly fished by purse seine for farming purposes. After capture they are kept in semi-offshore floating cages and fed for a 2 to 3-year period. During this period, they were fed with a variety of small pelagic species.

The total tuna production is exported to Japan. Due to the restricted national quota for tuna fishing, and also to the fact that there are not frequent giant tunas in the Adriatic Sea, about 50 percent of tuna for farming purposes is imported from Italy, Spain and Tunisia (12)

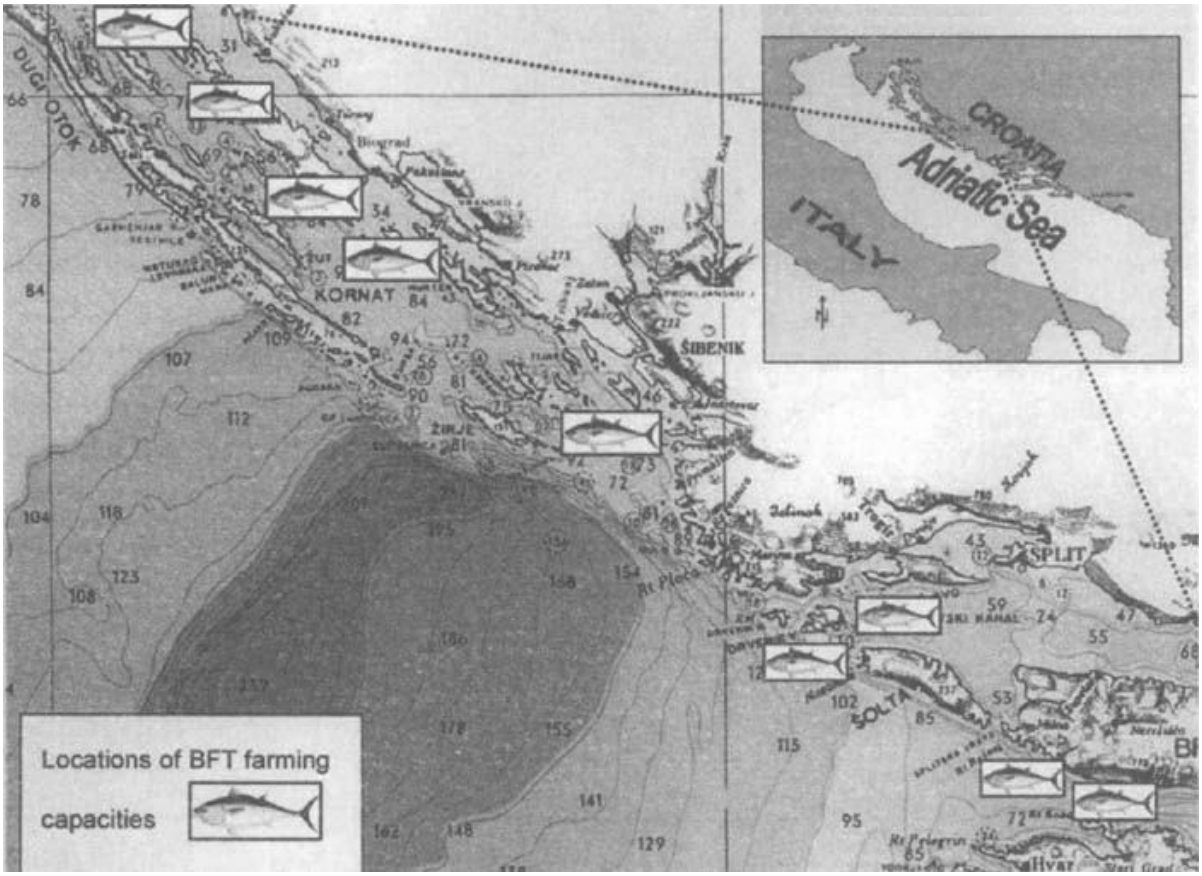


Fig. 26. Locations of Bluefin Tuna fattening ranches.

Albania

Marine aquaculture is a recent activity in Albania and it is concentrated in limited areas, particularly in the southern coast in Saranda. From 2002 Albanian marine fish farming in floating cages produces seabream (*Sparus aurata)* and seabass (*Dicentrarchus labrax*).

Montenegro

On the Montenegrin coast there is only one fish farm within the Boka Kotorska Bay in the locality of Ljuta. In this farm seabream (*Sparus aurata*) and seabass (*Dicentrachus labrax*) have been reared since 1998.

Slovenia

Slovenian marine aquaculture never reached great importance at the commercial level. The species reared are seabass (*Dicentrarchus labrax*) and seabream (*Sparus auratus*) and there are only 3 farms which rear only blue mussel (*Mytilus galloprovincialis*). Because of limited natural resources (short coastal area) marine aquaculture has never had a real basis for fast growth. Farms for mollusks and fish are located in the same basin (Piran Basin), where mollusks are produced in a standard manner and fish are cultured in cage systems.

7. Data to build GIS layers of the spatial distribution of both fisheries resources and relevant fishing activities

In the last 30 years, an important amount of environmental and fisheries related information in the Mediterranean has been collected from different sources like national and EU funded research projects and studies, data collection framework and surveys at sea (GRUND and MEDITS in particular). Existing information is mostly dispersed and refers to different spatial and temporal scales. Georeferenced organization of this information by using Geographical Information System techniques will allow making this information homogeneous and improve their usability. Most of the original data are still not available to the scientific community at large as the accessibility to datasets by end users is generally limited, however it is more and more possible to overcome this problem by collaborating with the scientific bodies in charge of the databases management; furthermore some mapping of the Adriatic marine resources already published are available.

Since 1982, the Italian government has provided financial support for scientific and technical research on biological resources evaluation to improve marine fisheries management. In this framework, national experimental trawl surveys started in 1984 on a seasonal basis. All Italian seas (except part of the Ionian Sea east of Sicily) were considered; 15 Operative Units including more than 120 researchers and technicians were involved with 17 motor-trawlers. The collected data were uploaded in a data bank, which first application -thanks to the financial support of the European Commission and the Italian Agricultural Politics Ministry- has been the use of the data collected in the years 1985 to 1987 to produce an atlas (4) of distribution and abundance of the 10 main Italian demersal species *(Aristaeomorpha foliacea, Aristeus antennatus, Parapenaeus longirostris, Nephrops norvegicus, Eledone cirrhosa, Octopus vulgaris, Phycis blennoides, Micromesistius poutassou, Merluccius*

merluccius and *Mullus barbatus* in spring and summer towards a Geographic Information System based on ARC/INFO (fig. 2).

Contacts for Experimental GRUND trawl surveys in the Adriatic:

Operational Unit n° 12 - Laboratorio di Biologia Marina e Pesca di Fano, Prof. C. Piccinetti

Operational Unit n° 13 - Laboratorio Provinciale di Biologia Marina, di Bari, Prof. G. Marano

Operational Unit n° 14 - Istituto Sperimentale Talassografico del CNR, Taranto e Istituto di Zoologia e Anatomina Comparata dell'Università di Bari, Prof. A. Tursi

In 2000 an Arc-View extension software which provides the geographical representation of abundance indices relative to MEDITS surveys was presented in Madrid at the meeting of the Scientific Advisory Committee of the GFCM. This Extension uses a database providing the basic standard files of the MEDITS surveys. It is already available in a CD which supplies suitable to be used by any researcher, not only MEDITS partners.

Contact for Experimental MEDITS trawl surveys:

Dr Anna Maria Spedicato, MEDITS project leader, COISPA Tecnologia & Ricerca s.c.r.l. Via dei Trulli 18/20, 70126 Torre a Mare (Bari) E-mail: coispa@tin.it

In 2008 the EU Council Regulation No 199/2008 concerning the establishment of a Community framework for the collection, management and use of data in the fisheries sector and support for scientific advice regarding the Common Fisheries Policy regulation underlines that It is in the interest of the scientific community that data which does not allow for personal identification is available to any party who has an interest in its analysis. These data, in particular those georeferenced collected during the MEDITS surveys at sea are relative to the hauls, catches by species, and size and maturity status and are put into national computerized databases and they are accessible to the Commission and Member States shall make detailed and aggregated data available to end-users to support scientific analysis as a basis for advice to fisheries management, including to Regional Advisory Councils, in the interest of public debate and stakeholder participation in policy development and for scientific publication.

According to the 199/2008 regulation Member States shall transmit detailed and aggregated data in a secure electronic format. Where detailed and aggregated data are requested for scientific publication, Member States may, in order to protect the professional interests of the data collectors, withhold data transmission to the end-users for a period of three years following the date of collection of the data. Member States shall inform the end-users and the Commission of any such decisions. In duly justified cases the Commission may authorize that period to be extended.

The end-users of data shall be responsible for correct and appropriate use of the data with regard to scientific ethics; they shall inform the Commission and the Member States concerned of any suspected problems with the data and provide the Member States concerned and the Commission with references to the results of the use of the data.

In order to obtain access rights, end users need to contact the national correspondents for the EU data collection, or submit a request by sending an e-mail to the following address: datasubmission@jrc.ec.europa.eu (Contact information : STECF secretariat, TP 051, 21027 Ispra (VA), Italy)

More recently one of the objectives of the MEDISEH project (which is part of the EU consortium MAREA “Mediterranean Halieutic Resources Evaluation and Advice” project consortium regards the Mediterranean Sensitive Habitats. It consists in compiling historical

and current data from the Mediterranean regarding in particular: (1) habitats protected under the Mediterranean regulation, (2) nursery areas and spawning aggregations of demersal and small pelagic fish and (3) areas under any form of protection within national and international legislation. The final target is the Compilation and mapping of environmental and fisheries related information in the Mediterranean Sea by means of Geographical Information Systems.

MEDISEH Contacts:

- MEDISEH Coordinator: Dr M. Giannoulaki (HCMR), marianna@hcmr.gr
- Task 1.4 Reviewing and mapping of all types of existing marine protected areas in different GSAs in the Mediterranean basin; Scientific Responsible: C. Smith (HCMR), csmith@hcmr.gr
  Partners involved: HCMR, CoNISMa, CNR-IAMC, CNR-ISMAR, COISPA, IEO, CIBM, MRRA
- Task 2.1 Mapping of nursery and spawning grounds of small pelagic fish Scientific Responsible: Dr M. Giannoulaki (HCMR), marianna@hcmr.gr Partners involved: HCMR, CNR-IAMC, CNR-ISMAR, IEO
- TASK 2.2 Mapping of nursery and spawning grounds of demersal fish Scientific Responsible: Dr F.Colloca (CNR-IAMC), francesco.colloca@iamc.cnr.it Partners involved: CIBM, COISPA, HCMR, CNR-IAMC, CNR-ISMAR, IEO, CoNISMa
- WP3. GIS rendering: GIS Toolbox and geo-reference database Scientific Responsible: V. Valavanis (HCMR), vasilis@hcmr.gr Partners involved: HCMR, CNR-IAMC, CNR-ISMAR, IEO,CIBM

8. Likely development of fishing activities within the area in the future

Fishing capacity of the Northern and Central Adriatic Sea trawler fleet, as identified with the quantity of capital and is often associated with the variables of gross tonnage (GT) and engine power has undergone a constant reduction over the last decade (fig.27)

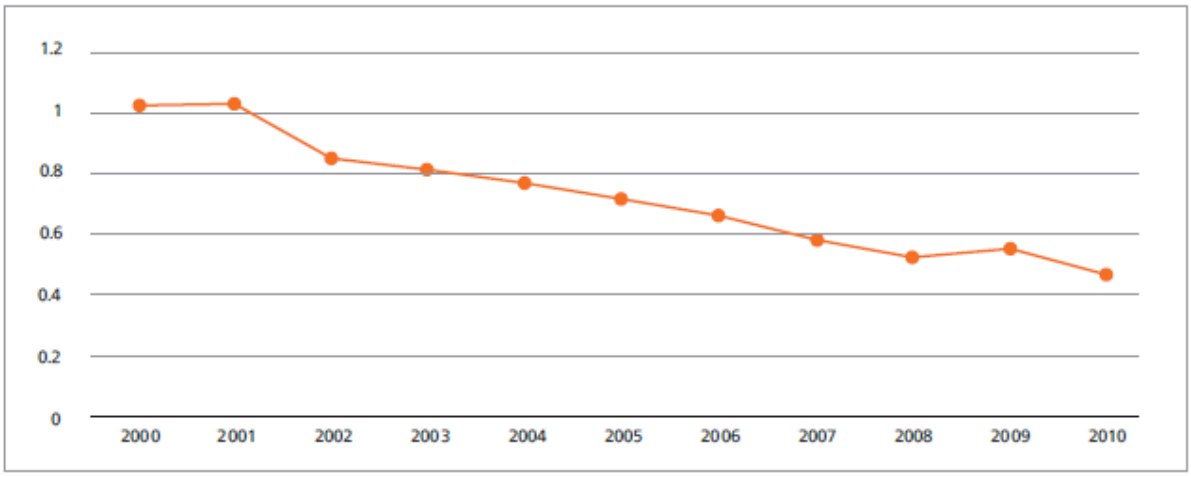


Figure 27 Total fishing day trends for the Northern and Central Adriatic trawler fleet for the period 2000-2010, index numbers (base year 2000) - Source: MiPAAF-Irepa.

According to the recent GFCM analyses, the examination of management dynamics shows that the reduction of the fishing capacity, together with the fishing effort, in the case of trawler fishing in the Adriatic has not produced stable results in terms of sustainability and stock recovery. Despite a significant reduction of both fishing capacity and activity, CPUEs in the last three years have shown a worrying decrease that indicates a decline in fishable biomass that is proportionally greater than the reduction in the fishing effort.

Reversal of the current trends requires the adoption of management systems capable of intervening effectively in productive and environmental dynamics in order to achieve long-term sustainability. This is necessary to ensure both the conservation of fish resources and the survival of economic activities providing stable incomes and employment.

The Fisheries Restricted Areas

The Italian fisheries legislation (Art. 98 of Presidential Decree 1639/1968) set out the possibility of limiting or prohibiting fishing operations in certain marine areas that have been recognized as spawning or nursery areas for economically important marine species or in areas that have been depleted due to over-exploitation. This law establishes the setting up of Fisheries restricted areas specifically for fishing activities and predates by about 15 years the legislation on Marine Protected Areas (1982). There are many provisions that directly or indirectly limit the areas where fishing is permitted, but establishing Fisheries restricted areas remains the most rapid and suitable tool for protecting commercial fish species.

Fig.28 Location of the main Adriatic Fisheries restricted areas (Unimar,2008).

The fisheries management plan project

A technical paper presented at the 13th Coordination Committee of AdriaMed in 2012, included information for the elaboration of a management plan of the Jabuka/Pomo Pit area, namely: preliminary information on additional data from trawl survey in the Central Adriatic in summer 2011; suggestions regarding the mesh size to propose for bottom trawls; future effort restrictions and temporal closures; monitoring through biological surveys and socio-economic surveys to assess the impact of fishing activities and the consequence of fishing effort management options.

The general objectives of the sub-regional plan for small pelagic fisheries in the Adriatic Sea are:

1) To manage the small pelagic fisheries in the Adriatic Sea to provide significant social and economic benefits to range States, in accordance with established national goals, while maintaining stocks within safe biological limits.

2) To manage the fishing capacity of range States to ensure equal opportunities for the sustainable development of fishing activities, while avoiding a situation of overcapacity that may threaten the conservation and rational use of fisheries resources.

In relation to the General Objective (1) the operational objective should be to maintain the biomass of sardine and anchovy above agreed precautionary biological reference points (B > Bpa). In the absence of a reference point for biomass, fishing mortality should be kept at values which minimize the risk that stock sizes fall below minimum biological acceptable level.

In relation to General Objective (2) the operational objective should be to develop a plan of action for the management of the fishing capacity of the small pelagic fisheries in the Adriatic Sea.

This Plan of action should be developed in accordance to FAO International Plan of Action on the Management of Fishing Capacity (IPOA-Capacity) and to any adopted Regional Plan of Action for the Management of Fishing Capacity (RPOA-Capacity) for the Mediterranean.

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