

Review of long-term changes in trammel bottom set catches, crustacean, cephalopoda and fish communities along the Eastern Adriatic (Croatian) coastal area

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State and changes in the coastal crustacean, cephalopoda and fish communities are investigated from 1960. These investigations begun, and were particularly intensive, in the mid-Adriatic area (Dalmatia). Data of state and changes in the coastal communities are based on experimental trammel bottom set catch analyses from 1960 to 1995. For all that we have supposed that the changes in trammel bottom set catches reflect the same changes in communities structure. In this opportunity, changes (qualitative and quantitative) in the coastal communities on the Kornati Islands (1960-1992), Split area (1960-1994), mid-Dalmatian Islands (1960-1994), Palagruža Islands (1961-1995) and southern Adriatic (1972-1988) areas are discussed. Communities up to 30 m depth were investigated. The changes in the communities were manifested as continued decline in trammel bottom set catch quantities (CPUE) of about 63-64%, particularly during the first decade of investigations, than alternation in the presence of different fish families (mostly Scorpaenidae, Labridae, Serranidae, Mullidae, Sparidae) or fish species Scorpaena porcus, Symphodus (Crenilabrus) tinca and Mullus spp. respectively, as well as edible crustacean (Maja crispata) and cephalopoda species (Sepia officinalis, Octopus vulgaris) in the catches. All observed changes in the crustacean, cephalopoda and fish communities are primarily results of intensive and unreasonable exploitation of the living resources in the coastal area.

Key words: Long-term changes, trammel bottom set catches, fish and edible invertebrate communities, coastal sea area, eastern Adriatic

INTRODUCTION

The coastal area of the eastern Adriatic is traditionally the most important fishing area for the category of professional, sport and other fishermen who use in their fishing activities small fishing gears. Of approximately 55 fishing gears which are used in the eastern part of the Adriatic Sea (CETINIĆ, 1990) all of them are used in the coastal area, except otter-trawl,

purse seine for Atlantic bluefin tuna and relatives fishing and pelagic trawl for small pelagic fish fishing.

The coastal fishing compared to other two types of fishing: trawl (demersal) and pelagic, according to the quantity of fish, crustacean and cephalopoda catches, is the most important along the eastern Adriatic coast. According to the estimated quantities of present annual catches in the East Adriatic from about 50,000 mt

(JARDAS and PALLAORO, 1997) to 70,000 mt (VODOPIJA, 1997; TREER and JUKIĆ-PELADIĆ, 1997) on trawl and pelagic fishing, if taken in account lower estimated value, belongs about 20,000 mt (40%) and on coastal fishing about 30,000 mt (60%).

The coastal area is distinguished by greater productivity rate compared to the open sea thanks to relatively smaller depth, vicinity of the land and fresh-water inflow (BULJAN, 1964, 1969; PUCHER-PETKOVIĆ and ZORE-ARMANDA, 1973; PUCHER-PETKOVIĆ, 1974). In the channel areas and areas under the influence of fresh-water inflow, coves, bays and mouth of rivers, where the whole coastal fishing took place, the mean of gross primary production moves between 60 and 150 gC m⁻² a year⁻¹, and in the open sea 55 gC m⁻² a year⁻¹.

Intensive fishing in the coastal area influences the state and changes in crustacean, cephalopoda and fish communities. These changes were noticed during the analyses of long-time series of experimental catch data of some fishing gears which are used in particular coastal areas. In this way specially important are the trammel bottom set catches because of their great catchability and small selectivity rate, which results of their construction properties. The first data about quantitative and qualitative structure of trammel bottom set catches are dating from the period 1960-1964 (MOROVIĆ, 1965). The analyses of the catches, with shorter and longer spaces between them, were continued even later on the same coastal areas (MOROVIĆ, 1970, 1971, 1979; JARDAS, 1979, 1979a, 1980, 1980a, 1982, 1986; JARDAS and PALLAORO, 1989; JARDAS *et al.*, 1998). Based on these data the present short review of changes in quantity and structure of trammel bottom set catches, (i.e. in populations of some significant and/or numerous crustacean, cephalopoda and fish species), in the coastal area of the east Adriatic for the period 1960-1995 is given.

MATERIAL AND METHODS

Study area

Crustacean, cephalopoda and fish communities in the Mid-Adriatic (Dalmatia) coastal area including Kornati Islands, Split area, mid-Dalmatian Islands and Palagruža Islands, as well as South Adriatic coastal area (Montenegro coast) were investigated (Fig. 1)

Palagruža Islands are situated rather offshore, in the middle of the Adriatic, and surrounded by the open sea with depths exceeding 155 m. They are about 24 nautical miles away from the closest island of Sušac, 33 nautical miles from the island of Lastovo and 37.5 nautical miles from the islands of Vis and Korčula.

Trammel bottom sets and fishing methods

The used trammel bottom sets had the following construction characteristics: length 31 - 36 m, height 1.3 - 1.5 m, external netting panels ("popon") with 114 mm and internal netting panel ("maha") with 28 and 32 mesh size. The operating net surface was on average 49 m².

Experimental fishing was carried out with different number of nets tied together. Usually 10 or 11 nets were used together (86% of the catches). Nets were commonly set at the bottom at the depth between 2 and 30 m, rarely at greater depths, but most frequently down to 15 m (80% of the catches). Fishing operations were performed exclusively at night, that is nets were set on the bottom in the evening and hauled in the morning next day, in accordance with the common practice of professional (commercial) trammel bottom set fishing along the eastern Adriatic coast.

Fishing were performed on different bottom types: rocky, sandy and muddy, overgrown by algae or marine phanerogam (*Posidonia*). Since the net series were very long (310 - 360 m) and usually set at different depths, almost all the catches were realized from more than one bottom type.

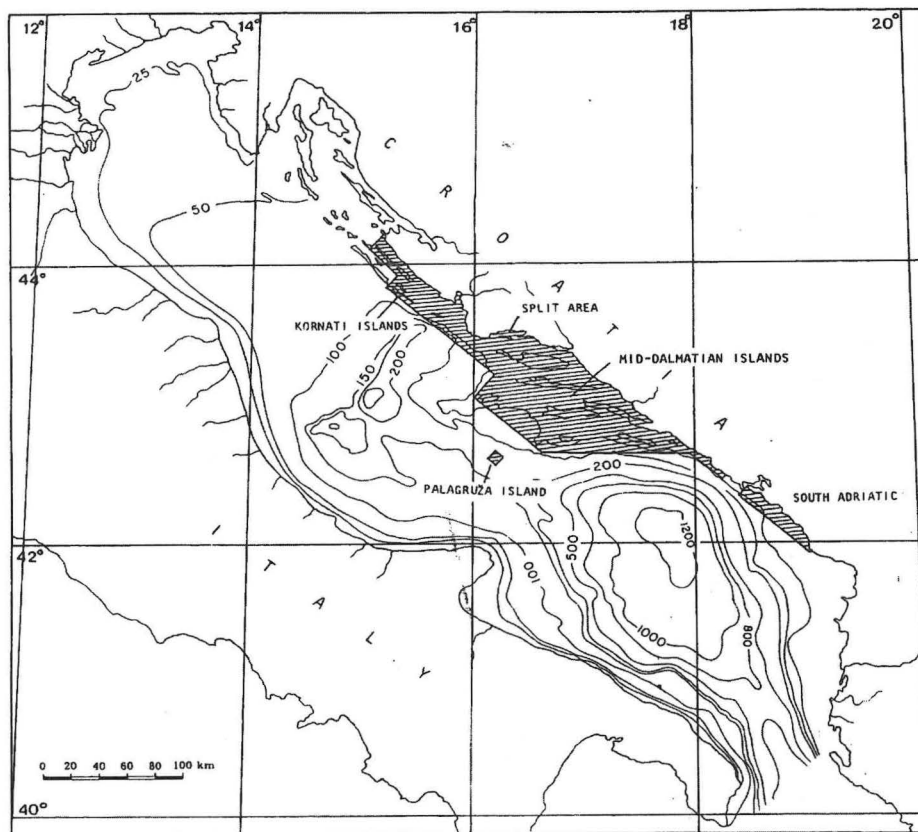


Fig. 1. Study areas on the coastal eastern Adriatic

The fishing operations were not done on the same positions of the area, but were scattered all over the whole area.

data nor the same time series of data for all study areas; time series of data were somewhat different from one area to another (Table 1).

Time series of data

Experimental trammel bottom set catches made between 1960 and 1995 were the subject of analyses. The field and published data by MOROVIĆ (1965) for the area of Mid-Dalmatia were also used for the 1960 - 1964 period. The remainder of the data was obtained by the author's field work. For catches which were the subject of study, we did not have the year to year

Catch analyses

Qualitative and quantitative structure of catches as well as basic biometrical characteristics (Lt in cm, W in g) of crustacean, cephalopoda and fish species were analysed. All the data on the catch quantities were expressed per standard net (catch per unit effort - CPUE, in kg) for the comparability of catches realized by different number of nets tied together.

Table 1. Time series of data on the trammel bottom set catches in the coastal East- Adriatic study areas

Study area	Time series of data		
Kornati Islands	1960-1964	1977-1987	1990-1992
Split	1960-1964	1977-1979	1990-1994
Mid-Dalmatian Islands	1960-1964	1971-1987	1990-1994
Palagruža Islands	1961	1970-1971	1987-1995
South Adriatic (Montenegro coast)	-	1972	1987-1988

For this review, beside the original author's data (partly published), previously published data of other authors were used, too. Due to the fact that the original data were not always available, detailed analysis of the catches was not given, like index of its variability (confidence interval or standard deviation), seasonal variability, etc.

RESULTS

Changes in the trammel bottom set catch weights

During the thirty-five year period of analyses of the quantities of experimental trammel bottom set catches in the eastern Adriatic, considerable changes were recorded. The records revealed a decline in weight of catches of fish and edible invertebrates, that is crustaceans and cephalopods, expressed as CPUE. For the estimation of CPUE in the Mid-Dalmatian area between 1960 and 1964, MOROVIĆ (1970, 1971) distinguished five CPUE classes: < 0.5 kg (very poor), 0.5 - 0.8 kg (poor), 0.8 - 1.5 kg (good), 1.5 - 2 kg (very good) and > 2 kg (excellent). We applied the same scale of distinguished CPUE classes for comparison of different CPUE classes presented in the 1960 - 1964 period and those realized later. In a few words, a tendency of declining presence of higher CPUE classes on the one hand, and increase in the presence of the lower CPUE classes on the other, is characteristics of all the study areas for the period of research. The extent of the changes was as follows:

Kornati Islands: During the first period of studies (1960 - 1964) the CPUE was, on the average, 1.48 kg. In the following 1977 - 1987 interval of studies the average CPUE dropped to 0.54 kg, to be maintained at the same level in the 1990 - 1992 period. With respect to the first records from 1960 - 1964, the average CPUE decreased by 63.5%, or to put in another way, it declined to not more than 36.5% of the initial CPUE value (Fig. 2A).

Defined CPUE classes showed marked alternations as to their presence. While in 1960 - 1964 period 75.5% CPUE exceeded 1.5 kg: > 2 kg made 12.5% and 1.5 - 2 kg 62.5%, and no

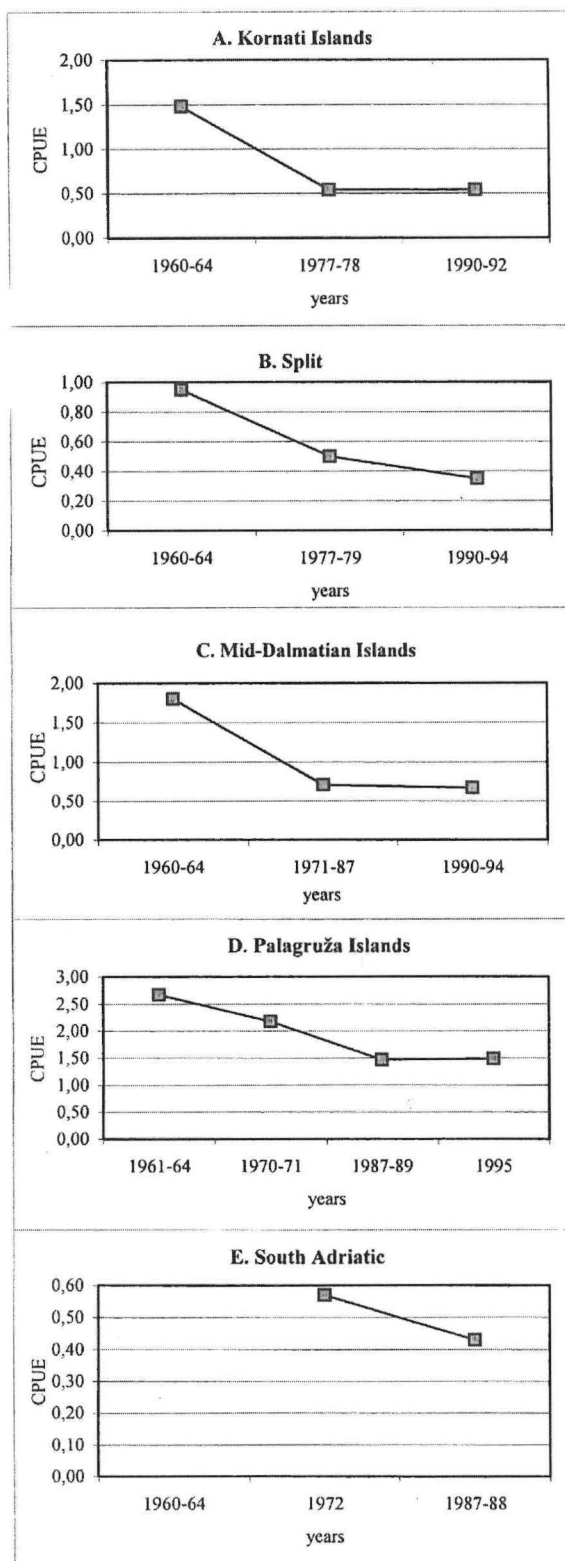


Fig. 2. Quantity of experimental trammel bottom set catches, expressed in CPUE, in the Kornati Islands, Split area, Mid-Dalmatian Islands, Palagruža Islands and South Adriatic coastal area

average CPUE was less than 0.8 kg. The CPUE exceeding 1.5 kg disappeared in the periods that followed with an apparent increase in CPUE below 0.8 kg and the dominance of CPUE below 0.5 kg (Fig. 3).

Split area: The CPUE steadily decreased in this area as well. Between 1960 - 1964 and 1977 - 1979 the average CPUE fell from 0.95 kg to 0.50 kg or by 47.7%, and between 1977 - 1979 and 1990 - 1994 from 0.5 kg to a very low level of 0.35 kg, or by 30%. The decline was 63.3% throughout the period of the study (Fig. 2B).

Alternation in the presence of different CPUE classes were marked in this area as in the area of Kornati Islands. The presence of all CPUE classes steadily dropped to 0.8 kg to be completely absent in the 1990 - 1994 period. At the same time the presence of CPUE lower 0.5 kg per net increased from 9.4% in 1960 - 1964 to 82.3% in the 1990 - 1994 period (Fig. 3).

Mid-Dalmatian Islands area: Average CPUE fell steadily from the 1960 - 1964 average of 1.8 kg to 0.71 kg or by 60.8% in the 1971 - 1987 period. From 1971 - 1987 to 1990 - 1994 the catch further declined by 5.6%, that is from 0.71 kg in 1971 - 1987 to 0.67 kg in 1990 - 1994. This decrease was 63.0% for the whole period of the study (Fig. 2C).

As in the areas of Kornati Islands and Split, we can see a regular decline in the number of "good" CPUE (0.8 - 1.5 kg) replaced by "poor" (0.5 - 0.8 kg) and "very poor" (< 0.5 kg) CPUE. So the CPUE classes of 1.5 - 2 kg and more disappeared in 1990 - 1994 and the CPUE of 0.8 - 1.5 kg fell from 51.6% as reported for 1960 - 1964 to a low level of 28.6% in 1990 - 1994 period. At the same time the CPUE < 0.5 kg increased by 38.1% in 1990 - 1994 with respect to the 1960-1964 period (Fig. 3).

Palagruža Islands area: Qualitative and quantitative changes in the fish populations in the coastal area of Palagruža Islands were observed, with shorter or longer interruptions, from 1961 to 1995. During the past 28 years some changes occurred in the fish populations similar to those in other studied coastal areas. In the year 1961 the CPUE was 2.68 kg, than it fell to 2.18 kg in 1970 - 1971 and to 1.47 kg in the

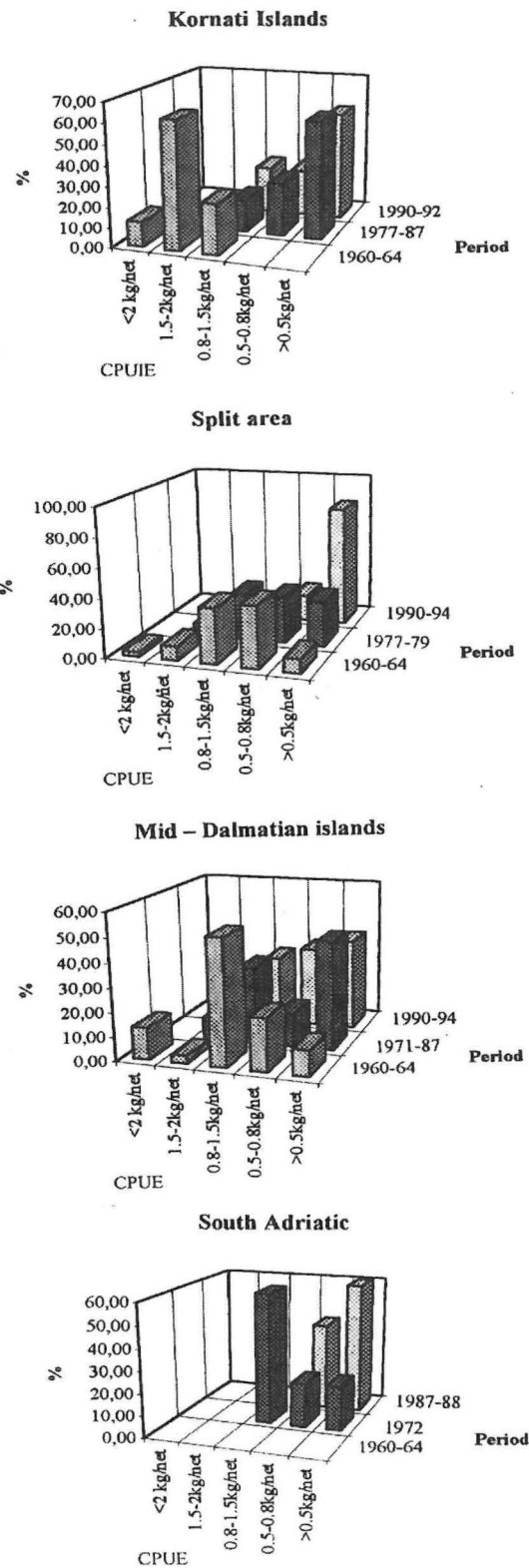


Fig. 3. Changes in the presence of CPUE classes in the experimental trammel bottom set catches in the Kornati Islands, Split, Mid-Dalmatian Islands and South Adriatic coastal area during the investigated time intervals

Table 2. Differences in numerical and weight abundance of common fish families in experimental trammel bottom set catches from the Palagruža Islands area

1961	1970-71	1987-1989	1995	b
CPUE of fishes				
2.10	1.92	1.27	0.71	
Scorpaenidae (number % / weight %)				
12.5 / 42.3	13.9 / 26.1	55.7 / 4.4	23.6 / 12.2	0.7840 / -0.9497
Labridae (number % / weight %)				
13.6 / 9.2	3.7 / 3.0	3.5 / 4.4	3.5 / 3.6	-0.2366 / -0.1130
Mullidae (number % / weight %)				
28.8 / 19.6	71.1 / 52.6	7.3 / 6.1	15.2 / 8.9	-1.0159 / -0.7513
Serranidae (number % / weight %)				
10.1 / 3.7	1.1 / 0.5	2.1 / 1.1	1.4 / 0.4	-0.1895 / -0.0684
Sparidae (number % / weight %)				
3.5 / 2.3	3.2 / 3.2	4.6 / 4.7	18.3 / 15.2	0.3241 / 0.2891
Other fishes (number % / weight %)				
31.5 / 22.9	7.0 / 14.6	26.8 / 18.5	38.0 / 59.7	0.3339 / 0.7924

1987 - 1989 period and finally it was 1.49 kg in the 1995 (Fig. 2D).

South Adriatic: In 1972, when the studies of fish and edible invertebrates communities along the coast of the southern Adriatic (Montenegro coastal area) began, the average CPUE was 0.57 kg. It declined to 0.43 kg (about 25%) in 1987 (Fig. 2E). In 1972 there were no CPUE classes exceeding 0.8 - 1.5 kg recorded in that area. In 1987 - 1988 the CPUE exceeding 0.8 - 1.5 kg also disappeared. At the same time, the presence of 0.5 - 0.8 kg and particularly < 0.5 kg CPUE classes increased from 20.0 to 40.0%, respectively (Fig. 3).

Changes in the catch composition

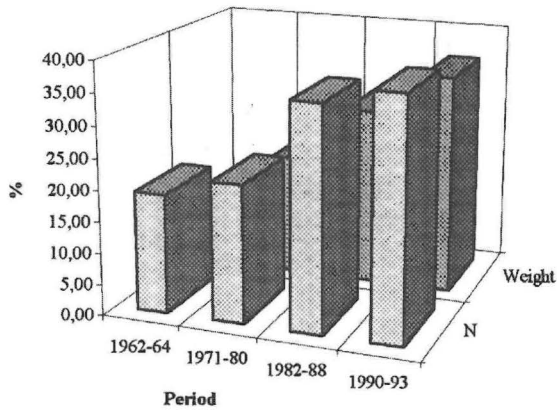
On the coastal area of the eastern Adriatic five fish families, i.e. Scorpaenidae, Labridae, Serranidae, Sparidae and Mullidae, prevail in the trammel bottom set catches (JARDAS, 1979, 1979a, 1980, 1980a, 1982, 1986; REGNER *et al.*, 1985; JARDAS and PALLAORO, 1989).

The presence of mentioned fish families in the trammel bottom set catches in the Palagruža Islands area (on this coastal area this matter was only studied) in the 1961-1995 period show certain differences (Table 2). In general, numerical

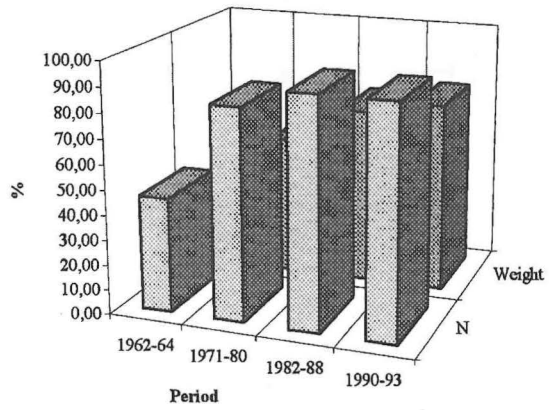
and weight abundance of Labridae, Mullidae and Serranidae families in the catches shows a tendency of slight decrease, and Sparidae family shows a tendency of slight increase in both the numerical and weight abundance. In fact the Scorpaenidae family as the most numerous in the trammel bottom set catches along the eastern Adriatic coast, in the studied period shows a tendency of slight increase in number on one hand, and slight decrease in weight on the other. Values for both abundances for all targeted fish families show notable variety from one period to another, which is probably a consequence of inadequately large samples and different seasons of sampling.

Generally speaking, the experimental trammel bottom set catches from the study area of the coastal middle and southern Adriatic were also dominated, in number and weight, by the following fish species: *Scorpaena porcus*, *Symphodus (Crenilabrus) tinca* and *Mullus* spp. (mainly in weight), cephalopoda species: *Sepia officinalis* and *Octopus vulgaris* and crustacean species *Maja crispata* (MOROVIĆ, 1965, 1971; JARDAS, 1979, 1980, 1980a, 1982, 1985, 1986). The trends of the numerical and weight abundance of these species in trammel bottom set catches between 1962 and 1993 are given in Fig. 4.

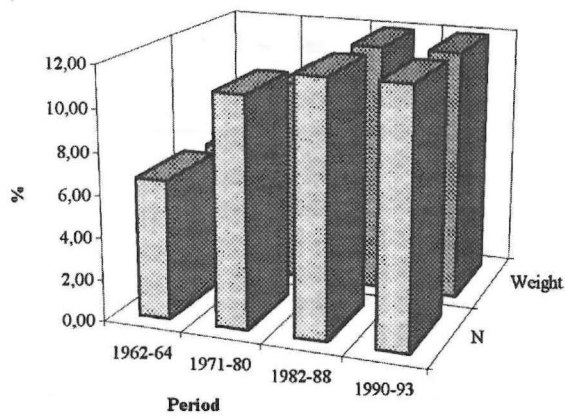
Scorpaena porcus



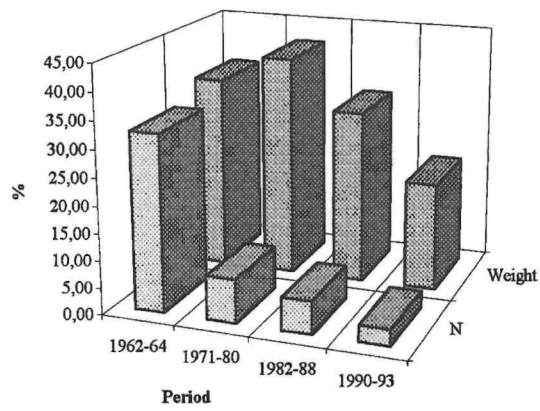
Sepia officinalis



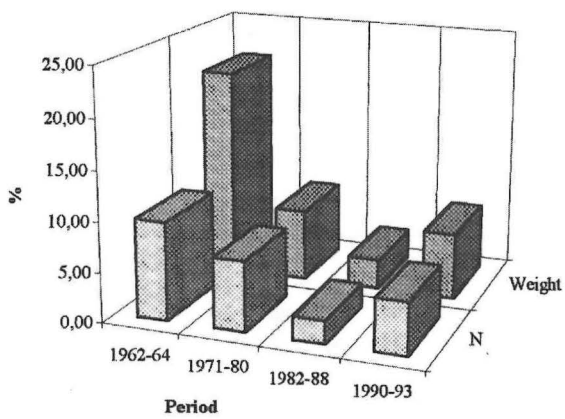
Symphodus tinca



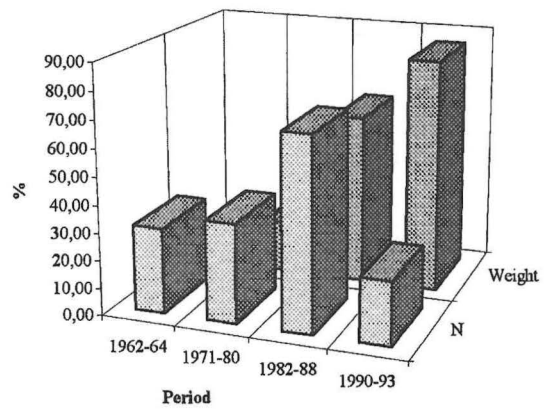
Octopus vulgaris



Mullus sp.



Maja crispata



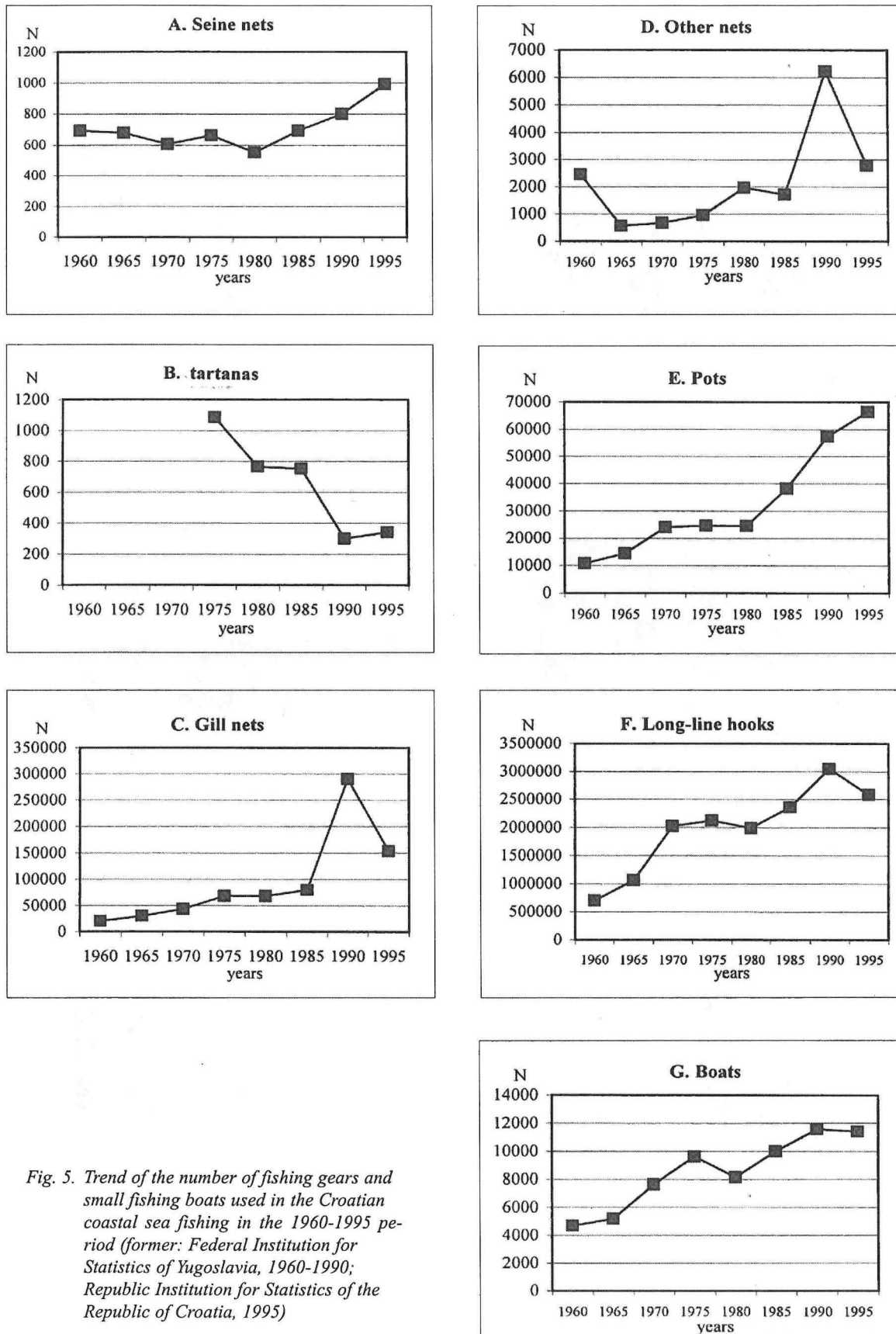


Fig. 5. Trend of the number of fishing gears and small fishing boats used in the Croatian coastal sea fishing in the 1960-1995 period (former: Federal Institution for Statistics of Yugoslavia, 1960-1990; Republic Institution for Statistics of the Republic of Croatia, 1995)

A trend of steady increase in both the number and weight abundance of fish species *Scorpaena porcus* and *Symphosus (Crenilabrus) tinca*, cephalopoda species *Sepia officinalis*, and decapod crustacean species *Maja crispata* was observed for the entire period of the study. On the contrary, the *Mullus* spp. (particularly *M. surmuletus*) and the cephalopod species *Octopus vulgaris* showed a decrease in both the numerical and weight abundance.

DISCUSSION

Owing to the continued research of coastal communities of the fish and edible invertebrates ever since 1960 it has been possible to observe a number of events. GRUBIŠIĆ (1968, 1974) assessed the fishing grounds of the eastern Adriatic and pointed a large number of signs of its biological impoverishment caused by over-exploitation. MOROVIĆ (1965, 1970, 1971, 1979) pointed to a sharp decline in the trammel bottom set catches in the Adriatic coastal area. The same author also showed the accompanying decrease in the length and weight, as well as, presence of some fish species in the catches. The same changes and their extent were also reported later (JARDAS, 1979a, 1980, 1980a, 1982, 1986; JARDAS and PALLAORO, 1989).

All previously mentioned authors believed that the observed changes were due to overfishing, use of harmful gears, violation of legislation and poor implementation of legal measures concerning the exploitation and protection of marine biological resources (Law on the Marine Fisheries and legal provisions). Growing marine pollution (UNEP Rep., 1994) adversary affects the biological resources of the coastal sea of the eastern Adriatic. Pollution is particularly pronounced in the vicinity of large urban and industrial centers. The extent of the pollution influence on the coastal biological resources could not yet be adequately assessed.

Growing intensity of eastern Adriatic coastal exploitation, as the main cause of observed changes in the communities of fish and edible invertebrates, is clearly shown by the statistics of the recent variations in the number

of fishing gears and fishing boats (Fig. 5). The number of seine nets has been 1.4 times increased since 1960 and the number of gill nets 7.6 times, that of trammel sets alone 6.3 times, fish and crustacean pots more than 6 times, hooks of long-lines 3.7 times and fishing boats 2.4 times. Parallel to this obvious increase in fishing effort, the realized catch of fish and edible invertebrates stagnates from year to year in the coastal areas and is indicated by the calculated regression coefficient $b = 19.07$ mt (1980-1995; JARDAS and PALLAORO, 1998). The same trends of increase of fishing gears (fishing effort) and realized catch from year to year from the eastern Adriatic coastal area was reported from the period 1970-1978 (BASIOLI, 1979; JARDAS, 1980, 1980a, 1982). Moreover, calculated catch regression coefficient was negative, $b = -162.3$ mt in that period. This course of fishing effort and catch is one of the indicators of the overfishing of exploited communities which, as has been shown, is reflected upon the quantities in experimental trammel bottom set catches.

It may be said for the situation in the eastern Adriatic that the intensity of exploitation of an area is inversely proportional to its distance from the nearby mainland or island. These "outer areas" give better average landings per trammel bottom set than the "inner areas" (MOROVIĆ, 1965, 1970, 1971). This may be confirmed by the data of Palagruža Islands presented here. In the surroundings of these islands, far away from the mainland and any other island, the average catch was all the time considerably in excess in comparison with the catches of other coastal areas. However, it should be emphasized that these differences recently decreased. The disappearance of these differences was recorded already by MOROVIĆ (1971) who compared the experimental trammel bottom set catch data from outer islands of Lastovo, Sv. Andrija and Palagruža and "inner areas" for the 1962-1965 and 1968-1970 period. Present data for Palagruža Islands area up to 1995 confirmed these statements once again.

After MOROVIĆ (1965, 1970, 1971, 1979) Palagruža Islands area had always been richer in

fish than other eastern Adriatic coastal grounds. This phenomenon, author attempted to explain in terms of the position of the islands far off the mainland, by the configuration of the sea bottom and smaller fishing effort than in other areas.

However, sea area around the Palagruža Islands on the Palagruža Sill is in general more productive than the sea area in the Middle and South Adriatic. Together with Jabuka Pitt this sill separates Middle Adriatic from the South Adriatic with deep South Adriatic Pit (basin). Therefore this area is subject to rather intensive exchange and mixing of waters of different origin. This is probably the most important characteristic of the region. Intensive mixing and water exchange influence the turnover of salts which in turn affects the rate of organic production (ZORE-ARMANDA, 1984).

Higher level of organic production in the Palagruža Sill area is particularly indicated by lower sea water transparency and higher level of oxygen and nutrient salts content that in the corresponding layer (upper 100 m) of the open Middle and South Adriatic.

CONCLUSIONS

The decrease of quantity and quality of the trammel bottom set catches (or generally) in the coastal area of the eastern Adriatic in the period

since 1960 is significant. During the observation of changes in the catches in the period 1960 – 1995 the decrease of CPUE in Dalmatian area was between 63% and 69%, except 24% in the area of the South Adriatic (Montenegro seaside), but in the shorter period of time (1972 – 1987).

The decline of CPUE was more significant during the first decade of investigation. Those changes are consequence of lasting and progressive growing intensity of exploitation.

The decrease of the quantity was followed by qualitative changes in the catches.

The qualitative changes in the catches in the area of Palagruža Islands (off-shore area in the middle Adriatic) have been recorded as an alternation in the presence of dominant fish families: the presence of Scorpaenidae family has increased and that of Labridae and Serranidae family and *Chromis chromis* species has decreased.

Throughout the study area the number and weight of fishes *Scorpaena porcus* and *Symphodus tinca*, decapod crustacean *Maja crispata* and cephalopod *Octopus vulgaris* decreased.

In addition to these qualitative changes, an increased average length and weight of fish species *Scorpaena porcus*, *Symphodus tinca* and *Mullus surmuletus* were recorded, probably due to density dependent effects of communities and populations.

REFERENCES

- BASIOLI, J. 1979. An increase in small-scale fisheries is not followed by catch increase. *Morsko ribarstvo*, 1: 19-22. (in Croatian)
- BULJAN, M. 1964. An estimate of productivity of the Adriatic Sea made on the basis of its hydrographic properties. *Acta Adriat.*, 11 (4): 35-45. (in Croatian)
- BULJAN, M. 1969. La produttività dell'Adriatico stimata in base alle sue proprietà idrografiche. Il patrimonio ittico dell'Adriatico, difesa e valorizzazione. Comunicazione al convegno italo-jugoslavo, Venezia 1969, pp. 3-15.
- CETINIĆ, P. 1990. Some problems of the Adriatic coastal fishing and its protection measures (in Croatian) *Morsko ribarstvo*, 3: 86-89.
- GRUBIŠIĆ, F. 1968. An attempt at evaluating the Yugoslav Adriatic fishing-ground. *Pomorski zbornik*, 6: 823-844. (in Croatian)
- GRUBIŠIĆ, F. 1974. Indicators of impoverishment in the Adriatic Sea - a consequence of intensive fishing. *Acta Adriat.*, 16 (5): 97-117. (in Croatian)
- JARDAS, I. 1979. State of the coastal communities of fishes, cephalopoda and crustaceans along the Yugoslav coast and perspective of catch. *Ichthyologia*, 11 (1): 63-101. (in Croatian)

- JARDAS, I. 1979a. What and how much is caught by trammel bottom sets along the eastern Adriatic. *Morsko ribarstvo*, 2-3: 51-54. (in Croatian)
- JARDAS, I. 1980. Fishery resources and Yugoslav fisheries in the coastal area of the Adriatic Sea. *FAO Rapp. pêches/FAO Fish. Rep.* (239): 53-59.
- JARDAS, I. 1980a. Coastal fish communities and exploitation. *Morsko ribarstvo*, 4: 153-157. (in Croatian)
- JARDAS, I. 1982. Influence of the intensive fishing on fish communities in the coastal Eastern Adriatic. *Ichthyologia*, 14 (1): 21-39. (in Croatian)
- JARDAS, I. 1986. Trammel bottom set catches along the eastern Adriatic coast (1971-1984). *FAO Rapp. pêches/FAO Fish. Rep.* (345): 189-199.
- JARDAS, I. and A. PALLAORO. 1989. Some indicators of the decline of the coastal Adriatic fishing resources (1960-1988). *Pogledi*, 19: 159-176. (in Croatian)
- JARDAS, I. and A. PALLAORO. 1997. State and management of near-shore biological resources. *Tisuću godina prvog spomena ribarstva u Hrvata*. HAZU Zagreb, pp. 381-399. (in Croatian)
- JARDAS, I., A. PALLAORO, M. KRALJEVIĆ, J. DULČIĆ and P. CETINIĆ. 1998. Long-term changes in biodiversity of the coastal area of the Eastern Adriatic: fish, crustacean and cephalopoda communities. *Period. Biol.*, 100 (1): 19-28.
- MOROVIĆ, D. 1965. Le problème de la pêche côtière d'après une analyse des captures au tramail. *Proc. gen. Fish. Coun. Medit.*, 8: 351-360.
- MOROVIĆ, D. 1970. Trammel bottom set catches and their analysis from a biological viewpoint. *Morsko ribarstvo*, 3: 119-121. (in Croatian)
- MOROVIĆ, D. 1971. Ichthyofauna exploitation and protection in the coastal region of the central and south Adriatic. *Simp. o zaštiti prirode u našem kršu*, JAZU Zagreb, pp. 339-353. (in Croatian)
- MOROVIĆ, D. 1979. The fishing of benthal fishes in the Mid-Dalmatian region. *Acta Biol., JAZU*, 8: 1-10. (in Croatian)
- PUCHER-PETKOVIĆ, T. 1974. Essai d'évaluation de la production primaire annuelle dans l'Adriatique. *Rapp. Comm. int. Mer. Médit.*, 22 (9): 71-72.
- PUCHER-PETKOVIĆ, T. and M. ZORE-ARMANDA. 1973. Essai d'évaluation et pronostic de la production en fonction des facteurs du milieu dans l'Adriatique. *Acta Adriat.*, 15 (1): 39 pp.
- REGNER, S., V. ALEGRIA-HERNANDEZ, I. JARDAS, S. JUKIĆ, I. KAČIĆ, M. KRALJEVIĆ and G. SINOVČIĆ. 1985. Resources, state and development of Yugoslav marine fisheries. *Privreda Dalmacije*, 1: 13-27. (in Croatian)
- TREER, T. and S. JUKIĆ-PELADIĆ. 1997. Fisheries. In: *Hrvatska poljoprivreda na raskrižju*. Nacionalno izvješće Republike Hrvatske. World Food Summit, Rome, 1996, pp. 117-121. (in Croatian)
- UNEP Monitoring Programme of the Eastern Adriatic Coastal Area - Report for 1983-1991. *MAP Techn. Rep., Ser. No. 86*, Athens, 1994, 311 pp.
- VODOPIJA, T. 1997. The current situation and future development of Croatian marine fisheries. *Tisuću godina prvog spomena ribarstva u Hrvata*. HAZU Zagreb, pp. 427-435. (in Croatian)
- ZORE-ARMANDA, M. 1984. Hydrographic and productivity conditions of the Palagruža region in the Middle Adriatic. *Acta Adriat.*, 25 (1 / 2): 119-138.

Pregled dugogodišnjih promjena u lovinama poponica i zajednica rakova, glavonožaca i riba uz istočnu obalu Jadrana

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SAŽETAK

Priobalje istočnog Jadrana je tradicionalno najvažnije ribolovno područje za kategoriju športsko-rekreacijskih, dopunskih i profesionalnih ribara koji u ribolovu koriste male ribolovne alate. U priobalju se, od oko 55 ribolovnih alata koliko ih je poznato u istočnom Jadranu, upotrebljavaju gotovo svi osim dubinske kočice, lebdeće kočice i tunolovke. Prema procjenama od ukupnog godišnjeg ulova ribe i jestivih beskralježnjaka u istočnom Jadranu (oko 50-70 tisuća tona) u priobalnom području se ostvari - uzevši kao osnovicu ulov od 50 tisuća tona - oko 60% ulova.

Intenzivan ribolov u priobalnom području odrazio se na količinu lovina koje se ostvaruju priobalnim ribolovnim alatima, osobito mreža poponica, te sastav populacija i zajednica riba i jestivih beskralježnjaka. U ovom radu su analizirane eksperimentalne lovine mreža poponica ostvarene u razdoblju od 1960. do 1995. god. i to na području Kornata (1960.-1992.), Splita (1960.-1994.), srednjedalmatinskih otoka (1960.-1994.), Palagruže (1961.-1995.) i južnog Jadrana (1972.-1988.). Lovine su ostvarivane poponicama standardnih konstrukcijskih osobina (dužina 31-36 m, visina 1,3-1,5 m, veličina oka mahe 28-32 mm) i na uobičajeni način ribolova, na dubinama do oko 30 m.

Na odabranim pozicijama ribolov je obavljan u pravilu s 10 ili 11 međusobno povezanih mreža, a ulov je u cilju usporedbe sveden na ulov po jedinici ribolovnog napora, tj. na prosječni ulov po jednoj mreži.

Promjene u lovinama, a to ujedno znači u populacijama i zajednicama, su se očitovale u kontinuiranom opadanju ulova po jedinici ribolovnog napora na svim istraživanim područjima za oko 63-64% u odnosu na početne lovine (u južnom Jadranu za oko 25% u petnaestogodišnjem razdoblju), zatim u alternaciji nekih porodica riba (uglavnom Scorpaenidae, Labridae, Sparidae, Mullidae i Serranidae) te vrsta *Scorpaena porcus*, *Symphodus (Crenilabrus) tinca* i *Mullus* spp. od riba, *Maja crispata* od rakova i *Sepia officinalis* i *Octopus vulgaris* od glavonožaca u lovinama. Sve navedene promjene su prvenstveno posljedica dugotrajnog, intenzivnog i nerazumnog iskorištavanja živog bogatstva priobalnog područja.