Adriatic Sea Fisheries: outline of some main facts

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Abstract

Following a brief introduction to some principal characteristics of the Adriatic Sea, the paper focuses on two main aspects of Adriatic Sea fisheries: fishery production and the fishing fleet. The evolution of capture fisheries landings over thirty years (1970-2000) is outlined: demersal and pelagic fishery production is compared and the quantities landed of some key shared stocks are described. The evolution of the Adriatic fishing fleet is reported in terms of number of fishing units, length category and fishing technique. The importance of basic reliable, comparable and easily integrated statistics is underlined; in the case of Adriatic shared fisheries the need for international cooperation is fundamental together with increased multidisciplinary analysis for the management of shared fishery stocks for the achievement of effective sub-regional fishery management.

1. Brief introduction to the Adriatic Sea

The Adriatic Sea is a semi-enclosed[1] basin within the larger semi-enclosed sea constituted by the Mediterranean, it extends over 138000 km^2 (Buljan and Zore-Armanda, 1976) it may be seen as characterised by Northern, Central and Southern sub-basins with decreasing depth from the south toward the north. Along the longitudinal axis of the Adriatic geomorphological and ecological changes can be observed, resulting in the remarkable differences of the northern and southern ends. Six countries, whose coastline development differs greatly, border the Adriatic. Some key-features of Adriatic coastal states for which marine fisheries are relevant are given in Table 1.

The Adriatic 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 (Figure 1).

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 characterised by relict sand (Alfirević, 1981). 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 (Bombace, 1990).

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[1] Semi-enclosed and enclosed seas are here defined according to Art. 122 of the United Nations Convention on the Law of the Sea (1982) as follows: "… a gulf, maritime basin or sea surrounded by two or more States and linked to another sea or to the ocean via narrow straits of exit, or entirely or mostly made up of territorial seas and exclusive economic zones of two or more coastal States".

The hydrography of the region is characterised 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 (Buljan and Zore-Armanda, 1979; Artegiani *et al*., 1981).

Table 1. Some data on Adriatic coastal states participating in AdriaMed.

	Notes	Albania	Croatia	Italy	Serbia-Montenegro	Slovenia
Coastline*(km)	The total length of the boundary between the land area (including islands) and the sea.	362	5835 (mainland 1777 km, islands 4058 km)	7600 (inclusive of Ionian and Tyrrhenian coastline)	199	47
Population* (July 2002 est.)		3 544 841	4 390 751	57 715 625	10 656 929	1 930 132
Population growth rate*	Annual population growth rate.	1.06% (2002 est.)	1.12% (2002 est.)	0.05% (2002 est.)	-0.12% (2002 est.)	0.14% (2001 est.)
Gross Domestic Product (GDP - real growth rate)*	Measure of the economy of a country; the total market values of goods and services produced and capital within the country borders during a given period.	7.3% (2001 est.)	4% (2001 est.)	1.8% (2001 est.)	3.5% (2002 est.)	4.5% (2000 est.)
Education index, 1999 **	Based on the adult literacy rate and the combined primary, secondary and tertiary gross enrolment ratio.	0.80	0.88	0.94	n.a.	0.94
Human development index (HDI) value, 1999 **	A composite index measuring average achievement in three basic dimensions of human development—a long and healthy life, education and knowledge and an acceptable standard of living.	0.72	0.80	0.90	n.a.	0.87
Urban population (as % of total) 1999 **	The mid-year population of areas defined as urban in each country, as reported to the United Nations.	41	57.3	66.9	n.a.	50.3
Infant mortality rate (per 1,000 live births) 1999 **	The probability of dying between birth and exactly one year of age expressed per 1,000 live births.	29	8	6	17*	5
Diffusion of recent innovations: Internet hosts (per 1,000 people) **	A computer system connected to the Internet	0.1	6.7	30.4	n.a.	20.3
Personal computers (per 1,000 people) ***		8 (2001 est.)	86 (2001 est.)	195 (2001 est.)	23 (2000 est.)	276 (2001 est.)
Agriculture, value added (% of GDP) ***	Agriculture corresponds to International Standard Industrial Classification (ISIC) divisions 1-5 and includes forestry, hunting and fishing, as well as cultivation of crops and livestock production. The net output of the agriculture sector after adding up all outputs and subtracting intermediate inputs.	31 (2001 est.)	10 (2001 est.)	3 (2001 est.)	15 (2000 est.)	3 (2001 est.)
Industry, value added (% of GDP) ***	Industry corresponds to ISIC divisions 10-45. It comprises value added in mining, construction, electricity, water, and gas.	23 (2001 est.)	34 (2001 est.)	29 (2001 est.)	32 (2000 est.)	38 (2001 est.)
Services, etc., value added (% of GDP) ***	Services correspond to ISIC divisions 50-99 and they include value added in wholesale and retail trade (including hotels and restaurants), transport and government, financial, professional and personal services such as education, health care and real estate services.	42 (2001 est.)	56 (2001 est.)	68 (2001 est.)	52 (2002 est.)	59 (2001 est.)
Per caput fish supply (Kg/year, 1997-99) ****	Data should be regarded as giving only an order of magnitude indication of consumption levels.	2.0	4.3	21.9	2.7	6.7

***The CIA World Fact-book: Web 2002 Edition (public domain)** --- http://www.countryreports.org/ --- http://www.atlapedia.com/
****UNDP. Human Development Report ---** http://www.undp.org/hdr2001/indicator/
*****The World Bank ---** http://devdata.worldbank.org/data-query/
****** FAO Yearbook of Fishery Statistics - 2001 ---** ftp://ftp.fao.org/fi/stat/summ_01/appIybc2001.pdf

Geo-morphological characteristics of the Adriatic basin, geo-political changes along the Eastern coast, existing national statistical divisions and fishery resource distribution have led to the identification of the two Geographical Sub-Areas (GSA) as shown in Figure 2. Croatia, Bosnia-Herzegovina, Italy and Slovenia border the GSA 17 (North and Central Adriatic), Albania, Italy (South-Eastern coast) and Serbia and Montenegro are included in the GSA 18 (AdriaMed, 2001; GFCM, 2001).

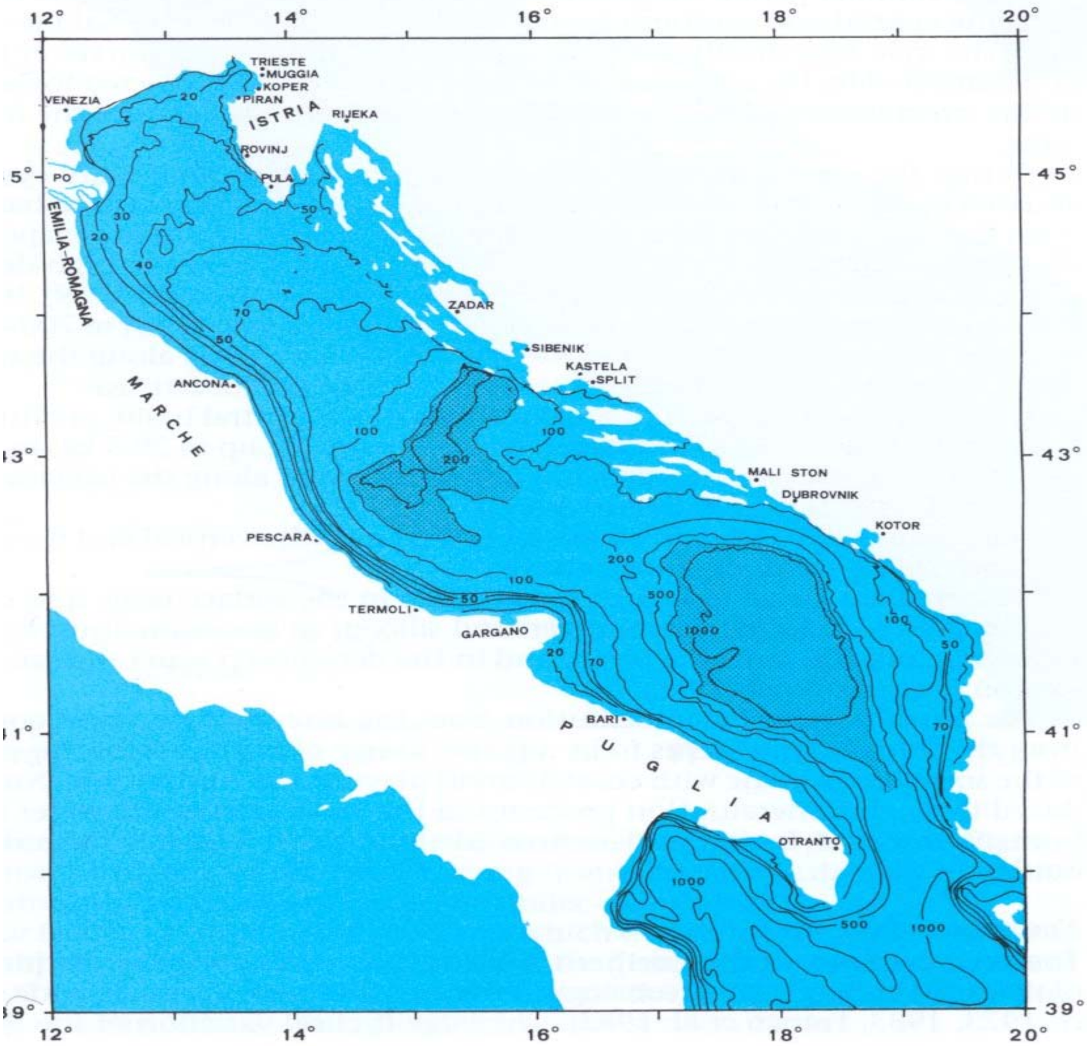


Figure 1. Adriatic Sea bathymetry (from Fonda Umani *et al.,* 1990).

The presence of the characteristics of a semi-enclosed sea as defined in Article 122 of the 1982 UNCLOS (United Nations Convention on the Law of the Sea) make the Adriatic a particularly suitable case to meet the provisions contained in Part IX (Article 23) of UNCLOS on cooperation of coastal states in enclosed or semi-enclosed seas (Sersic, 1992).

Finally, the Code of Conduct for Responsible Fisheries (as formulated by FAO in 1995) in coherence with UNCLOS and accounting for the Declaration of Cancun (1992), the Rio Declaration (1992), the provisions of the Agenda 21 of UNCED, the 1992 FAO Technical Consultation on High Sea Fishing, the 1984 FAO World Conference on Fisheries

Management and Development and other relevant international fisheries instruments (FAO and UN, 1998), further emphasizes the necessity, when in presence of shared stocks, for coastal states to cooperate for fisheries research and management.

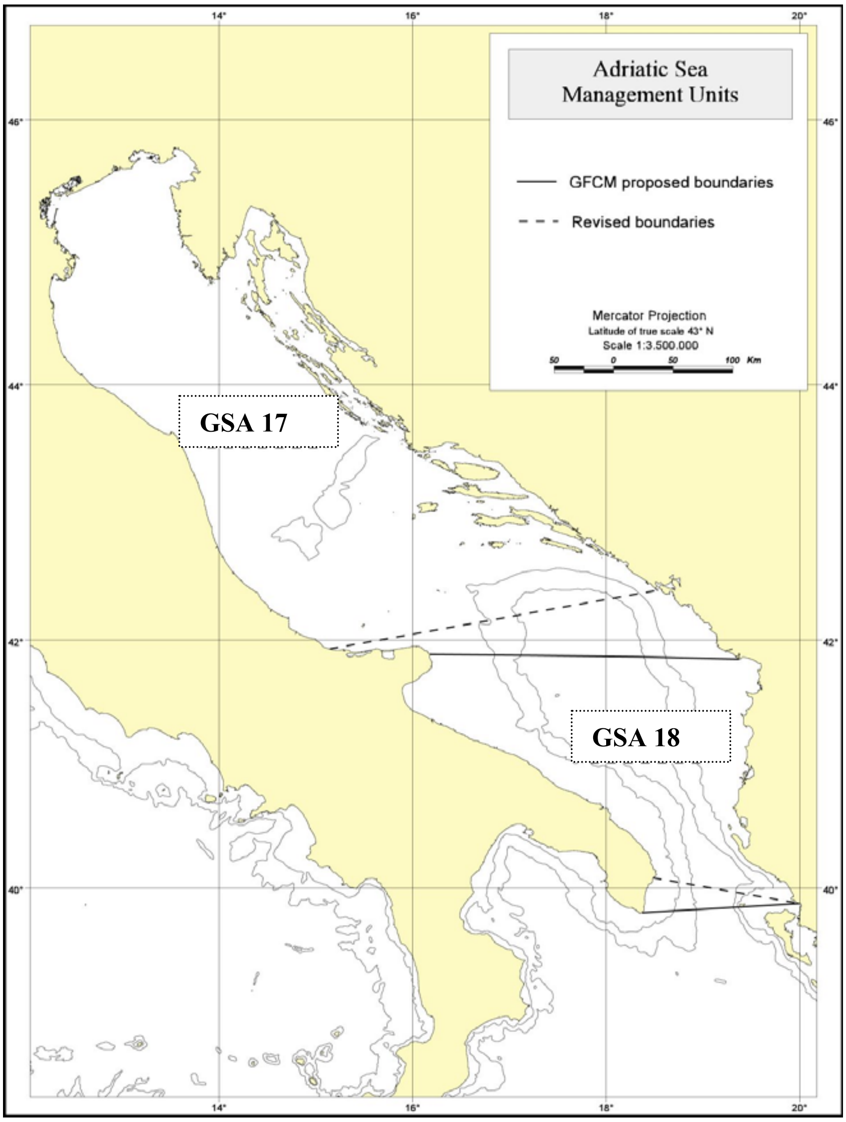


Figure 2. Map showing the boundaries of the Adriatic Sea Geographical Sub-areas 17 and 18 (formerly Geographical Management Units 37.2.1.a and 37.2.2.b) as originally indicated by the GFCM (solid line) and with the proposed (and currently adopted) revision (modified by AdriaMed, 2001).

2. Fishery production over time (1970-2000)

Recently the issue of shared fishery stocks in the Mediterranean has gained particular attention within international bodies such as the General Fisheries Commission for the Mediterranean (GFCM), its Scientific Advisory Committee (SAC) and the European Commission (EC). For instance, areas in the Mediterranean where shared stocks are reported or believed to occur are indicated in the EC Communication COM 535 (2002). It may be noted that with the exception of highly migratory stocks that are shared over the most of the

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

Evidence of the transboundary and straddling nature of some important stocks may be drawn from the geographical occurrence pattern in late spring and early summer of the European hake (*Merluccius merluccius*) and Norway lobster (*Nephrops norvegicus*) which are high-value stocks targeted by the Adriatic demersal fishery (Figure 3a, 3b).

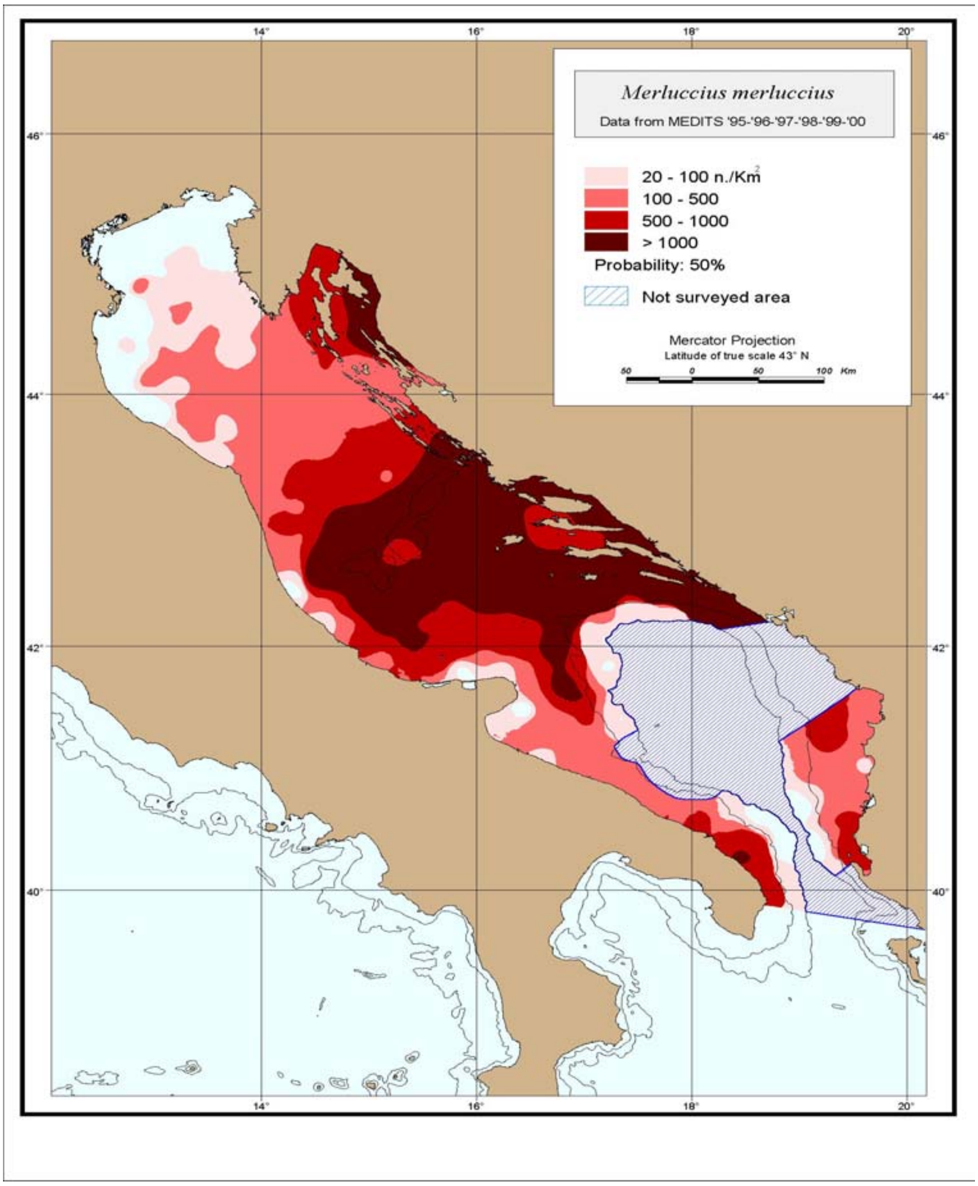
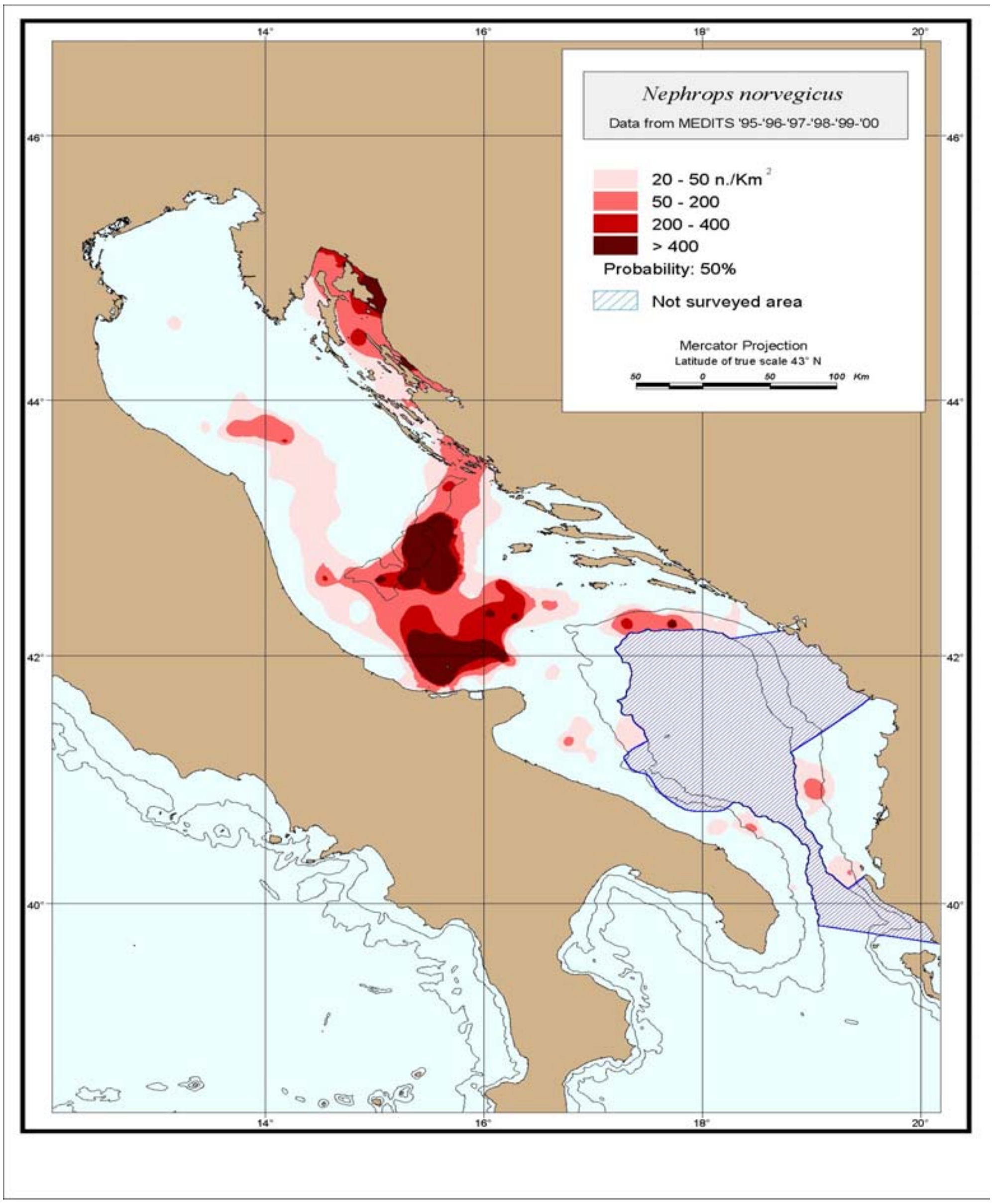


Figure 3a. Distribution of *M. merluccius* in the Adriatic Sea: indicator kriging representation (Gramolini *et al.,* in press). Data: Medits Programme.



Figures 3b. Distribution of *N. norvegicus* in the Adriatic Sea: indicator kriging representation (Gramolini *et al.,* in press). Data: Medits Programme.

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 AdriaMed (AdriaMed, 2000; Mannini *et al*., 2001). The recognition of the shared-stock status of the priority species (Table 2) was subsequently proposed to the national management authorities of the AdriaMed member countries (Albania, Croatia, Italy and Slovenia), and then endorsed at the 28th Session of the GFCM (GFCM, 2003).

The overview of capture fisheries landing trends from the Adriatic over thirty years (1970-2000) roughly outlines the fisheries production performance of the region. Data are from the open-access FAO statistics as compiled in the Fishstat Plus version 2.3 (FAO 2001). Nominal

landing figures are provided to FAO by member states and their reliability, which can differ greatly between countries and regions, cannot be easily assessed.
Therefore, caution needs to be exercised when considering trends in fisheries landing. It is important to note that the following main factors may be behind apparent landing trends: changes in the level of accuracy of fishery statistics reporting, trends in fishing intensity on the species in question, environmental trends in the productivity of the system, socio-economic factors affecting relative demand or accessibility of the species concerned.

Table 2. Relevant common species whose stocks are shared by at least two Adriatic countries (from AdriaMed Technical Documents N. 2 and 3).

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.

Underestimation of quantities landed is a common problem affecting the available statistics to an often unknown extent. For instance, and as an extreme case, according to a field interview survey conducted in Montenegro, it would appear that this country's landing statistics in recent years were underestimated by a factor of six (Regner, 2002). Nevertheless, although landing figures are likely to be (sometimes largely) underestimated in many cases, it can be reasonably assumed that overall, major trend patterns in fisheries landings are reflected in the time series. During the thirty-year period under consideration (1970-2000) the total landings of the Adriatic commercial capture fisheries of Albania[2], Croatia, Italy, Slovenia, Federal

[2] According to GFCM definition of statistical sub-areas the Adriatic Sea falls within the area 2.1, thus including only the Northern and Central basins, while the Southern Adriatic basin and consequently the coast of South-eastern Italy and of Albania are included in the Ionian Sea (area 2.2). In order to have as comprehensive a picture as possible of all Adriatic Sea fishery production, Albanian data originally classified as from the Ionian Sea have been included in the Adriatic data set used. Unfortunately, this was not feasible for South-western Italy (Apulia Region).

Republic of Yugoslavia (FRY) and the ex-Yugoslavia Republic reached its maximum in 1981 with about 220000 t of declared landed catch, to subsequently decline to the minimum of 100000 t in 1999 (Figure 4). Nominal total landing of Adriatic fisheries amounted to about 110000 t in the last available year (2000).

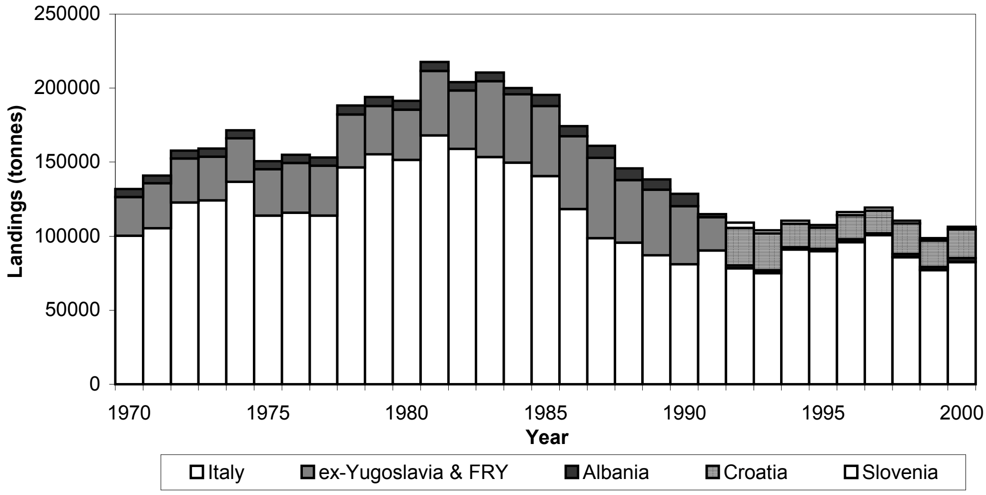


Figure 4. Adriatic Sea capture fishery production (excluding bivalve molluscs and aquaculture, see also text footnote 2). Data: FAO.

Recent demersal[3] and pelagic[4] fishery landings were compared to peak landings by area (Table 3). The comparison indicated that overall landing of the selected demersal species assemblage has currently declined to about 60-70% when compared to peak landing which in both western and eastern Adriatic demersal fisheries[5] was reached during the second half of the 1980s. In 1999 small pelagic fishery yields amounted to 53 % (western fishery) and 35% (eastern fishery) of the maximum pelagic landing achieved in the early and mid 1980s.

[3] Demersal species are here defined as those belonging to ISSCAAP (International Standard Statistical Classification of Aquatic Animals and Plants) groups 31, 32, 33, 34, 38, 43, 45, 47 and 57 which included, in this paper, mainly: soles, turbots, gurnards, hakes, sparids, surmullets, sharks and rays, cephalopods, spottail squillid mantis, deepwater rose shrimp and Norway lobster.

[4] Pelagic fish are here defined as those belonging to ISSCAAP groups 33, 35 and 37, which include, in this paper, clupeoids, mackerels, mullets and garfish.

[5] The terms Western fisheries and Eastern fisheries are used to mean the landings of the Italian fishery and those, pooled, of ex-Yugoslavia and Albania (1972-91) and of Croatia, Slovenia, Federal Republic of Yugoslavia (Republic of Serbia and Montenegro) and Albania (from 1992 onward) respectively.

Table 3. Comparison by area of recent landings to peak landings of selected species from Adriatic Sea demersal and pelagic fishery, based on three-year running means (see footnote 3 and 4). Year 1999 is the last data point available in the running mean series. Data source: FAO

Demersal fishery				
Area	**Recent landing (t)**	**Max landing (t)**	**Year of max landing**	**Recent/max landing**
West Adriatic	25951	42442	1986	0.61
*East Adriatic	5414	8124	1989	0.67
Pelagic fishery				
Area	**Recent landing (t)**	**Max landing (t)**	**Year of max landing**	**Recent/max landing**
West Adriatic	51825	97624	1980	0.53
*East Adriatic	16770	47772	1986	0.35

* Pooled data: 1972-1991 from Albania and ex-Yugoslavia, 1992-2000 from Albania, Croatia, Slovenia and FRY.

Pelagic catch dominated the marine fish landing, particularly in the East Coast fishery (Mannini and Massa, 2000), even though from the mid 1980s 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.

Demersal and pelagic landing patterns, expressed as a percentage variation relative to the mean, highlights the regression of small pelagic fisheries production in both the anchovy-based western fishery and the sardine-based eastern fisheries (Figures 5a and 5b).

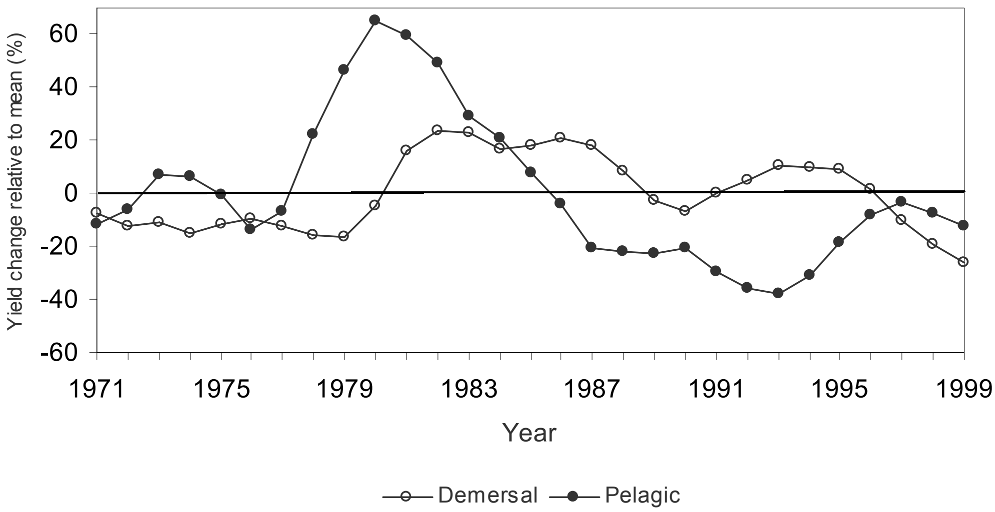


Figure 5a. Percentage landing change relative to mean value of Western Adriatic fisheries. Data source: FAO.

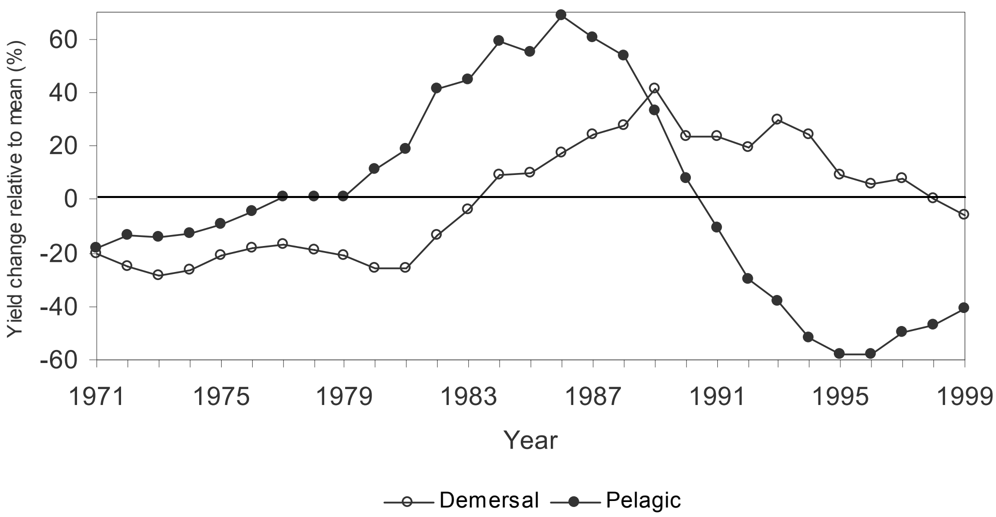


Figure 5b. Percentage landing change relative to mean value of Eastern Adriatic fisheries. Data source: FAO.

Both fisheries were strongly affected by factors of different origin producing a significant impact on the small pelagic fishery performance, such as subsidised production during part of the 1970s and 1980s (Bombace, 1993; Cingolani *et al*., 1998, 2000; Jukić-Peladić, 2001), anchovy recruitment failures (Bombace, 2001; Cingolani *et al*, 1996), and socio-economic changes affecting the sardine fishing industry in the Eastern Adriatic (Kapedani, 2001; Jukić-Peladić, 2001; Marčeta, 2001). Unlike the small pelagic fishery, demersal landing has developed and persisted above the average since the 1980s to begin declining in the second half of the 1990s. Out of the 15 species which currently contribute to total Adriatic landings with at least 1%, the quantities landed over time of some key-shared stocks are described hereunder.

Merluccius merluccius (2.6% average contribution to total landing; 10.7% average contribution to demersal landing as defined in footnote 3): 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 to less than 4000 t according to the last available statistics (Figure 6). The average hake landing from 1970 to 2000 was about 4000 t.

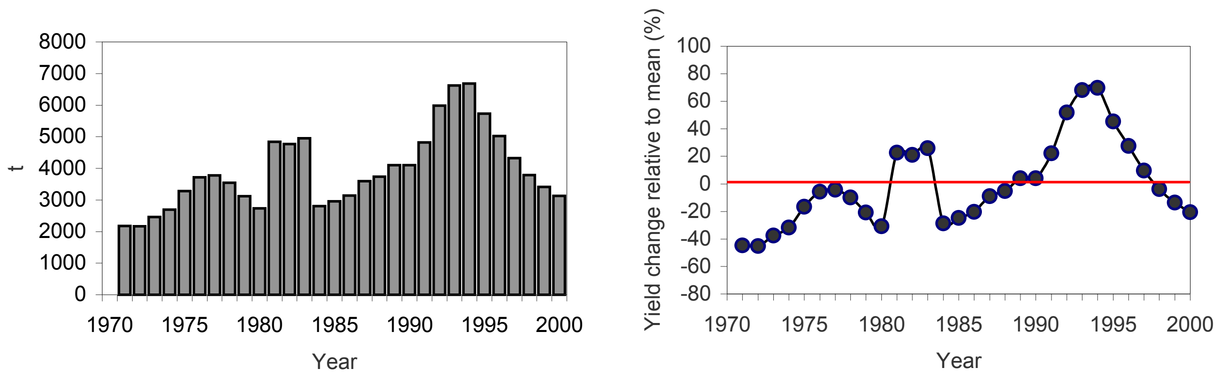


Figure 6. Landing (right) and percentage landing change relative to mean value (left) of *M. merluccius* from the Adriatic Sea (GFCM Geographical sub-area 17 and 18, three-year running average). Italian landings from area 18 are not included (see footnote 2).

Mullus spp. (1.3% average contribution to total landing; 5.5% average contribution to demersal landing as defined in footnote 3): The surmullets (*Mullus* spp.) landing has been increasing almost regularly with modest fluctuations since the second half of the 1980s, to reach multiple maxima each of about 3000 t throughout the second half of the 1990s somehow levelling the yield increase of the previous decade (Figure 7). Over the period from 1970 to 2000 the average landing of red mullet according to official statistics was about 2000 t.

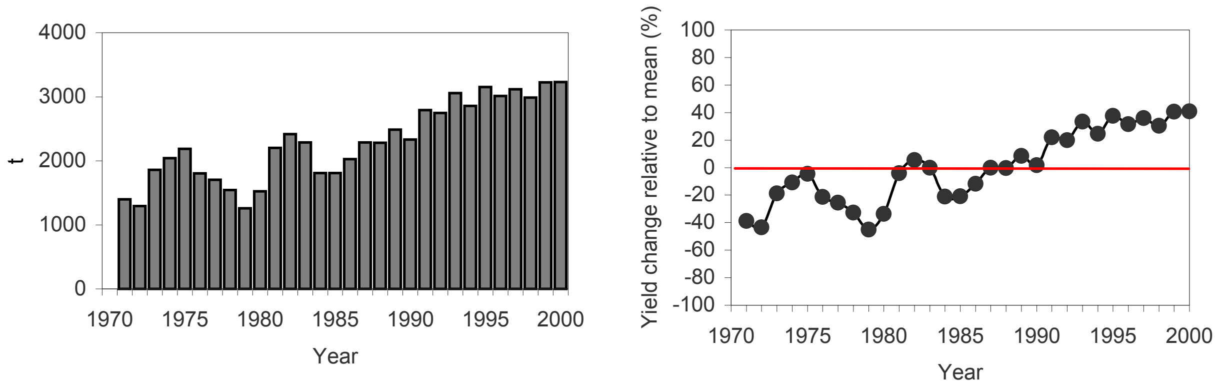


Figure 7. Landing (right) and percentage landing change relative to mean value (left) of *Mullus* spp. from the Adriatic Sea (GFCM Geographical sub-areas 17 and 18, three-year running average). Italian landings from area 18 are not included (see footnote 2).

Nephrops norvegicus (1 % average contribution to total landing; 4.3% average contribution to demersal landing as defined in footnote 3): The nominal landing of Norway lobster reached the highest level of about 2500 t in 1993, when the increasing pattern started during the early 1980s strongly reversed to less than 1000 t in the year 2000. The average landing over the 1970-2000 period could be estimated at about 1500 t (Figure 8).

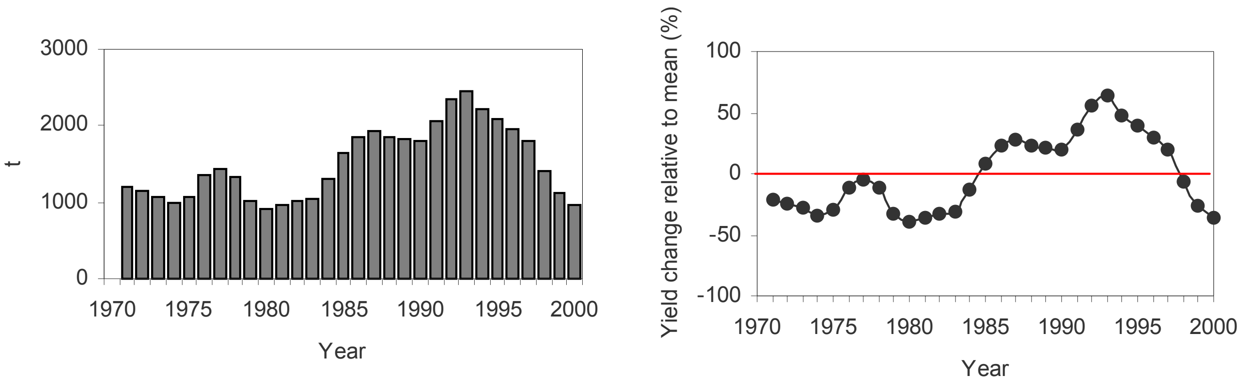


Figure 8. Landing (right) and percentage landing change relative to mean value (left) of *N. norvegicus* from the Adriatic Sea (GFCM Geographical sub-areas 17 and 18, three-year running average). Italian landings from area 18 are not included (see footnote 2).

Engraulis encrasicolus (19.1% average contribution to total landing; 32.3% average contribution to pelagic landing as defined in footnote 4): Anchovy landings during the last thirty years are characterised by two major factors: the landing peak of more than 50000 t in

1981 and the subsequent decline to the minimum of 10000 t in 1987, which lasted till the early 1990s.

Since then yield has been increasing to the current level of more than 30000 t (Figure 9). Average landings over this period can be estimated at about 27000 t.

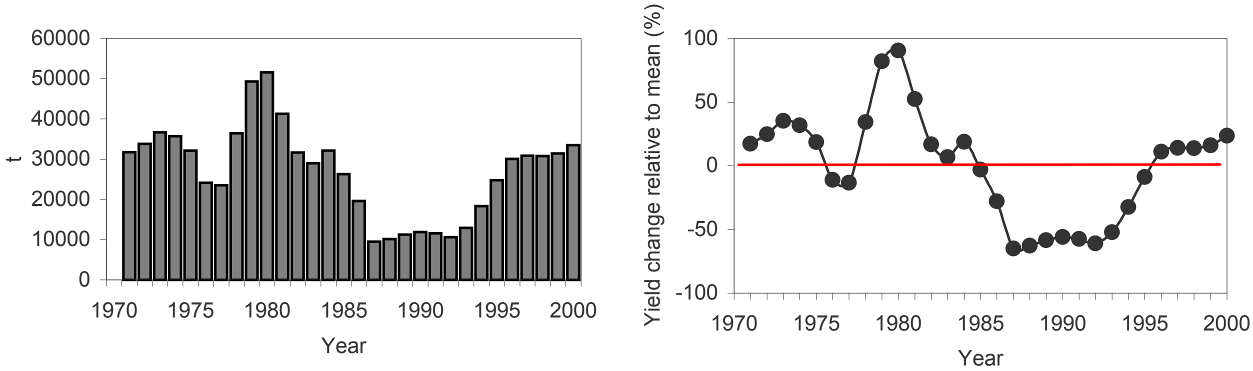


Figure 9. Landing (right) and percentage landing change relative to mean value (left) of *E. encrasicolus* from the Adriatic Sea (GFCM Geographical sub-areas 17 and 18, three-year running average). Italian landings from area 18 are not included (see footnote 2).

Sardina pilchardus (31.9% average contribution to total landing; 54% average contribution to pelagic landing as defined in footnote 4): the Sardine yield pattern shows a rising trend since the beginning of the available time series to peak at more than 80000 t in 1982 and to regress to the minimum of 28000 t from 1994 onwards. Over the whole period, Adriatic sardine landings averaged at about 48000 t (Figure 10).

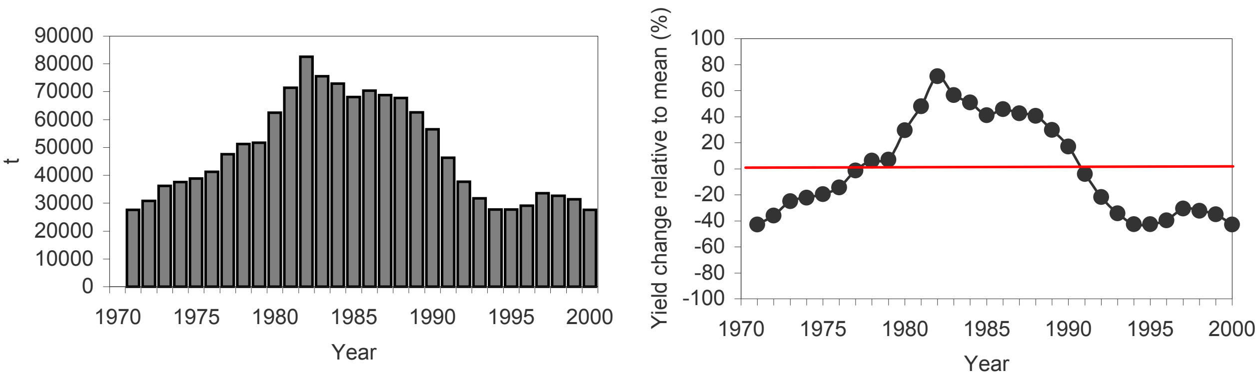


Figure 10. Landing (right) and percentage landing change relative to mean value (left) of *S. pilchardus* from the Adriatic Sea (GFCM Geographical sub-areas 17 and 18, three-year running average). Italian landings from area 18 are not included (see footnote 2).

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. The occurrence of many species in the demersal fishery landings would appear to confer a relatively moderate temporal variability to total landing. For instance, in Adriatic GSA 17 the temporal variability of the nominal total landed biomass (CV_t = 13.6) is lower that that of single species or species group landed biomass whose CV_i ranged from 17.7 to 78.9 (Table 4). Total demersal landed biomass variability between periods would be more conservative than single species or species group landings. This aspect of exploited demersal fishery communities has been recently investigated and discussed in detail by Blanchard and Boucher (2001) comparing different areas of the Eastern Atlantic and Mediterranean using both fishery dependent and independent data. Apart from the possible reasons behind this fact, its role with respect to Adriatic demersal fishery production should be taken into consideration. Within the overall exploitation of Adriatic demersal communities the relatively high variability of landed quantities of individual species (or groups of species) determines, within the observed trends, the relative stability of the temporal variation of total landing. This may cause the total landing of the valuable multispecies assemblages to rely on a relatively constant supply even if within decreasing total quantity. This fact, coupled with the rise in prices which maintains the profitability of fisheries, can contribute to promote fishing activity (i.e. effort) thus generating further exploitation (see Irepa, 2003, for detailed analysis of the performance of Italian fisheries).

Table 4. Individual and total coefficient of variation in the landed biomass of demersal resources of the Geographical Sub Area 17 in the Adriatic Sea.

Species	**Geographical Sub-Area 17**	**Species**	**Geographical Sub-Area 17**
Pagellus spp.	78.93	Rajiformes	38.76
Todarodes sagittatus	78.75	Pleuronectiformes	37.29
Parapenaeus longirostris	69.40	*Dicentrarchus labrax*	36.59
Conger conger	64.53	*Nephrops norvegicus*	35.03
Triglidae	60.56	*Micromesistius poutassou*	34.12
Dentex dentex	57.80	Scophthalmidae	34.01
Mustelus spp.	54.36	*Mullus* spp.	31.41
Gobiidae	52.70	*Loligo* spp.	31.22
Sparus aurata	51.04	*Sepia officinalis*	31.00
Boops boops	48.58	*Octopus vulgaris*	29.71
Eledone spp.	44.46	*Oblada melanura*	28.28
Merluccius merluccius	43.56	Scorpaenidae	27.18
Squalidae	40.60	*Solea solea*	26.70
Lophius piscatorius	40.00	Crustacea	22.19
Spicara spp.	39.41	*Squilla mantis*	17.68
		CV tot	**13.64**

3. Fishing fleet

Tentatively, the evolution of Adriatic fishing fleet size, in terms of total number of fishing units as available from various sources, is given in Figure 11. It is possible that in some cases the records concerning small-scale artisanal fishery vessels were inaccurate or incomplete.

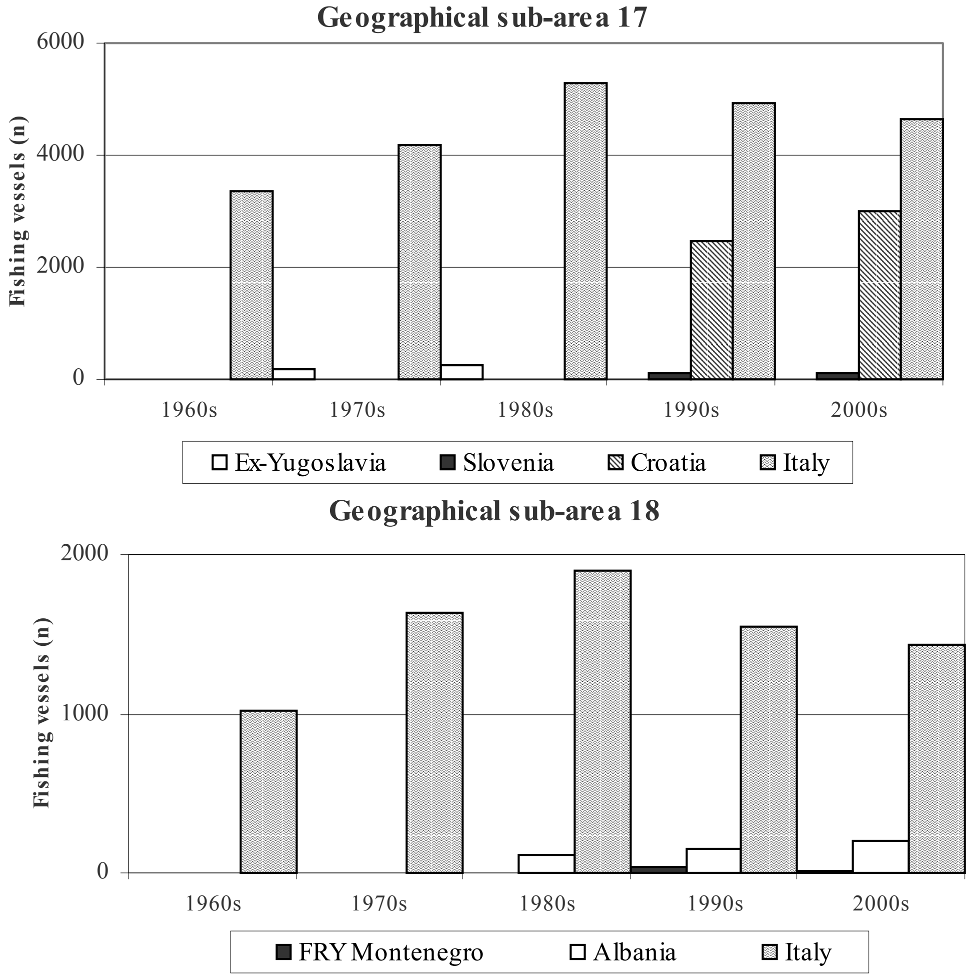


Figure 11. Tentative estimate of the Adriatic fishing fleet evolution in terms of number of units from the 1960s taken from available literature and the AdriaMed database (year 2001). In some cases, data on small-scale fishing fleets are approximate or incomplete. Source: AdriaMed (unpubl.), Breuil (1997), Caddy and Oliver (1996), Dujmušić (2000), Ferretti and Arata (1987), Katavić (2002), Regner (2002), Irepa.

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 (in this latter case small-scale fishing vessels were not included) while the opposite can be 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 actual number of small artisanal units was certainly under-reported[6]. This is due to the fact that in some countries artisanal fishery is partially recorded or an official census is not taken. Average vessel age of national fleets ranged from about 25 (Italy) to 38 years (Croatia).

At present (as of 2001), the numerical composition of the Adriatic Sea fishing fleet by vessel/gear consists of three main categories made up of fishing units equipped, or permitted to operate, with multiple gears (i.e. polyvalents), passive fixed gears (mostly belonging to small scale fishery) and bottom trawl gear (Figure 12). To some extent the unspecified polyvalent category might be overestimated and consequently others underestimated, as vessels within this group could carry out a specific fishery (e.g. passive gear fishing or small coastal trawling) for a consistent part of the year.

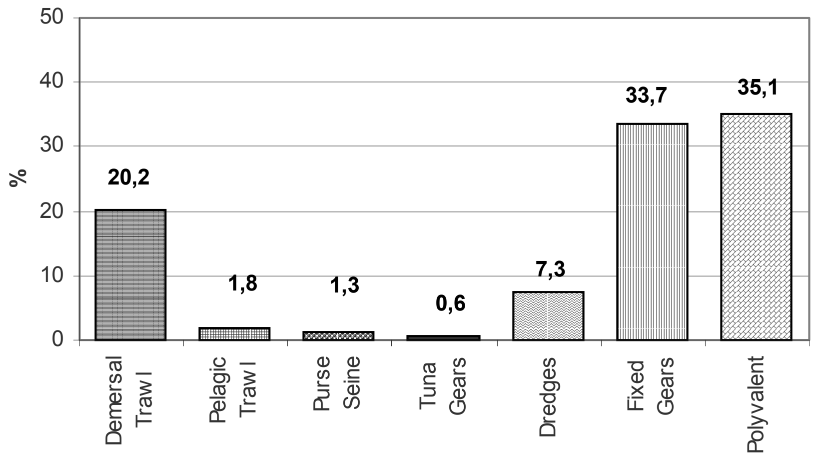


Figure 12. Adriatic Sea fishing fleet composition in 2001 (Albania, Croatia, Italy and Slovenia) expressed as the numerical percentage of vessels by fishing technique category. Source: AdriaMed database compiled in cooperation with the Fisheries Directorates of Albania, Croatia, Italy (through Irepa assistance), and Slovenia.

In terms of fishing capacity, a more indicative insight into the Adriatic fleet is obtained using vessel tonnage (Figure 13). Overall fleet tonnage for the most part resulted as allocated within the demersal trawl category followed by the polyvalent category. Fishing units performing pelagic fishery (mostly small pelagic fishery) ranked third (including both pelagic trawlers and purse seiners).

[6] At the time of the preparation of this paper, national fleet size estimates were being reviewed and updated by the Countries concerned.

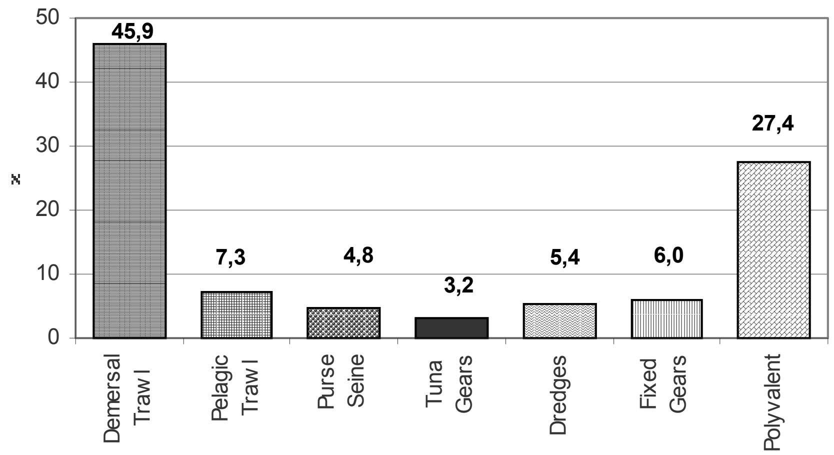


Figure 13. Adriatic Sea fishing fleet composition in 2001 (Albania, Croatia, and Italy) as percentage tonnage (GT) allocation by fishing technique category. Source: AdriaMed database compiled in cooperation with the Fisheries Directorates of Albania, Croatia, and Italy (through assistance from Irepa).

Fishing fleet composition in number by vessel size (length overall, LOA) and fishing gear showed (Figure 14) that most of the small scale fixed gear fishery is performed by small units of less than 12 m (LOA), most polyvalent vessels fall within the small vessel class with only about 20% being within the medium-size vessel category.

Most demersal and pelagic trawlers, purse seiners and tuna vessels belong to the medium-size category (12-24 m LOA) 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).

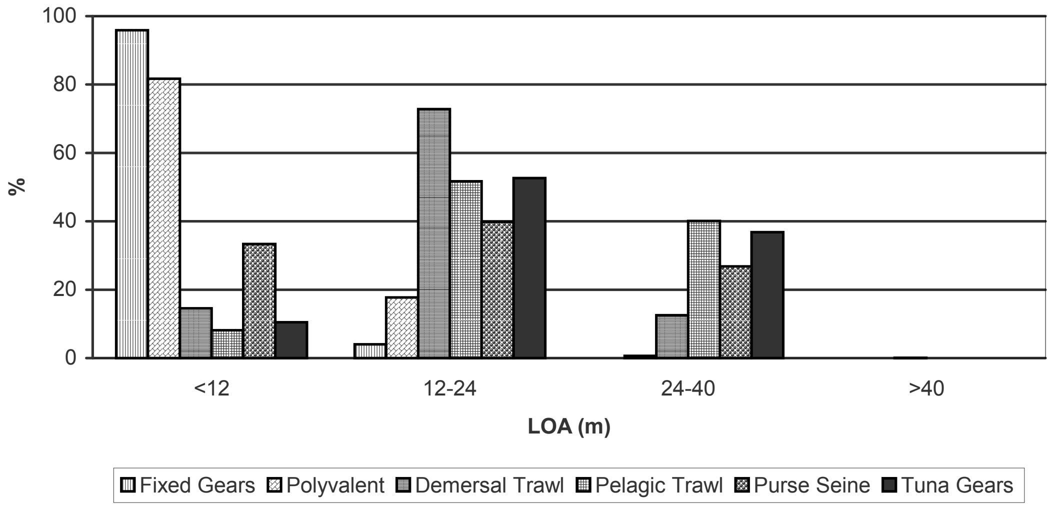


Figure 14. Adriatic fishing vessels numeric distribution in 2001 (Albania, Croatia, Italy and Slovenia) by length class (LOA) and fishing technique category. Source: AdriaMed database compiled in cooperation with the Fisheries Directorates of Albania, Croatia, Italy (through assistance from Irepa), and Slovenia.

4. Some remarks

The Adriatic Sea is probably the largest and the best-defined area of occurrence of shared stocks in the Mediterranean. The main issues related to shared stocks and to the management of their fisheries have been known for a long time. In 1980 Gulland observed with reference to scientific cooperation in research on shared stocks that "The main benefit from international cooperation in research is that it becomes possible to consider all the information concerning a stock of fish wherever it occurs. In the absence of such information it is very easy for a country to misinterpret what is happening to the stock in its EEZ, even when it has good information on everything that is happening in that zone" (Gulland, 1980, p. 8). With reference to the Adriatic Sea fisheries some facts can be pointed out and taken into account for the needs of fishery management planning.

Maximum total landing of both demersal and small pelagic resources was reached in the 1980s. Small pelagic fishery production has been affected by both environmentally induced stock size fluctuations (emphasised to some extent by fishery exploitation) as in the case of the western anchovy fishery and socio-economic factors (most likely combined with low stock size) as in the case of the eastern sardine fishery. Western demersal fishery in terms of landed production fully developed during the 1980s while the eastern demersal fishery has been developing since the 1980s. The western fishing fleet size reached a maximum in terms of number of vessels during the 1980s to start decreasing from the 1990s. The eastern fishing fleets started to increase considerably in the 1980s. Owing to several reasons (e.g. vessel age, available technology, crew skills, land-based services and infrastructures) vessel fishing power and fleet capacity can be assumed to vary widely between national fleets.

The development of Adriatic fisheries, as may be observed from the available landing data time series, seems to some extent to resemble the generalized fishery development model (Grainger and Garcia, 1996) which is composed of four phases: underdeveloped, developing, mature and senescent. This could be particularly the case for demersal fisheries, which are in general less prone to environmentally induced stock size fluctuations. Following Grainger and Garcia's definition of "meta-fishery" to mean a fishery targeting a species assemblage through an interacting multi-gear fleet in a given area (Grainger and Garcia, 1996), Adriatic demersal meta-fishery would appear to have developed through the 1980s reaching the mature phase in the late 1980s and 1990s to subsequently go through a senescent phase. The impact and sustainability of the overall growth of the demersal trawl fleet (as number of fishing units) in recent times should be closely monitored as it may have led to excessively high exploitation rates particularly affecting some key-species (Ungaro *et al*., 2003).

The state of heavy exploitation of Adriatic fishery resources is evident and for some stocks is critical. It can be noted that several different factors, often interacting simultaneously, have affected Adriatic fisheries. Fishery production dynamics are based not only on resource availability but are also strongly driven by market demand and prices. Socio-economic forces have been observed to be determinant in shaping fishery exploitation patterns. The understanding of any fishery system, and the Adriatic makes no exception, increasingly calls for multidisciplinary analysis; basic reliable fisheries statistics are fundamental and, in the case of Adriatic shared fisheries, should necessarily be comparable and easily integrated.

Recently, management of shared stocks has been the topic of the Government of Norway-FAO Expert Consultation on the Management of Shared Fish Stocks where beyond the biological aspects, the economics of the management of shared stocks was also given relevance (Munro, 2003). The Consultation, while noting that the management of shared fishery resources is one of the great challenges in the pursuit of sustainable fisheries, highlighted the fact that non-cooperative management easily leads to overexploitation. It has to be recognised that management and enforcement of rules are rather obviously more complex for shared fisheries than for non-shared fisheries.

The Code of Conduct for Responsible Fisheries (FAO, 1995; *Article 7.1.3; 7.3.1; 7.3.2; 7.4.6; 12.7*) clearly and unequivocally addresses issues concerning shared stocks, emphasis is given to cooperation among States as an essential and unavoidable requirement for the responsible exploitation of such resources. Nevertheless, cooperative fishery research and, above all, management can be really effective when each part foresees benefits equal or superior to those it would expect in a scenario with no cooperation (FAO, 2002).

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