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*Scientific Cooperation
to Support Responsible Fisheries in
the Adriatic Sea*

Adriatic Sea Small-Scale Fisheries





*SCIENTIFIC COOPERATION TO SUPPORT
RESPONSIBLE FISHERIES IN THE ADRIATIC SEA*

MiPAF

Food and
Agriculture
Organization
of the
United Nations

Italian Ministry
of Agriculture
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Policies

AdriaMed

GCP/RER/010/ITA

Adriatic Sea Small-Scale Fisheries

Report of the AdriaMed Technical Consultation on Adriatic Sea Small-Scale Fisheries

Split, Croatia, 14th – 15th October 2003

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Preface

The Regional Project “Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea” (AdriaMed) is executed by the Food and Agriculture Organization of the United Nations (FAO) and funded by the Italian Ministry of Agriculture and Forestry Policies (MiPAF).

AdriaMed was conceived to contribute to the promotion of cooperative fishery management between the participating countries (Republics of Albania, Croatia, Italy, Serbia-Montenegro and Slovenia), in line with the Code of Conduct for Responsible Fisheries adopted by the UN-FAO.

Particular attention is given to encouraging and sustaining a smooth process of international collaboration between the Adriatic Sea coastal countries in fishery management, planning and implementation. Consideration is also given to strengthening technical coordination between the national fishery research institutes and administrations, the fishery organizations and the other relevant stakeholders of the Adriatic countries.

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GCP/RER/010/ITA Publications

The AdriaMed Project publications are issued as a series of Technical Documents (GCP/RER/010/ITA/TD-00) and Occasional Papers (GCP/RER/010/ITA/OP-00) related to meetings and research organized by or conducted within the framework of the Project.

Occasionally, relevant documents may be translated into national languages as AdriaMed Translations (GCP/RER/010/ITA/AT-00).

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Preparation of this document

This document is the final version of the AdriaMed Technical Consultation on Adriatic Sea Small-scale Fisheries, organized by the AdriaMed Regional Project (*Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea*) on 14-15 October 2003 in Split (Croatia), hosted by the Institute of Oceanography and Fisheries.

Small-scale fisheries worldwide account for a substantial part of fish production and are very relevant for their social, economic and ecological implications. As opposed to large-scale commercial (or industrial) fisheries, small-scale fisheries are relatively less documented and investigated, as well as being difficult to monitor because of their characteristics. In the Mediterranean small-scale fisheries are believed to contribute significantly to the overall capture fishery production.

While many articles and recommendations of the Code of Conduct for Responsible Fisheries refer to industrial fisheries and related practices, the Code is also relevant to small-scale fisheries. Various references are made in the Code to small-scale, artisanal fishing practices, in particular these are addressed under Article 12.12 which underlines the need for research on small-scale fisheries because of their possible bearing on sustainable fisheries.

In line with its mandate and coherently with the indications given by the Code of Conduct for Responsible Fisheries, the small-scale fisheries issue was dealt with by the AdriaMed Project. The AdriaMed Technical Consultation on Adriatic Sea Small-scale Fisheries was the first of such a topic specifically focused on the Adriatic Sea region. The Consultation aimed at reviewing the current knowledge on this sector, identifying needs and priorities and establishing the basis for cooperative future work at the regional level. In particular, species whose stocks are shared and small-scale fisheries them were taken into consideration.

The Consultation and this Technical Document fall within the shared fishery resources and fishery management components of the AdriaMed Project. The present work is addressed primarily to fishery scientists, managers and professionals.

It is hoped that it will contribute to strengthen international cooperation and to promote responsible fisheries around the Adriatic Sea.

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AdriaMed.

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ABSTRACT

The AdriaMed Technical Consultation on Adriatic Sea Small-Scale Fisheries was held on 14th and 15th October 2003 in Split, Croatia. The Consultation was attended by 21 experts from the four countries participating in the Project (Albania, Croatia, Italy and Slovenia). The objectives of the Technical Consultation were to review, on the basis of participants' experience, the current knowledge and the status of small-scale fisheries in Adriatic countries, to consider the existing monitoring systems, to have up-to-date information on the available scientific and technical knowledge in each country and on the on-going programs focusing on small-scale fisheries. In particular, species whose stocks are shared and small scale fishing gears exploiting these species were dealt with by the Technical Consultation. The Technical Consultation identified the following activities to be regarded as priority and functional to promoting regional scientific cooperation, focusing on the small-scale fishery sector: i) compilation of a gear catalogue of the gear types presently employed by the fisheries of the Adriatic coastal countries; ii) a case study aimed at the in-depth analysis of selected fishing communities; and iii) a fishing effectiveness appraisal based on comparative analyses of similar fishing gears or of the gears targeting a given species in different areas around the Adriatic basin. Four national reports and eight scientific contributions on small-scale fishery exploitation dynamics and interaction with other fisheries presented during the Consultation are included in the document.

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Adriatic Sea Small-Scale Fisheries
Report of the AdriaMed Technical Consultation on Adriatic Sea Small-Scale Fisheries
Split, Croatia, 14th – 15th October 2003

Opening of the Meeting and election of the Chairperson (Agenda item 1)

The AdriaMed Technical Consultation on Adriatic Sea Small-Scale Fisheries was held on 14th and 15th October 2003 in Split, Croatia. The Technical Consultation was organized in the context of the FAO-AdriaMed Regional Project (Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea). It was hosted by the Institute of Oceanography and Fisheries of Split.

The Consultation was attended by 21 experts from the countries participating in the Project and the FAO-AdriaMed staff. AdriaMed staff constituted the Secretariat. The list of participants is given in Annex A of this report.

The meeting was opened by Dr Stipe Jukić-Peladić on behalf of the host institution and its director Dr Ivona Marasović. Dr Jukić-Peladić stated the importance of assessing the current state of the small-scale fishery sector in the Adriatic and of identifying common priorities at regional levels, thus making a step towards the implementation of the FAO Code of Conduct for Responsible Fisheries. He expressed his hope that this meeting will follow the success achieved by AdriaMed in promoting and strengthening scientific cooperation for fishery research and management. He underlined that the complexity of fisheries research and, particularly of fisheries management in the Adriatic and in the Mediterranean in general, was due to the multispecies and multigear nature of fisheries. This is further complicated by the increasing use of coastal areas, pollution, sport and recreational fisheries.

The FAO-AdriaMed representative, Dr Piero Mannini, recalled the reasons for organizing this meeting, including the need to address small-scale fishery in consideration of the shared stocks issue, which is particularly relevant in the case of Adriatic fisheries. He explained that the Code of Conduct for Responsible Fisheries and its implementation is a central tenet of the AdriaMed Project that, in the case of small-scale fishery, should mean securing employment, income and sustainable fishing practices. He emphasized that this was the first regional, technical meeting specifically dealing with small-scale fisheries of the Adriatic Sea.

Dr Jakov Dulčić acted as a Chair for the meeting. The Agenda adopted by the Consultation is attached as Annex B. As indicated in the Agenda, the Consultation was organized around national reports and the presentation of working papers.

Objectives of the Technical Consultation (Agenda item 2)

The Secretariat introduced the objectives of the meeting with reference to the background information previously circulated. In the Adriatic Sea region, as in the world in general, unlike the larger-scale commercial (or industrial) fisheries, the small-scale fisheries are

relatively less documented and investigated, as well as being difficult to monitor, because of their characteristics (e.g. landing points are many and scattered along the coast, fishing activity can be irregular, the multiplicity of gear and of the resources exploited, etc.). Yet, the Mediterranean small-scale fisheries are thought to be in line with worldwide tendencies, contributing significantly to the overall fishery production. In the case of the Adriatic Sea, many species, whose stocks are shared, are exploited not only by large-scale commercial fisheries but also by small-scale fisheries either regularly or during specific phases of their life-cycle.

While many articles and recommendations of the Code of Conduct for Responsible Fisheries refer to industrial fisheries and related practices, the Code is also relevant to small-scale fisheries. Various references are made in the Code to small-scale, artisanal fishing practices, in particular these are addressed under Article 12.12 which underlines the need for research on small-scale fisheries because of their possible bearing on sustainable fisheries.

In December 2002, the AdriaMed Coordination Committee considered the relevance of small-scale fisheries and the role in the exploitation of some shared stocks, and agreed to establish a network of regional experts. In the initial stage, the network would focus on the appraisal of the current knowledge concerning the exploitation carried out by the small-scale fishery sector on those priority demersal species whose stocks are shared and which are also targeted by large-scale commercial fishery. Consequently, the objectives of the Technical Consultation were to review, on the basis of participants' experience, the current knowledge and the status of small-scale fisheries in Adriatic countries, to consider the existing monitoring systems, to have up-to-date information on the available scientific and technical knowledge in each country and on the on-going programs focusing on small-scale fisheries. In particular, species whose stocks are shared and small scale fishing gears exploiting these species were to be dealt with by the Technical Consultation. Needs and priorities should be identified and the basis established for cooperative future work either within AdriaMed or other contexts.

An overview was given of current world marine capture fisheries production also comparing large-scale and small-scale fisheries in terms of employment, fish caught for direct human consumption, capital cost of each job, by-catch discarded and fuel consumption. An insight was also provided into the characteristics of the Adriatic region fishing fleet standardized by vessel size (length, tonnage, engine power) and fishing technique category. Lastly, it was proposed that the Meeting should agree on a working definition of small-scale fisheries.

In face of the necessity to define small-scale, artisanal fisheries, full consensus could not be reached, particularly whether or not small vessels (i.e. less than 12 m overall length), equipped with active gears such as trawl nets, should be accounted in the small-scale fishing category. Various broad definitions were considered, and it was concluded that although being aware of the current European Commission classification of small-scale fishery (i.e. fishery performed by boats less than 12 m overall length equipped with passive gear), due to differences in the four countries concerned, a more flexible working definition would be preferable for the aims of the Consultation. Participants agree to refer to small-scale fisheries using a slightly modified extracted from a document prepared for the 25th Session of the Committee on Fisheries in 2003 (COFI/2003/9): "Small-scale fisheries can be broadly

characterized as employing labour intensive harvesting, processing and distribution technologies to exploit marine and inland water fishery resources *by relatively small fishing vessels*. The activities of this sub-sector, conducted full-time or part-time or just seasonally, are often targeted on supplying fish and fishery products to local and domestic markets and for subsistence consumption”.

Presentation of National reports (Agenda item 3-6)

Albania (Cobani, this report). Most small-scale, artisanal fishing is practised without a licence; only a small fraction of fishing units are licensed and therefore registered, while the large majority are not officially accounted for. Artisanal fishery has developed remarkably since the 1990s as an alternative to unemployment and low income in coastal areas. A first field survey exercise, carried out in view of this Technical Consultation by the Fishery Department in summer 2003, recorded 462 fishing units (363 with engines and 99 without), performing (either full or part-time) small-scale coastal fishing with an estimated number of more than 900 fishers, most of them part-time fishers, primarily employed in agriculture. One of the main constraints of the sector is the local non-availability of fishing gear material.

It was observed that this was the first time that the issue of Albania small-scale fisheries had been specifically dealt with. Due to the unofficial nature and dimension of the sector, conflicts between illegal inshore trawling and small-scale fishery are not reported, although they are believed to happen. Specific national fishery policy is expected to be formulated on the basis of this first appraisal. A licensing scheme and management plan will have to be devised.

Croatia (Dulčić, *et al.*, this report). Croatia has a long tradition of small-scale coastal fishing, as indicated by the 55 different fishing gears officially listed as currently employed. The total amount of small-scale licences was estimated at around 8500 in 1999 by national experts but at present it could be much higher. The impact on coastal resources is believed to be significant. Long-term (1960-1995) localised monitoring of some fishing communities showed evidence of marked decline of CPUE, in contrast to the increased number of fishing gears. It is thought, although unsubstantiated because of lack of specific fishery statistics, that small-scale fishery could comprise more than half of the Croatian landings of demersal species. Seemingly, the number of fishers has increased during the last decade as small-scale fishery constitutes an important means of support and subsistence for coastal and particularly islands communities. The utility of having information from historical data sets was remarked upon, as such information may prove highly valuable to assess the impact of fishery exploitation on target resources. It was noted that the available 1960-95 time series could show the effect of exploitation on the stocks from the initial relatively virgin condition to the present one.

In order to contain conflicts between active and passive fishing gears, particularly in the channels area of Croatia, current fishery regulations have a system of seasonal and spatial closure thus to avoid the simultaneous use of potentially conflicting gears. Small-scale fishery is a crucial issue in Croatia, based on the estimated number of fishers, some of whom are not authorized but still tolerated because of the difficult living condition affecting coastal

and particularly island communities. It is estimated that about 80 000 people depend to some extent on small-scale fisheries.

Italy (Sabatella, this report). Currently, statistics on Italian capture fisheries are collected by Irepa through a National Observatory; the adopted sampling scheme allows for the monitoring of the national small-scale fishery through a sample of 3.5% of the total small-scale fleet. In the year 2002, out of the total fishing fleet of 15 915 vessels, 10 296 belonged to the small-scale segment, 2 983 of which operated in the Adriatic and employed 4 875 fishers. The landing volume from the Italian Adriatic small-scale fishery amounted to more than 24 000 tonnes.

The performance of the Italian small-scale fishing fleet operating in the Adriatic was analysed through a set of biological, economical and social indicators and associated reference points. In the last few years, the Italian small-scale fishery has undergone a strong reduction in terms of capacity and effort, meanwhile experiencing decreasing catch and increasing price trends. From the social point of view, it would seem that income generated by the sector is excessively low in comparison to other productive activities although partly compensated by the high degree of ownership share that is a typical feature of small-scale fisheries.

Key-factors to be taken into account for the sustainability of small-scale fisheries and their management were proposed. Possible options for the future development of the sector in terms of income integration (e.g. fishery tourism) and fishery management (e.g. rights-based management) were presented.

Slovenia (Marčeta, this report). Small-scale fishery is poorly known and basically not monitored. Officially, small-scale fisheries were not recognized as category within national fisheries. Practically, small boats equipped with passive fishing gears were regarded as components of the small-scale artisanal fishery sector. The current number of fishing units that may be attributed to the small-scale fishery sector is estimated at 73 vessels. Indicatively, the average yearly catch could be estimated at around 100 tonnes. The establishment of a basic monitoring system was indicated as a priority action.

Small-scale fishery exploitation dynamics and interaction with other fisheries (Agenda item 7)

The heterogeneity of small-scale fisheries could be well depicted through various examples and studies of fishing activities that fall within the small-scale, artisanal fishery category. Interaction among fisheries, selectivity of some gears and the sustainability of fishing practices were discussed.

The interaction between the artisanal and the recently developed “mechanized clam kicking” fisheries in the Lagoon of Venice was proposed (communication by Giovanardi; for further

details see the footnote*) as a case of potential conflict because these different techniques and fishing strategies exploit different resources in the same environment. On the one hand, the artisanal fishery is a small-scale and multi-target fishing activity with an old tradition, which is carried out by means of static gears like fyke nets and traps. On the other hand, “mechanized clam kicking” fisheries adopts recently developed mechanical dredges (“rusca” dredge) for collecting the exotic Manila clam *Tapes philippinarum*, that was introduced in the Venice lagoon in 1983 and rapidly spread all over this area. This activity became a semi-industrial activity, and at present about 600 fishing boats are operating in the Venice lagoon. This was reflected in the sudden increase of Manila clams catches whereas, at the same time, a continuous negative trend in artisanal fishery catches has been observed. Preliminary assessment of “mechanical clam” fishery would indicate strong interactions with the benthic compartment and a rather high discard rate compared to the artisanal fishing activities.

Results of an ecosystem approach (communication by Giovanardi; for further details see the footnote*) to study the complex effects of clam harvesting, implemented through a trophic mass-balance model, indicated that the two fishing activities are strongly interrelated, even though they exploit different resources; furthermore, mechanical dredges used under a free-access regime is recognised to be a driving force able to affect the lagoon ecosystem status and create a considerable disturbance. According to the model, because of the indirect effects of “mechanical clam dredging” on the artisanal one, the elimination of Manila clam fishing activity would produce a strong increase (33%) in artisanal fishery catches even with no change in fishing effort. The model simulations would also forecast an increase in the mean trophic level of the artisanal fishery catches as a further effect of eliminating mechanical clam harvesting.

An example of traditional small-scale fishery, which would not fall in within the small-scale category *sensu strictu*, was provided by the case of the “bianchetto” and “rossetto” fishery in the Gulf of Manfredonia in the south-western Adriatic Sea (Ungaro et al., this report, a). This is a coastal trawling activity that targets transparent goby *Aphia minuta mediterranea* (“rossetto”) and sardine (*Sardina pilchardus*) fry (“bianchetto”). This type of fishery is classified as “special fishery” by the European Commission, and it is carried out in exception to EC Regulation 1626/1994. The fishery has a significant local, socio-economic importance. It is conducted in wintertime and two types of gear are used: the “Italian” otter trawl and high vertical opening otter trawl (“French” type trawl). It is a semi-selective activity, and most of the catch is made up of target species (more than 50% in weight and 75% in number of individuals), particularly in the case of the high vertical opening otter trawl. So far no scientific evidence indicates the risk of over exploitation of target species; however, because of the characteristics of this fishery, regular scientific monitoring would be advisable. Interactions with offshore trawl fishery have been assessed as negligible.

*Pranovi, F., Libralato, S., Raicevich, S., Granzotto, A., Pastres R. & Giovanardi, O. (2003) Mechanical clam dredging in Venice Lagoon: effects on ecosystem stability evaluated with a trophic mass-balance model. *Marine Biology P.S.*, 143: 393-403

Pranovi, F., Da Ponte, F., Raicevich, S. & Giovanardi O., (2003) A multidisciplinary study of the immediate effects of mechanical clam harvesting in the Venice Lagoon. *ICES J. Mar. Sci.*, 61/1: 43-52.

Another fishery, whose classification as small-scale would be questionable, is the drifting long-line fishery in the southern Adriatic Sea (Marano, *et al.*, this report). This is a passive, offshore fishing occurring up to 40-50 nautical miles from the southwestern coast (GFCM GSA 18), carried out also by small vessels. Target species are swordfish (*Xiphias gladius*) and albacore (*Thunnus alalunga*). Approximately twenty to thirty days' fishing days per year are allocated to swordfish and albacore fisheries respectively. By-catch is mainly of blue shark (*Prionace glauca*) and blue fin tuna (*Thunnus thynnus*) respectively, in the order of 10-20% and 5-7% in both number and weight. Discard at sea is either of non-commercial species such as blue stingray (*Pteroplatytrygon violacea*) or of the protected loggerhead turtle (*Caretta caretta*). It is a seasonal fishing activity that opportunistically depends on the availability of swordfish and albacore in the fishing ground, when it would not appear favourable the effort can be diverted to trawl or long-line demersal fisheries.

Unlike the albacore catch, the occurrence of juvenile swordfish was found to be particularly consistent. Recently, the fishery is reported to have implemented some self-management by refraining from albacore fishery to avoid the catch of juvenile swordfish. Only the Italian fleet carries out this fishery, and no interaction is reported with other fishing activities. Due to the incidence of juvenile swordfish, should this fishery develop further, the precautionary approach should be applied.

A detailed description of small-scale fisheries in the Maritime Department of Ancona (central-northern Adriatic, GSA 17) is given by Fabi and Grati (this report, a). The activity pattern of the different fishing gears, their fishing grounds, target, by-catch and discard species were analysed over a four-year period. The catch composition by main species and fishing gear selectivity parameters were also presented.

Within the same area of GSA 17, the interaction between rapido (sort of beam trawl) trawling and small-scale fishery for common sole and cuttlefish was investigated (Fabi and Grati, this report, b). Common sole is exploited by both small-scale (gill-net) and rapido trawl fisheries, particularly within the six nautical mile strip from the coast. While indirect interaction exists as the two fisheries target the same stock, a more direct, although limited, interaction might happen at around three nautical miles from the coast where both fishing gears are allowed to operate (trawling is forbidden within the three-mile strip). Trawl net is less selective than gill net, being mostly made up of juvenile common sole. So far, despite the massive juvenile catch, landings and LPUE data from both fisheries do not show indications of stock decline.

As in the case of common sole, the cuttlefish fishery reflects, even more, the offshore-inshore behaviour of the species. No direct overlapping occurs between rapido trawl fishery and small-scale fishery (trammel net and trap fisheries) because fishing grounds are kept necessarily separate to avoid fishing gear damage. The intensive exploitation by different gears on the spawning stock and juveniles (juveniles particularly by rapido trawlers) could be one of the causes of the observed decline in stock. A marked decline in common cuttlefish catch was also reported in the eastern sector of the same GSA (GSA 17). Fishing mortality on juveniles due to the low selectivity of the rapido trawl is a matter of concern, and a way to contain it should be considered. Moreover, the mesh-size of Italian and Croatian rapido trawl nets have different selectivity, being of 52 and 82 mm (stretched) respectively. It was agreed

that further research effort would be necessary for a better knowledge of the spatial occurrence pattern within the year of common sole and cuttlefish because this is related to the life cycle of these important species that also constitute typical shared stocks. Common sole and cuttlefish, like many other groundfishery resources, are caught both inshore by small-scale fisheries and offshore by larger-scale operations' hence, it would be necessary to coordinate their operations or, at least, assess their impact jointly. As an example of potential conflict avoidance between fisheries, rapido trawl fishery (originally developed for scallops) is forbidden in western Istria from mid-September to mid-December, the main season for the small-scale trammel fishery.

Offshore bottom long-line fishery in the south Adriatic Sea (GSA 18) is discussed by Ungaro *et al.*, (this report, b). Currently, this fishery is conducted on the edge of the continental shelf and slope bottoms by only a relatively small Italian fishing fleet. Although the fishery is performed throughout the year, the activity rate is highly variable depending on weather conditions and on the alternation with the drift long-lining fishery (see Ungaro *et al.*, this report). Yet, the offshore bottom long-lining is reported to ensure good economic returns because of the typology and quantity of the landed catch.

The hook size presently employed makes it a rather selective fishery, mostly exploiting the adult stock of a few species, particularly of the hake which makes up most of the catch. Offshore bottom long-line fishery interacts with demersal trawl fishery either directly by trawlers when towing the net that may incidentally destroy long-lines, or by competition for the same resources. This is particularly relevant for a key-stock such as the hake when trawlers mostly catch juveniles, while bottom long-liners exploit the adult spawners that appear to be less vulnerable to the trawl gear. Under the present scenario, should bottom long-line develop consistently in the future, the ensuing fishing mortality exerted on juveniles by trawlers and on spawners by bottom long-liners could seriously affect on the already heavily exploited hake stock.

An introduction to the Adriatic Sea biodiversity together with an outline of the complexity of the Croatian small-scale coastal fishery sector and of the available knowledge is presented by Dulčić *at al.*, (this report, a). Furthermore, scientific information on some important fish and invertebrate species mostly exploited by the Croatian small-scale fisheries is compiled and summarised by Dulčić *at al.*, (this report, b).

A brief description of the small-scale fishery sector in Italy along the coast of the Emilia-Romagna Region (GSA 17) is given by Fiori *et al.*, (this report). The multigear polyvalent nature of a large part of the local fishing fleet is described. The aims of on-going research focused on the actual small-scale fishery (i.e. passive gear only) are also indicated.

Main gaps and priorities concerning small-scale fisheries and their management (Agenda item 8)

Common constraints and priorities for the small-scale fishery sector of Adriatic coastal states were highlighted. Primarily, it should be pointed out and considered that some countries have

monitoring data while others are dealing mostly with estimates that are mostly guess estimate. It was stressed that the social and economic component of small-scale fishery should be included in defining main gaps in and priorities for scientific knowledge.

Lack of appropriate and complete statistics was identified as one of the main constraints for most of the Adriatic coastal countries. It was pointed out that a distinction has to be made between types of statistics needed, such as biological and economic, and that economic statistics should, among other things, include data such as level of employment, catch quantity and value. Furthermore, data on fleet composition, fishing season, area and, ideally, on by-catch should be collected.

Another gap was the lack of up-to-date information regarding the different types of fishing gear used in small-scale artisanal fisheries. It would be extremely relevant to produce a catalogue with a detailed description of the gears used in each country.

One of the suggested priorities included comprehensive case studies on selected coastal communities that are mostly dependant on small-scale artisanal fishery; these could be done according to a standard scheme that could potentially be applied later to other communities. This also considers that it might be difficult to have enough resources to carry out proper statistical analyses of the entire small-scale fishery sector and that the case-study approach is a realistic way to collect detailed data on small-scale fishery. Each country could implement one or few case studies based on a common work plan agreed at regional level. This would improve the comparison of results, their validity and extension to on a wider scale.

The importance of recovering and making full use of available historical time series data was stressed, especially because data of this type are especially lacking in Mediterranean region. However, attention should be paid to verifying data sources because sometimes, even species are misidentified.

In terms of management problems and future development, it was stated that up to now, management has often been based on one fishing gear, whereas individual species are caught with variety of gear types, and that management needs to be based on all gear types used. For instance, Croatian lobster fishery management is based on traps while lobsters are currently mostly caught by gill and trammel nets. The need to improve the knowledge on temporal and spatial occurrence and abundance patterns of the main species exploited by small-scale fishery was reiterated. This should be further integrated with the quantitative evaluation of interaction between different fishing gears. Interaction evaluation should be done for main target species, secondary target, and by-catch species.

Outlining of a possible joint work program to be implemented at regional level in the Adriatic (Agenda item 9)

The Technical Consultation identified the following activities to be regarded as priority and functional to promoting regional scientific cooperation, focusing on the small-scale fishery sector. Other issues that may be highly relevant at national level were not included; although

these were brought forward at the Consultation, they were not considered in the present context.

Upon extensive discussion the following topics were agreed on:

- a. Compilation of a gear catalogue with an up-to-date and detailed description of all fishing gear types presently employed by the fisheries of the Adriatic coastal countries.
- b. A case study aimed at the in-depth analysis of selected fishing communities. Multidisciplinary study at selected sites, according to common protocol, on the different fishing gears, their use and exploited resources, fleet and gear spatial and temporal dynamics, market and social components, economic profitability.
- c. A fishing effectiveness appraisal based on comparative analyses of similar fishing gears or of the gears targeting a given species (in terms of catch composition, species vulnerability to fishing gears, gear selectivity, abundance indexes) in different areas around the Adriatic basin, thus generating improved scientific advice for fishery management and technology improvements. Two approaches could be considered: A similar gear approach or a target species approach (e.g. the Italian small-scale fishery catch common sole with gillnets and the Croatian fishery with a trammel net).

Other matters (Agenda item 10)

The Meeting was briefed by the AdriaMed representative on the EU-funded Interreg IIIA programme whose formulation was under way and which will include topics and activities directly related to Adriatic Sea small-scale fisheries.

Annex A

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Annex B

Agenda

1. Opening of the Meeting and election of the Chairperson
2. Objectives of the Technical Consultation
3. Current knowledge and status of small-scale fisheries in Adriatic countries
4. Existing monitoring systems for small-scale fisheries
5. Available scientific and technical knowledge on small-scale fisheries in each country
6. On-going programmes focussing on small-scale fisheries
7. Small-scale fishery exploitation dynamics and interaction with other fisheries
8. Main gaps and priorities concerning small-scale fisheries and their management
9. Outlining of a possible joint work-programme to be implemented at regional level in the Adriatic
10. Other matters

Small-scale fisheries in Albania

Mimoza Çobani*

Abstract

Artisanal fishery in Albania has developed remarkably since the 1990s as an alternative to unemployment and low income in coastal areas. A first field survey exercise, carried out by the Fishery Department in summer 2003, recorded 462 fishing units (363 with engines and 99 without), performing (either full or part-time) small-scale coastal fishing with an estimated number of more than 900 fishers, most of them part-time fishers, primarily employed in agriculture.

Keywords: artisanal fishing; data collections; fishing vessels statistics; socio-economic aspects; MED, Adriatic Sea; MED, Albania

1. Introduction

Small-scale artisanal (traditional) fishery is a category which includes the fishing activity carried out with small boats with/without an engine, along the coast up to 12 miles offshore with no commercial purposes, but for the fisher's own consumption; it is a sector that has a low level of investment.

Artisanal fisheries is a term used to describe low-capital ventures where the fisherman is often the owner of the vessel, in contrast to industrial fisheries involving major investments by companies or financial groups. This fishing is often associated with the notion of "coastal fishing"; that is to say that fisheries are located on the continental shelf and very close to a coastal zone. Fishing grounds can be reached in a limited time from the ports (or beaches). The target species are usually of high commercial value.

Historically, from the Illyric times, artisanal fishery in Albania was very important in the coastal zones. Coastal people were occupied mostly with fishing; this activity became one of the most important food sources. Researchers of ancient culture have called those inhabitants "fisherman people"; the remnants of fishing activity have been found in the dwellings of Illyric tribes. Fish bones, fishing tools, boned or bronze hooks, iron or boned harpoons, boats made of tree trunks and similar items have been discovered. The fishing net, although not preserved from the times, was widely used as a principal fishing tools. Some tools have been found along the coastal zones. A wooden tool with a hole in the middle of it, which was for hanging nets on the surface of the water, the weights created from terracotta used in the bottom part of the nets, needles for net stitching or knitting which, by their shape are identical to those that are in use nowadays. All of this shows the importance of fishing activity in Illyric people, from whom the Albanians descend.

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This tradition has been handed down over the years, generation by generation. The fishing boats nowadays have various shapes depending on the physical characteristics of the coastal zones where the fishermen operate (the water depth, water flow etc.). We can mention the typical boat of Shkodra called "take" or another boat called "Patogu boat"; the former has a thin and long shape, the latter is relatively short and wide in the middle of the boat axes (like a nut shell) they also have a different draught. Artisanal, traditional fisheries in Albania nowadays are expanding along the coast (427 km). This fishing category exploits the shallow area of the sea in a range comprised within 12 miles (central and northern Albanian coast) and 6 miles (southern Albania) from the coast, according to the structure of the zone. This is because the Albanian Adriatic Sea represents the so-called area "batlla" which lies between Drini Bay and Buna Bay.

This area has a square shape (10 miles by 5 miles) with a depth that varies from 39 to 51 m. It is rich in fish but is not possible to catch them by trawl nets ("batlla" means obstacles caused by different levels of reefs). Therefore fishermen who use selective fixed gears, which belong to the artisanal fishing category, frequent this area. In Albania human settlements are mostly concentrated along the coast. Recent political and economic changes brought about important demographic movements. The coasts became much more populated while the interior of the country less so. Furthermore, given the opening up of Albania, an increase in tourism has provided the fishing community with a good opportunity for better income through small-scale fishery. In the light of the responsible fishery issue, in application of the Albanian fishing law, which is relatively recent (1995) and in the current context resulting from a long political and economical transition, fisheries management entails a significant work load.

2. Monitoring of small-scale fisheries

In the reorganization process of the national fishery sector, it is natural to start with data collection on the semi-industrial marine and inland fishery sectors as an important part of the fisheries management. A recent field survey on national small-scale artisanal fishery provided a first insight on the importance of this sector in terms of species caught and quantities, socio-economic aspects and relations with other fishing categories, and the legislative aspects.

Where Albania is concerned, around 85% of the small-scale fishing category consists of illegal, unreported fishing. Therefore, not only for its quantification, but also to set up a reporting structure, this sector should be included in management plans by the relative administrative body. Socio-economic and scientific aspects as well as interactions with other fishing categories need to be covered. Such monitoring should also improve the frequency of data collection and maintenance in the fishery sector. Systems recently implemented by FAO in other countries should also be applied in Albania.

Data collection is based on the Law 7908 dated 05/04/1995 as well as on the Regulation No. 1 dated 26/03/1997. The declaration of statistical data is one of the fundamental conditions for the renewal of fishing licenses. In the context of the further improvement of the data collection system on fisheries and of approaching Albanian legislation to that of the EU, preparatory work has begun on the improvement of the data collection system in the fisheries sector. It consists in the consideration given to the EC Regulations No. 1543/2000 dated June 29 2000 which determines the "Community structures for the collection and

processing of necessary data in order to follow common policies in fisheries", as well as the EC Regulation No. 1639/2001 dated July 25, 2001 that establishes a "minimal program and a broad program for data collection in the fisheries sector and determines the ways to apply the Regulation (EC) 1543/2000". These regulations provide for the establishment of an efficient system of data collection as well as the development and funding of monitoring programs.

In this context, the support of the FAO AdriaMed Project has been obtained as a first step, through the establishment of the ALBFISH Unit. Future efforts will be focused on further expanding this Unit. The database prepared with the assistance of FAO and currently under completion, includes data on industrial fishing. According to FAO, EC and national standards these data are going to gradually generate the national outlook of this fishing category.

Data will be made available over the Internet in the form of official reports. The maintenance of this system is expected to continue and the number of local monitoring experts will be increased in order to cover all categories of fishing. Monitoring experts are supposed to be established under the fishing associations (based on the Law 8870, dated 21.03.2002 "Some changes on the Law No 7908, dated 5.4.1995, on Fishery and Aquaculture" which establishes the Fishery Management Organizations, FMO, in the four main ports of Albania, and in inland waters).

The funding of research efforts under this program is also an important aspect. This will be implemented through the redesigning of the Fishery Research Institute projects' funding. Completion of these components will enable the endorsement and implementation of the above regulations. The first survey of artisanal fisheries is considered as an important step.

3. First appraisal of the national small-scale fishery sector

Until the year 2000 artisanal traditional fisheries were disregarded; this was principally due to the small quantity of fish caught and the final destination of the production, which is almost always for consumption by the fisher and his immediate family. Furthermore, sport fishing is included in the same category with artisanal fishery. In recent years this latter has developed due to the low employment that exists in Albania that also affects the coastal communities. On the other hand, the measures taken by the Fishery Directorate to strengthen the application of fishing law along the coasts, especially concerning lagoons, created the necessity for other alternatives for the communities around those areas. Those fishermen who were refused a lagoon fishing license by the fishery administration (license board) found an alternative by switching to small-scale coastal fishing.

In the last months, the Ministerial Fishery Inspectorate began to consider artisanal fishery in order to know the situation and to start basic monitoring of this fishing category. Taking into consideration the inspectorate body (there are 15 inspectors dispersed in all districts of Albania) questionnaires were prepared to be compiled through interviews to artisanal fishers. For the survey reported in this paper seven inspectors were involved covering the coastal area.

3.1 Data collection system

The coastline of Albania (Figure 1) was divided into nine areas/segments according to geographical occurrence, from north to south as follows:

- Mouth of the River Buna - Vilun (Velipoja).
- Shengjin area.
- Drini Bay.
- Drini Bay - Mouth of the River Mat.
- Mouth of the River Mat - mouth of the River Ishem.
- Area of Durres and Kavaja.
- Area of Lushnja and Fieri.
- Area of Vlora (Himara - Qeparo).
- Area of Saranda.

In preparing the questionnaire (Figure 2), the following aspects which could better outline the artisanal fisheries in Albania were considered: number of fishing boats, fishing tools, fishery production, fishers' problems and socio-economic information.



Figure 1. Map of Albania

Questionnaire

Concerning the Small Scale Fisheries or Artisanal (traditional) Fisheries of the _____ area.

Fisher name: _____.

Total fishing boats: _____

- Boat size (length, engine power) _____
- Construction material _____
- Auxiliary tools _____
- Number of fishers on board _____
- Family activity (yes/no) _____
- For how many years _____
- Registered (yes/no) _____
- Place and kind of building (industrial, traditional, imported or no) _____

Fishing tools used:

- Kind of fishing gear/tools (mrezha, njica, hooks) _____
- Quantity _____
- Total length/size of the tool _____
- Kind of catch _____
- Time of fishing. _____
- Average fishing days/month. _____

Catch:

- Average quantity per fishing day _____
- Main species _____
- Destination. (Family consumption, sale) _____
- Annual income _____
- Primary or secondary activity _____
- Target species. _____
- Geographical characteristics of the area _____
- Fishers' problems. _____
- _____
- _____

Interviewer: _____

Date: _____

Figure 2. Questionnaire on the small scale fisheries in Albania

4. Results and discussion

Field survey results are compiled by coastal areas in the Tables below (Tables 1, 2, 3, 4, 5 and 6):

Table 1. Total number of small boats and persons employed by coastal area.

Area	Number of boats (< 12 m length)	Fishers employed
Mouth of the River Buna - Vilun	15	23
Shengjin area	19	39
Drini Bay	20	41
Drini Bay - Mouth of the River Mat	11	22
Mouth of the River Mat-mouth of the River Ishem	20	55
Area of Durres and Kavaja	173	346
Area of Lushnja and Fieri	31	104
Area of Vlora (Himara - Qeparo)	151	306
Area of Saranda	22	25
Total	462	961

Table 2. Boat construction material and propulsion by coastal area.

Area	Wood	Fibreglass	Metal (mostly steel)	Inflatable motor boat	Mix	With engine	Without engine
Mouth of the River Buna - Vilun	3	11			1	13	2
Shengjin area	4	15				19	
Drini Bay	11	9				10	10
Drini Bay-Mouth of the River Mat	3	5	2		1	10	1
Mouth of the River Mat - mouth of the River Ishem	13	3		1	3	20	
Area of Durres and Kavaja	52	87	7	19	8	139	34
Area of Lushnja and Fieri	30	1				9	22
Area of Vlora (Himara - Qeparo)	92	55		4		128	23
Area of Saranda	10	12				15	7
Total	218	198	9	24	13	363	99

Table 3. Boat origin and engine power by coastal areas.

Area	Industrial		Artisanal		Engine size (H/P)
	Foreign	National	Foreign	National	Average
Mouth of the River Buna-Vilun	10			5	11
Shengjin area	15			4	15
Drini Bay	12			8	10
Drini Bay - Mouth of the River Mat	7			4	13
Mouth of the River Mat - mouth of the River Ishem	4			16	14
Area of Durres and Kavaja	112		19	42	13
Area of Lushnja and Fieri	1		2	28	0,5
Area of Vlora (Himara-Qeparo)	13		121	17	25
Area of Saranda	10		1	11	30

Table 4. Fishing activity and landing destination.

Area	Fishing days/month (average)	Fishing method				Product destination (%)	
		Trammel net	Encircling gill-net	Hook	Others	Market	Family and market
Mouth of the River Buna - Vilun	9	15	14	6			100
Shengjin area	10	19	19	10		98	2
Drini Bay	11	20	20	12	12*	65	35
Drini Bay - Mouth of the River Mat	11	11	11	5		45	55
Mouth of the River Mat - mouth of the River Ishem	12	18	18		7*	100	
Area of Durres and Kavaja	13	173	173	149		30	70
Area of Lushnja and Fieri	14	31	22	20	20*	84	16
Area of Vlora (Himara - Qeparo)	13	151	151	138	23*	30	70
Area of Saranda	14	20		2			100

*Fishing tools used in the lagoons such as traps, fixed gillnets, fyke nets, shore or shallow water-operated lift nets and stationary uncovered pound nets.

Table 5. Common species caught by coastal areas.

Species	Common English name	Mouth of the River Buna-Vilun	Shengjin area	Drini Bay	Drini Bay- Mouth of the River Mat	Mouth of the River Mat- mouth of the River Ischem	Area of Durres and Kavaja	Area of Lushnja and Fieri	Area of Vlora (Himara-Qeparo)	Area of Saranda
<i>Anguilla anguilla</i>	European eel			X	X	X	X	X	X	
<i>Auxis rochei</i>	Bullet tuna									X
<i>Boops boops</i>	Bogue									
<i>Dentex dentex</i>	Common dentex	X								
<i>Dicentrarchus labrax</i>	European seabass	X	X			X	X	X	X	X
<i>Epinephelus spp.</i>	Groupers nei						X			
<i>Galeorhinus galeus</i>	Tope shark						X			
<i>Lepidopus caudatus</i>	Silver scabbardfish								X	X
<i>Lichia amia</i>	Leerfish		X	X	X	X				
<i>Merluccius merluccius</i>	European hake	X	X	X	X	X			X	X
<i>Mugil cephalus</i>	Flathead grey mullet	X	X	X	X			X		
<i>Mullus surmuletus</i>	Surmullet						X	X		
<i>Mullus barbatus</i>	Red mullet			X	X			X		
<i>Octopus spp.</i>	Octopuses nei	X	X	X	X	X	X			
<i>Pagellus erythrinus</i>	Common pandora			X	X				X	X
<i>Palinurus elephas</i>	Common spiny lobster								X	X
<i>Penaeus</i>	Penaeus shrimps nei	X	X	X	X					
<i>Scomber scombrus</i>	Atlantic mackerel	X	X							X
<i>Sepia officinalis</i>	Common cuttlefish		X	X	X	X	X	X	X	
<i>Solea</i>	Sole		X	X	X	X	X	X		
<i>Diplodus spp.</i>	Sargo breams nei	X	X	X	X	X	X	X	X	X
<i>Sparus aurata</i>	Gilthead seabream	X	X	X	X	X	X	X	X	X
<i>Spicara spp.</i>	Picarels nei								X	X
<i>Squilla mantis</i>	Spottail mantis squillid	X								
<i>Umbrina cirrosa</i>	Shi drum						X	X		
	Cartilaginous fishes nei	X								
	Echinoderms		X			X				

Table 6. Average daily and annual catch and income per boat.

Area	Daily fish catch per boat (kg)	Annual fish catch per boat (kg)	Annual income per boat (\$)
Mouth of the River Buna -Vilun	10	1080	3240
Shengjin area	5	600	1800
Drini Bay	14	1848	5544
Drini Bay- Mouth of the RiverMat	14	1848	5544
Mouth of the River Mat - mouth of the River Ishem	12	1728	5184
Area of Durres and Kavaja	9	1404	4212
Area of Lushnja and Fieri	15	2520	7056
Area of Vlora (Himara - Qeparo)	10	1560	4680
Area of Saranda	6	1008	3024

Generally, artisanal fishery is not a primary economic activity as fishermen are mainly employed in agriculture. Lagoon fisheries, also included in the survey reported in this paper, make an exception. Lagoon fishermen exploit both the lagoon and the marine coastal zones combining the seasonal lagoon catch by traps with trammel net fishing along the coast. They comply with fishery regulations related to fish stocking of their lagoons as this is considered fundamental for their activity. This category of fishermen proved to be appropriately licensed.

It should be noted that the average income indicated in Table 6 is higher in the coastal areas that include lagoons than in the other areas. Those subjects are users of the stationary uncovered pound nets called "stavnike". This terminology comes from the Russian language as well as the technology which was brought from Russia during the 1950s and 1960s.

According to the survey information, almost all fishermen have carried out this activity for more than 10 years, in some cases for 20 years, following a family tradition.

Among the major constraints reported and problems affecting the small-scale fishery sector is the lack of quality fishing nets (in general low quality Turkish-made nets are used) and the impossibility of having direct access to a source of equipment. Fishing gear imported from abroad does not offer a suitable range of quality and price. Another problem is the illegal inshore trawl fishing which causes damage or loss of small-scale fishing gears. Lastly, the sale of the catch (when sufficiently abundant) to restaurants or fish companies is reported to be negatively affected because of the small quantities sold.

This category of fisher is very poor but is characterised by good expertise in preparing and maintaining the boats in an artisanal way, making the nets, and by the knowledge of the sea to foresee and plan fishing activity. Artisanal fishers know the fish behaviour well and their biological seasonality. This traditional local knowledge would need to be framed and valued by scientific programmes and to be considered by policy makers in a way that this fishing category could be an integral part of management plans. Also, artisanal traditional fisheries may contribute to deter illegal fishing by semi-industrial fishing boats operating in shallow water near the coast. This first simple attempt to monitor the Albania small-scale fishery will help the national fishery management authority as it provided an improved understanding of the situation of this sector. It can contribute to its management and to the establishment of a more regular monitoring scheme. It is hoped that FAO AdriaMed support will be ensured thus allowing this important sector of Albanian fisheries to be taken into due consideration.

Small-scale fisheries in Croatia

Dulčić J.* , Soldo A.* and Jardas I.*

Abstract

Croatia has a long tradition of small-scale coastal fishing, as indicated by the 55 different fishing gears officially listed as currently employed. The total amount of small-scale, artisanal fishers is estimated at around 18000, including both those licensed (i.e. 8500) and those unlicensed. The types and quantities of fishing gear and equipment used in Croatia and the legal provisions regulating their use are outlined.

Keywords: artisanal fishing; fishing gears; legal aspects; fishery regulations; MED, Croatia; MED, Adriatic Sea.

1. Brief historical traits Croatian fisheries

It is difficult to determine the length of the fishing tradition on the east coast of the Adriatic Sea and to date its beginning. The first available data are heaps of seashells discovered during the unearthing of Neolithic settlements along the eastern coast of the Adriatic.

The influence of Greek expansion in this cultural and geographic intermingling of various «ethnic» groups was probably significant, especially with respect to trade and the exploitation of marine resources. The arrival of the Romans marked the beginning of a new period for the Croatian coast. The colonisation of the eastern coast by Roman citizens was rapid. The Romanization of the remaining Illyric population on the coast and the islands was carried out equally rapidly. The fall of the Roman Empire brought a special set of circumstances in this part of the Adriatic. In Dalmatian municipalities, particularly in Zadar in the tenth century, Croatian fishermen are mentioned in an extant document. This was in a donation dated circa 995 in which, for the first time, Croats are mentioned as involved in fishing along the coast. The deed is written in Dalmatian Beneventan script and states that the aristocracy of the town of Zadar during the prior Madij-a (986-999) donated the fishing-grounds around the island of Molat, and in Telašćica of the island of Dugi Otok to the Benedictine monastery of St. Krševan in Zadar. This deed is especially interesting and important since it shows that Croats inhabited the islands of the Zadar archipelago and were engaged in fishing long before this time. This is confirmed by another document concerning Croats and fishing dating from 1056 in Zadar. The document mentions the «gripatores» (fishermen), and three of them have Croatian names: Župana (Supana), Petutel and Podboj, with the note «and their other colleagues» (*et college eorum ceteri*). The establishment of the Arpad dynasty on the Adriatic Sea was not a concern for Venice whose fleet continued to rule the Adriatic. The Arpad dynasty, however, did not understand the importance of the sea for the people and the prosperity of the state. The continuous conflict between the Arpad dynasty and Venice for control of the Adriatic, a struggle spanning three centuries, mostly harmed the Dalmatian towns and ended tragically. In 1409, for a sum of 100 000 ducats paid to King Ladislav of

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Naples, Venice bought Zadar, Novigrad, Vrana and the island Pag and all rights to Dalmatia. As a result the Dalmatian towns came under Venetian rule, which lasted for almost 400 years (1420-1797). Under Venetian rule the Dalmatian towns were separated from their natural Croatian hinterland and incorporated into the new Venetian geographical system. This had dire consequences for their further development, and especially for their economy. The exploitation of Dalmatian towns was most strongly felt in places with a developed fishery, an activity controlled by Venice through its salt trade monopoly. In taking over the administration of Dalmatia, Austria did not put enough effort into changing this situation. Difficult economic conditions in Dalmatia continued, and did not change during the Yugoslavian administration (1918-1990). The Croatians, who have lived on the Adriatic shores for thirteen centuries, have not been able to develop professional, industrial fisheries, though for centuries they depended on coastal seasonal fishing.

2. Definition of small-scale and artisanal fishery currently used in Croatia

Traditionally, biological resources in the sea have been distinguished as pelagic, demersal and coastal even though there is no clear distinction between them in nature. Near-shore biological resources are exploited by small-scale or coastal fishing which makes use of all fifty-five kinds of fishing gear known on the Croatian coast, apart from tuna seine, bottom trawl and pelagic trawl (Cetinić *et al.*, 1999a, 1999b, 1999c; Cetinić and Soldo, 1999). A large number of different fishing gear, whose names originate from the names of fish and other marine organisms that are caught, have been used in Croatia. Coastal fishing is carried out within the distance of one nautical mile from the mainland and island coasts, in the shallow water at the depth of no more than approximately 80 m (Cetinić *et al.*, 1999a, 1999b, 1999c). This is a highly productive area due to nutrient concentration (Buljan, 1964), because of continental influence and inflow of freshwater. This area is characterized by high production of organic matter expressed in carbon production, by high fish production which is estimated on primary production (Pucher-Petković and Zore-Armanda, 1973). The coastal area of the eastern Adriatic presents a little more than 3% of the total surface of the Adriatic (Grubišić, 1968). The greatest number of commercially significant fish and invertebrate species live on this small area of the Adriatic Sea. Different constructions of bottom otter trawls, dredges for shell fishing, purse seines, beach seines, gill nets, trammel nets, combined trammel-gillnets, pots, long-lines, hooks and lines, filter nets, surrounding nets, lift nets, falling gear, entangling nets, barrier gear, harvesting machines, grappling and wounding, and fishing using ropes (tramata fishing) are used in this zone. Lighting can also be used for some fishing gear (Cetinić *et al.*, 1999a, 1999b, 1999c). The coastal fishing on the Croatian coast of the Adriatic is believed to be under great pressure, in terms of heavy fishing effort and also of great fishing intensity. Unfortunately, the level of exploitation is unknown because the catches of the coastal fishing gears are not recorded, but it is certainly higher than total allowable catch. Therefore, coastal fishing catches for statistical purposes are presumed and they can be considered as underestimated. It is very hard to reduce fishing effort by decreasing the number of fishing licenses, because of the unpopularity of such measures. Therefore, it is essential to apply other forms of fishing regulations. One of the most practical forms of fishing regulations under the conditions mentioned is the prohibition of the use of some fishing gear or fishing methods in certain areas and periods (Cetinić *et al.*, 1999a,

1999b, 1999c). In order to apply better and more successful measures of fishery resource protection, a constant monitoring and assessment of the impact of fishing gear on coastal fish and other marine organisms communities has to be performed, especially when fishing gear that are classified as harmful, because of their construction-technical characteristics, are considered. The coastal waters of the eastern Adriatic are traditionally the most important fishing areas for professional, sport and other fishermen who use small-scale fishing gears. The statistics on marine fishing published by the Institution of Statistics of the Republic of Croatia shows that in recent years (1983-1993) landing ranged from 24000-54000 tonnes in the eastern Adriatic. The near-shore belt along the Croatian coast and around the islands extends on average to 300 m offshore with a maximum depth of 80 m. This area constitutes up to 6% of the total Croatian Adriatic fishing grounds or up to 14% of the inner (costal) Croatian fishing grounds. The eastern Adriatic coast provides 12-13% of the total Adriatic catch, exceeding the proportion coming from demersal fishing in the channels area and the open sea (4-6%). Small pelagic fish make up the bulk of the eastern Adriatic landings (55-80%), of which sardine constitutes the greatest part (50-75%). A part of sardine catches is also from the coastal area. The near-shore coastal fishing has recently been reported as yielding more than pelagic and trawl fishing (Jardas and Pallaoro, 1997). According to an arbitrary estimate, in 1994 pelagic fishing yielded 9400 tonnes trawl fishing 9-11000 tonnes and near-shore fishing about 30000 tonnes (Jardas and Pallaoro, 1997). The coastal fishery catch was of higher quality. Having in the mind the commercial importance of the Adriatic fishing, evolution, distribution and structure of its target stocks, position and methods of fishing, fishing vessels and gear, the distinction has been made between bottom, pelagic and coastal fishing. Bottom fishing includes exploitation of benthic and demersal species of fish and marine organisms at greater depths and on flat substrates. Pelagic fishing includes the exploitation of pelagic species, particularly small and large pelagic fish. Coastal fishing includes the catch of fish and invertebrates within the belt of 1 Nm off the coast of mainland and islands and from reef areas. According to the Law of Marine Fisheries of the Republic of Croatia (Narodne Novine, 46/97), commercial, small-scale and sport/recreational fishing may be distinguished. Commercial fishing is a profit-making activity, which means that it is conducted on a professional basis. So, far about 2200 licenses have been issued to professional fishermen. In accordance with the current (2003) regulations in force (Narodne Novine, 49/96, 63/97, 118/97), small-scale fishing is performed for the fisher's own needs and catch by small-scale gear must not be traded (Narodne Novine 46/97). It is not a professional activity, the types and quantity of gear are limited. So far, about 8500 licenses (Cetinić and Soldo, 1999) have been issued to small-scale fishermen.

3. Types and quantities of fishing gear and equipment used in Croatia

Cetinić and Soldo (1999) reported on the types and quantities of fishing gear and equipment used in Croatia and the legal provisions regulating their use. As previously indicated commercial, small-scale and sport/recreational fishing are distinguished. So far about 2200 licenses have been issued to professional fishermen. In accordance with the regulations in force (Narodne Novine, 49/96, 63/97, 118/97), for commercial fishing the use, type and quantity of fishing gear permitted are shown in Table 1 (see in Cetinić and Soldo, 1999).

Table 1. Fishing gears allowed to be used in commercial fishing (Narodne Novine, 49/96, 63/97, 118/97).

Fishing gear	Type and/or size	Target species
Trawls	One bottom trawl net	
	One pelagic trawl net	
	One small coastal trawl net	
	One dredge	Clam
	Two dredges (rampon)	
Harvesting machine	One hydraulic dredge («vongolara»)	Shellfish
Surrounding nets (purse seines)	Tuna seines	Large pelagic fish
	One	Small pelagic fish
	One	Grey mullet
	One	Garfish
	One	Large -scale sand smelt
Seine nets	Summer seine	Sardine
	Winter seine	Picarel
	Beach seine «migavica»	
	Garfish seine	
	Tuna seine «šabakun»	
	Large-scale sand smelt seine	
	Seine «kogol»	
Gillnets	Seine «strašin»	
	Total length up to 200 m	Large-scale sand smelt
	500 m	Mediterranean sand smelt
	1000 m	Picarel
	2000 m	Bogue
	2000 m	Different fish
	1000 m	Atlantic bonito
	1000 m	Lobster
	2500 m	Crab
	2000 m	Cartilaginous
	2000 m	Angelshark
	500 m	Picarel
	800 m	<i>Spicara flexuosa</i>
unlimited	Sardine	
Three layer trammel net	Total length up to 800 m	All fishes
	800 m	Common cuttlefish
	800 m	Salema
	3500 m	Flatfishes
Traps	Loft, up to five pieces	
	Up to 50 pieces	Different fish
	Up to 100 pieces	Lobster
	Up to 200 pieces	Norway lobster
	Fyke net with one wing	Smelt
	Fyke net «fagunet», up to five pieces	

Fishing gear	Type and/or size	Target species
Hooks and lines	Up to 200 pieces of hand lines with ripping hooks	Cephalopods
	Up to 5000 pieces of hooks of bottom long lines	
	Up to ten pieces of different hand lines and trolling lines	
	Up to 100 pieces of floating lines	
Grappling and wounding gears	Up to five tridents, rakes or tongs	
Fishing using ropes («tramata»)	One «ludar»	
	One «zagonica»	
	One «fruzata»	
Axes and rakes	Up to two axes, up to three rakes	Corals, shellfish, sponges, sea cucumbers, sea-urchins, marine plants
Gadgets	Up to 20 pieces	<i>Eunice</i> spp.
	Up to five pieces	Crabs

Small-scale fishing is performed for the fisher's own needs and the sale of the catch is not authorized (Narodne Novine 46/97). It is not a professional activity. Kind and quantity of fishing gear are regulated as given in Table 2. So far, about 8500 licenses have been issued to small-scale fishermen (Cetinić and Soldo, 1999).

Table 2. Fishing gears allowed to be used in small-scale fishing (Narodne Novine, 89/96, 30/97, 78/98).

Fishing gear	Size	Target species
Gillnets* and trammel nets	Total length up to 50 m	Large-scale sand smelt
	60 m	Mediterranean sand smelt
	120 m	Picarel (<i>Spicara smaris</i>)
	120 m	Picarel (<i>Spicara flexuosa</i>)
	50 m	Bogue
	100 m	
	150 m	
Hook and lines	Handlines with rigging hooks	Cephalopods
	Three gadgets (traps)	<i>Eunice</i> spp.
	Fifteen floating lines	
	Five pieces of different hand lines and trolling lines	
	Long-line with up to 300 hooks	
Seine net	One seine «kogol»	
	One seine «strašin»	
Traps	Up to five pieces	
Tridents (with or without light)	Up to three tridents	
Collection of shellfish	One rake and one tong	Shellfish

*In small-scale fishing with gillnets up to 250 m of total length of all kinds of nets are allowed to be operated per fishing vessel.

4. Brief outline of Croatian fisheries legislation

The Croatian Law on Marine Fisheries includes a large number of legal issues applied worldwide.

Following the provisions of the Law the following have been banned:

- Catch and trade of juvenile fish and of other marine organisms;
- Catch of fish and other marine organisms during closed fishing season and their trade when fresh.

For rational management and protection of commercially important fish species under the provisions of the Law on Marine Fisheries and its specific regulations the following have been decided on:

- What is meant by the juvenile fish and other marine organisms;
- Minimum size limit of commercially important fish species and marine organisms, below which they cannot be caught, collected or traded;
- Rules governing closed seasons for the gathering and trading of individual species of fish and other marine organisms;
- Catch banned in some fishing zones and areas;
- Number and size of fishing vessels, engine power, type and quantity of fishing gear and equipment allowed to be used in some fishing zones and areas;
- Time limits on fishing in some fishing zones and areas;
- Allowable catch quantity in some fishing areas and zones (i.e. allowable catch quantity per single license);
- Number of licenses that may be issued in a single fishing zone and area;
- Construction and technical features, method of operation and purpose of individual fishing gear type and fishing equipment;
- Special habitats of fish and other marine organisms where fishing has been banned.

The Croatian Law on Marine Fisheries in force also includes the legal provisions for the monitoring program of the state of populations of fish and other marine organisms of importance for marine fisheries all over the fishing zones or their parts as well as the monitoring of the quality of marine areas where rearing activities are conducted.

4.1 Fishing effort as a measure of fishing regulation in Croatian marine fisheries

Even though Croatian legislation does not explicitly mention fishing effort as a measure of fishing regulation, various regulations provided by the Law (summarised in the previous paragraph) have the function of regulating and monitoring fishing effort. Of the provisions of the Law only some have been detailed by sub regulations:

- Engine power not to exceed 184 kW (250 HP) for bottom trawlers fishing in the interior sea (channels area);
- Restriction of the types and quantities of fishing gear and time of fishing in some fishing areas and zones;
- No new licenses shall be issued for certain kinds of fishing such as fishing for Norway lobster with traps, bottom trawls in the interior sea, dredges for *Pecten jacobaeus*, tramata fishing, trammel nets, tuna seines and floating long-lines;

- Definition of some construction and technical characteristics, methods of operation and purpose of fishing gears.

Even though these are the measures that limit any further increase in fishing effort, they are not sufficient for fishing effort reduction. It is believed that present fishing effort is too high, particularly in the case of demersal trawl fishing. Therefore a more efficient measure of protection of living marine resources would be to limit the maximum annual catch by establishing maximum sustainable yield in individual areas and zones. In particular this could apply to bottom trawling in the interior sea, with special attention to channels along the mainland coast. Since it would appear very difficult and unpopular to limit the number of licenses for defined fishing methods in a defined area, in order to protect resources, it would be simpler, more practical and more efficient to determine maximum allowable yield per single license.

One of the protection measures that can control fishing effort, is a fishing ban in some areas and closed seasons. Establishing special habitats for fish and other marine organisms in which all fishing or some types of fishing gear would be forbidden permanently or for some time during the year, would be a far more efficient measure.

Since present legal provisions regulate some construction-technical characteristics of individual gear types, such as mesh size and gear size, it would be necessary to regulate other construction-technical characteristics of other gear that are known to adversely affect the state of exploited species. For instance, consideration should be given to technical aspects such as the hanging ratio and webbing cut, thread thickness and some other details of gear design.

4.2 Protection of juveniles

Control of age/length at recruitment is carried out by regulating the mesh and hook sizes, and the minimum size of commercially important species, below which they must not be caught, collected or traded (Narodne Novine 145/98).

Even though the minimum legal sizes should correspond to that at the species' sexual maturity, they are considerably smaller than those provided by the current regulations. Therefore their effect as a management measure is practically very limited (Cetinić *et al.*, 1998). Even though the survival rate of fish and other marine organisms caught by bottom trawls and returned back to the sea is unknown, this measure should be applied for two of the most important species targeted by trawl fishing (the European hake, *Merluccius merluccius*, and the Norway lobster, *Nephrops norvegicus*) in order to oblige fishermen to avoid those grounds when juvenile specimens of these species significantly occur in trawl catches. This particularly refers to the Norway lobster, which after having been caught is, in most cases, alive and undamaged so that the chances of its survival after returning it to the sea are high.

The minimum size limit of fish and other marine organisms is of considerable importance when combined with the minimum mesh size or hook size of gear (Soldo *et al.*, 1999). This is also true in the case of the Adriatic Sea that is characterized by a large number of exploited species and of fishing gear types, some of which are even named after fish they target. Moreover, this particularly applies to the protection of species in coastal fishing which change sex and therefore both sexes should be protected.

Specific regulations are set for the minimum mesh size for almost all fishing gear, but since these measures are for the most part not based on any research results but on fishing practice itself, the catches comprise considerable percentages of immature specimens.

4.3 Closed seasons

Some regulations order closed seasons only for three crustacean species, common spiny lobster, European lobster and spider crab, but not for any fish species. Given the importance of closed seasons for the recovery of species, this should be extended to all commercially important species, since no other means of protection can replace undisturbed spawning, which is not only the prerequisite for the survival of any population but also for the successful fishing. It is believed that spawning individuals of some species are more vulnerable to fishing. Therefore, closed seasons should be applied to some commercially important fish species for improved protection and management of eastern Adriatic Sea fishery resources.

The bottom trammel net is the most widely distributed gear type in Croatian coastal fisheries. It can be used from August 15th to April 30th. All benthic and benthopelagic species and even large pelagic species can be caught with it. This gear is used during the night on all types of bottoms, usually up to 30 m depth.

«Strašín» and «kogol» are two types of small coastal bottom trawl which are used during the night primarily for picarel fishing although other coastal bottom species can be caught with them. Both gears can be used only on boats with an engine power of 18.5 KW (25 HP) in the period from October 1st to April 30th. They are used from 5 to 20 m depth. Bar of mesh in the cod end must not be less than 12 mm.

«Tartana» is small coastal otter trawl which can be used on the boats with the engine power of 18.5 KW (25 HP). It is designed primarily for picarel fishing from 20 to 50 m depth, during the period from November 1st to March 1st, exclusively during the night. With the «tartana» fishing otter boards are used. Bar of mesh must not be less than 12 mm.

Coastal beach seine («migavica») is designed primarily for daytime picarel fishing, but some other demersal fish and invertebrate species could be caught. It is used from October 1st to April 30th. Fishing with coastal beach seine is done on bottoms up to 30 m depth. This net is pulled from the shore or from a boat moored to the shore. Bar of mesh in the cod end of coastal beach seine must not be less than 12 mm.

«Tramata» is the way of fishing with gill nets using ropes for fish scaring. Ropes are used for enclosing a larger sea area and the fish gathered are harvested by the gill nets. This kind of fishing is done only during the summer period and mostly sparid fish are caught, primarily saddled sea bream and salema. This kind of fishing is only carried out in coastal areas up to 50 m depth. Some available information on sparid exploitation by Croatian small-scale coastal fishery is given in Table 3, and 4.

Table 3. Family Sparidae in catches of the coastal fishing gears in the eastern Adriatic Sea.

Fishing gear	Fishing area	Max fishing depth (m)	Bottom	Number of analysed catches	Period
Trammel bottom set	Middle and South Adriatic: from Vir Island to Konavli	30	Variable	243	1987-1996 all year
«Strašín»	Middle Adriatic: Trogir area	20	Sandy-muddy Posidonia beds	6	1988, autumn
«Kogol»	Middle Adriatic: Brač, Šolta, Korčula and Hvar Island	20	Sandy-muddy Posidonia beds	15	1991-1992, autumn
«Tartana»	Middle Adriatic: Tribunj area, Pag, Murter and Vrgada Islands	40	Sandy-muddy Posidonia beds	17	1991-1992, winter-spring
Coastal beach seine	Middle Adriatic: Šibenik and Primošten areas, Murter and Šolta Islands	30	Sandy-muddy Posidonia beds	35	1991-1996, autumn, winter, spring
«Tramata»	North Adriatic: Istra, Krk, Cres and Lošinj Islands, Middle Adriatic: Šibenik, Split and Makarska areas, Pag, Silba, Drvenik, Hvar, Lastovo, Korčula, Vis	50	Variable	47	1986-1993, summer

Table 4. Percentage weight and numeric (in parenthesis) composition of Sparidae species in sampled catches of coastal fishing gear along the Croatian coast.

Species	Trammel bottom set	Strašín	Kogol	Tartana	Coastal beach seine	Tramata
<i>Boops boops</i>	0.10 (0.26)	0.35 (0.59)	-	0.26 (0.15)	13.08 (21.26)	0.06 (0.07)
<i>Dentex dentex</i>	0.54 (0.37)	-	0.42	0.01	0.67	2.05
<i>Dentex gibbosus</i>	0.02 (0.02)	-	-	-	-	-
<i>Diplodus annularis</i>	5.25 (12.50)	1.91 (6.32)	3.92 (6.55)	0.10 (0.13)	1.07 (0.69)	0.02 (0.04)
<i>Diplodus puntazzo</i>	0.18 (0.30)	0.35 (0.23)	0.28 (0.25)	0.03 (0.01)	0.37 (0.09)	1.79 (0.46)
<i>Diplodus sargus sargus</i>	0.02 (0.02)	-	-	-	-	0.64 (0.20)
<i>Diplodus vulgaris</i>	1.23 (1.47)	-	0.59 (0.12)	0.50 (0.16)	4.17 (1.17)	6.16 (4.53)
<i>Lithognathus mormyrus</i>	1.22 (0.50)	-	-	-	-	0.82 (0.38)
<i>Oblada melanura</i>	0.15 (0.13)	-	0.24 (0.17)	-	2.08 (1.31)	68.11 (82.81)
<i>Pagellus acarne</i>	0.55 (0.76)	-	-	0.13 (0.13)	0.63 (0.39)	-
<i>Pagellus bogaraveo</i>	-	-	-	0.05 (0.03)	-	-
<i>Pagellus erythrinus</i>	2.13 (2.16)	-	0.04 (0.08)	9.73 (5.88)	2.36 (1.01)	0.06 (0.04)
<i>Pagrus pagrus</i>	0.05 (0.04)	-	-	-	0.04 (0.02)	0.01 (0.01)
<i>Sarpa salpa</i>	0.30 (0.11)	-	-	-	1.01 (0.26)	17.46 (8.09)
<i>Sparus aurata</i>	2.24 (0.28)	-	-	-	0.21 (0.01)	0.24 (0.04)
<i>Spondyliosoma cantharus</i>	0.43 (0.39)	-	0.20 (0.25)	0.04 (0.01)	0.83 (0.36)	0.38 (0.15)

5. Priorities and main gaps related to the Croatian small-scale fisheries sector

A lack of the appropriate and complete statistics could be identified as one of the main gaps in knowledge of Croatian fisheries. For example, Croatia has no statistical data regarding supposedly 18000 small-scale fishermen. It could be pointed out that a distinction needs to be made between types of statistics needed, such as biological and economic statistics the latter should, among other things, include data on parameters such as level of employment, catch quantities and value. Furthermore, data on number of vessels, fishing season, area, and quantitative composition of by-catch should be collected. As one of the priorities which could be considered would be to conduct a case-study on small coastal communities mostly dependent on fishery. There may be never enough resources to do a proper statistical analysis with appropriate coverage. Case-study is a realistic approach to collecting data on small-scale fishery. It should be pointed out that a lack of knowledge on distribution, behaviour and biomass of several common species is also one of the main gaps. Furthermore the importance of recovering available historical time series of data that are often lacking should be taken into account. Due care should be used in the interpretation of these data since different data collectors may have been involved (fishermen, technicians, scientists) and collected species are sometimes misidentified. In terms of small-scale fisheries management, it should be remarked that, currently, management is mainly based on single fishing gears while individual species are caught with variety of gear types. Management would need to be based on all gear types that are used, for example in Croatia lobster management is based on traps while lobsters are currently mostly exploited by gill net and trammel net fisheries which are not considered in this case. However, it could be observed that such complex management should be a second step and that first is what is needed to know about the species distribution in the whole Adriatic Sea since we presently lack basic information. A further need would be the quantitative evaluation of interaction between the different fishing gears employed in Croatian small-scale fisheries.

6. Current projects related to small-scale fisheries

a) Biodiversity and the status of ichthyocenosis in Croatian coastal area

The aim of the project is the systematic research on the state and changes in coastal areas studying population dynamics of commercially important fish, cephalopod and crustacean species. An additional aim is to obtain new biological knowledge in order to enable the realization of reasonable and sustainable fishery management together with protection of fish communities. It has been presumed that the coastal communities have significantly declined in number or even split, thus their effective protection is needed. One of the major criteria for sustainable exploitation and successful protection is the well-rooted understanding of species population dynamics. The expected results of the project will be used as necessary scientific support to fishery management of living coastal sea resources.

b) Project «Jadran» - Management of biological resources and protection of biodiversity

The project focuses on the degradation of ecologically and economically important areas (spawning and nursery areas, *Posidonia* meadows, estuaries, rocky shelters) formulating advice for fishery management and sustainable development. The project aims at the appraisal

of the state of commercially important species and at establishing biologically acceptable catch levels. Considerations is also given to the protection of biodiversity elaborating measures to protect the biodiversity of the Adriatic ecosystem.

c) Monitoring of coastal water quality (Vir-Konavli area) - Monitoring of coastal resources (trammel bottom sets)

d) Climate change and Adriatic ichthyofauna (in cooperation with Slovenia)

e) Status of demersal resources of fishing ground of the northern part of western coast of Istria

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Small-scale fisheries in Italy

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Abstract

Statistics on Italian capture fisheries are collected by Irepa through a National Observatory. In the year 2002, out of the total fishing fleet of 15 915 vessels, 10 296 belonged to the small-scale segment, 2 983 of which operated in the Adriatic and employed 4 875 fishers. The landing volume from the Italian Adriatic small-scale fishery amounted to more than 24 000 tonnes. The performance of the Italian small-scale fishing fleet operating in the Adriatic is analysed through a set of biological, economical and social indicators and associated reference points. Key-factors to be taken into account for the sustainability of small-scale fisheries and their management are proposed. Possible options for the future development of the sector in terms of income integration (e.g. fishery tourism) and fishery management (e.g. rights-based management) are presented.

Keywords: artisanal fishing; indicators; economic analysis; socioeconomic aspects; fishery management; MED, Adriatic Sea; MED, Italy

1. The definition of small-scale and/or artisanal fishery currently adopted in Italy

The small-scale fleet segment is composed of vessels with total length (LOA) of less than 12 m. They are only allowed to use passive gears excluding towed gears of whatever type. The definition adopted coincides with that provided for in European Commission Regulation (EC) No 2091/1998 of 30 September 1998 concerning the segmentation of the European Community fishing fleet and fishing effort in relation to the multi-annual guidance programmes. This definition is also provided for in Commission Regulation (EC) No 1639/2001 of 25 July 2001 establishing the minimum and extended Community programmes for the collection of data in the fisheries sector and laying down detailed rules for the application of Council Regulation (EC) No 1543/2000.

2. Status of the national small-scale fisheries

2.1 Role in the whole fishery

The small-scale fleet segment is the most important of the Italian fisheries. A total of 10 296 vessels are involved and they account for almost 50 percent of total employment. In terms of capacity the small-scale segment makes up only 15 percent of the national Gross Registered Tonnage (GRT), but covers 65 percent of fishing boats in number and 65 percent of the total days at sea (Table 1). The average size of these vessels is 2.6 GRT and 25 kW, while the

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average size of national fleet is 11 GRT and 79 kW. Small-scale vessels are older than other segments of the fleet, 28 years on average.

The small-scale fisheries segment accounts for about 18 percent of the national catch and for 26 percent of national value of landings. The difference between these two figures depends on the species targeted by small-scale gear, which are mostly of high value. The vessel owner usually fishes with an additional person. The number of fishers in 2002 was 19 358, that is the highest level of employment by fleet segments.

Table 1. Italian fishing fleet by segment, 2002.

Fleet segments	N. of vessels	GRT	kW	Days at sea	Employment
Bottom Trawler	2 353	91 092	509 557	441 421	9 029
Midwater Pair Trawler	126	6 784	41 651	22 264	806
Purse seiner	180	7 836	43 479	20 645	1 321
Dredger	714	7 399	76 780	71 892	1 503
Small-scale fishery	10 296	27 081	255 334	1 657 952	19 358
Multi-purpose	2 051	27 501	270 408	317 927	5 395
Tunas	195	10 650	55 969	28 436	948
Total	15 915	178 344	1 253 177	2 560 539	38 360
% small-scale fishery/total	65	15	20	65	50

Source: Irepa-Mipaf.

The number of small-scale vessels registered in the Adriatic regions is 2 983; they account for 29 percent of the total number in the segment and cover 23 percent of total GRT for Italy (Table 2).

Table 2. Geographical distribution of small-scale vessels, 2002.

	Adriatic regions	Tyrrhenian and Ionian regions	Italy
Absolute values			
Number of vessels	2 983	7 313	10 296
Total GRT	6 336	20 746	27 081
Total kW (1000)	78	178	255
Days at sea (1000)	511	1 147	1 658
Employment	4 875	14 484	19 358
Average values			
GRT	2.1	2.8	2.6
kW	26.0	24.3	24.8
Days at sea	171.3	156.8	161.0
Employment	1.6	2.0	1.9

Source: Irepa-Mipaf.

2.2 Main trends

In recent years, the Italian small-scale fleet has undergone a huge reduction where all the capacity and economic indicators. In the period 1998-2002, there has been a reduction of 18 percent in total GRT. The total number of vessels has decreased by more than 2 thousand

units (Table 3). This trend is due to the decommissioning scheme under the EC Multi Annual Guidance Plan (MAGP) IV. Between 1998 and 2002 total production decreased, reaching 55 562 tonnes in 2002. The value of landings witnessed a less significant reduction, thanks to the increase in average prices. Prices mostly increased in the last quarter of 2000 as a consequence of a change in consumers preferences due to the Bovine Spongiform Encephalopathy (BSE) crisis; in the following months, prices continued to rise.

Table 3. Main trends in effort indicators of Italian small-scale vessels.

	1998	1999	2000	2001	2002
Fleet - number of vessels	12 480	12 482	11 990	10 775	10 296
Fleet - total GT (1000)	33.2	33.1	31.7	28.4	27.1
Fleet - total kW (1000)	304.0	302.8	290.4	264.3	255.3
Days at sea (1000)	2 105	2 116	2 047	1 830	1 658
Employment on board (FTEs ¹)	25 539	25 387	24 668	20 844	19 358
Invested capital (million Euro)	468	477	522	487	477

Source: Irepa-Mipaf.

Small-scale fishery shows low capital intensity and it is highly affected by climate conditions, market fluctuations and by the interaction with trawlers fishing the same species, often in the same grounds, which substantially reduce the availability of fish.

With respect to revenue, gross cash flow decreased steadily from 1998 to 2002 (-20 percent). The reduction is a consequence of external factors; in particular the rise in costs (mainly fuel prices) had a large impact on fishing activity. Fuel costs, which is the main cost item in fishery accounts, increased continually from the spring of 1999 until the last months of 2000. The increase in operational costs has had a negative impact not only on the profitability of the fishery sector, it has also caused a reduction in the crew share (Table 4).

Table 4. Main trends in economic indicators of Italian small-scale vessels (million Euro).

	1998	1999	2000	2001	2002
Value of landings	449.6	456.8	495.7	414.8	360.2
Fuel costs	32.1	37.5	39.6	35.5	32.3
Other running costs	50.7	49.9	52.2	45.7	40.7
Vessel costs	30.2	32.0	34.4	32.9	32.7
Crew share	120.1	118.6	129.4	106.5	95.6
Gross cash flow	216.4	218.8	240.0	194.3	158.9
Depreciation	20.5	20.6	22.3	15.3	20.1
Interest	3.9	3.7	3.5	2.8	2.7
Net profit	192.0	194.4	214.2	176.3	136.1
Gross value added	336.5	337.4	369.4	300.8	254.5

Source: Irepa-Mipaf.

However, the economic performance of the small-scale vessels is very different from one area to another (Table 5). In Adriatic regions, both landings and value per effort unit are

¹Full-time employees were considered to be those who perform a full day's work for the entire week in the local unit. Source: *The Eurostat Concepts and Definitions Database (CoDeD)*

higher than in the other regions; this difference is due to factors such as the lowest effort and the different composition of the landings.

Table 5. Landings and value of landings for small-scale vessels, year 2002 (M = million).

	Adriatic regions	Tyrrhenian and Ionic regions	Italy
Absolute values			
Volume of landings (t)	24 459	31 102	55 562
Value of landings (M Euro)	148	212	360
Price (€/kg)	6.05	6.82	6.48
Average values			
Landings/vessel (t)	7.5	4.4	5.4
Value/vessel (1000 Euro)	45.3	30.2	35.0
Landings/days (kg)	42.7	28.7	33.5
Value/days (Euro)	258.5	195.5	217.2

2.3 Sustainability analysis

Questions of sustainability are now the most important considerations in fisheries management. Also the reform of the EU Common Fisheries Policy (CFP) is aimed at achieving biologically, environmentally and economically sustainable fisheries.

In order to describe in simple terms the extent to which the objectives set for sustainable development are being achieved at regional level, some indicators of sustainability are reported. The purpose of these indicators should be to show whether a fishery is currently economically, socially, and biologically sustainable, and if not, whether it is capable of being exploited in a sustainable manner.

Among different indicators, and following FAO (1999) and OECD (2001) studies, the following were used:

- Ecological sustainability: Landing per unit of effort (LPUE);
- Economic sustainability: Gross revenues/effort;
- Social sustainability: Gross value added/employee.

2.3.1 Ecological sustainability

The processing of the data collected from 1998 to 2002 on the small-scale fishery segment operating in the Adriatic Sea shows a tendency towards the stability of unitary productivity until the year 2001, and a contraction in 2002 (Figure 1).

The pattern of unitary productivity registered until 2001 is due to the stability of the fishing effort and of the total catches. Although fishing capacity, measured in terms of tonnage and engine power, has constantly decreased over the last few years, the total fishing days over the same period increased and until it reached its highest level in 2001 (about 197 fishing days for small-scale fishery vessels operating in the Adriatic).

On the contrary, a reduction both of the fishing effort and of the catches was registered in 2002. The decrease registered in the catches was proportionally higher than the effort reduction (respectively –30 percent and –23 percent), which led to a decline in productivity.

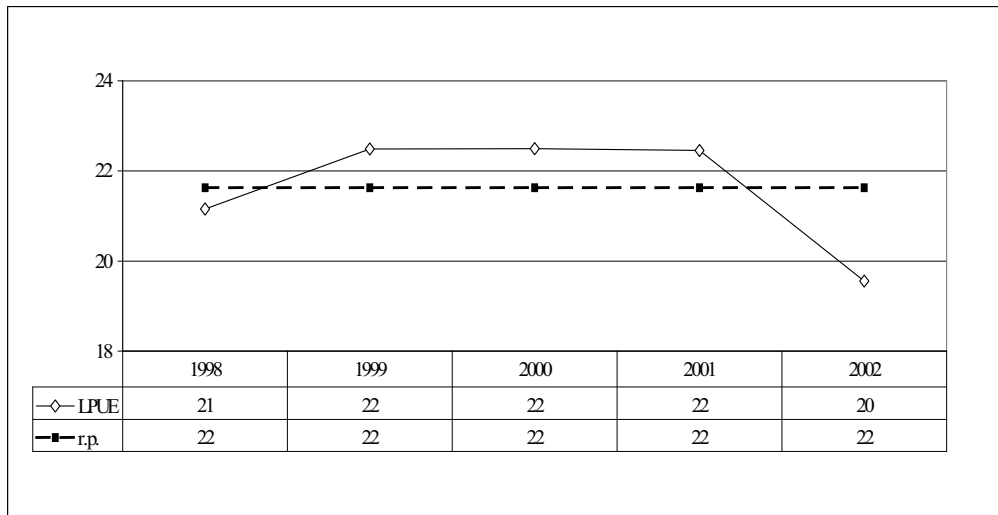


Figure 1. LPUE - Adriatic small-scale fishery, 1998 – 2002.

The increase in the days at sea registered until 2001 was partly generated by the positive trend of prices. Despite the constant reduction of catches, the fishers increased their fishing activity and, thanks to the positive trend of sales, this strategy has proved successful. In the year 2002, on the contrary, in order to minimize risks, fishers reduced their fishing trips with a view to optimising in economic terms the time spent at sea.

2.3.2 Economic sustainability

The economic effectiveness of the fishery sector was estimated by the economic productivity indicator, conceived as the ratio between the daily value of landings and the tonnage used by each fishing system.

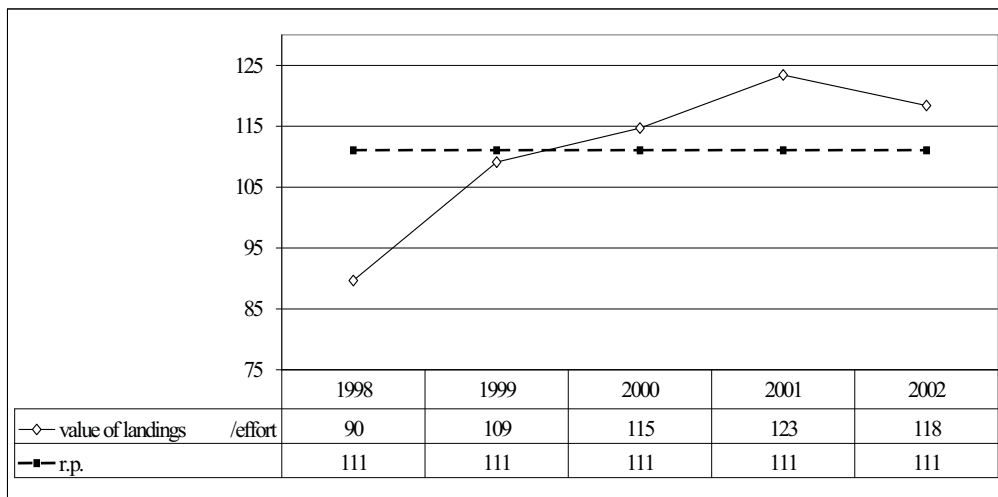


Figure 2. Economic productivity - Adriatic small-scale fishery, 1998 – 2002.

The state and the economic achievements of small-scale fishery in the Adriatic represent the synthesis of different trends registered in the catches and the prices of landings. The period considered covers a full economic cycle. Namely, two years (1998 - 1999) characterized by stability of prices and a slight increase in production, and three years (2000 - 2002) over which, thanks to the increase in prices that compensated for the reduction of landings, the economic trend was clearly favourable. From the year 2000 onwards the economic productivity exceeded the reference point until the highest value was reached in 2001 (123 Euro per effort unit; Figure 2).

The improvement of the economic productivity registered over the last few years does not imply a well-balanced exploitation of the fishery stock and the economic as well as biological appropriateness of fishing capacity and effort. Indeed, the economic productivity for each vessel benefited from the positive trend in the prices of products which was influenced by the reduction of offer and a more effective marketing system. This issue becomes relevant since this price trend, which has been mainly caused by mechanisms not directly linked to the process of production and that led to a rise in sales, generates behaviour aimed at increasing fishing effort.

As previously highlighted, high levels of activity have coincided with periods of high in price rises, so that the above-mentioned processes threatened to further endanger the state of the fishery resources.

2.3.3 Social sustainability

The long-term safeguard of employment as well as of the economic welfare of manpower is the main objective of sustainable development. The achievement of this aim does not coincide with the rational exploitation of fishery resources. Indeed, measures such as the reduction of fishing capacity, the introduction of marine protected areas and the closure of fishing areas have had a negative impact in terms of employment and income of those communities strictly dependent on fishery.

Over the last three years, about 8 600 jobs were lost (equal to 18 percent of the total number of onboard workers). This shrinking concerned all fishing systems even though coastal trawling and small-scale fishery were most strongly affected. From 1998 until today, small-scale fishery vessels registered a loss of 4 500 workers. Among them, 1 800 units were working on vessels operating within the Adriatic area.

Over the last few years, several factors increased the loss of jobs in the sector:

- The decline of physical productivity;
- The rise in operative costs;
- The incentive allocated for the withdrawal of vessels (permanent withdrawal);
- The re-conversion into activities either linked to the fishery sector or not;
- The ban on several fishing techniques;
- The overall reduction of incentives and benefits (allowances, subsidies);

Since these factors entail the reduction of labour remuneration, they have worsened the economic state of onboard workers.

In the context of small-scale fishery, the added value per employee has been chosen as an indicator of social sustainability, instead of fishers' income.

The crew of this segment is often composed of a single person who is both the vessel owner and fisherman. Consequently, the economic account of these fishing boats is extremely

simplified. In fact, given that the labour cost item is absent, the added value, which represents the remuneration both of the labour and the capital, can be obtained by deducting the consumption from the income.

Although the percentage increase of the above-mentioned indicator registered from 1998 to 2002 was lower than the economic sustainability indicator, the former has shown the same trend as the latter. Over the past five years, the added value for each worker has grown by 29 percent (Figure 3), whereas the saleable gross production for each effort unit has increased by 32 percent. This difference is due to the higher relevance assigned to the operative costs in the last few years compared to the past. Particularly, since the year 2000, the price of fuel has grown remarkably and its percentage of the total intermediate consumption is higher than other costs.

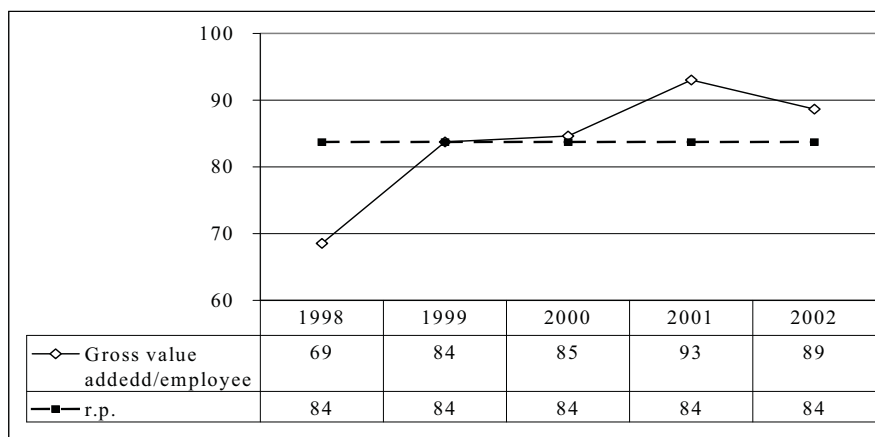


Figure 3. Gross value added per employee -Adriatic small-scale fishery, 1998 – 2002.

However, the level of annual income registered in the small-scale fleet is still low compared to other productive activities. Over the years, the persistence of such standards of revenues could even lead fishers, who are socially and culturally closer to seafaring life, to quit the activity. This phenomenon is mainly registered where the fishing industry is larger, such as, for example, the Sicilian provinces and the largest Adriatic fisheries centres.

Given the inadequate level of revenues, it is only the high degree of ownership share due to the artisanal feature of fisheries that prevents the fishers from quitting the activity. In conclusion, the owner working on board can compensate for the decrease in the manpower income with the increase in the gross profit share. The overlapping of ownership and crew, which prevails among small-scale fishery vessels, is also widespread among fisheries characterized by a bigger fleet with a crew of 4-5 people.

3. A brief description of planned national and international programmes focussing on the small-scale fishery sector

3.1 European programmes

Small-scale fishery is managed at national level as a consequence of the fact that target stocks are primarily distributed in national waters and caught only by one member state. At

European Union level, some programmes focussing on the small-scale fishery sector have been presented in the last months, as a consequence of the activity of the revision of the Common Fishery Policy.

The Community Action Plan for the conservation and sustainable exploitation of fisheries resources in the Mediterranean Sea under the Common Fisheries Policy² is of particular importance as it recognises the individual nature of the Mediterranean Sea. This plan has been followed by the Council Proposal 589/2003 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea.

This proposal, in particular:

- Introduces new technical measures to improve gear selectivity;
- Strengthens the current ban on the use of towed gears in coastal areas;
- Limits the overall sizes of certain fishing gears that affect fishing effort;
- Introduces a procedure for establishing temporary or permanent closures of areas to specific fishing methods;
- Provides for the adoption in the Mediterranean area of management plans combining the use of effort management with technical measures;
- Introduces provisions to ensure that leisure fishing is conducted in a way that reduces interference with professional fishing and does not jeopardize the sustainability of certain resources;
- Delegates powers to member states to regulate fishing activities in their territorial waters and under certain conditions that do not have any significant Community dimension or environmental impact, including certain local fisheries currently authorised under Community law.

In order to weigh the social, economic and regional consequences of the restructuring of the EU fishing industry, the EC has published a plan³ in which the socio-economic impact of fishing effort limitations and reductions in vessel numbers are evaluated and a review of all the existing means to alleviate such impact within the existing Community aid regimes are presented.

The restriction of aid for modernisation, as well as the elimination of aid for renewal and export of fishing vessels and the more attractive scheme to permanently reduce capacity are likely to have consequences for the sector.

Several measures exist to support the restructuring of the fisheries sector⁴. Notwithstanding this, financial aid measures in favour of small-scale fisheries have not had the desired effect of protecting this segment. On the contrary, the share of small-scale fisheries in the fleet has constantly diminished over the years.

To maintain employment in coastal areas and to mitigate the socio-economic impact of multi-annual management plans in coastal areas most dependent on fishing, the structural aid regime could also be adapted to tailor the needs of small-scale coastal fleets. In particular, for groups of vessel owners or fishing families involved in small-scale coastal fisheries, the

² Brussels, 09.10.2002 COM(2002) 535 final.

³ Action plan to counter the social, economic and regional consequences of the restructuring of the EU fishing industry, Brussels, 6.11.2002 COM(2002) 600 final.

⁴ Council Regulation amending Regulation (EC) No 2792/1999 laying down detailed rules and arrangements regarding Community structural assistance in the fisheries sector.

Financial Instrument for Fisheries Guidance (FIFG) may provide a lump-sum premium of up to €150 000 for integrated collective projects dealing with such domains as:

- Safety equipment on board and the improvement of sanitary and working conditions;
- Technological innovations (e.g. more selective fishing techniques);
- Organisation of the production, processing and marketing chain (e.g. promotion and added value of the products);
- Professional qualification or training;

Finally, for each Member State in the Community, a multi-annual guidance programme (MAGP)⁵ sets objectives for reducing the size of the fishing fleet in order to bring fishing effort into line with available resources. The fourth generation of MAGPs, adopted in December 1997, sets targets for the period 1997-2001. This period was extended by Council Decision until the end of 2002.

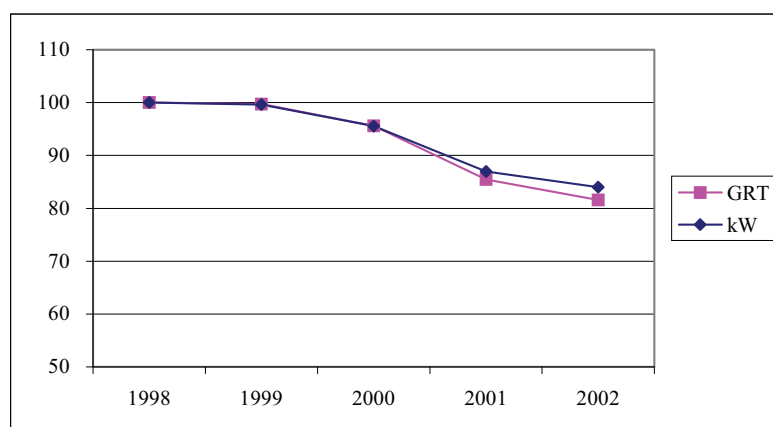


Figure 4. Trends in capacity indicators - Small-scale fishery, 1998 – 2002.

At 30 June 2002⁶, all countries had met their overall intermediate target for kW. As for the Italian small-scale fishery segment, the achievement of the objective is registered in terms of tonnage, whereas, in terms of engine power a further reduction is required.

From 1998 till now, the small-scale fishery sector has endured a constant reduction, which accelerated as of 2000 (Figure 4).

3.2 National programmes

With regard to national programmes focussing on the small-scale fishery sector, the fishery and aquaculture orientation and modernization act⁷ is mentioned; this act equates the status of the fisher producer to that of the agricultural producer.

The fishery entrepreneur is defined as a person who “ performs an activity directed to fishing or harvesting aquatic organisms within marine, brackish or fresh water habitats as well as the

⁵ Reg CE n.2792/1999 and decision 2002/652/EC prolonging the multi-annual guidance programmes until 31 December 2002.

⁶ Report from the Commission to the Council and the European Parliament on the intermediate results of the multi-annual guidance programmes for the fishing fleets at 30 June 2002 Brussels, 03.09.2002, COM(2002) 483 final.

⁷ Legislative Decree no. 226 of 15th May 2001.

activities associated with them, including the implementation of active management measures aimed at enhancing the production and the sustainable development of aquatic ecosystems”. Accordingly, amongst the innovations provided for by the new regulation, fisheries have been entrusted with the multi-functional role of protecting the aquatic ecosystems and of acknowledging the legal status of fishery and fishery tourism.

In 1999, in order to promote fishers’ integration, the Small-scale Fishery Plan was adopted⁸. The Plan introduces consortia aimed at orientating, coordinating and managing fishing activities

The consortia shall be established by fisheries that represent at least 70 percent of the small-scale fishing vessels operating within the pertinent territory.

The consortia shall have the following objectives:

- a. Draw up and enforce a plan for the management of resources. To monitor the compliance with self-regulation rules;
- b. Promote initiatives directed to preventing conflicts with other fishing activities conducted within the same area of concern;
- c. Build up on shore structures aimed at supporting productive activities (i.e. small fish markets, collection and storage centres, transport etc.);
- d. Foster initiatives aimed at improving the quality of the members’ catch.

4. The identification of priorities and main gaps related to the Italian small-scale fishery sector concerning management issues

The complexity of the small-scale fisheries, in terms of species and diversity of fishing techniques and practices, together with its economic structure, enables fishers to be flexible, adapt quickly and to counteract undesired effects of external factors, including management measures. Therefore a global and coherent management approach is needed which will make use of the various available tools in an integrated way.

In order to identify the priorities concerning management issues, the following “key factors” have to be considered:

Technological interactions: different fishing gears catching the same species are quite frequent and might involve small-scale artisanal fisheries, bottom trawlers and other towed gears. In particular, there are about 650 trawlers with length (LOA) less than 12 metres.

Competition with other uses: sport and recreational fisheries, tourism.

Old age of fishing vessels: the average age of the fishing vessels in the Mediterranean fishing industry is quite old (28,5 years). This makes working, living, health and safety conditions on board far from optimal.

Lack of recruitment: fishing activities, which have represented traditional working opportunities in fisheries dependent areas, are not attracting young generations anymore.

Labour-intensive nature of small-scale fishery: small-scale coastal fishery accounts for the most important production segment and registers the highest number of fishers. Given

⁸ Decree issued by the Italian Ministry of Agricultural and Forest Policies on 14th September 1999 (as subsequently modified by the Ministerial Decree of 30th May 2000).

the labour-intensive nature of this segment, any restrictions to the fishing effort could have a serious impact on employment.

Fragmentation of the production and low concentration of the landings.

4.1 Opportunity of the existing management measures

Over the last few years, the opportunities for redevelopment offered to the marine fishery sector have included activities such as marine aquaculture and fishery tourism. Particularly, the latter is growing rapidly and spreading throughout the country especially in areas mainly devoted to tourism. This activity offers professional fishers the opportunity to take tourists aboard their fishing boats on daily excursions. For this reason, it represents a real opportunity to supplement fishers' income.

Another significant aspect of fishery tourism concerns the possibility to increase the use of traditional fishing gears since on this type of vessel the use of trawl gears is strictly forbidden. Other expected advantages are represented by the development of structures as well as infrastructures. Moreover, activities associated with tourism and recreational fishery should be performed with a view to disseminating the knowledge of the sea and fishery amongst the general public in order to raise people's awareness of professional fishery and to broaden the available information related to coastal habitats.

The establishment of marine protected areas (MPA) has also offered opportunities to supplement fishers' income. As a matter of fact, even though MPAs impose drastic changes in the fishing systems, they can nonetheless boost the development of new activities and so can be seen as a potential source of income integration. Particularly, as well as the activities associated with the establishment of marine protected areas, such as fishery tourism, catering, the promotion of quality trademarks, the rediscovery of fishery craft products manufactured locally, the possibility of involving fishers in monitoring and supervising environmental activities can also be considered.

4.2 Further options for management measures

The expected management measures concerning small-scale fishery will be centred on the possibility of enforcing property rights on the country's actual situation. Of all the management measures available to managers, territorial user rights-based fishery management systems seem to have the best record of correcting the fundamental problem of nonexclusive harvesting rights and of reducing conflicts among users, producing superior economic performance while conserving fishery resources (Sutinen, 2002).

For small-scale fishery, it is difficult to establish a system of "strong" property rights because of the multi-specific nature of the activity, but it is possible to introduce the principle of "exclusivity" such as in the case of the self-managed fisher associations for bivalve molluscs fishery.

The small-scale fishery consortia are the operational instruments for the implementation, in the future, of rights-based management. The goals that this new management approach should achieve are:

- Reduction of over-capacity and fishing effort;

- Improving product quality;
- Increasing the value of landings;
- Reduction in exploitation cost;

In conclusion, a rights-based fishery management system is able to combine resource protection with economic and social objectives.

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Appendix 1

The Irepa national observatory for monitoring techno-economic data of the Italian fleet^a

Data collection and estimates of economic parameters concerning the Italian fishing fleet are produced by IREPA (Institute for Fisheries and Aquaculture Economic Research) through a National Observatory, which dates back to the early 1980s. In 2000, IREPA started a process of rationalisation and harmonisation of the existing surveys on the fishery sector in collaboration with Italian National Statistical Institute (ISTAT) that also carries out the process of validation of the sample survey. The practical outcome of the process was the definition of a sample survey on the catches and the relative values whose objective is satisfying the EU legislation and, more in general, the national and international information needs.

The IREPA monitoring system for economic data on the Italian fishery sector is based on three main modules: fishing effort and activities, landings and prices by species, and economic data. In 2003, the number of small-scale vessels in the sample was 310 (3.5 percent of the total number of small-scale vessels).

1. Aims of the monitoring system

The aim of the statistical survey is to gather information on the most significant parameters of the fishery sector.

The existing observatory consists of three main modules:

- Module of evaluation of fishing effort and activity;

^a In this Appendix, a synthesis of the Irepa methodology is reported. For detailed information: IREPA. (2001) IREPA implementation of a national monitoring system of socio-economic parameters of the Italian fishing fleet. In: *AdriaMed (2001). Socio-economic Aspects of Adriatic Sea Fisheries. Report of AdriaMed Meeting on Socio-Economic Aspects of the Adriatic Sea Fishery Sector. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-5. AdriaMed Technical Documents*, 5: 32-41.

- Module of evaluation of landings and prices by species;
- Module of evaluation of economic and social data.

The survey is based on a single panel. Around 1000 vessels are monitored each week and elementary data are later expanded to the universe (the whole Italian fleet) using statistical sampling procedures.

2. Description of the survey

Data collection concerning the fishery sector in Italy is very complex due to the high number of species caught, the spreading of the fleet along the 8000 Km of coastline and the vast number of landing points available (estimated at around 800).

The National Fleet Register (Archivio Licenze di Pesca - ALP), where all Italian fishing vessels are included, constitutes the list from which the sampling units are extracted.

2.1 The questionnaire

Sample data are recorded by means of three specific questionnaires:

1. An annual questionnaire to record technical, dimensional and vessel-management information on the sample units and relevant socio-economic aspects (number of ship owners, their ages, their property quotas and the relationships between them);
2. A quarterly questionnaire to record data on fixed and variable costs, and on social aspects of property and crew;
3. A weekly questionnaire to record information reporting activity such as fishing time and area, average number of crewmembers, gears used, quantities, prices and revenues – as per species or group of species – and trade channel for sales;

A computerised questionnaire specifically processed for this survey is used for the gathering of information. The interviewers are provided with PCs to fill in the questionnaires and forward them via the Internet. Some examples of computer displays relating to the software used by interviewers to collect and transfer information to head office are shown in Figure 1.

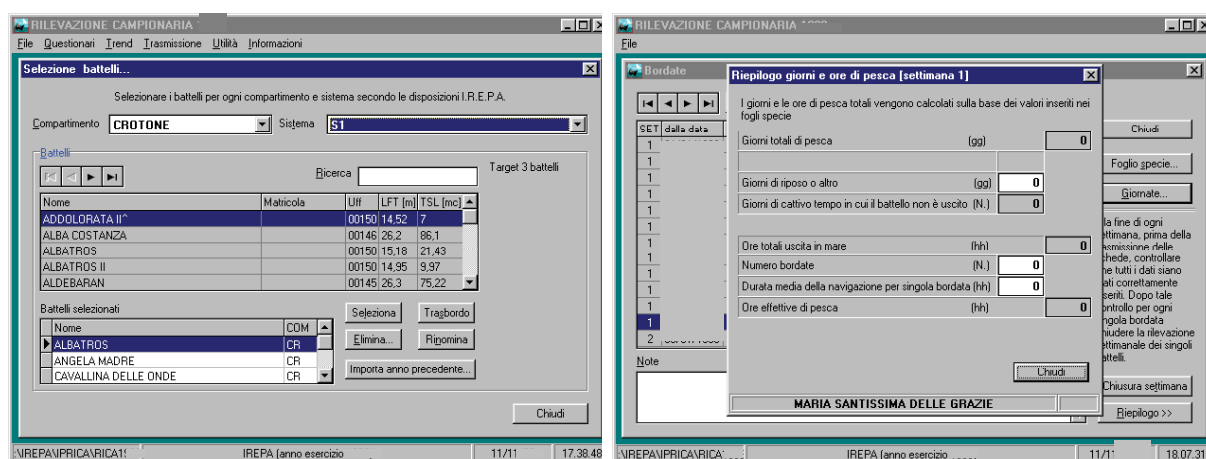


Figure 1. Display for the selection of vessels to be examined (left) and (right) display for assigning activities (fishing days, rest days, sailing hours, number of tacks, duration of sailing).

2.2 Sampling design: Single Stage Stratified Sampling

The sampling design is based on a single stage sample stratified over two variables (Figure 2). Stratification is carried out in order to create strata as homogeneous as possible, using characteristics correlated to the target variables.

The maritime regions of the Italian coast represent the first stratification variable from an administrative point of view. The sampling design considers only 13 of these 15 maritime regions, since there are no enrolment offices in Basilicata and, due to the small size of Molise's fleet (0.3 percent of the total number of Italian fishing vessels), the latter has been aggregated to Abruzzo. Some regions are further subdivided (Sicilia, Puglia, Calabria) in order to report data for FAO/GFCM Geographical Sub-Areas as well.

The second stratification variable is the fishing system used by the vessel; the fishing fleet is therefore divided in groups and each fishing vessel belongs to one of these groups according to the fishing system it uses. The identification of the fishing system follows the fishing systems actually present in the Italian fleet, while taking into account criteria of consistency with the segmentation considered under the EU regulation on data collection (EC Regulation n. 1639/01).

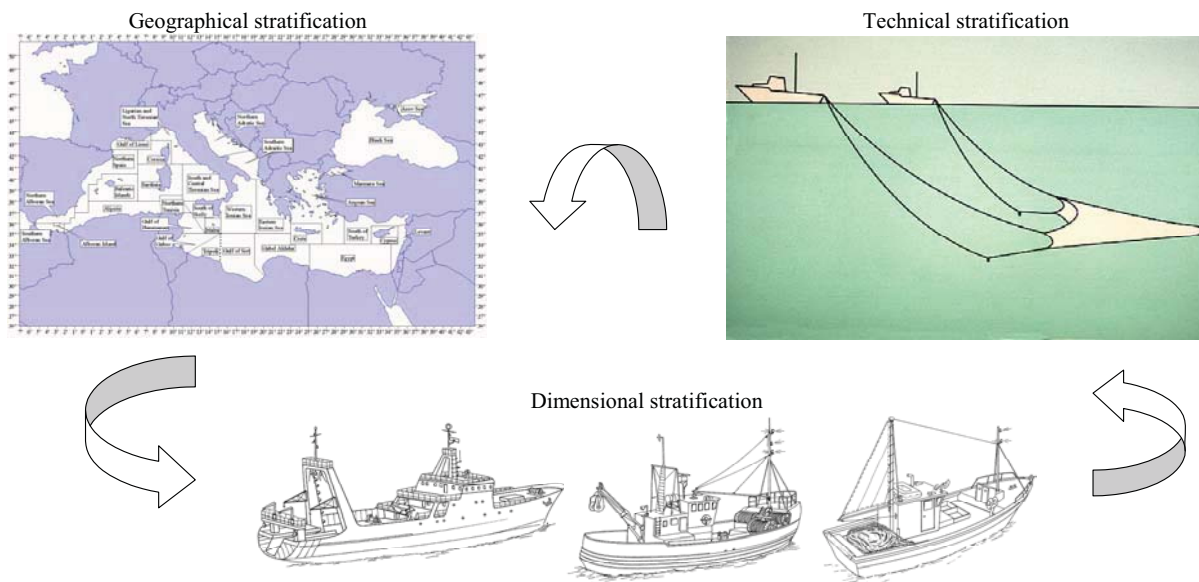


Figure 2. The process of stratification.

Furthermore, another stratification is carried out on the basis of the dimensional parameter LOA (length overall). This in order to obtain more homogeneous study domains and to take into account new EC regulations on data collection.

The statistical survey is composed of the following steps:

1. Calculation of the sample size and allocation across strata;
2. Expansion of the data through appropriate expansion factors;
3. Control and validation of sampling data.

Small-scale fisheries in Slovenia

Bojan Marčeta *

Abstract

Small-scale fishery is poorly known and basically not monitored. Officially, small-scale fisheries is not recognized as category within national fisheries. Practically, small boats equipped with passive fishing gears are regarded as components of the small-scale artisanal fishery sector. The current number of fishing units that may be attributed to the small-scale fishery sector is estimated at 73 vessels. Indicatively, the average yearly catch could be estimated at around 100 tonnes. The establishment of a basic monitoring system is indicated as a priority action.

Keywords: artisanal fishing; fishing vessels; fishery development; MED, Slovenia; MED, Adriatic Sea

1. Introduction

The knowledge on small-scale fishery in Slovenia is very poor. We know that small fisherman do exist but nobody knows the appropriate definition of what small-scale fishery is. The Slovene fishing fleet has never been officially classified into categories of small- and large-scale fishery, so the definition is missing. Nevertheless, unofficially the division between small- and large-scale fishery was always present. Small boats equipped with gillnets, entangling nets, pots, and long-lines were considered as belonging to small-scale fishery. On the contrary, fishing boats equipped with active fishing gear (e.g. purse seines, trawls or dredges) were considered as large-scale fishery.

The need for an appropriate definition of Slovene fisheries has arisen during the ongoing organization of the National Statistical System for marine fishery. The system is based on two different data collecting approaches: sampling for small-scale and logbook for large-scale fishery. The proposed categorization is based on overall vessel length (LOA), which means that vessels less than 10 m LOA are considered as small-scale fishery.

For the categorization of fisheries two scales, absolute and relative could be used. The relative scale deals with catch capacity, which is lower in small-scale fishery (Ruttan *et al.*, 2000). In the Slovene case, landing data for appropriate vessels are not complete or are entirely missing. In these circumstances the use of a relative scale is not appropriate.

This report is the first attempt at classification of Slovene fishery based on an absolute scale and considering the size of fishing vessels as well as the type of fishing gear.

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2. The definition of small-scale fishery

According to the data from the Fishing Vessel Register for the year 2003 in the framework of the national statistical system for marine fishery, the Slovene fishing fleet consists of about 107 fishing units. The main characteristics of the Slovene fishing fleet are given in Table 1. Overall length (LOA) distribution and the main purpose of fishing units is shown in Figure 1.

Table 1. Main characteristics of the Slovene fishing fleet.

	Min	Max	Total
Overall length [m]	3,4	29,13	
Engine power [kW]	2,57	597	6572
Gross tonnage	0,41	156,2	794

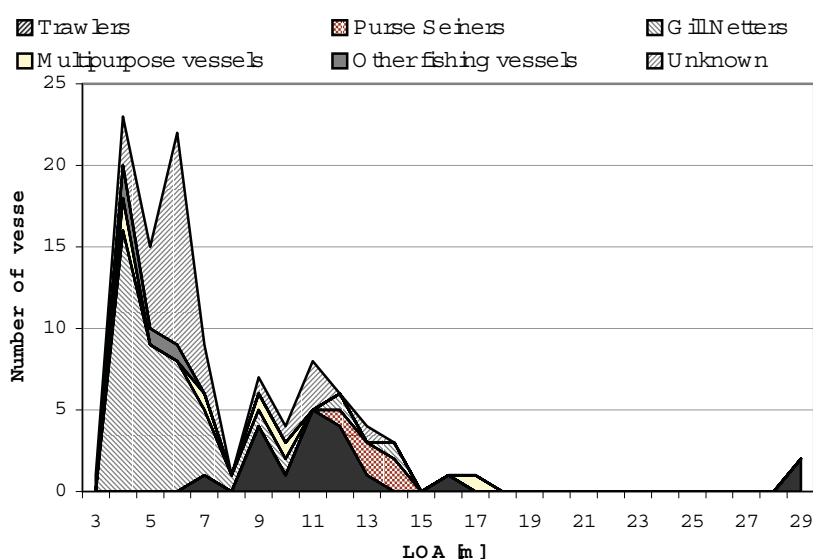


Figure 1. Overall length (LOA) distribution and main purpose of Slovene fishing units. Source: Fishing Vessel Register (2003).

To obtain a list of small-scale fishing units from the Slovene fishing fleet the following units were excluded:

- All units with LOA equal or above 10 m;
- All units using active fishing gears (in this case trawlers only) irrespective of their LOA.

A Proposed definition of Slovene a small-scale fishing unit based on an absolute scale: a small-scale fishing unit is every fishing boat for which the overall length is less than 10 meters and which has permission to use gears other than active fishing gears (e.g. trawls, dredges, purse seines, fishing machines).

As previously stated, there is no specific knowledge on the status of the national small-scale fisheries. Furthermore there is currently no monitoring system or programme which includes the small-scale fisheries sector.

3. Size of the small-scale fishery sector

3.1 Fishing units

According to the proposed definition, the Slovene small-scale fishing fleet would consist of about 73 fishing units. Their main characteristics are listed in Table 1.

The structure of the small-scale fishing fleet according to the purpose of fishing units is shown in Figure 2. The overall length distribution and the main purpose of fishing units are given in Figure.

Usually the owner of the fishing unit works alone and has no employed persons; only the owner's family is dependent on the profits from the catch sale.

Table 1. The main characteristics of the Slovene small-scale fishing fleet.

	Min	Max	Total
Overall length [m]	3,4	9,6	
Engine power [kW]	2,57	123	1655
Gross tonnage	0,41	5,3	118

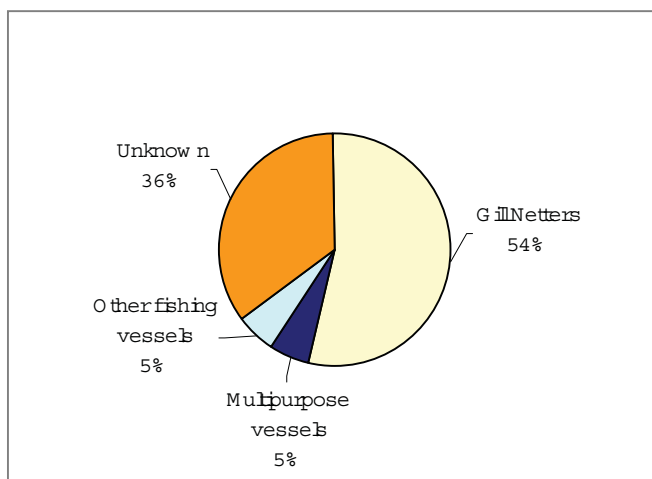


Figure 2. Overall length (LOA) distribution and main purpose of the Slovene small-scale fishing units.

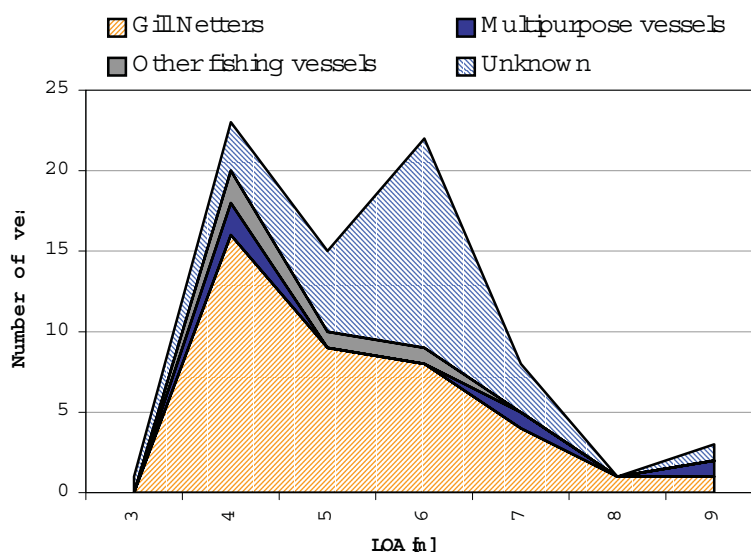


Figure 3. Structure of the Slovene small-scale fishing fleet according to the purpose of fishing units.

3.2 Catch

Catch data as available from the Statistical Office of the Republic of Slovenia are not suitable to estimate the quantity and quality of small-fishery catch. Tentatively, the approximate estimation of small-scale fishery catches was done by subtraction of the catch of species which are almost entirely fished by active gears (most pelagic species, e.g. Clupaeidae, Scombridae and demersal species, particularly *Eledone moschata*).

The yearly catch from small-scale fishery ranged from a maximum of 552 tonnes in 1983 to a minimum of 30 tonnes in 1997 (Figure 4).

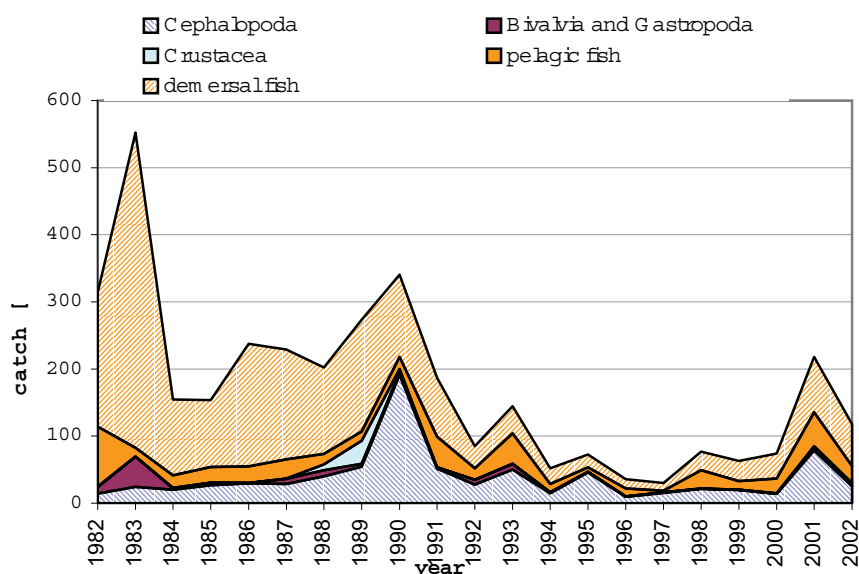


Figure 4. Approximate estimation of the small-scale fishery catch based on yearly catch data from the Statistical Office of the Republic of Slovenia. Species almost entirely fished by active gears were excluded.

Reduced access to fishing grounds in the early 1990s and adaptation of fishermen to the new geo-political situation are probably the most important reasons for the catch decrease. In the period from 1991 to 2002 the average annual catch was 96 tonnes. The catch structure for the same period is shown in Figure 5. The fishing grounds of small-scale fishing units are limited to the Slovene territorial waters.

4. Available scientific and technical knowledge on small-scale fisheries

Scientific investigations on small-scale fishery have never been performed. Knowledge on fishing gear is incomplete and is limited only to main categories of fishing gears that are in use by Slovene small-scale fishers. There are no data on construction and quantity of various fishing gears or data on spatial and temporal use and target species.

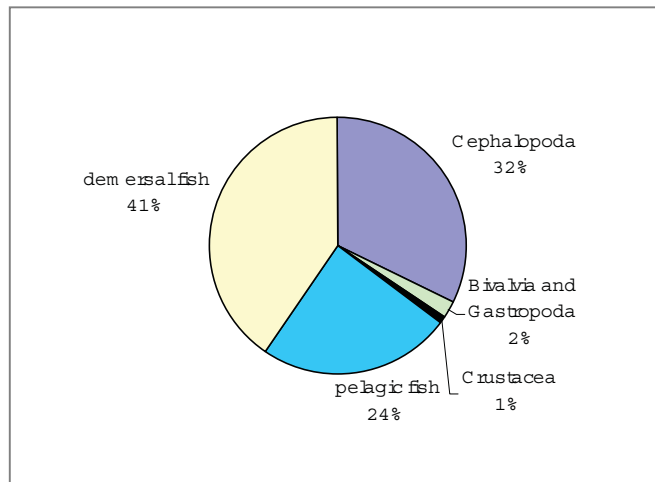


Figure 5. Small-scale fishery catch composition in period from 1991 to 2002. Approximation based on catch data available from the Statistical Office of the Republic of Slovenia.

5. National and international programmes

In the frame of FAO-AdriaMed the National Statistical System for Marine Fishery is being developed in Slovenia. By means of a sampling approach, the system will collect data from small-scale fishery. Data will not only cover catch and effort but also catch composition as well as spatial and temporal distribution of fishing activity.

The Fishing Vessels Register, which is part of the national statistical system, is almost complete. Currently the effort is directed towards the necessary regulations that will make the use of the fishery statistical system possible from the year 2004.

6. Identification of priorities and main gaps

Slovene small-scale fishermen are using a variety of fishing gears which are often hand-made or at least artisanally modified; some kind of local catalogue of fishing gears could be very useful. For example, the catalogue would be important as a reference text for collecting data in the framework of the national statistical system for marine fishery.

The Slovene small-scale fishery has always been excluded from fishery research programmes. As a consequence even the most basic data are missing. Regular monitoring that focuses on this sector of Slovene fisheries would provide a valuable contribution to fill the current gap in knowledge.

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The traditional “Bianchetto” and “Rossetto” fishery in the Gulf of Manfredonia (southern Adriatic Sea, GFCM Geographical Sub-area 18)

Ungaro Nicola*, Marano Giovanni*, De Zio Vito*, Pastorelli AnnaMaria*, Rositani Lucio*

Abstract

The traditional fishery targeting the transparent goby (*Aphia minuta mediterranea*, locally known as “Rossetto”) and sardine (*Sardina pilchardus*) fry (locally known as “Bianchetto”) has a long history and represents the most important small-scale activity in the Gulf of Manfredonia (southern west Adriatic Sea, GFCM GSA 18). Transparent goby and sardine fry fishery in the area is carried out by means of towed gears. It could be considered as a semi-selective fishing, and experimental data analysis shows the high vertical opening trawl net is more selective with respect to the traditional otter trawl. The fishery of “Bianchetto” and “Rossetto” partially interacts with offshore bottom trawling. In fact, some species are common to both the activities (European hake, red mullet, etc.) although their catches are very low in the traditional fishery. The small quantity of valuable resources in the catches other than “bianchetto” and “rossetto” could be related both to the authorised fishing period (winter time) and the exploited area, according to the bio-ecological characteristics of species such as the European hake (*Merluccius merluccius*) and the red mullet (*Mullus barbatus*). However, due to the fishing gear and the characteristics of the activity, this traditional fishery (when authorised) has to be carefully monitored on a scientific basis.

Keywords: artisanal fishing; coastal fisheries; fry, MED, Adriatic Sea, South.

1. Introduction

The fishery targeting the transparent goby (*Aphia minuta mediterranea*, locally known as “Rossetto”) and sardine (*Sardina pilchardus*) fry (locally known as “Bianchetto”) is classified as “Special fishery” by the European Commission, which has practically forbidden this kind of fishery in the EU waters since the 1st of January 1999, according to the EC Regulation 1626/94. In spite of this, the fishery has been so far carried out under the repeal allowed by the Italian Presidential decree 1639/68 (Cau, 2000) and it is quite an important activity in some Italian coastal areas (Auteri *et al.*, 2000, Giovanardi *et al.*, 2000).

The traditional “bianchetto” and “rossetto” fishery has a long history and represents the most important small-scale activity in the Gulf of Manfredonia (Ungaro *et al.*, 1994) and its social and economic relevance is very high at local level, involving 250-350 fishers and their families.

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2. The fishing activity

In the Gulf of Manfredonia, “bianchetto” and “rossetto” fishery is carried out by means of towed gears. Commercial landings consist mainly (more than 90%) of *A. minuta mediterranea* and *S. pilchardus* fry specimens although small quantities of other species are also captured (Ungaro *et al.*, 1994).

Transparent goby and sardine fry fishery by means of towed gears exploits soft bottoms in the Gulf of Manfredonia (southern west Adriatic Sea, GFCM GSA 18) mostly from 8 m down to 15-20 m bottom depth (Figure 1).



Figure 1. Bottom area exploited by transparent goby and sardine fry fishery.

The fishing fleet is concentrated in the maritime district of Manfredonia. In recent years the approximate number of authorised vessels was 150 compared to 200-250 in the past (Ungaro *et al.*, 1994). Most of the vessels are characterised by tonnage (GRT) of less than 10 tonnes and engine power below 150 kW (Ungaro *et al.*, 1994). The fishery, when authorised, is carried out during wintertime (15 January-15 March as a rule) for a period of 60 days (Ungaro *et al.*, 1994; Casavola *et al.*, 1999), but the actual number of effective fishing days is lower.

Two different towed gears are used. The first is the "Italian" type otter trawl; the second is a high vertical-opening otter trawl. Both the gears are equipped with a small mesh covered codend system. The codend mesh size is 36-40 mm (stretched) as required by current bottom trawling regulations, while the cover mesh size is 5 mm.

The target species (transparent goby and sardine fry) are mostly collected in the cover and by-catches are usually retained in the codend. The main features of the nets utilised (length, otter boards etc.) are generally the same as the gears used in the bottom trawl mixed fishery. Although both types of fishing net have been used until now, in the last ten years the shift from the traditional otter trawl net to the high vertical opening trawl has been recorded.

3. The fishery yield and catch composition

Transparent goby and sardine fry fishery in the Gulf of Manfredonia by means of towed gears could be considered as a semi-selective fishing activity. In fact, most of the catches consist of the target species (more than 50% in weight and 75% in number of individuals considering both the cover and cod-end retained species) although other species are also collected.

The rough estimation of landed catch provided values ranging from 25 to 50 kg/boat/day (Ungaro *et al.*, 1994), and a high variability rate is reported for the past years.

Sardine fry represented more than 75% of the landed catches and the transparent goby almost all the remaining part (Ungaro *et al.*, 1994).

The main by-catch species in the “bianchetto” and “rossetto” fishery are listed in Table 1 together with the rough estimate of their percentage occurrence.

Table 1. By-catch species percentage occurrence in transparent goby and sardine fry fishery catch (* < 0.5%, ** < 1-2%, *** < 5%).

<i>Allotheutis media</i> **	Midsized squid
<i>Arnoglossus spp.</i> *	Scaldfish spp.
<i>Boops boops</i> **	Bogue
<i>Deltentosteus quadrimaculatus</i> **	Four-spotted goby
<i>Diplodus annularis</i> *	Annular seabream
<i>Engraulis encrasicolus</i> **	European anchovy
<i>Gobius niger jozo</i> **	Black goby
<i>Lesuerigobius suerii</i> **	Lesueur's goby
<i>Liza spp.</i> *	Mullet spp.
<i>Merluccius merluccius</i> *	European hake
<i>Mullus barbatus</i> *	Red mullet
<i>Pomatoschistus sp.</i> ***	Sand gobies
<i>Sepioloa sp.</i> **	Bobtail squids
<i>Spicara spp.</i> **	Picarels
<i>Squilla mantis</i> *	Spottail mantis squillid
<i>Trigla lucerna</i> *	Tub gurnard

The species composition of the catch has also been evaluated by means of experimental sampling on board during fishing activity. The catches from the “high vertical opening trawl net” and “Italian otter trawl net” have been compared (Figures 2 and 3), and the first gear appears to be more selective.

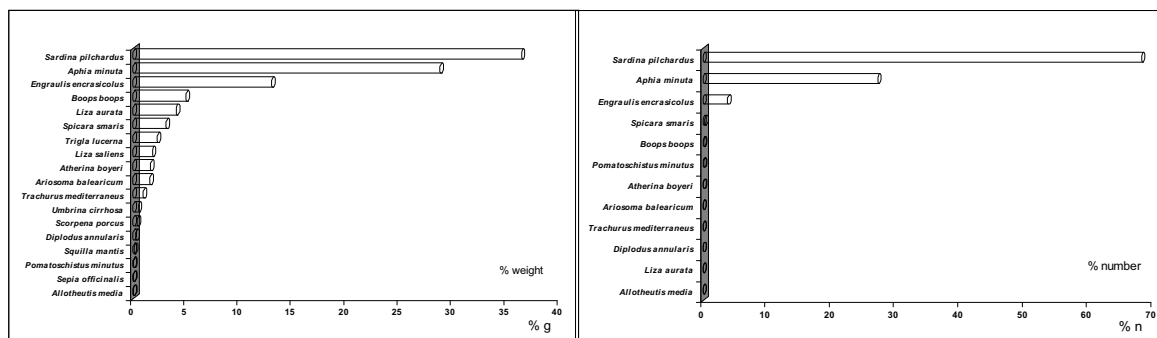


Figure 2. Species percentage in weight and number in the catch of high vertical opening trawl net (covered codend) (Ungaro, unpubl.).

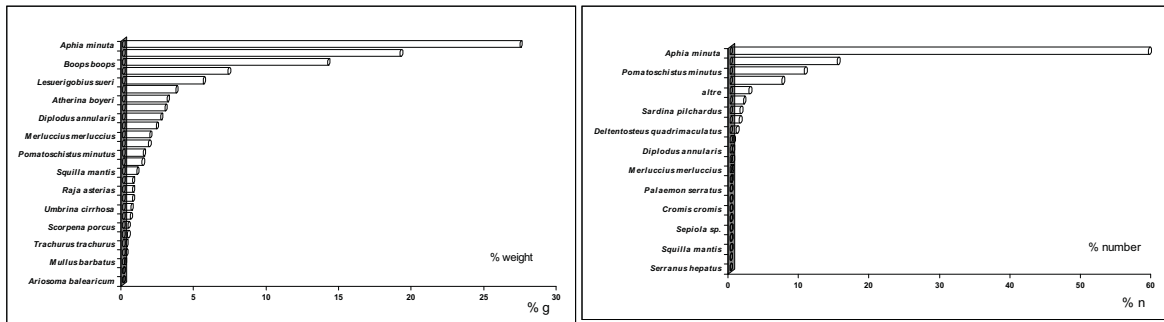


Figure 3. Species percentage in weight and number in the catch of Italian otter trawl net (covered codend) (Ungaro, unpubl.).

4. Discussion and conclusions

The fishery of “Bianchetto” and “Rossetto” in the Gulf of Manfredonia has to be considered as traditional fishing activity due to the long history and the high social impact.

Transparent goby and sardine fry fishery by means of towed gears could be considered as a semi-selective technique (Ungaro *et al.*, 1994; Casavola *et al.*, 1999), and experimental data show the high vertical opening trawl net as being more selective with respect to the traditional otter trawl. Nevertheless, the use of more selective gears such as the surrounding net without purse line has to be recommended (Auteri *et al.*, 2000).

There is no scientific evidence of overexploitation of the target species due, for example, to the catch of sardine fry (Romanelli and Giovanardi, 2000; Romanelli *et al.*, 2002). Sardine is present in substantial quantities in the Adriatic (Marano, 2000) and transparent goby is characterised by the short life-span and the small size (maximum length < 6 cm TL; Frogliola and Gramitto, 1989).

The fishery of “bianchetto” and “rossetto” partially interacts with offshore trawling. In fact, some species are common to both the activities (European hake, red mullet, etc.) but their catch quantities in the sardine fry and transparent goby fishery are very low (insignificant). The low quantity of other valuable resources in the catch could be related both to the authorised fishing period (winter time) and the fishing area, according to the bio-ecological characteristics of species such as the European hake (*Merluccius merluccius*) and red mullet (*Mullus barbatus*) (Relini *et al.*, 1999). However, due to the fishing gear and characteristics of the activity, this fishery (when authorised) has to be carefully monitored on a scientific basis.

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Drifting longline fishery in the southern Adriatic Sea (GFCM Geographical Sub-Area 18)*

Marano Giovanni[#], De Zio Vito[#], Pastorelli AnnaMaria[#], Rositani Lucio[#], Ungaro Nicola[#]

Abstract

Drifting longline fishery is a relatively new activity for the southern Adriatic Sea (GFCM GSA 18) mostly targeting swordfish and albacore. Both catch and C.P.U.E. values from the area show high variability mostly due to the restriction or enlargement of fishing seasons year by year and to the number of operating vessels. Immature specimens represent most of the swordfish catches while most of albacores are adult individuals. This pelagic fishery has to be carefully monitored and a precautionary approach for the management of the activity should be adopted.

Key-words: artisanal fishing; pelagic fisheries; longlining; tuna fisheries; catch/effort; size distribution; MED, Adriatic Sea, Southern

1. Introduction

Drifting longline fishery is a relatively new activity in the southern Adriatic Sea (GFCM GSA 18), if compared with other fisheries such as trawling. The fishery developed during the 1970s and 1980s in the Adriatic and mostly targets the swordfish (*Xiphias gladius*) and the albacore (*Thunnus alalunga*) (De Zio *et al.*, 1986; Marano *et al.*, 1988a; Marano *et al.*, 1988b).

The social-economic impact of drifting longline fishery is quite important at local level, although lower than bottom trawling. The Italian Government therefore supported research projects in the last decades of the 20th Century in order to manage this fishing activity in the best way (Marano *et al.*, 1988b). The Marine Biology Laboratory of Bari (southwestern Adriatic) has been responsible for the GFCM GSA 18 since 1984, regarding the monitoring of the fishery catch and effort, as well as for the biological research on the most important species, (Marano *et al.*, 1998).

2. The fishing activity

The drifting longline fishing area is wide, including most of the southern Adriatic basin (offshore waters) (Figure 1). The fishing fleet utilizing drifting longlines is only from Italy. Moreover, large pelagic fish are caught in the southern Adriatic almost exclusively by means of this gear. Low numbers of large pelagic fish are also caught by other gears, most additional

* This paper is largely based on: Marano G., De Zio V., Pastorelli A. M., Rositani L. and Ungaro N. Large Pelagics fishery in the Southern Adriatic Sea (GFCM Geographical sub-area n° 18): target species, catches and fishing effort in the last decades of the 20th Century. (*In press*).

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catches are from big game sport-fishing boats (tuna or tuna-like fish). Occasionally fishing trips have been carried out in the last years by purse-seiners from other areas of the Mediterranean Sea (Tyrrhenian Sea), mostly targeting small and medium sized bluefin tuna.

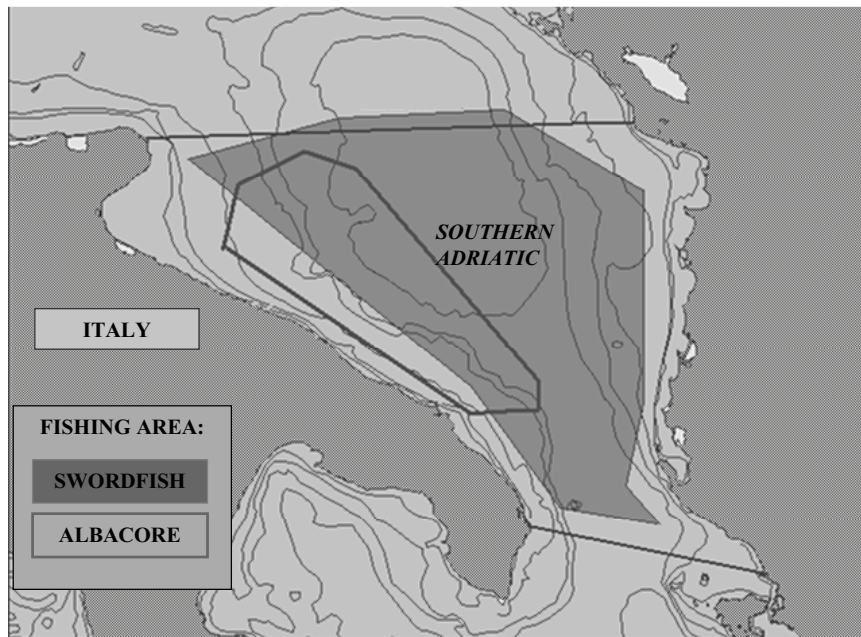


Figure 1. Fishing area for *X. gladius* and *T. alalunga*.

The Italian maritime departments involved in the drifting longline activity are those of Bari and Brindisi and the main landing ports are Monopoli, Savelletri, Mola and Otranto. Currently the estimated number of fishing vessels is between 15 and 20, and a decreasing trend is reported for the last years (Table 1). Tonnage (GRT) and engine power of the vessels mostly range between 10 and 15 t and 75 and 150 kW respectively.

Table 1. Drifting longline fishery: number of vessels per year in GSA 18 (from Marano *et al.*, 2000).

	1984	1985	1986	1987	1990	1991	1992	1993	1994	1995	1998	1999	2000
Mola	7	6	6	7	6	4	2	2	3	6	2	2	2
Monopoli	41	41	36	25	17	32	23	16	20	14	17	12	11
Savelletri	7	5	6	7	4	4	4	4	6	5	5	4	2
Otranto	8	9	7	7	7	7	7	5	4	5	2	2	2

Drifting longlines are from 40 to 60 nautical miles long, and the number of hooks is 2000-3500 and 3500-5000 for swordfish and albacore fishing respectively. The size of hooks is different also, 8-10 cm for swordfish and 4-5 cm for albacore (Table 2). Moreover, an increasing use of line hauler has been observed in the last 10 years.

The drifting longline fishery is seasonal: the swordfish fishing season is mostly concentrated between July and December (the ports of Mola, Monopoli and Savelletri), while the Albacore fishing season is from September to November. The different periods generally correspond to the spawning and post-spawning seasons for the species (Orsi Relini *et al.*, 1996; Marano *et*

al., 1999). Currently a rough estimate of 30 and 20 days of effective fishing per year could be reasonable for swordfish and albacore respectively.

Table. 2. Some features of the drifting longline used in GSA 18 (modified from Marano *et al.*, 2000).

Hook size (swordfish)	8-10 cm
Hook size (albacore)	4-5 cm
Number of hooks (swordfish)	2000 – 3500
Number of hooks (albacore)	3500 – 5000
Mainline diameter	1.40-1.60 mm
Mainline length	40-60 km
Branch line diameter	1.20 mm
Branch line length	4-6 m
Distance between floats	35-40 m
Line material	Monofilament
Bait for swordfish	Mackerel
Bait for albacore	Sardine

3. The fishery yield and catch composition

Swordfish catches decreased in the last five reported years in the southern Adriatic, from 205,890 kg in 1995 to 84,632 kg in 1998 and 63,566 kg in 1999, the 1995 value represents the maximum landing estimate for the 1984-2000 period. However, a slight increase (92,155 kg) has been reported for the year 2000. Monopoli was the most important landing port (more than 70-80% of total catches). Fishing effort (E = total number of the hauled hooks per year) was highly variable, as well as C.P.U.E. values in weight and number (Figure 2).

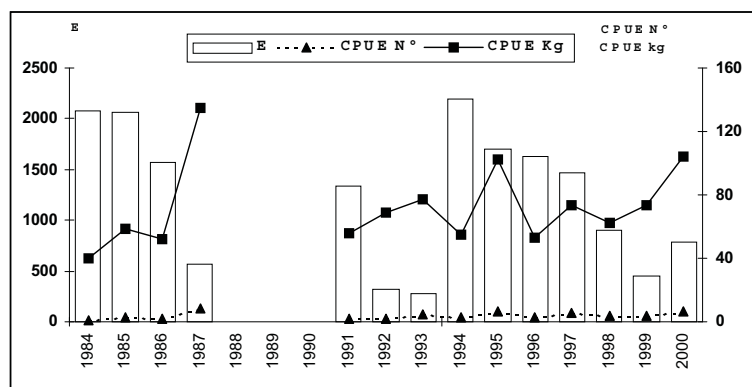


Figure 2. Swordfish fishery: trend (1984-2000) of fishing effort (E) and CPUEs (number and weight). Data not available for the years 1988, 1989 and 1990 (from Marano *et al.*, in press).

Length-frequency distribution of swordfish from fishing ports (Monopoli, Savellettri and Mola) were different but the percentage of specimens smaller than 120 cm Lower Jaw Fork Length (LJFL), the minimum legal size, was always higher than 50%. The comparison between size distribution in 1985 and 2000 showed small differences. However, the apparent

decrease of large individuals above 180-200 cm LJFL should be noted (Figure 3). Mean weight of fished specimens was below 20 kg in the last years of the 20th Century, while it was mostly between 20 and 30 kg during the 1980s.

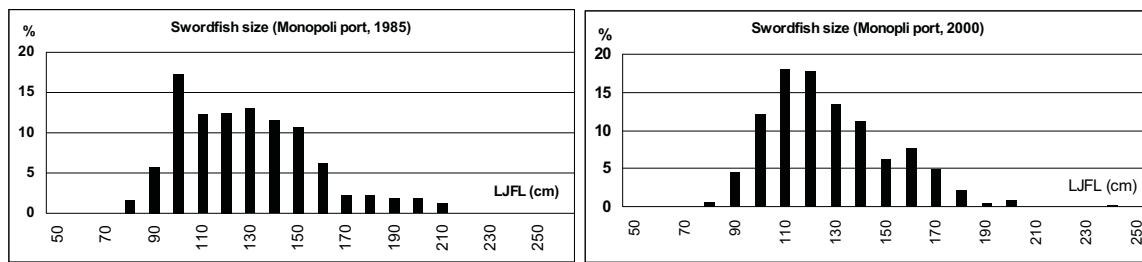


Figure 3. Swordfish length distributions in 1985 (top) and 2000 (bottom) commercial catches (from Marano *et al.*, in press).

Albacore catch and C.P.U.E. values did not show a well-defined trend, during the last years of the time period considered albacore fishery was self-regulated by fishermen from Monopoli port. In fact, the fishermen stopped the fishing activity in order to protect the juveniles of swordfish. The albacore fishery totally ceased during 1998, while the number of fishing trips during 1999 was 87 (Figure 4).

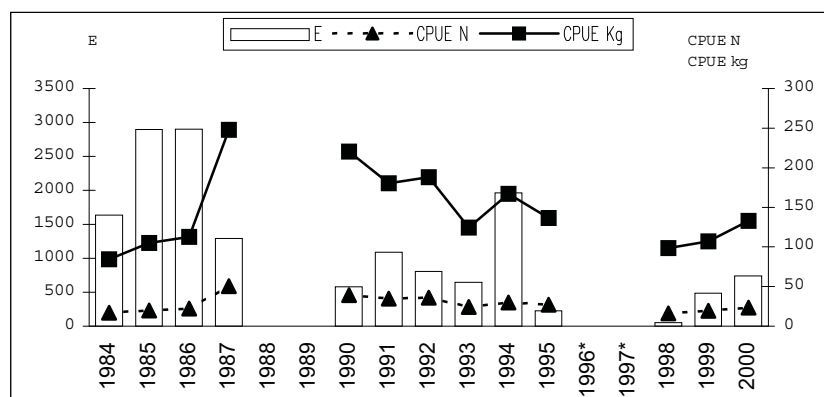


Figure 4. Albacore fishery: trend (1984-2000) of fishing effort (E) and CPUEs (number and weight). Data not available for the year 1988 and 1999. Voluntary fishing ban during 1996* and 1997* (from Marano *et al.*, in press).

With regard to the albacore size distributions, most of the specimens caught were larger than 60 cm Fork Length (FL) throughout the period investigated (Figure 5).

Mean weight of specimens was very stable; it ranged mostly between 5 and 6 kg during the years from 1984 to 2000.

Beside swordfish and albacore target species, other fish are also caught. Occasional catches are mostly represented by the following species:

Thunnus thynnus (Atlantic bluefin tuna)

Auxis rochei (Bullet tuna)

Euthynnus alletteratus (Little tunny)
Sarda sarda (Atlantic bonito)
Prionace glauca (Blue shark)
Ruvettus pretiosus (Oilfish)
Alopias vulpinus (Thresher)
Brama brama (Atlantic pomfret)
Coryphena hippurus (Common dolphinfish)
Lamna nasus (Porbeagle)
Lichia amia (Leerfish)

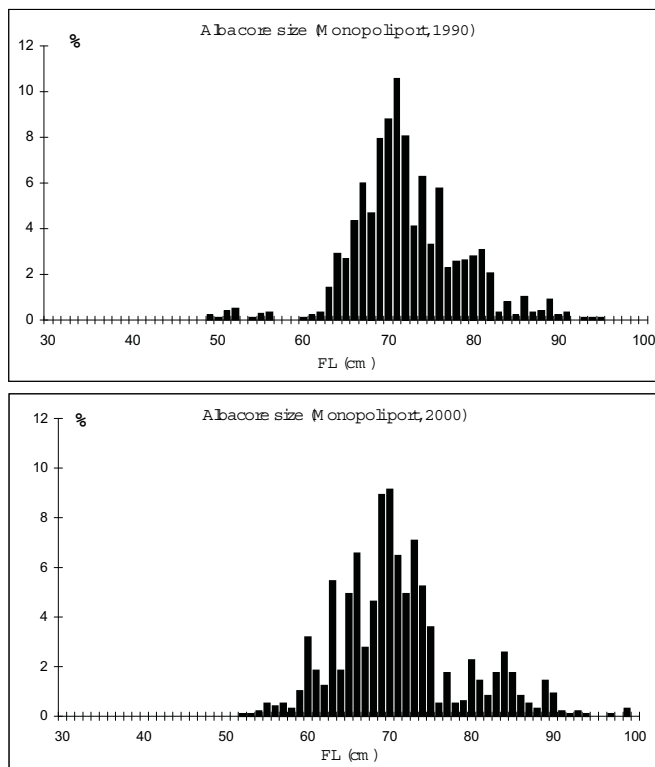


Figure 5. Albacore length distributions from 1990 (top) and 2000 (bottom) commercial catches (from Marano *et al.*, in press).

Pteroplatytrygon violacea (Blue stingray) is frequently caught but it is discarded at sea as not marketable species. Moreover, the gear accidentally catches specimens of Loggerhead turtle (*Caretta caretta*), which are immediately released at the sea. The incidence of the most important occasional catches, such as the blue shark and the Atlantic blue fin tuna, was 10-20% (both in number and weight) for *P. glauca* and 5-7% for *T. thynnus*.

4. Discussion and Conclusions

Both catch and C.P.U.E. values of drifting longline fishery for large pelagics in the southern Adriatic Sea underlined high variability mostly due to the duration (restriction or enlargement) of the fishing season year by year and to the number of operating vessels. This fishery could be considered as “opportunistic”; each year fishermen decide whether or not to

fish for large pelagics after preliminary fishing trials. If the catches prove to be unsatisfactory, the fishing activity targets other resources (i.e. demersals) by using different gear (trawl net, bottom longline).

The drifting longline fishery for swordfish has to be carefully monitored due to the large number of immature individuals caught by the gear. In fact, swordfish size at sexual maturity is 110-120 and 130-140 cm LJFL for males and females respectively; corresponding to specimens aged 2 and 3 years (Megalofonou *et al.*, 1987; Orsi Relini *et al.*, 1993; Orsi Relini *et al.*, 1996).

Most of albacore catches are of adult individuals above the size at sexual maturity of 60-65 cm FL, corresponding to two year old specimens (Marano *et al.*, 1999). However, the accidental catch of swordfish juveniles during the albacore fishery suggests a precautionary approach should also be adopted for this fishing activity.

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Small-scale fisheries in the maritime department of Ancona (Central Northern Adriatic Sea)

Gianna Fabi* and Fabio Grati*

Abstract

The paper reports data from the artisanal fishing fleet operating in the Adriatic Sea, in the area of the Ancona Maritime Department. The artisanal fleets existing in the area consist of 77 artisanal vessels having an average GRT of about 3.0, LOA of 6-12 m. The following fishing gears are described: gillnet for common sole (*Solea vulgaris*), gillnet for other highly valuable species (i.e. *Sciaena umbra*, *Umbrina cirrosa* and *Dicentrarchus labrax*, sparids), trammel net, basket traps for *Nassarius mutabilis* and traps (pots and fyke nets) for *Sepia officinalis*

Keywords: artisanal fishing; coastal fisheries; fishing vessels; *Solea vulgaris*, *Sciaena umbra*; *Umbrina cirrosa*; *Dicentrarchus labrax*; *Nassarius mutabilis*; *Sepia officinalis* MED, Adriatic Sea.

1. Introduction

Data reported in this context come mainly from investigations carried out since 1999 on the artisanal fleets operating along the Italian coast of the Adriatic Sea, in the area of Ancona Department extending between the Conero Promontory and Senigallia, about 35 km of shoreline (Fabi *et al.*, 2002a). They can be considered as representative of the artisanal fleets operating along the coast of Marche region, from San Benedetto del Tronto to Pesaro; (Fabi and Grati, 2002). Investigations include:

- Census at both local maritime offices and landing sites for getting information on number and technical features of vessels, on technical characteristics of gears used in the different seasons and on the main target species;
- Weekly sampling at the main mooring places to record amounts and composition of landings, technical features of gears, fishing time and exploited grounds;
- Periodic observations onboard of commercial vessels over two years (1999-2000) for collecting biological data on the catches of target species and on the quali-quantitative composition of discard of the most important fishing gears (sole gillnet, trammel nets, traps for *Sepia officinalis*); catches were subdivided in: target species, kept by-catch, discard of commercial species (henceforth referred to as “discard C”) and discard of non-commercial species (“discard NC”).

Other data were obtained inside two research projects focused on specific aspects (Fabi and De Ranieri, 1998; Fabi and Sartor, 2001).

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2. Description of the investigated fleets

The artisanal fleets existing in the area consist of 77 artisanal vessels having an average GRT of about 3.0, LOA of 6-12 m, average engine power of about 40 kW and a crew of 1-2 people. They include both fibreglass planing vessels and wooden displacing boats. Most of these vessels moor at three landing places (Senigallia, Ancona and Portonovo), while the remaining ones are dislocated along the coast.

2.1 Listing of various fishing gears

Gillnet for common sole (*Solea vulgaris*), gillnet for other highly valuable species (i.e. *Sciaena umbra*, *Umbrina cirrosa* and *Dicentrarchus labrax*, sparids) and trammel net are the most common set nets used in the area. A relevant importance is also assumed by traps (pots and fyke nets) for *Sepia officinalis* and basket traps for *Nassarius mutabilis* (Table 1; Figure 1).

Table 1. Main fishing gears utilised in the study area and respective target species and fishing period.

FISHING GEAR	TARGET SPECIES	FISHING PERIOD
Sole gillnet	<i>Solea vulgaris</i>	January-December
Gillnet	<i>Lithognathus mormyrus</i> , <i>Dicentrarchus labrax</i> , <i>Sciaena umbra</i> , <i>Umbrina cirrosa</i> , mugilids	November-March
Trammel net	<i>Sepia officinalis</i>	April-June
Trammel net	<i>Lithognathus mormyrus</i>	February-March
Pots and fyke nets	<i>Sepia officinalis</i>	April-June
Basket traps	<i>Nassarius mutabilis</i>	October-May

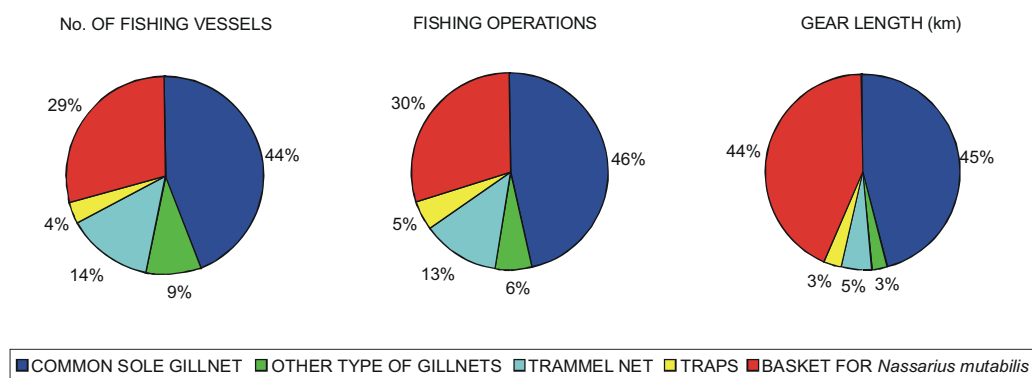


Figure 1. Percentage importance of the different set gears used by the artisanal fleets of Ancona Department.

2.2 Fishing grounds

The fleets mainly operate in a coastal area of about 300 km² extending between Marotta at north and the Conero Promontory at south and from 0.1 to 3 nautical miles offshore, because at greater distances the set gears could be damaged by trawling. These vessels extend their fishing grounds outside 3 nm from the coast only during the biological fishing stop (closed fishing season) of trawlers.

The sea bottom at north of Ancona is homogeneous and sand-muddy, gradually sloping down off-shore and reaching 15 m depth at about 3 nm from the coast. Conversely, it is mainly rocky or mixed rock-muddy at south, in front of Conero Promontory (Figure 2).

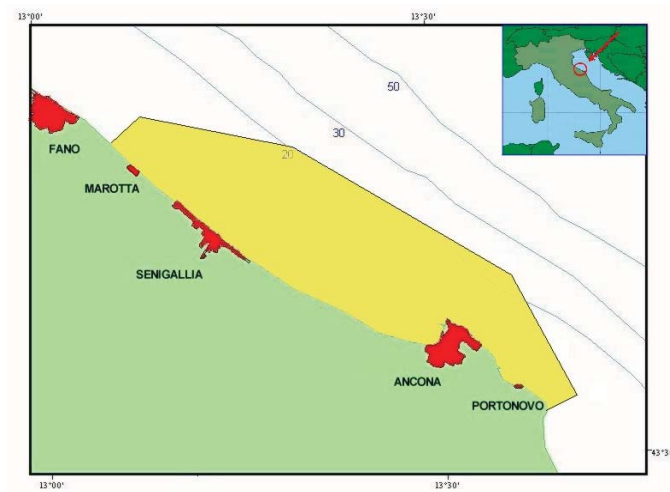


Figure 2. Fishing grounds of the artisanal fleets existing between Senigallia and Portonovo.

3. Gillnets for common sole

3.1 Fishing equipment

The artisanal fleets targeting common sole use a specific, polyamide monofilament gillnet having a low height (1.6-2.5 m) and a very low floating buoyancy which allows the gear to partially lay down on the seabed so favouring the capture of benthic fishes (Table 2). Diameter of netting yarn varies from 0.18 to 0.22 mm and the mesh size between 64 and 68 mm (stretched).

The length of nets ranges from 1,000 to 5,000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning.

Table 2. Technical characteristics of common sole gillnet.

PANEL						FLOATS Total No.	HEADLINE		LEADLINE (g/m)
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Diameter of the filament (mm)	Hanging ratio		Diam. (mm)	Material	
1.6	40	2000	68	0.20	0.29	16	3	PA	35
2.0	42	2000	68	0.18	0.31	16	4	PA	40
2.5	53	2000	64	0.20	0.41	8	5	PE	40
2.5	56	2000	68	0.20	0.41	8	5	PE	35
2.5	56	2000	64	0.22	0.43	8	5	PE	35

3.2 Fleets concerned

The fleet percentage using this gear varies among seasons, with the lowest values in winter and the highest ones in summer, when almost all operating vessels of the area target the

common sole with gillnets (Figure 3). The total number of vessels yearly devoted to this fishery increased in the last four years.

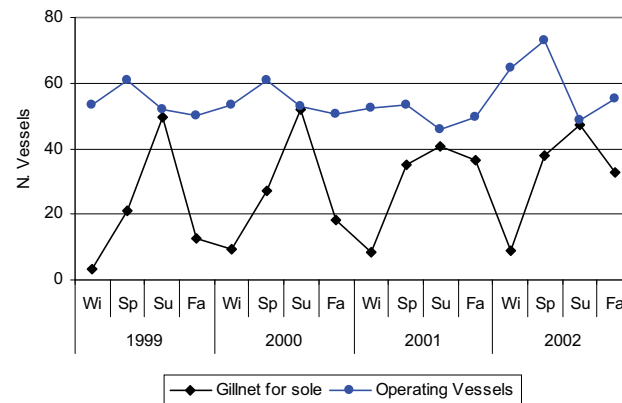


Figure 3. Seasonal trend of number of vessels using gillnet for common sole. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

3.3 Fishing grounds

The gillnet for common sole is employed on the coastal sandy and muddy seabeds between 1 and 4 nm offshore (Figure 4).

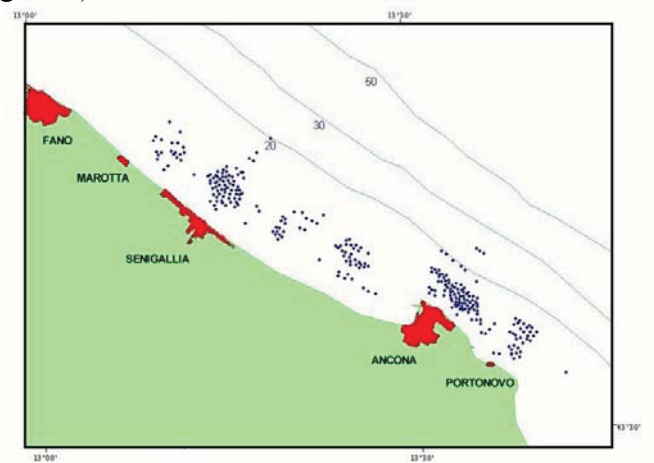


Figure 4. Fishing grounds of the artisanal fleets operating with gillnets for common sole.

3.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average permanence of 12 hours at sea. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and all year round, following a seasonal pattern characterised by the highest values in summer, when most of the small-scale fishing vessels are involved, and the lowest ones in winter. The extension of the fishing period increased in the last four years.

3.5 Data on catches

3.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 0.74 t to 125 t (Figure 5), showing only in the two first years a direct relationship with the amount of employed nets. The average seasonal landings per year increased from 1999 to 2000, remaining practically constant in the subsequent period. Differently, the average seasonal LPUEs per year amounted to 6.4 kg in 1999 and then stabilised at 4.5-5.0 kg/5000m/h.

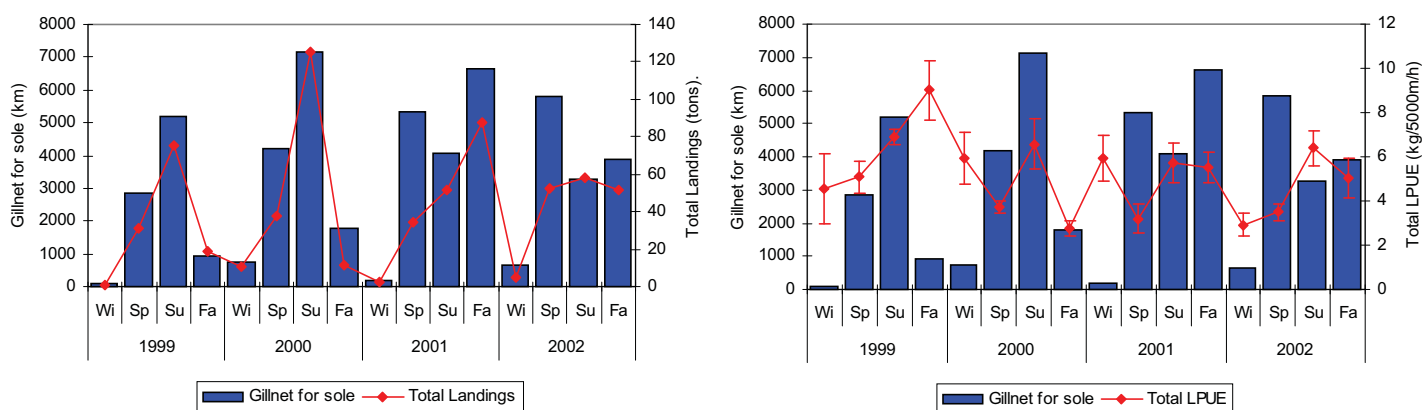


Figure 5. Seasonal trend of the total catches and LPUE of the vessels using gillnets for common sole.

Solea vulgaris accounted from 24% to 80% of the annual landed catch in weight. Annual landing of this species gradually increased over the four years reaching in 2002 a value corresponding to 2 times that recorded in 1999. At the same time LPUE remained practically constant (Figure 6).

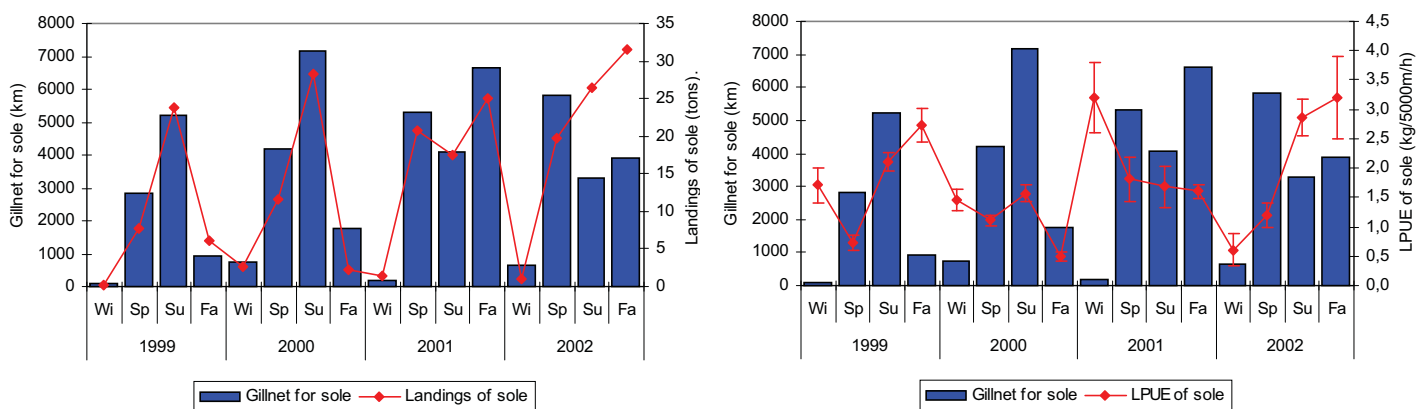


Figure 6. Seasonal trend of *S. vulgaris* total landings and LPUE.

Data on landing composition showed that *Squilla mantis* and *Trigla lucerna* can be considered respectively second and third target species for this fishery. Other accessory species are *Solea impar*, *Lithognathus mormyrus*, *Liza ramada*, *Diplodus annularis*, even though they appear in catches occasionally.

3.5.2 Discarding

Discard of commercial species is scarcely important for this fishery, representing 7% in weight of the total catches (Figure 7). The most relevant species are *Aporrhais pespelecani*, *S. mantis*, *Trachurus mediterraneus* and *T. lucerna*. The former is retained in other fisheries (i.e. artisanal trawling), but it is commonly discarded in set nets because scarcely abundant in catches. *S. mantis* e *T. mediterraneus* are generally represented by damaged specimens, while the discard of *T. lucerna* mainly includes no valuable specimens smaller than the sexual maturity size reported in the area (24.0 cm TL; Froglija, 1984). In fact, the juveniles of this species concentrate in the coastal area from spring to fall (Froglija, 1984) and easily enmesh in set nets independently from the mesh size because of their particular body shape (Fabi and De Ranieri, 1998). Discard of *S. vulgaris* is practically absent, as also the few damaged specimens are sold, although at lower prices in respect of the intact ones.

Alosa fallax, *Liocarcinus vernalis*, *Goneplax rhomboides* and *Corystes cassivelaunus* dominated discard NC, although their percentage contribution to this fraction noticeably changed among seasons.

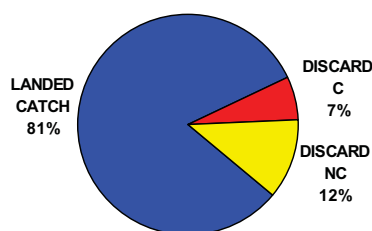


Figure 7. Composition of the total catches obtained with sole gillnets (1999-2000).

3.5.3 Demography and biological data of sole catches

Most of sole total catch obtained with the 64 mm and 68 mm mesh sizes consisted of juveniles belonging to age class 1, as shown in Table 3 realised on the basis of the Von Bertalanffy parameters estimated through the otolith reading method (Froglija and Giannetti;1986).

Table 3. Length/age percentage composition of *S. vulgaris* catches (1999-2000).

Mesh size	Length (cm) / Age class											
	13-18 / 0		19-25 / 1		26-30 / 2		31-33 / 3		34-35 / 4		36 / 5	
	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%
64 mm	1.73	3.45	89.56	92.07	8.71	4.48						
68 mm	0.75	1.84	77.86	85.04	19.83	12.54	1.56	0.58				

The length-frequency distributions of catches showed a slight shifting to the right side with the increasing of the mesh size, as a consequence of net selectivity. In fact, the 64 mm mesh catch ranged from 16.0 cm to 30.0 cm TL with an average length of 21.7 cm and a modal class at 21.0 cm TL, while that of the 68 mm mesh fell between 16.0 and 33.0 cm TL, with a mean TL of 23.0 cm and a modal class at 22.0 cm TL (Figure 8).

Analysis of gonads carried out on a total of 1087 specimens (517 males and 570 females) did not show any difference between the two sexes in spring and summer, while in fall catches males were significantly more abundant than females (Table 4).

In spring and summer, when the fishing activity is greater, most of catches consisted of immature individuals, but the percentage of sexually mature specimens gradually increased during the year until to reach about 38% of males and 7% of females in fall.

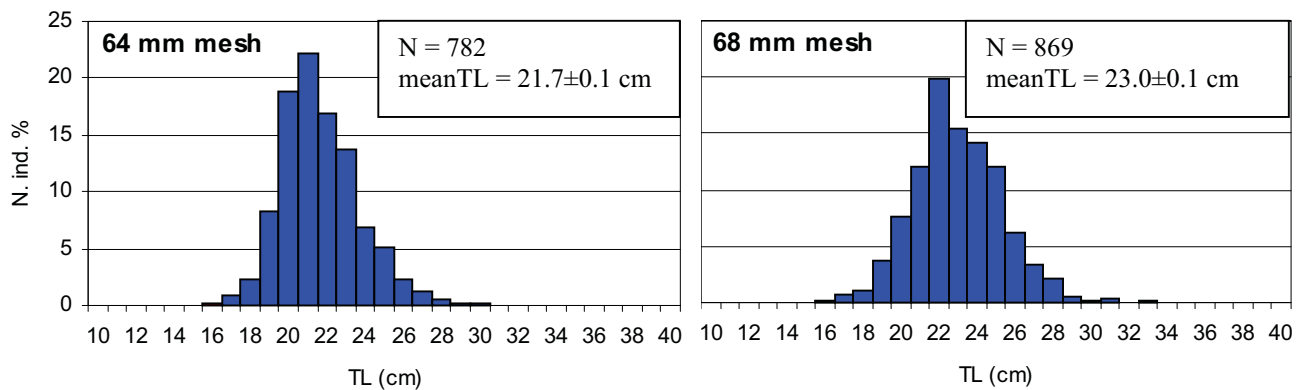


Figure 8. Demographic structure of gillnet catches of *S. vulgaris* obtained with the two mostly used mesh sizes.

Table 4. Number of *S. vulgaris* males and females recorded in the catches of vessels using sole gillnets (1999-2000). ** = highly significant.

SEASON	N. MALES	N. FEMALES	TOTALE	SEX RATIO M/F	TEST χ^2
Spring	91	110	201	0.83	0.180
Summer	331	333	664	0.99	0.938
Fall	148	74	222	2.00	0.000**
Total	570	517	1087	1.10	0.108

4. Other types of gillnets

4.1 Fishing equipment

The other types of gillnet used in the area can be grouped into only one category as they are made of polyamide monofilament, are 3-6 m high and have a great floating buoyancy and a mesh size ranging from 72 to 100 mm (stretched; Table 5). The length of nets ranges from 1,000 to 5,000 m.

Table 5. Technical characteristics of gillnets.

PANEL						FLOATS Total No.	HEADLINE		LEADLINE (g/m)
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Filament diameter (mm)	Hanging ratio		Diam. (mm)	Material	
3-6	80	2000	100	0.25	0.40	48	5	PA	100
3-4	64	2000	80	0.25	0.40	48	5	PA	100
3-4	64	2000	76	0.20	0.42	48	5	PA	100
3-4	53	2000	72	0.20	0.37	48	5	PA	100

4.2 Fleets concerned

These nets (Table 5) are occasionally used by a few fishing vessels mooring in the area between Ancona and Portonovo to catch either striped sea breams, sea basses and corbs in particular sea conditions or grey mullets in winter.

The scarce importance of this fishing *métier* is confirmed by the low number of vessels seasonally practicing it, which ranged from 0 (spring'02) to 10 (winter '99) in the overall period (Figure 9).

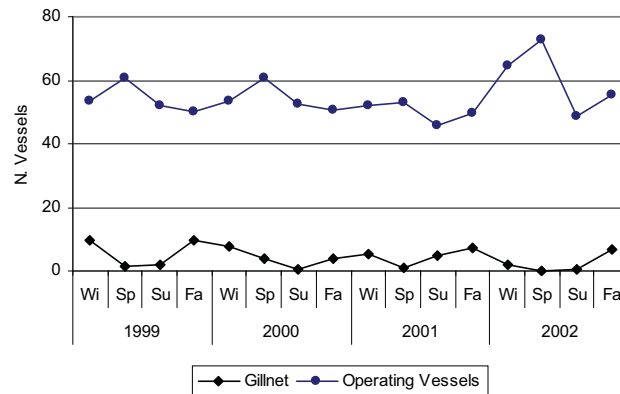


Figure 9. Seasonal trend of vessels using gillnet. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

4.3 Fishing grounds

The fishing grounds are represented by rocky and sand-rocky bottoms located between 0.1 and 2 nm off the Conero Promontory and by a sand-muddy area placed about 5 km at north of Ancona characterised by the presence of sealines connecting off-shore platforms with the coast (Figure 10).

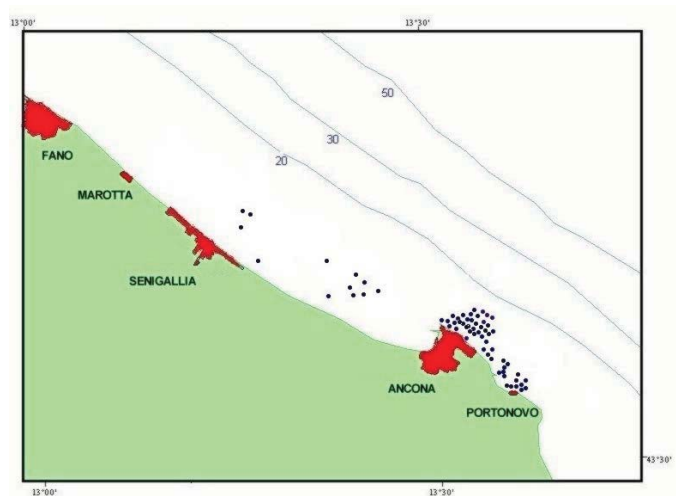


Figure 10. Fishing grounds of the Ancona and Portonovo artisanal vessels operating with gillnets.

4.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average of 12 hours at sea. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and follows a seasonal pattern characterised by the lowest values in summer.

4.5 Data on catches

4.5.1 Landings and LPUE

Over the period 1999-2002 seasonal landings ranged from 0.01 t (summer '00) to 17 t (fall '01; Figure 11), with a direct relationship with the total amount of employed nets. The average seasonal landing per year showed some fluctuations, reaching a peak (6 t) in 2001 and ranging from 2 to 4 t in the other years. The average seasonal LPUE per year went from 6 to 16 kg/5000m/h.

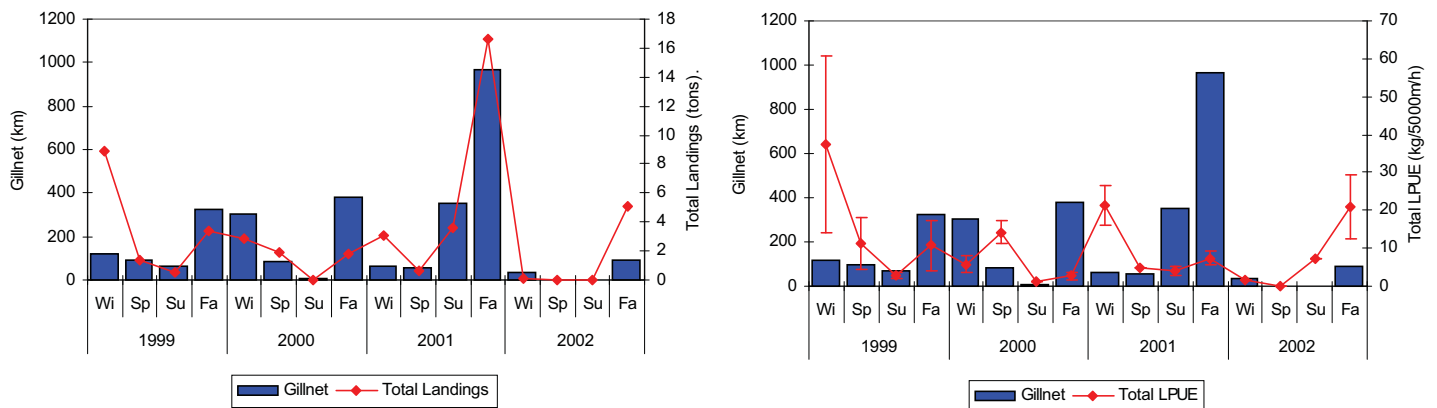


Figure 11. Seasonal trend of total catches and LPUE of the vessels using gillnets.

The weight percentage of target species pool on the total landings greatly varied among seasons, going from 0 to 100% (Figure 12). Anyway, in most of cases their contribution was similar or higher than that of the accessory species and ranged from 47% to 98%.

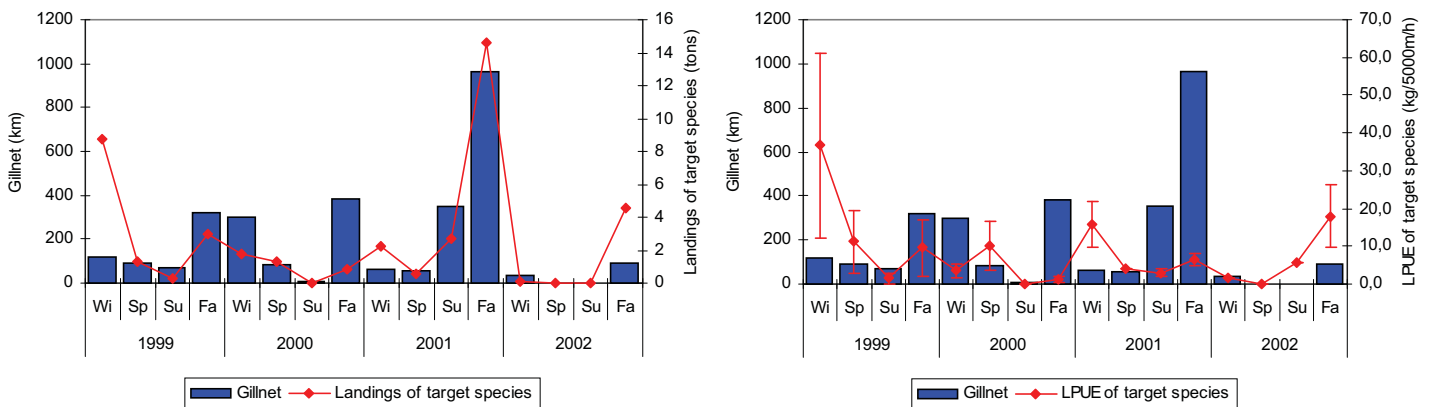


Figure 12. Total landings and LPUE seasonal trend of the pool of target species caught with gillnets.

Data on landing composition show that these gillnets are used for catching five target species: *L. ramada*, *L. mormyrus*, *D. labrax*, *S. umbra* e *U. cirrosa*. *L. ramada* and *L. mormyrus* were the main target species in landings, while *Diplodus annularis*, *Liza saliens*, *T. lucerna* and *Seriola dumerili* dominated the landed by-catch.

4.6 Selectivity

Selectivity of this type of nets towards *L. mormyrus* was estimated through Sechin method (Sechin, 1969) considering 45 mm and 70 mm mesh sizes (stretched; Fabi and De Ranieri, 1998; Fabi et al., 2002b).

With the 45 mm mesh optimal catch size was 16.5 cm TL, corresponding to a selection range ($p \geq 5\%$) of 13.6-19.8 cm TL (Table 6). Some specimens exceeded this range as a consequence of the tangled and/or pocket effects which were negligible on the left side (small individuals) and greater on the right one (greater individuals).

With the 70 mm mesh optimal catch size was 26.3 cm TL, corresponding to a selection range ($p \geq 5\%$) of 22.7-30.3 cm TL. The portion of specimens falling out of the selection range was greater than in the 45 mm mesh and more consistent for the small individuals.

Table 6. Selection parameters obtained for *L. mormyrus* through the Sechin method.

Mesh size (mm)	Optimal catch size(cm)	Size range (cm) $p \geq 5\%$		% individuals		
				$p < 5\%$	$p \geq 5\%$	$p \leq 5\%$
45	16.5	13.6	19.8	0.5	92.1	7.4
70	26.3	22.7	30.3	14.3	77.1	8.6

5. Trammel net

5.1 Fishing equipment

In the central northern Adriatic Sea trammel net underwent several modifications in the last few years, mainly consisting in the use of thinner filaments. At present, the most commonly used net is made of a polyamide twisted filament, the outer panels and the inner one are 2 and 3 m high respectively and the mesh size is 340 mm (stretched) in the formers and 70 mm in the latter (Table 7). Length of nets ranges from 500 to 1,000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning.

Table 7. Technical characteristics of trammel net.

INNER PANEL						FLOATS Total No.	HEADLINE		LEADLINE (g/m)
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Filament diameter (mm)	Hanging ratio		Diam. (mm)	Material	
3.0	50	2000	70	210/1	0.36	57	5	PA	100
OUTER PANELS									
Height (m)	Length (m)	No. of meshes / Length	Stretched mesh size (mm)	Filament diameter (mm)	Hanging ratio				
2.0	50	334	340	210/6	0.44				

5.2 Fleets concerned

Trammel nets are used only by fishers who operate in the area between Ancona and Portonovo to catch striped sea breams in winter and cuttlefishes in spring. Fleet percentage using this net strongly varies among seasons, with the highest values in winter-spring and the lowest ones in summer, when no vessel adopts this gear (Figure 13).

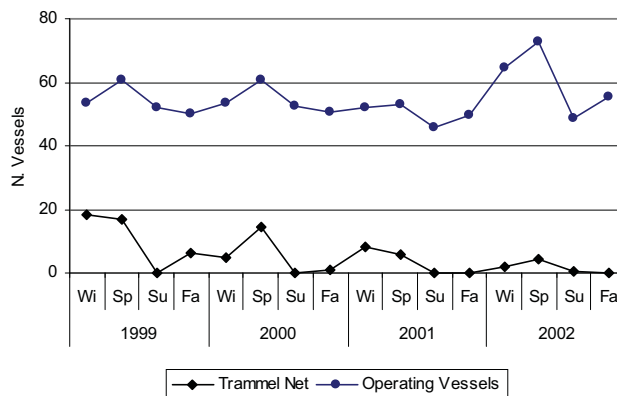


Figure 13. Seasonal trend of vessels using trammel nets. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

The number of vessels yearly devoted to this fishery gradually decreased over the four years, likely due to the scarce abundance of the two target species at sea, as shown in the following chapters.

5.3 Fishing grounds

The fishing areas for striped seabream (*L. mormyrus*) are represented by sand-rocky bottoms between 1.5 and 3 nm from the Ancona harbour and between few hundreds of meters and 1.5 nm from the coast in the Portonovo bay. In spring, when *S. officinalis* migrates inshore for reproduction, the local fishers utilise trammel nets in the same areas, but exploit also shallower waters (5-15 m; Figure 14).

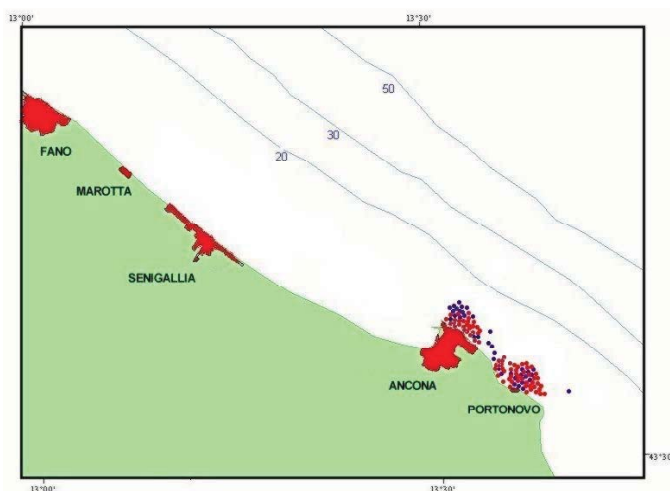


Figure 14. Fishing grounds of the artisanal vessels operating with trammel nets. Grey spots: *S. officinalis*; black spots: *L. mormyrus*.

5.4 Fishing time over the year

Nets are usually sunk at dusk and pulled in at dawn for an average of 12 hours at sea in the catch of *L. mormyrus*, while they are left at sea for 24 hours in the case of *S. officinalis*. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and from fall to spring, although the fishing season was shorter in the last two years than in 1999-2000 (Figure 13).

5.5 Data on catches

5.5.1 Landings and LPUE

Over the years 1999-2002 seasonal landings ranged from 0.1 t (winter '02) to 20 t (winter '99), showing a direct relationship with the total amount of employed nets (Figure 15). The average seasonal landing per year amounted to 10 t in 1999 and decreased afterwards. Also the average seasonal LPUE per year gradually decreased, reaching in 2002 a value corresponding to 50% of that recorded in 1999.

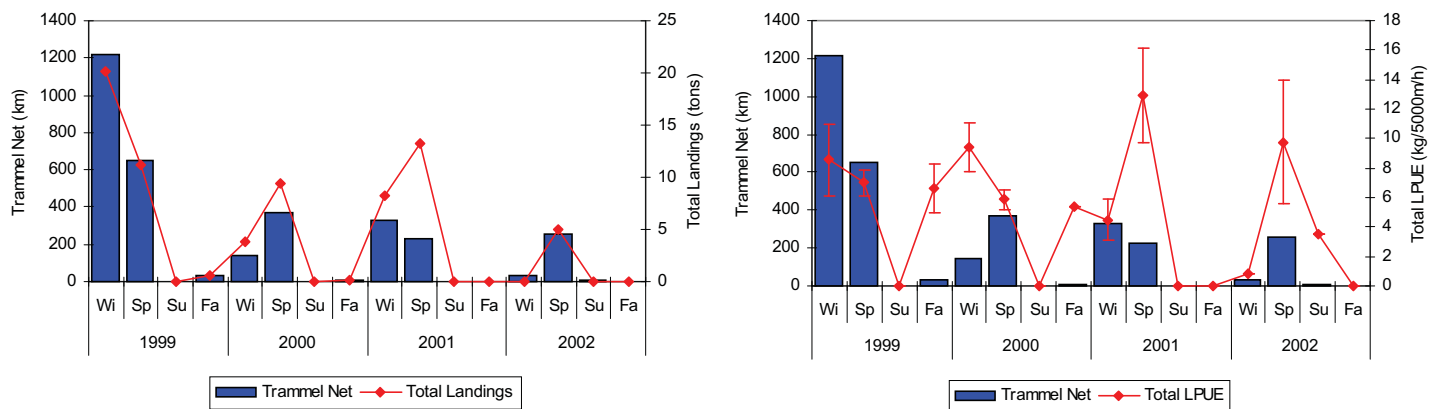


Figure 15. Seasonal trend of the total catches and LPUE of the vessels using the trammel nets.

Figure 16 and 17 clearly show the different seasonal occurrence of the two target species in landings: *L. mormyrus* reaches the highest values in winter and *S. officinalis* in spring.

Lithognathus mormyrus accounted from about 70% of the total landing in weight in winter 1999, afterwards its contribution drastically fell down until to become nil in 2002 (Figure 16).

A similar trend was also recorded for LPUEs of this species.

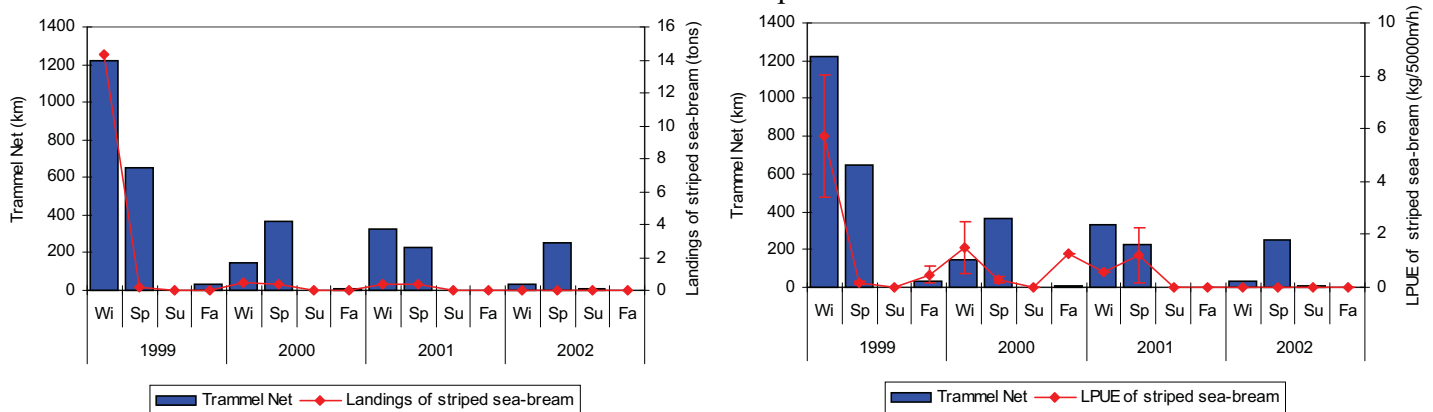


Figure 16. Seasonal trend of total landings and LPUE of *L. mormyrus*.

In spring, when *S. officinalis* represents the main target species for the trammel net fishery, the seasonal landings of this cephalopod ranged from 3 to 12 t, corresponding from 60% to 90% of total landings obtained with this type of net. In the remaining seasons the percentage contribution of cuttlefish to the total landings was generally less than 4%.

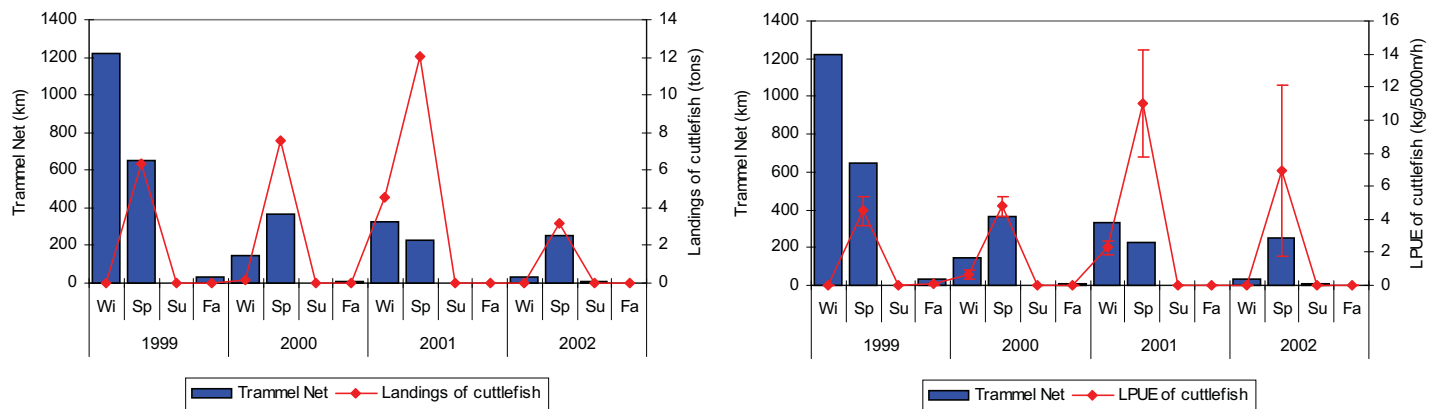


Figure 17. Seasonal trend of total landings and LPUE of *S. officinalis*.

The average seasonal landing per year increased until 2001 and drastically dropped down in the last year, independently from the reduction of the fishing effort (Figure 17). Conversely, the LPUEs increased in the last two years, even though they were characterised by a higher variability.

By-catch was dominated by *L. ramada* in winter-spring, *S. mantis* in spring, *D. annularis* and *Eledone cirrhosa* in fall. This last species was represented by adults having mature gonads.

5.5.2 Discarding

Discard of commercial species is low in this fishery, amounting to about 3% of the total catch (Figure 18). It mainly consists of damaged specimens of *L. mormyrus* in winter and of small, no valuable individuals of *T. lucerna* in spring.

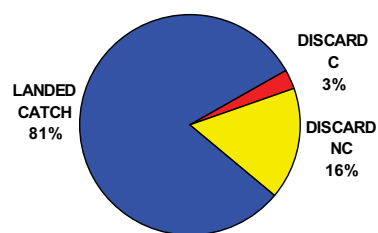


Figure 18. Composition of the total catches obtained with trammel nets (1999-2000).

Discard of non-commercial species appears more consistent, representing about 16% of the total catch and is dominated by *Maja crispata* and *Liocarcinus vernalis*.

5.5.3 Demography and biological data of striped seabream catches

The trammel net total catch of striped seabream obtained with the 70 mm mesh size consisted of specimens greater than the size at first sexual maturity reported for this species (14.0 cm TL; Fischer *et al.*, 1981). Most of them belonged to age classes 3 and 4, as shown in Table 8 based on the Von Bertalanffy parameters estimated by Kraljevic *et al.* (1995).

Table 8. Length/age percentage composition of the commercial catches of *L. mormyrus*.

Mesh size	Length / Age class													
	17-21 / 2		22-25 / 3		26-28 / 4		29-30 / 5		31 / 6		32 / 7		33 / 8	
70 mm	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%
	2.6	5.6	62.4	68.3	26.3	21.1	5.4	3.4	0.6	0.3	1.3	0.7	1.4	0.6

The caught individuals fell in the size range 17.0–33.0 cm TL and had an average length of 24.7 cm. The size-frequency distribution showed three modes, but 94% of specimens had a mode at 24.0 cm TL and was included between 20.0 and 30.0 cm (Figure 19).

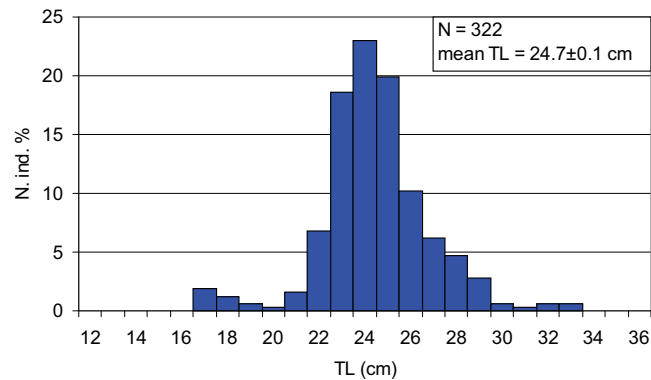


Figure 19. Demographic structure of *L. mormyrus* catches obtained with 70 mm mesh (1999-2000).

Analysis of gonads of 310 specimens (88 males, 177 females and 45 intersex) showed a significant dominance of females in winter (Table 9). Ratio between sexually mature and immature individuals was 3:1 for both sexes.

Table 9. Number of *L. mormyrus* males and females recorded in the winter catches of vessels using trammel nets (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	N. INTERSEX	TOTAL	SEX RATIO M/F	TEST χ^2
88	177	45	310	0.49	0.000**

5.5.4 Demography and biological data of cuttlefish catches

The cuttlefish catches obtained with 70-mm mesh trammel nets fell in the size range 9.0–25.0 cm ML with an average length of 14.9 cm. Most of specimens had a mode at 14.0 cm ML and measured between 9.0 and 22.0 cm (Figure 20).

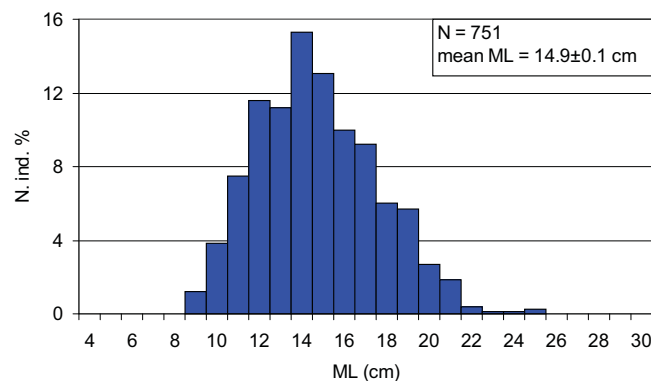


Figure 20. Demographic structure of *S. officinalis* catches obtained with 70 mm mesh (1999-2000).

Analysis of gonads carried out on 751 cuttlefishes (488 males and 263 females) showed a significant dominance of males (Table 10). Ratio between sexually mature and immature individuals was 3:1 for both sexes.

Table 10. Number of *S. officinalis* males and females recorded in catches of vessels using 70-mm trammel nets (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	TOTAL	SEX RATIO M/F	TEST χ^2
488	263	751	1.86	0.000**

5.6 Selectivity

Selectivity of this net towards *L. mormyrus* was estimated through Sechin method (Sechin, 1969) considering 45-mm and 70-mm mesh sizes (stretched; Fabi and De Ranieri 1998; Fabi et al., 2002b). The 45-mm mesh gave an optimal catch size of 16.5 cm TL and a selection range ($p \geq 5\%$) of 13.6-19.8 cm TL (Table 11). About 29% of specimens exceeded this range because of the tangled and/or pocket effects, which were negligible for the small individuals and more consistent for the greatest ones. With the 70-mm mesh optimal catch size was 26.3 cm TL, corresponding to a selection range ($p \geq 5\%$) of 22.7-30.3 cm TL. The specimens exceeding the selection range amounted to 33% of the catch, with a similar repartition on the left and right side of the interval.

Table 11. Selection parameters obtained for *L. mormyrus* through the Sechin method.

Mesh size (mm)	Optimal catch size(cm)	Size range (cm) $p \geq 5\%$		% individuals		
				$p < 5\%$	$p \geq 5\%$	$p \leq 5\%$
45	16.5	13.6	19.8	0.7	70.9	28.4
70	26.3	22.7	30.3	17.9	66.7	15.4

6. Basket traps for *Nassarius mutabilis*

Basket trap fishery is practised exclusively in the central and northern Adriatic Sea for catching changeable nassa (*N. mutabilis*). In the investigated area this activity is regulated by Ancona Port Authority, who establishes yearly duration of fishing season and TAC for each vessel.

6.1 Fishing equipment

Basket traps are frustum of cone shaped and consist of an iron frame whose basis and lateral surface are covered by a polyamide twisted filament net having a stretched mesh size of 18 mm. These gears are bounded at 10 m of distance each other to a rope anchored on the seabed and are baited with dead fish.

6.2 Fleets concerned

This fishery is practised by a good portion of vessels operating in the whole area. The fleet percentage varies among seasons, with a gradual decrease from winter to summer, when this fishery is usually forbidden and an increase in fall (Figure 21).

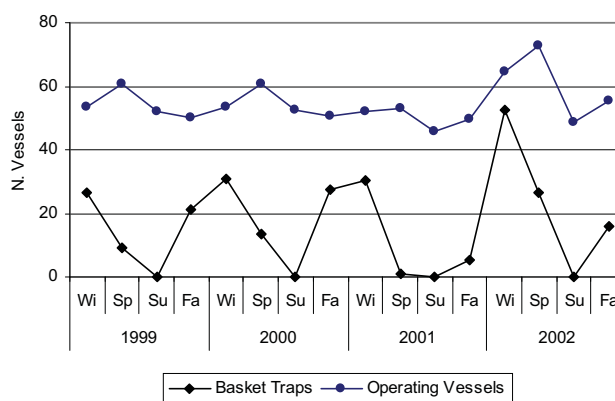


Figure 21. Seasonal trend of vessels using basket traps for *N. mutabilis*. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

6.3 Fishing grounds

The fishing grounds are represented by sand-muddy and rock-muddy bottoms located between 0.5 and 3 nm offshore (Figure 22).

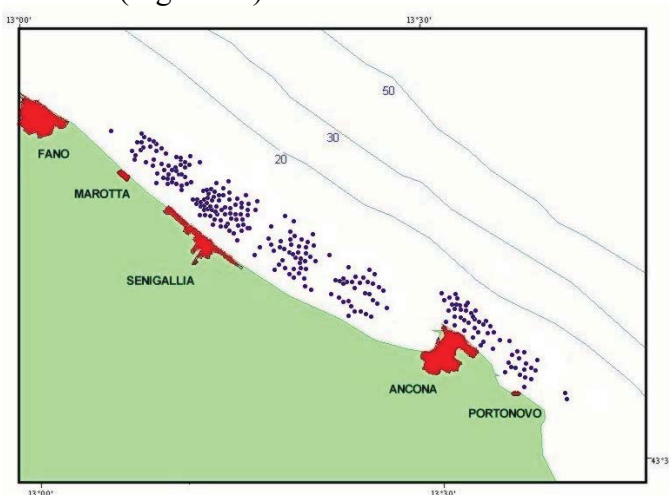


Figure 22. Fishing grounds of the artisanal vessels using basket traps for *N. mutabilis*.

6.4 Fishing time over the year

The fishing season commonly extends from fall to late spring. The gears are lowered into the sea at the beginning of this period and definitively recovered at its end. Fishing operations, consisting of emptying, baiting and control of gears, take place at 24-48 hour intervals, over all the week and show a seasonal trend characterised by a gradual increase from fall to spring.

6.5 Data on catches

6.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 4 to 340 t (Figure 23). In each year, seasonal landings showed a direct relationship with the total amount of employed gears, with an

increase from fall to winter and a decrease in spring. In winter, when the highest fishing capacity is applied, they gradually increased over the years. Total annual landings ranged from 194 t (1999) and 561 t (2002). The average seasonal LPUE remained rather constant on 4-8 kg/5000m/h.

The target species always made up almost entirely the total landing (Figure 24).

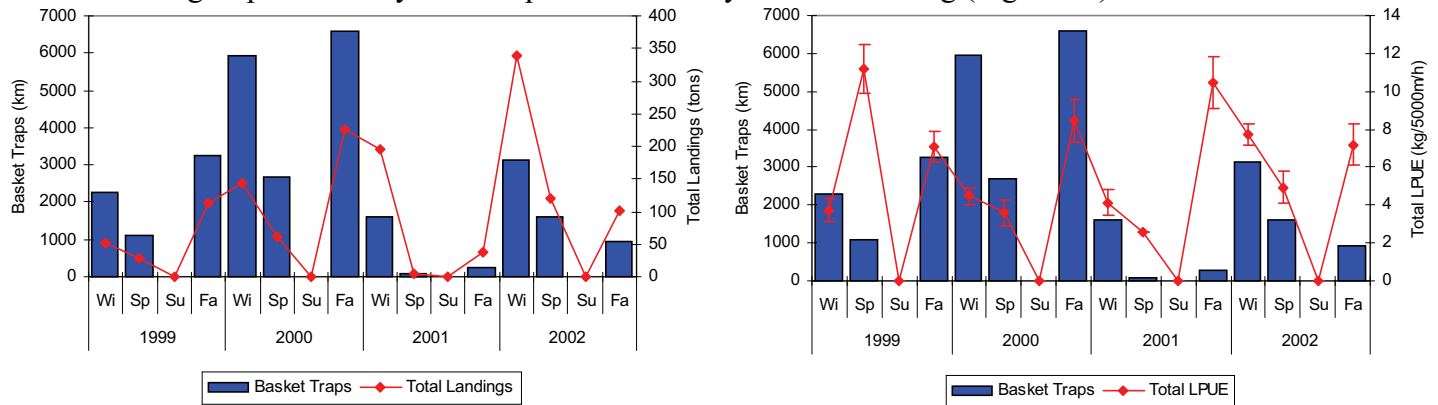


Figure 23. Seasonal trend of total catches and LPUE of the vessels using basket traps for *N. mutabilis*.

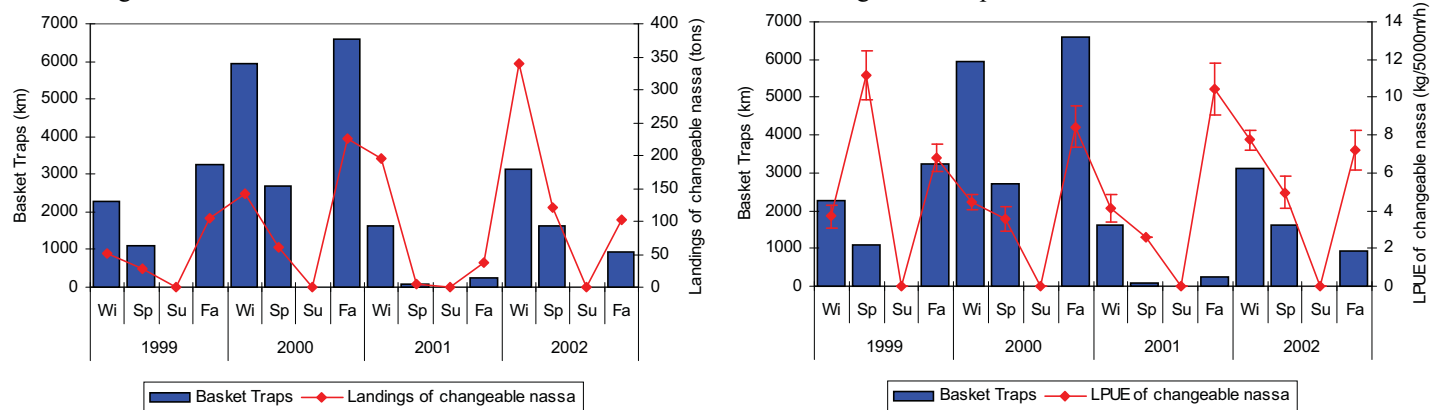


Figure 24. Total landings and LPUE seasonal trend of *N. mutabilis*.

The kept by-catch was dominated by *Gobius niger* and *Naticarius stercumuscarum*. Sometimes it also includes small amounts of *Bolinus brandaris*.

6.5.2 Discarding

Data on discard from direct observations on board are not available. Anyway, it has to be evidenced that total catches also include great amounts of *Nassarius reticulatus*, a gastropod having the same habitat and feeding behaviour of *N. mutabilis*. As this species has no commercial value, it is commonly destroyed or rejected at sea alive.

7. Traps for cuttlefish

7.1 Fishing equipment

Two types of traps are used in the area to catch cuttlefishes: fyke nets and pots. The formers

consist of plastic rings (5-6) sustaining an external polyamide twisted filament net and internal frustum of cone shaped openings made of the same net. Pots are parallelepiped shaped and consists of an iron frame covered by polyamide twisted filament net; each longer side is provided with an opening permitting the cuttlefishes to enter but not to go out. Fishermen put inside these gears either laurel branches or plastic strips to provide a substrate for cuttlefish egg attachment. Both fyke nets and pots are bounded at about 10 m from each other to a rope anchored to the seabed.

7.2 Fleets concerned

This fishery is practised especially in the northern part of the area where the sea bottom is more suitable. The fleet percentage devoted to it showed some fluctuations among the years (Figure 25).

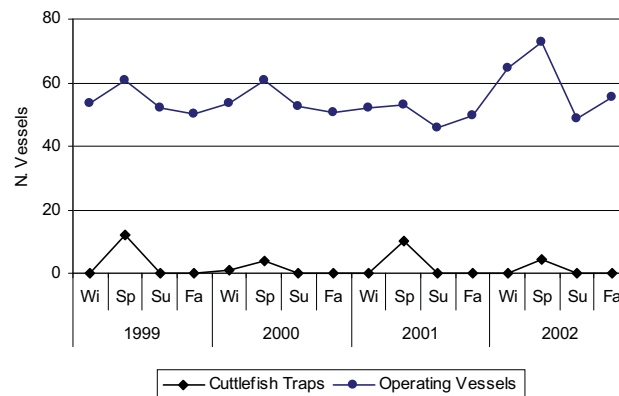


Figure 25. Seasonal trend of vessels using traps for cuttlefish. The total number of operating vessels is also reported for each season. Wi = winter; Sp = spring; Su = summer; Fa = fall.

7.3 Fishing grounds

Traps are mainly employed on sandy and muddy bottoms located at north of Ancona, between 1 and 3 nm offshore (Figure 26).

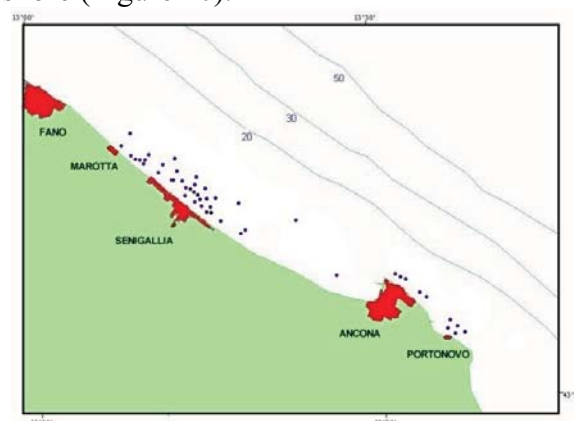


Figure 26. Fishing grounds of the artisanal vessels using traps for cuttlefish.

7.4 Fishing time over the year

The fishing season commonly extends from late winter to late spring. The gears are placed at

sea at the beginning of this period and definitively recovered at its end. Fishing operations, consisting of emptying, baiting and control of gears, take place at 24-48 hour intervals from Monday to Saturday, and show a seasonal trend characterised by an increase from winter to spring.

7.5 Data on catches

7.5.1 Landings and LPUE

In 1999-2002 seasonal landings ranged from 0.2 to 45 t (Figure 27), showing a direct relationship with the total amount of employed gears and great fluctuations among the years. A similar trend was also observed for LPUEs, which ranged between 0.7 kg/5000m/h and 4.5 kg/5000m/h. The target species always made up almost totality of landings (Figure 28).

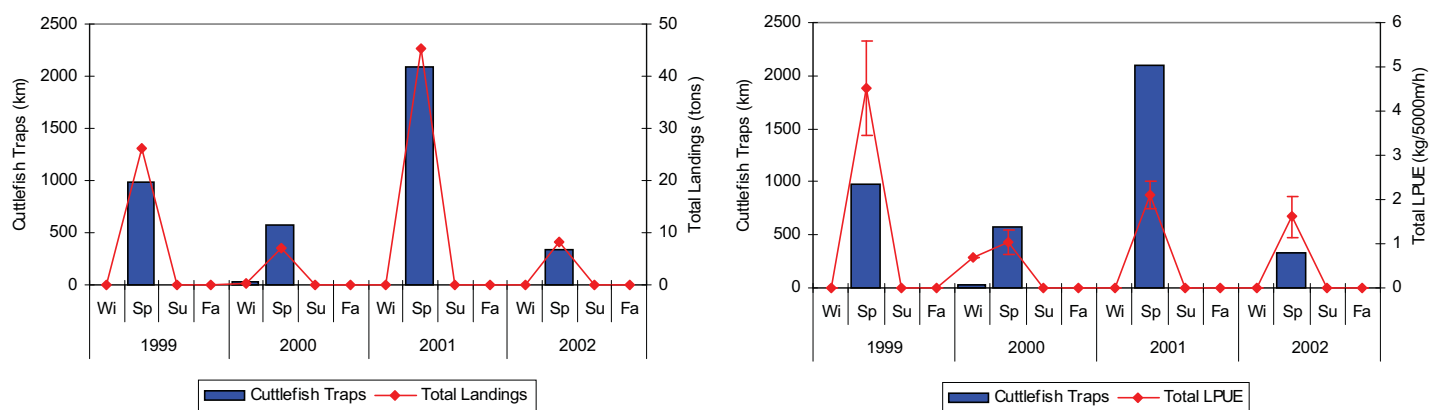


Figure 27. Seasonal trend of the total catches and LPUE of the vessels using traps for cuttlefish.

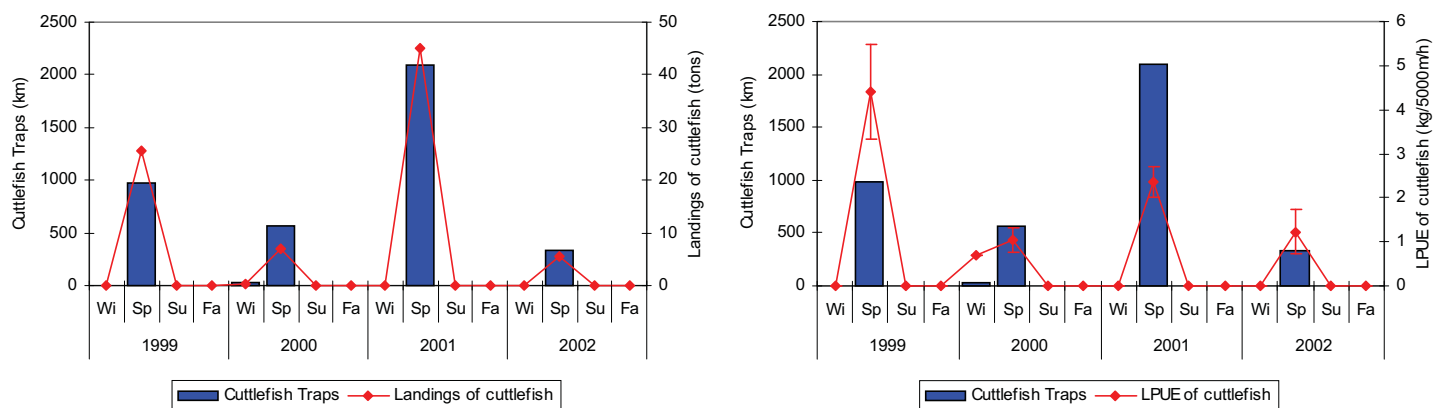


Figure 28. Seasonal trend of *S. officinalis* total landings and LPUE.

Landed by-catch was occasionally represented by *Conger conger*, *D. annularis*, *S. umbra*, *L. mormyrus* and *Liza* spp.

7.5.2 Discarding

Discard of commercial species is very scarce for this fishery, representing 3% in weight of the total catches (Figure 29). The most relevant species of this fraction are *Gobius niger* and *D. annularis*. Discard of non-commercial species amounts to about 6% of the total catch and mainly consists of *L. vernalis* and *N. reticulatus*.

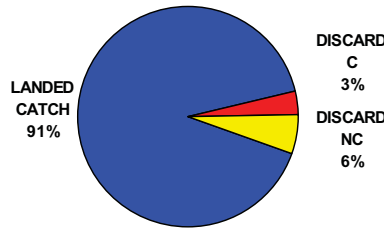


Figure 29. Composition of the total catches obtained with the traps for cuttlefish (1999-2000).

7.5.3 Demography and biological data of cuttlefish catches

Cuttlefish catches obtained with both types of traps fell in the size range 8.0–23.0 cm ML with an average mantle length of 13.8 cm (Figure 30).

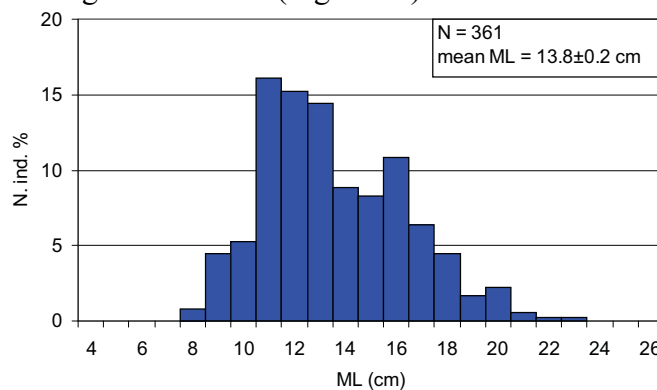


Figure 30. Demographic structure of *S. officinalis* catches obtained with traps (1999-2000).

Analysis of gonads carried out on 358 specimens (188 males and 170 females) did not show any significant difference between the two sexes (Table 12). All males and 85% of females had ripening gonads according with the fact that this species come inshore for reproduction. A deeper analysis on catch composition of the two types of traps evidenced that pots and fyke nets catch cuttlefishes in 17.6% and 16.1% of the possible cases respectively (Table 13; (Fabi and Sartor, 2001; Scarcella *et al.*, 2002). In 60% of these cases catches consist either of one specimen, male or female (sex ratio of 1:0 or 0:1), or of a couple of individuals (1:1).

Table 12. Number of *S. officinalis* males and females recorded in catches of vessels using traps (1999-2000). ** = highly significant.

N. MALES	N. FEMALES	TOTAL	SEX RATIO M/F	TEST χ^2
188	170	358	1.11	0.341

Table 13. Frequency of traps according to the sex composition of each trap.

	Total number of traps	FREQUENCY OF TRAPS BY SEX COMPOSITION (MALES:FEMALES)																		
		0:0	5:0	4:0	3:0	2:0	1:0	5:1	4:1	3:1	2:1	1:1	0:1	0:2	1:2	2:2	2:3	2:4	3:2	1:3
POTS	900	742	3	1	5	7	23	2	1	3	17	40	43	2	2	6	1	1	1	0
FYKE NETS	898	753	0	0	3	11	41	1	0	0	9	21	44	5	5	3	0	0	1	1

Further analysis carried out on the catches made of two or three specimens suggested, for males and only in the pots, a possible sexual attraction due to the occurrence of a female into the gear. On the contrary, the entry of females into the traps seems casual for pots, while in the case of fyke nets they show an attraction due to the presence of another female trapped inside

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Interactions between rapido trawling and small-scale fishery for common sole and cuttlefish in the central-northern Adriatic Sea

Gianna Fabi* and Fabio Grati*

Abstract

The paper analyses the interactions between rapido trawling and small scale fishery targeting common sole (*Solea vulgaris*) and cuttlefish (*Sepia officinalis*) with trammel net and traps in the central-northern Adriatic Sea (Ancona Maritime Department, Italy).

Keywords: artisanal fishing; fishing vessels; entangling nets; trap nets; trawling; sole fisheries; cephalopod fisheries; landing statistics; size distribution; *Solea vulgaris*; *Sepia officinalis*; MED, Adriatic Sea; MED, Italy

1. Introduction

The present paper deals on the interactions between rapido trawling and small-scale fishery targeting common sole with gillnets and cuttlefish with trammel net and traps in the Ancona Maritime Department, which is representative of several Adriatic departments included in the FAO GFCM GSA 17 at south of Po River. Data come from investigations carried out inside research projects funded by either the EC and the Italian Government (Fabi and Grati, 2002; Fabi *et al.*, 2002; Fabi and Sartor, 2002).

At present rapido trawl fishery is largely spread along the Italian coast of northern and central Adriatic Sea, while only a few vessels fish with this gear along the western Italian coasts. In the Adriatic area it is mainly used to exploit common sole (*Solea vulgaris*) and, in the northerner part of the basin (North of Po river), scallops (*Aequipecten opercularis*, *Chlamys glabra* and *Pecten jacobaeus*). In this paper only the rapido trawl fishery for common sole has been taken into account.

2. Description of fishing gears, fleets and fishing activity

2.1 Rapido trawl fishery

In the last twenty years capacity of the Adriatic rapido trawl fleets showed a tendency to increase both as number of vessels and engine power in the whole area. For example, the Ancona fleet, which is one of the most important for this type of fishery, doubled from 1984 to 2002. The vessel number increased from 8 to 12 in the period 1996-2002, and it has doubled again in 2003 (Figure 1). The vessels' overall length ranges from 25 m to 30 m, GRT between 95 and 155 and the engine power from 221 kW to 1,051 kW. Crew is composed of 5-6 people.

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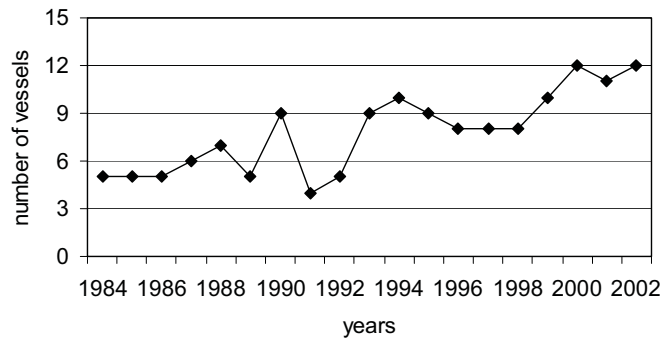


Figure 1. Ancona rapido trawl fleet: number of vessels from 1984 to 2002.

The rapido trawl resembles a toothed beam-trawl and is made of an iron frame provided with 3-5 skids and a toothed bar on its lower side (Figure 2). The teeth are fixed at 6-7 cm from each other and extend 0.5-1 cm under the skids. A wooden plank having an angle of about 30° to the ground is fitted to the front of the iron frame to act as a spoiler keeping the trawl in contact with the seabed. A nylon net bag is tied to the frame and its lower side is protected by a reinforced rubber diamond-mesh matting. Codend mesh size is generally larger than the minimum legal size for trawling (40 mm) and ranges from 48 to 52 mm (stretched). The mouth opening is 4.0 m.

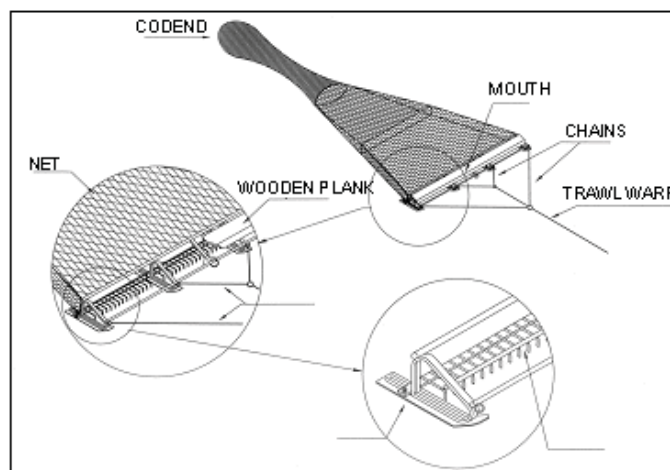


Figure 2. Scheme of a rapido trawl for soles.

Technical changes have been made to the gear over the time, in order to increase its efficiency, to tow it at a higher speed and to make it able to enter more deeply into the bottom sediment. These changes, concerning for example the increment of mouth width and of total weight, allowed to increase the swept area and to fish in formerly unexploited fishing grounds.

Each vessel tows 4 rapido trawls during each haul at a 7-knot speed. Hauls last about one hour. In the past rapido trawling was mainly carried out during night, alternated with bottom otter trawl by day. Since the beginning of the 1990s, it is used night and day without stopping for about 24 h and a total of 15-18 hauls per fishing day. Ancona vessels fish for four days a week (from Monday to Thursday). For the big size of these vessels and the great stability given by the gears when towed, this fishing activity is less affected by bad weather conditions

than otter and pelagic trawling.

2.2 Small-scale fisheries

The small-scale fishing fleets operating in the Adriatic Sea between Senigallia and the Conero Promontory (about 35 km of shoreline) can be considered as representative of the fleets existing along the coast of the Marche region (from San Benedetto del Tronto to Pesaro). They consist of 77 vessels, both fibreglass planing vessels and wooden displacing boats, having an average GRT of about 3 t, LOA of 6-12 m, average engine power of about 40 kW and a crew of 1-2 people. Most of these vessels moor at three landing places (Senigallia, Ancona and Portonovo), while the remaining ones are dislocated along the coast. These fleets use different gears (Figure 3) over the year: gillnet for common sole (*Solea vulgaris*), gillnet for other highly valuable species (i.e. *Sciaena umbra*, *Umbrina cirrosa* and *Dicentrarchus labrax*, sparids), trammel net for *Lithognathus mormyrus* and *Sepia officinalis*, traps (pots and fyke nets) for the last species and basket traps for changeable nassa (*Nassarius mutabilis*).

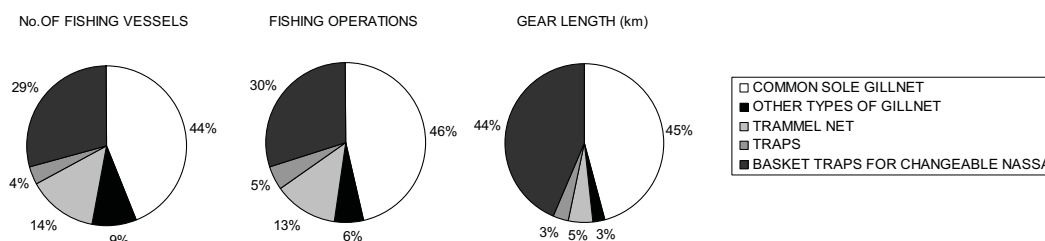


Figure 3. Small-scale fleets: percentage importance of the different fishing gears used in the area between Senigallia and Portonovo.

The fishery of common sole with gillnets represents one of the most important activity. The fleet percentage involved varies among seasons, with the lowest values in winter and the highest ones in summer (Figure 4), when almost all the operating vessels of the area target the common sole with this net. The vessel number yearly devoted to this fishery and the extension of the period of fishing activity increased in the last four years.

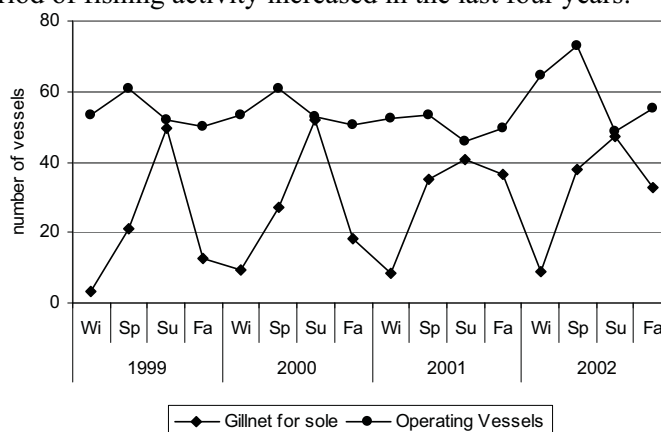


Figure 4. Small-scale fleets: seasonal number of vessels utilising gillnets for sole (diamond markers) between Senigallia and Portonovo (1999-2002). The total number of operating vessels is also reported (black dots).

The gillnet is made of a polyamide monofilament and is characterised by a low height (1.6-2.5 m) and a very low floating buoyancy which allows the gear to partially lay down on the seabed so favouring the capture of benthic fishes (Figure 5). The mesh size varies between 64 and 68 mm (stretched) and length of nets ranges from 1000 to 5000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning.

The nets are usually sunk at dusk and pulled in at dawn for an average permanence of 12 hours at sea. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions, and all the year round, following a seasonal pattern similar to that of the involved vessels, with the highest values in summer and the lowest ones in winter.

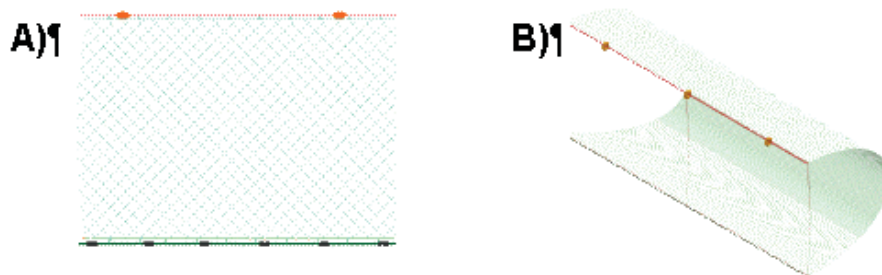


Figure 5. Small-scale fleets: A) scheme of the sole gillnet used in the central-northern Adriatic Sea; B) position assumed by the gillnet to the bottom.

Fishery of *S. officinalis* is strongly seasonal. In fact, as shown by the trend of the number of involved vessels, it is carried out from late winter to late spring, when this species comes inshore for reproduction (Figure 6). The vessel number carrying out this activity and the extension of fishing season decreased over the last four years. The gears used are trammel net and traps, the latter including fyke nets and pots.

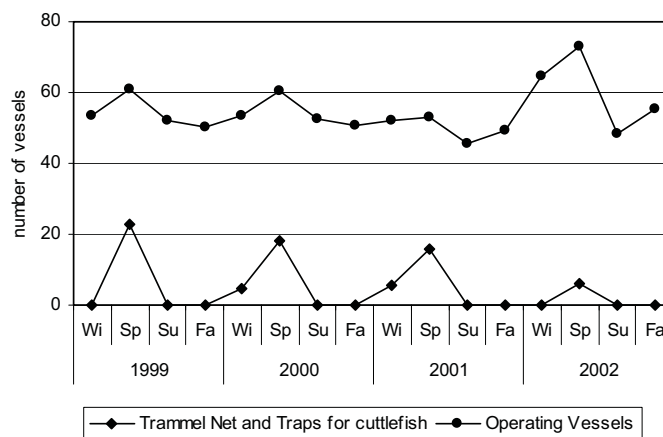


Figure 6. Small-scale fleets: seasonal number of vessels using trammel net and traps for cuttlefish (black rhombs) in the area between Senigallia and Portonovo (1999-2002). The total number of operating vessels is also reported (black dots).

Trammel net (Figure 7A) is made of a polyamide twisted filament, outer and inner panels are 2 and 3 m high respectively and the mesh size is 340 mm (stretched) in the former and 70

mm in the latter. Length of nets ranges from 500 to 1000 m, mainly depending on vessel size and availability of man-power at land for the gear cleaning. The nets are usually sunk at dawn and pulled in at dawn of the subsequent day, for an average of 24 hours. The fishing activity is carried out from Monday to Saturday, depending on the sea conditions.

Fyke nets consist of plastic rings (5-6) sustaining an external polyamide twisted filament net and internal, funnel-shaped openings made of the same net (Figure 7B). They are not baited.

Pots are parallelepiped shaped and consist of an iron frame covered by a polyamide twisted filament net; each longer side is provided with an opening permitting cuttlefishes to enter but not to go out (Figure 7C). Fishermen put inside these gears either laurel branches or plastic strips to provide a suitable substrate for the cuttlefish egg attachment.



Figure 7. A) Trammel net; B) fyke net; C) pot.

Both fyke nets and pots are bounded at about 10 m from each other to a rope anchored on the seabed. Fishermen commonly use 200 gears (2000 m of length).

These gears are placed at sea at the beginning of the fishing season and definitively recovered at its end. Fishing operations, consisting in the emptying of gears and their baiting (only in the case of pots), take place at either one, two or three days intervals, depending on the abundance of the resource at sea and the market demand.

3. Interaction for *Solea vulgaris*

3.1 Fishing areas

The area exploited by Ancona rapido trawlers extends from Cattolica (North) to Porto S. Giorgio (South), between 3 and 18 nm offshore and from 13 m to 70 m bottom depth (Figure 8). The seabed is sand-muddy and completely trawlable, except for small zones occupied by offshore gas platforms and the respective sea-lines.

The sole gillnet is employed on the coastal sandy and muddy seabeds between 1 and 4 nm offshore. Therefore, there would be a small overlapping between the fishing areas of the two fisheries, but it has to be considered that the gillnets are set out of 3 nm offshore only during the biological stop (closed fishing season) of trawling, occurring usually in summer (August-September) in this area.

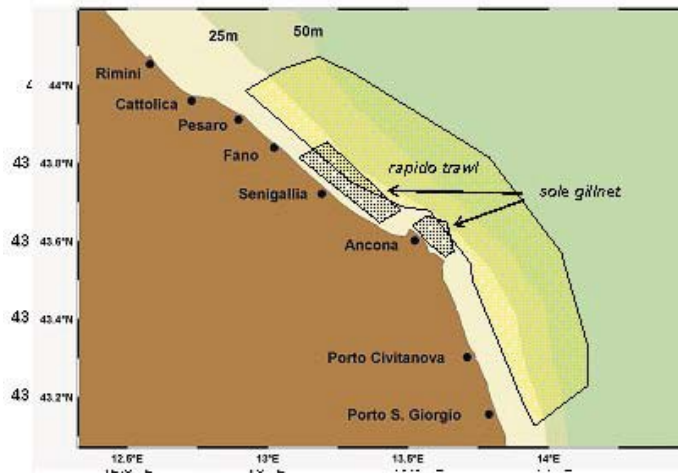


Figure 8. Fishing areas of Ancona rapido trawl fishery and of small-scale fleets of Ancona, Senigallia and Portonovo targeting *S. vulgaris* with gillnets.

3.2 Total landings

Landing data of Ancona rapido trawl fleet were collected over the period 1996-2002 using the daily auction documents of the Ancona market. Comparison of these data with recordings obtained directly at the landing site during periodical visits evidenced that 30-40% of soles are sold out of the official market. However, even though the official data have to be considered as underestimated, they can give a good idea of the trend of landings over the years. Total landings show a gradual increase, reaching in the last two years approximately 200 t, which correspond to about four times the total amounts landed in 1996-97 (Figure 9A). At the same time LPUEs gradually increased until reaching in 2001-02 values corresponding to about 3 times those recorded in 1996-97 (Figure 9B).

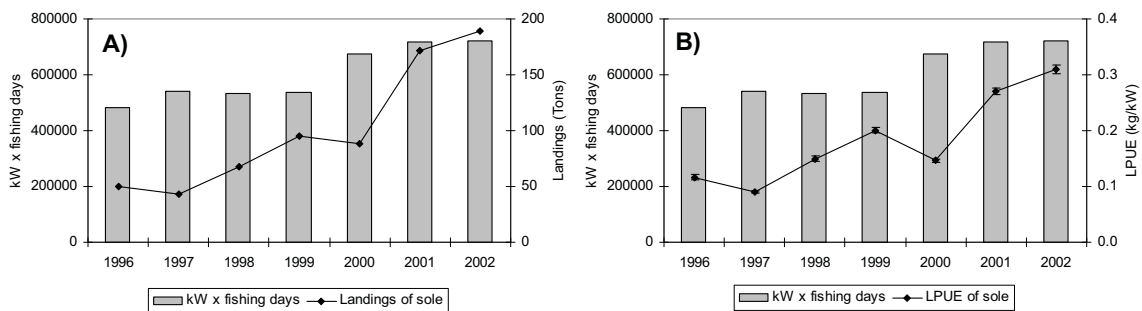


Figure 9. Ancona rapido trawl fleet: annual trend of fishing effort (kW x fishing days) and of *S. vulgaris* landings (A) and LPUEs (B).

Gillnet landing data were collected from 1999 to 2002 through weekly sampling at the main mooring sites of the area. These data were verified through periodical observations aboard of the professional fishing vessels during their normal fishing activity.

Figure 10 shows that the extension of fishing season and the increment of vessel number did not lead to an increase of the employed global fishing effort, because the fishing days remained practically constant over the years. Anyway, also in this case the sole annual landings gradually increased over the last four years reaching in 2002 a value corresponding to 2 times that recorded in 1999. At the same time LPUE remained practically constant.

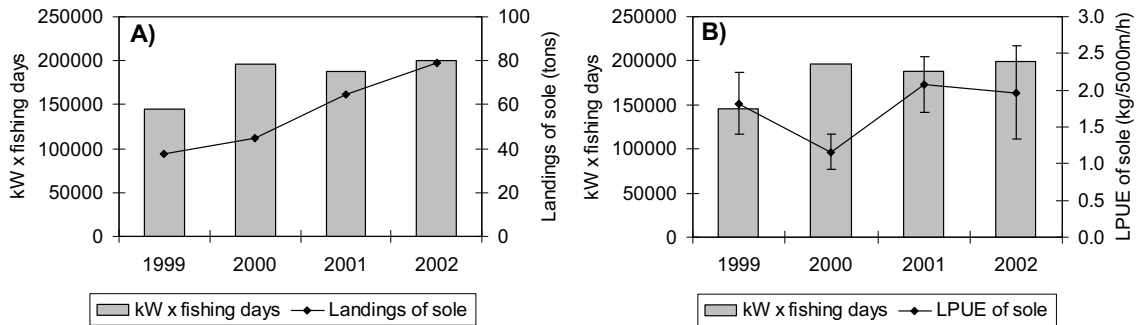


Figure 10. Small-scale fleets: annual trend of the fishing effort (kW x fishing days) applied by vessels using sole gillnets between Senigallia and Portonovo and of *S. vulgaris* landings (A) and LPUEs (B).

Comparison between the two fisheries shows that the annual landings of rapido trawlers were about two times those obtained by gill-netters.

3.3 Fishing yields

The fishing yields reached the highest values inside 6 nm offshore and gradually decreased going offshore, according to the behaviour of common sole, whose juveniles spend the first life months inside the lagoons of the northern Adriatic and in later summer go out from them and come down along the Italian coast (Figure 11). Then, as they growth, go away toward deeper waters.

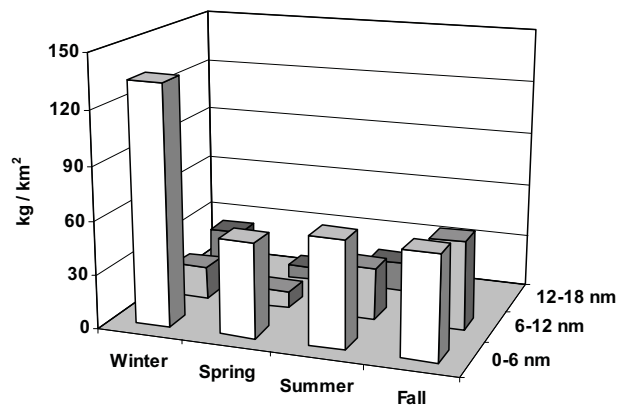


Figure 11. Rapido trawl fleet: seasonal fishing yields in weight of sole obtained at different distances from the shore.

3.4 Age composition

Most of total catch of the rapido trawlers consisted of common sole juveniles belonging to age classes 0 and 1, as shown by Table 1 realised on the basis of the Von Bertalanffy parameters estimated through the otolith reading method (Frogliola and Giannetti, 1986).

On the other hand, gillnet catches mainly included specimens belonging to the age classes 1 and 2, that were juveniles or individuals which had just reached the sexual maturity.

Table 1. Age class composition of the fishing yields in weight and number of individuals of *S. vulgaris* caught with rapido trawl and gillnet (fish ageing according to Frogliola and Giannetti, 1986).

Gear	Mesh size	Length (cm) / Age class											
		13-18 / 0		19-25 / 1		26-30 / 2		31-33 / 3		34-35 / 4		36 / 5	
		W%	N%	W%	N%	W%	N%	W%	N%	W%	N%	W%	N%
Rapido	48 mm	7.47	16.51	64.31	69.88	24.97	12.63	2.64	0.83	0.47	0.12	0.14	0.03
Gillnet	64 mm	1.73	3.45	89.56	92.07	8.71	4.48	-	-	-	-	-	-
Gillnet	68 mm	0.75	1.84	77.86	85.04	19.83	12.54	1.56	0.58	-	-	-	-

3.5 Length-frequency distributions in the catch

Common sole length-frequency distributions in rapido trawl catches clearly show a gradually higher occurrence of greater individuals going offshore. It is also evident the appearance in the inshore fall catches of juveniles belonging to the age class 0, which have a size range of 13-22 cm TL and a mode at 18 cm TL (Figure 12). These individuals continue to be caught in this area for about one year and at increasing distances from the coast in the subsequent years.

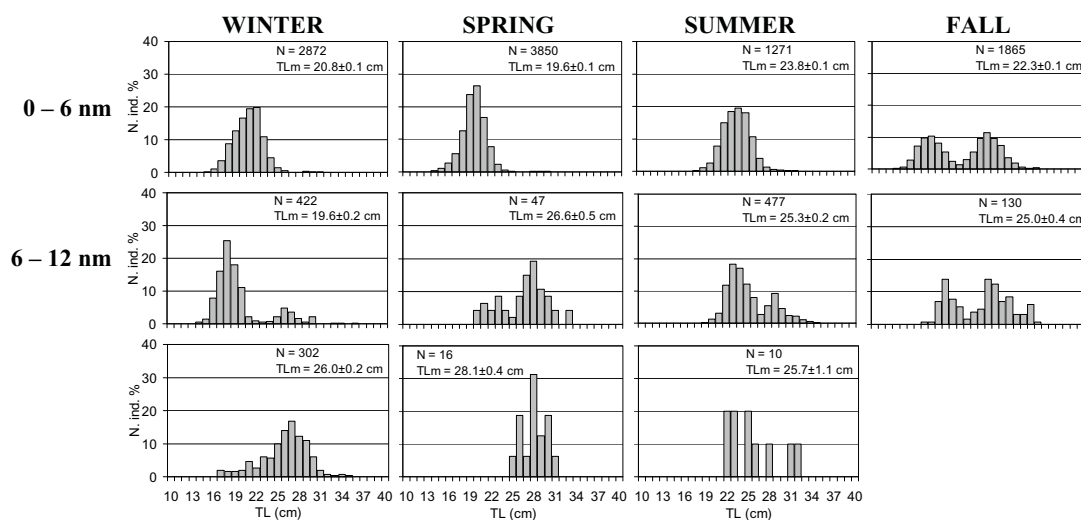


Figure 12. Ancona rapido trawl fleet: seasonal length-frequency distributions of *S. vulgaris* caught at different distances from the shore.

The length-frequency distributions from gillnet catches match with those of rapido trawlers in spring and summer, but in fall they do not include the youngest specimens, thank to the higher selectivity of the gears (Figure 13).

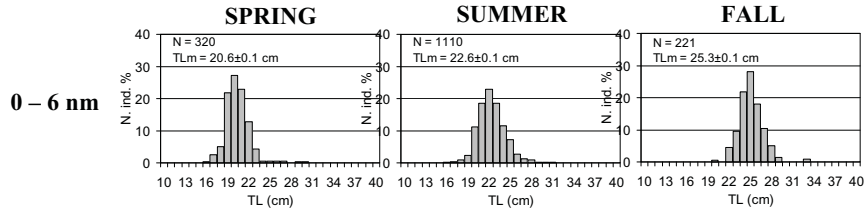


Figure 13. Small-scale fleets: seasonal length-frequency distributions of *S. vulgaris* caught with gillnets inside 6 nm offshore.

4. Interaction for *Sepia officinalis*

4.1 Fishing areas

No overlapping occurs between the fishing grounds exploited by rapido trawlers and artisanal fishermen for catching *S. officinalis* (Figure 14), mainly because the latter place their gears inside 3 nm offshore from the coast to avoid that they could be damaged by trawling (pelagic, otter and rapido trawling). Trammel net is exclusively used on the sand-rocky bottoms in front of Conero Promontory, while traps are mainly employed on the sandy and muddy bottoms at north of Ancona.

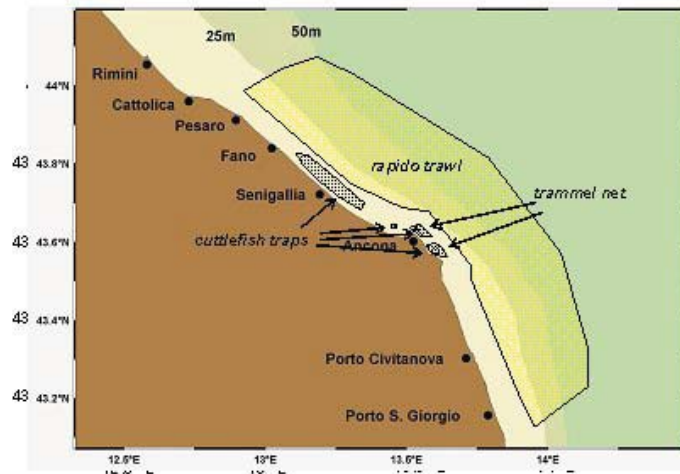


Figure 14. Fishing areas of Ancona rapido trawlers and of small-scale fleets targeting *S. officinalis* with traps and trammel net in the area between Senigallia and Portonovo.

4.2 Total landings

Total landings of cuttlefish obtained by Ancona rapido trawlers and by the small-scale fishers operating in the area between Senigallia and Portonovo were collected using the same methodologies employed for the common sole. Also in this case landing data of the rapido

trawl fleet have to be considered underestimated, even though the catch percentage of *S. officinalis* sold out of the market is smaller than for sole.

In the last six years total landings of cuttlefish ranged from 12 to 60 t and, in spite of the increased fishing effort, gradually decreased over the period showing only two picks, the former in 1997 and the latter in 2001 (Figure 15). The value recorded in 2002 was about 1/3 of that obtained in 1996.

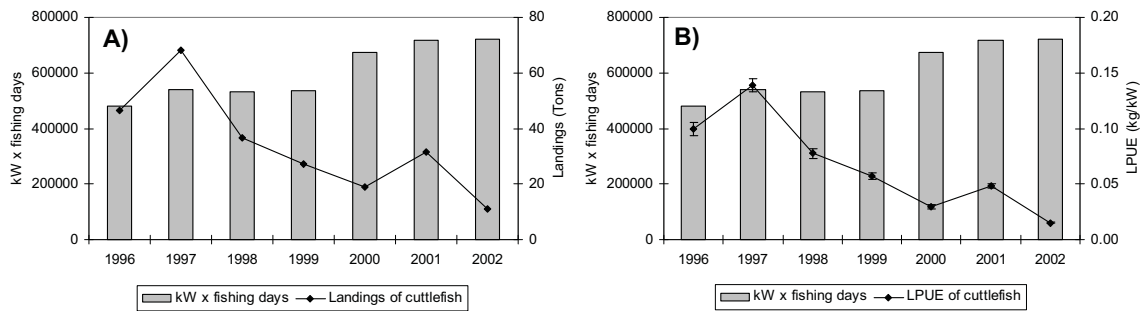


Figure 15. Ancona rapido trawl fleet: annual trend of fishing effort (kW x fishing days) and of *S. officinalis* landings (A) and LPUEs (B).

Landings of small-scale fleets followed the same pattern over the period 1999-2002, with a pick in 2001 and a drop in the subsequent year (Figure 16). Comparison between the two fisheries shows that the annual landings were similar except for 2001, when the set gear total landing was about twice that of rapido trawlers.

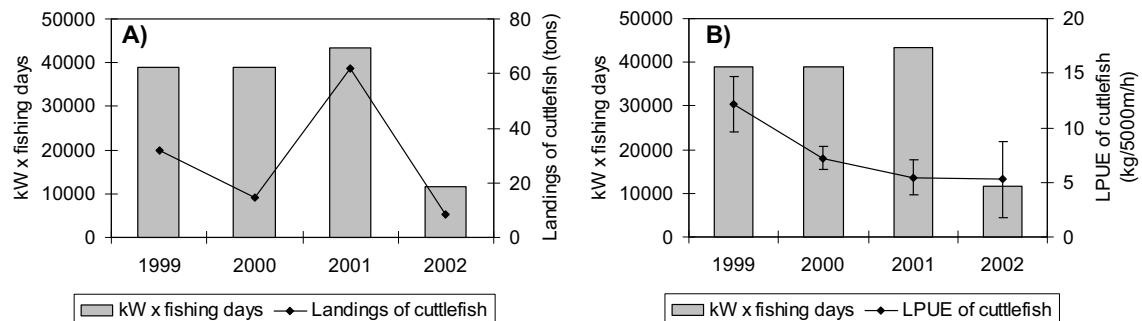


Figure 16. Small-scale fleets: annual trend of the fishing effort (kW x fishing days) applied by vessels using traps and trammel nets between Senigallia and Portonovo and of *S. officinalis* landings (A) and LPUEs (B).

Landing per unit of effort of both fisheries has been referred to kW x fishing days to allow direct comparison between them, although this parameter is not the most suitable for set gear (Fabi *et al.*, 2003). As concerns rapido trawl LPUE showed a similar pattern to that of total landings (Figure 15). The same was not for the small-scale fleets, due to the fact that the peak of total landing recorded in 2001 was due to an increase of the fishing capacity rather than an increment of LPUE (Figure 17).

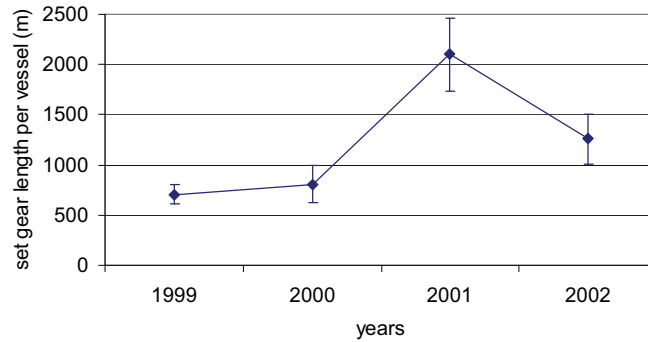


Figure 17. Small-scale fleets: annual trend of fishing capacity (traps and trammel nets employed by each vessel) deployed by the vessels operating between Senigallia and Portonovo.

4.3 Fishing yields

Rapido trawl fishing yields were strictly related to the spatial distribution of cuttlefish and to its seasonal migrations (Figure 18). A gradual increase occurs from spring to summer between 0 and 9 nm from the coast, followed by a reduction in fall when fishers catch cuttlefishes on the offshore grounds.

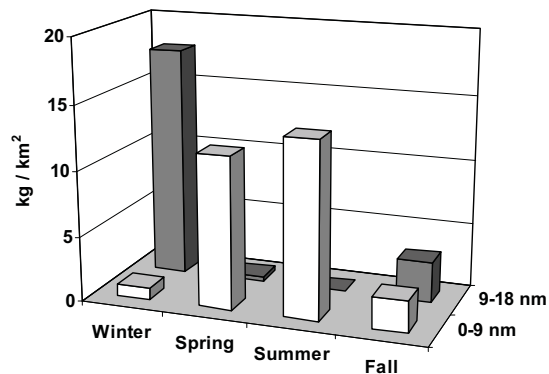


Figure 18. Ancona rapido trawl fleet: seasonal fishing yields in weight of cuttlefish obtained at different distances from the shore.

4.4 Length-frequency distributions in the catch

Cuttlefish length (mantle length, ML) composition of catches recorded at different distances from the coast confirm that in winter rapido trawlers exploit cuttlefishes between 9 and 18 nm offshore, following them in spring, when they come inshore from reproduction (Figure 19). In summer, inshore catches include both the last adults coming to reproduce and the juveniles born in spring. The latter continue to be caught in fall during their migration towards the offshore grounds where will be fished in winter.

Spring catches of set gears match with those of trawlers, even though size range, mean size and mode are slightly higher (Figure 20).

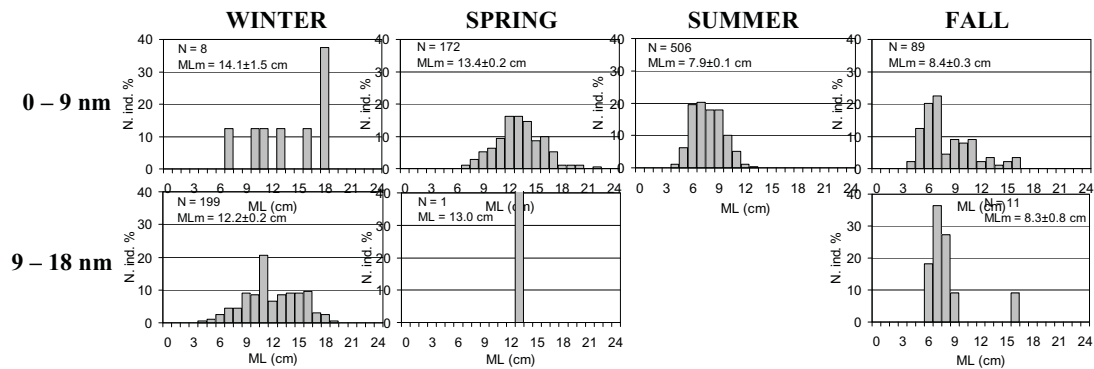


Figure 19. Ancona rapido trawl fleet: seasonal length-frequency distributions of *S. officinalis* caught at different distances from shore.

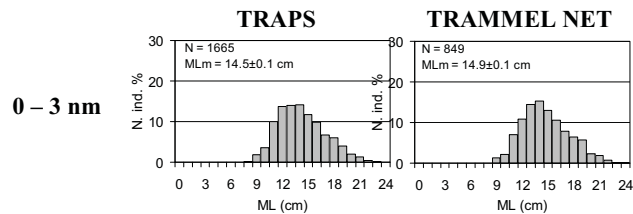


Figure 20. Small-scale fleets: length-frequency distributions of *S. officinalis* caught in spring with traps and trammel nets inside 3 nm offshore.

5. Conclusions

Data collected showed that for *S. vulgaris* a direct interaction between the rapido trawlers and small-scale fishers using set nets mainly occurs in the area inside 6 nm from the coast from spring to fall and affects the soles belonging to the age class 1 which concentrate in this zone. Anyway, the massive capture of juveniles does not seem at present to negatively impact the health of stock.

In the case of *S. officinalis* a direct interaction between the two fisheries occurs only in spring, in the coastal area and on adults which, consequently, are affected by the greatest fishing effort just during reproduction. This fact, associated to the catch of juveniles on offshore grounds by rapido trawlers might be one of the causes of the decrease observed for this species in the last years.

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Some information on offshore bottom longline fishery in the southern Adriatic Sea (GFCM Geographical Sub-Area 18)

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Abstract

The offshore bottom longline fishery in the Southern Adriatic Sea (GFCM GSA 18) mostly targets the European hake (*Merluccius merluccius*) and is carried out on the continental slope bottoms. The fishery is characterized by highly variable levels of activity according to the time periods and weather conditions. Nevertheless, fishermen consider the economic yield of this fishery as very interesting because of catch rate and quality, as it mainly consists of large-sized fish specimens. Some of the target species are also exploited by other fisheries such as bottom trawling. The possible increase of the fishing mortality of the older cohorts within the fish population is thought to be because of the bottom longline selectivity and efficiency. The monitoring of this fishery is therefore relevant for fishery management in the area, due to the gear features and catches.

Key-words: artisanal fishing; demersal fisheries; longlining; offshore; *Merluccius merluccius*; MED, Adriatic Sea, Southern

1. Introduction

Offshore bottom longline fishery in the Southern Adriatic Sea could be considered as a "small scale activity" due to the small number of vessels and fishermen involved. Moreover, the importance of the fishery is very low if compared with the demersal trawl fishery. Nevertheless, the social-economic impact of the offshore bottom longline fishery could be important at local level due to the high commercial value of the target species. Offshore bottom long-lining mainly targets the large-sized European hakes (*Merluccius merluccius*). Other high-priced species, such as scorpionfish, gurnards and blackspot seabream, are also caught contributing to the success of the fishing trips.

2. The fishing activity

Offshore bottom longline fishery is carried out mostly on the continental slope off the southern Adriatic Sea (GFCM GSA 18). Both soft and rocky areas are exploited. The fishing activity targeting the hake occurs on muddy bottoms from 200 to 400 m depth as a rule, while scorpionfish, gurnards and blackspot seabream are mostly caught at 150-350 m depths on mixed bottoms (De Zio *et al.*, 1998).

The number of boats involved in this fishery is quite low, and a rough estimate of 20-30 Italian vessels could be made for the basin. With regard to the Italian fleet, most of the boats are located in the harbours of Mola and Monopoli (both within the maritime department of

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Bari). Tonnage and engine power of the vessels are mostly between 10 and 15 t (GRT) and 75 and 150 kW respectively. Moreover, some boats from other maritime districts (i.e. Sicily) occasionally operate in the area.

Offshore bottom long-lining is carried out all year round. However, due to the fishing gear and characteristics of the activity (good sea conditions are needed as a rule) the number of fishing trips at sea is highly variable and 20-30 trips/boat per year can represent an indicative estimation. The duration of each trip is from two to four days, depending on the weather conditions.

The standard offshore bottom longline is generally 3500 m long, and the number of hooks ranges from 500 to 700 (Table 1). Each vessel can use more than one bottom longline set during the fishing trip. Details on the gear can be found in Pietrucci and Antolini (1990).

Table 1. Some features of the offshore bottom longline used in the GSA 18.

<i>Hook type and size</i>	Mustad 4-7
<i>Mainline length</i>	3500 m
<i>Mainline material and diameter</i>	Multifilament, 5.0 mm Monofilament, 2.0 mm
<i>Branch line length</i>	1.8 m
<i>Branch line diameter</i>	1.20 mm
<i>Distance between branch line</i>	5.5 m
<i>Baits</i>	Sardine, squids

The increasing use of the line hauler has been observed in the last 10 years, and some tests on full automation systems have been carried out (Romanelli and Tarulli, 2002).

3. The fishery yield and catch composition

The fishery mostly targets the hake, which represents between 40 and 70% of the total catch weight (De Zio *et al.*, 1998; Romanelli and Tarulli, 2002). Other species caught are considered as "secondary targets" when these are marketable or valuable, or as by-catch when they are less valuable or discards. These species are reported in Table 2.

Table 2. Secondary target and by-catch species from offshore bottom longline fishery.

Conger conger (European conger)
Galeus melastomus (Blackmouth catshark)
Helicolenus dactylopterus (Blackbelly rosefish)
Hexanchus griseus (Bluntnose sixgill shark)
Lepidopus caudatus (Silver scabbardfish)
Mustelus mustelus (Smooth-hound)
Pagellus bogaraveo (Blackspot(=red) seabream)
Phycis blennoides (Greater forkbeard)
Phycis phycis (Forkbeard)

Polyprion americanus (Wreckfish)
Raja spp. (Rays and skates)
Scorpaena elongata (Slender rockfish)
Scorpaena scrofa (Red scorpionfish)
Squalus acanthias (Picked dogfish)
Trigla lucerna (Tub gurnard)
Trigla lyra (Piper gurnard)

The secondary species fished with noteworthy yields are *C. conger* (10-20%), *H. dactylopterus* (5-10%), *P. bogaraveo* (2-4%) and *T. lucerna* (1-2%) (Figure 1).

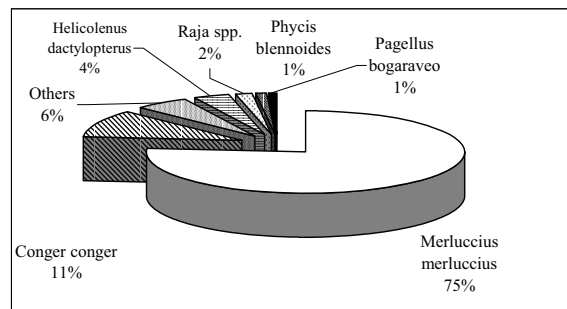


Figure 1. Species weight composition in bottom longline fishery catch in the southern Adriatic Sea; year 1992 (modified from De Zio *et al.*, 1998).

The quantity of landed catches could be estimated at 300-500 kg/vessel/fishing trip (De Zio *et al.*, 1998). The C.P.U.E (effort unit measure is 100 hauled hooks) for hake ranges between 5 and 7 both in number and weight (kg); the overall C.P.U.E. figures (all species) varies between 10 and 20 in number and 10 and 30 kg (Romanelli and Tarulli, 2002). The incidence of discarded species mostly refers to *G. melastomus* (blackmouth catshark), which can constitute an important percentage on deeper bottoms only (Romanelli and Tarulli, 2002). The catch of all species in offshore bottom longline fishery mostly consists of large-sized individuals (above the sexual maturity length). The length of the hake specimens is larger than 25-30 cm TL as a rule (Figure 2) (De Zio *et al.*, 1998).

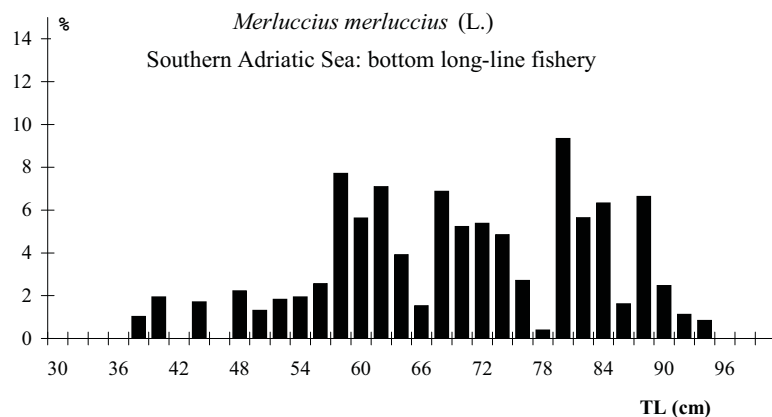


Figure 2. Length-frequency distributions of *M. merluccius* from bottom longline fishery in the southern Adriatic Sea; year 1992 (modified from De Zio *et al.*, 1998).

The offshore bottom longline fishery in GSA 18 interacts with other activities and mainly with bottom trawl fishery. In fact, for some species exploited by both bottom long-lining and trawling, the fishing areas and resource availability overlap, although the fishing effort deployed by trawling is much higher.

The Mediterranean hake is the main target species for both the activities but the fraction of population exploited by the two fisheries is quite different (Ungaro *et al.*, 2003); in fact, trawl fishery mostly catch juveniles (first age and length cohorts) while bottom long-lining mainly exploits larger sizes (spawners) (Figure 3). Similar results have also been reported for other species (Figure 4) (Ungaro *et al.*, 1999).

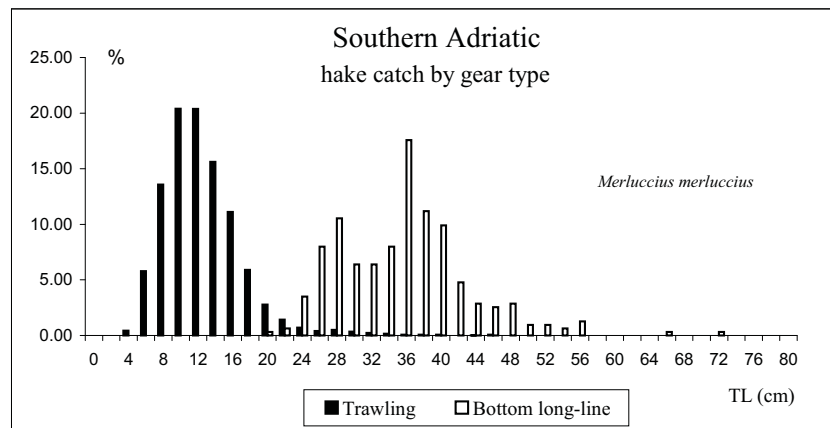


Figure 3. Length-frequency distributions of *M. merluccius* caught by bottom trawl and longline in the southern Adriatic Sea (Ungaro, unpubl.).

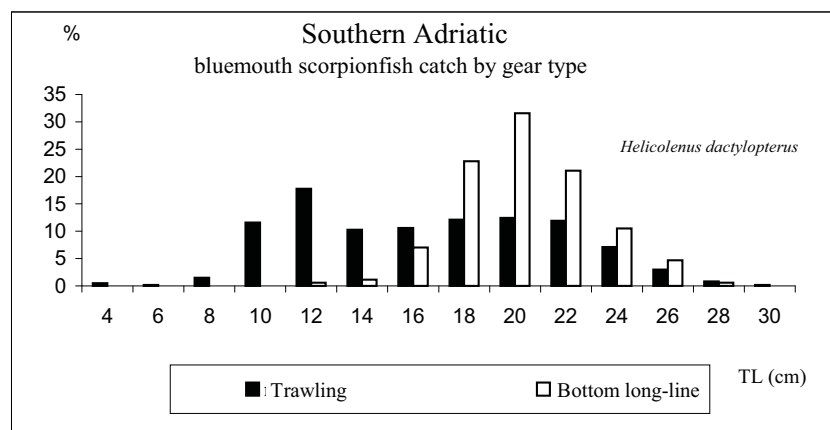


Figure 4. Length-frequency distributions of *H. dactylopterus* caught by bottom trawl and longline in the southern Adriatic Sea (modified from Ungaro *et al.*, 1999).

4. Discussion and Conclusions

The offshore bottom long line fishery carried out in the GSA 18 is characterized by high variability rate of the activity depending on time periods and weather conditions. Nevertheless, fishermen regard the economic yield of the fishery as very interesting because of C.P.U.E and quality of the catches. Moreover, most of the boats practicing bottom long-lining have the possibility to use the drifting longline for large pelagic fish (swordfish and

tunas) as an alternative according to the season, the resource availability and the economic profit.

The bottom longline catches mainly consist of large-sized specimens, so the possible increase in fishing mortality on older cohorts of the stocks due to the gear selectivity and efficiency, and the depletion of the spawning biomass could affect the population of some species. This is particularly the case of the Mediterranean hake, a very important resource for the whole fishery sector in the southern Adriatic Sea (Ungaro *et al.*, 1993; Ungaro and Marano, 1996). In fact, European hake size in the catch of both trawl and longline overlap from 20 to 40 cm length, which is the sexual maturity length range for the species (Ungaro *et al.*, 2003). The monitoring of bottom longline fishery, due to this gear features and catches, would therefore also seem a relevant issue for fishery management in the area.

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Adriatic fish biodiversity and review of bibliography related to Croatian small-scale coastal fisheries

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Abstract

The paper provides some basic bio-geographic features of the Adriatic ichthyofauna with attention to the new species occurring in the Adriatic region. A bibliographic outline of the scientific research carried out on coastal fish of Croatia is also given together with the historical background of the coastal fishery research. Investigations on small-scale coastal fisheries are described with emphasis to the effects of fishing gear on the fish assemblage in the Croatian coastal areas.

Keywords: artisanal fishing; marine fish; coastal fisheries; fishing gears; zoogeography; MED, Adriatic Sea; MED; Croatia

1. General features of the Adriatic Sea

The Adriatic Sea is a long depression or a synclinal. Its present shape and form originated at the beginning of the Quaternary period, when it was formed by a transgression. In the late Tertiary period in this area, the Earth's crust sagged forming a depression. Later, this was filled with seawater creating the northern Adriatic.

During the Pleistocene period, a part of the sag, the north Italian plain, became dry again. The deeper southern Adriatic was formed when the Earth's crust collapsed in the late Tertiary period. The Strait of Otranto that connects the Adriatic to the Ionian Sea was formed the same way.

The coastline of the Adriatic was unstable during the Tertiary period. The eastern, Dinaric part was flooded in the beginning. Later the water withdrew to the west flooding almost the entire Apennine coast and leaving the eastern coast dry. After that, the western part raised and the eastern part subsided, so water entered among the islands all the way to the present coastal line. The raising of the western and the lowering of the eastern coast probably still goes on.

Excluding the Black Sea, the Adriatic Sea is the northernmost part of the Mediterranean. This fact influences some important physical properties of even its southernmost areas. The Adriatic is a shallow sea. Most of the bottom, about 102 415 km² or 73 %, is less than 200 m deep. The depth gradually decreases from south to north. The Jabuka/Pomo Pit (273 m) and the south Adriatic Pit (1 330 m) are the only areas where the water is over 200 m deep, averaging 231 m therefore, most of the bottoms are on the continental shelf and a significantly smaller part on the continental slope (sea bottom under 200 m deep). The Adriatic Sea covers about 800 km by latitude and from 100 to 200 km by longitude. In the

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south, the Adriatic Sea is separated from the Ionian Sea, by the 72 km-wide Strait of Otranto, where a submarine sill of 800 m exists.

A series of thousands of large and small islands lies along the eastern coast, while there are almost no islands along the western shore. The eastern and western coasts have different morphological and topographic properties: the eastern coast is composed of limestone, its steep and narrow shelf deepens fast while the western coast has a wider shelf because of sediments brought by the river. The largest river input into the Adriatic comes from the Po River, with annual mean inflow of 1700 m s^{-1} . High variability of this inflow is the major factor that determines a number of parameters like temperature, salinity and transparency in the North Adriatic. The sea bottom of the Adriatic shelf is covered with recent sediments of various structural and mineral-petrographic composition. The muddy and sandy sediments cover the largest part of the shelf. Indeed this type of sediment covers almost the entire the south and central Adriatic region, together with the channel area of the north-eastern Adriatic, Gulf of Trieste and a narrow belt along the north-eastern side of the Italian coast. The muddy sediments also cover the most of the northern, a smaller part of the central and only some limited areas of the southern Adriatic.

The thermohaline properties of the Adriatic Sea are determined mainly by the air-sea interaction, water exchange through the Otranto Strait, river discharge, mixing, currents, and topography of the basin. The annual temperature range at the surface is $18 \text{ }^\circ\text{C}$ in the South and $25 \text{ }^\circ\text{C}$ in the North Adriatic. As a whole, the Adriatic is a temperate warm sea. The extremes of surface temperature have a large range, from $6 \text{ }^\circ\text{C}$ to $29 \text{ }^\circ\text{C}$. Temperatures of even the deepest layers are for the most part above $10 \text{ }^\circ\text{C}$. The south Adriatic is $8\text{-}10 \text{ }^\circ\text{C}$ warmer than its central and northern parts during winter. In other seasons the horizontal temperature distribution is more uniform. Generally, the open sea is warmer than the coastal waters. At the Split-Gargano transect the highest temperature occurs in the central part, the lowest surface temperatures occurs are near the eastern coast, and the lowest bottom temperatures are found towards the western coast.

Salinity of the Adriatic is relatively high and its ranges are significant. The southern part has salinity between 38.4 to 38.9 psu, and is especially high in the intermediate layer. In the northern part and in the coastal zones salinity is lower, and also more variable. The lowest salinity is found close to the Po River mouth. It could be generally said that the Adriatic Sea water salinity decreases from south to north and from the open sea to the coast. Long-term measurements in the coastal and open waters of the middle and southern Adriatic have shown a salinity-increased trend up to 1993/94 (Zore-Armanda *et al.*, 1999). This phenomenon probably, together with considerable year-to-year variability in three time series (Dubrovnik, Split, Trieste) of sea surface temperature (SST), plays an important role in the apparition of some rare fish in the Adriatic (Dulčić *et al.*, 1999a).

Currents are generally low speed and variable in direction. The current field shows a simple cyclonic circulation regime. Generally, streamlines follow the isobath lines along both costs, but wavelike patterns or meanders appear, influenced by the topography of the middle Adriatic (Palagruža sill).

Meteorological conditions favourable for the formation of water masses are outbreaks of cold and dry winter weather, when the bora wind (cold, north to northeast wind) is blowing. Three water types of Adriatic origin have been identified (Zore-Armanda, 1963; Artegiani *et al.*, 1997) and characterized with respect to the temperature and salinity (NadDW: North Adriatic Deep Water; MadDW: Middle Adriatic Deep Water; SadDW: South Adriatic Deep Water).

Due to its high density, the NAdDW fills up the Jabuka/Pomo Pit and only occasionally spreads to the South Adriatic. The MAdDW is formed in the Jabuka/Pomo Pit area, when there is no intensive northwestward flow, i.e. during the period of a low Mediterranean water inflow. The SAdDW originates in the South Adriatic Pit. Due to its high density, this water spreads into the bottom layer of the eastern Mediterranean. The fourth water type is not of Adriatic origin. The Levantine Intermediate Water (LIW) is formed in the Levantine Basin. This water experiences a salinity decrease on its way to the Adriatic, and eventually enters the Adriatic through the Strait of Otranto. This water type can be recognized in the intermediate layer of the South and Middle Adriatic as mLIW (modified LIW) water type (Orlić *et al.*, 1992). Seasonal distributions of water masses are closely related to the current fields.

The Adriatic shows considerable year-to-year variations in the oceanographic parameters, as highlighted by the amount of LIW present. The horizontal pressure difference varies between the northern and the southern Adriatic, which influence the intensity of water exchange between the Adriatic and the eastern Mediterranean as a consequence of the presence of a large pressure centre over the wider Mediterranean region. Year-to-year fluctuations of water exchange between these basins influence long-term fluctuations of a variety of parameters like salinity, temperature, transparency and nutrient salts density, the latest having a consequence on chlorophyll concentration fluctuations.

In addition, the man-made impact on at least some of the oceanographic properties has become clear over the past three decades. Nowadays, Adriatic oceanography, especially in the North Adriatic area, faces the necessity of dealing with increasingly urgent problems of the sea pollution, which might influence toxic phytoplankton blooms as well as biodegradation of the environment thus having consequences on biodiversity too.

The Adriatic Sea, especially its northern part, is one of the richest fishing grounds in the Mediterranean. The rich river inflows over the shallow shelf of the north Adriatic and in addition the mixing of bottom sediments make this area highly productive. The central and southern Adriatic are less productive, but their exposure to the influence from the north Adriatic and to the periodically stronger influence of the Mediterranean waters, enable high productivity in these areas as well. Open Adriatic waters are, therefore, distinguished as areas for pelagic fisheries. The areas off Ancona and around Palagruža Sill both are known as rich fishing grounds, especially for pelagic fisheries. 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 small-scale fishing gears in their fishing activities. The coastal area is characterised by greater productivity rate compared to the open sea thanks to relatively lower depth, vicinity of the land and fresh-water inflow. In the eastern Adriatic channel areas and in the areas under the influence of fresh-water inflow, coves, bays and mouth of rivers, where the coastal fishing takes place, mean gross primary production ranges between 60 and 150 gC m⁻² year⁻¹, while in the open sea it is 55 gC m⁻² year⁻¹.

2. Basic features of the Adriatic ichthyofauna

The present-day flora and fauna of the Adriatic Sea result from the numerous geological, geographical, climatic and biological influences occurring during its formation (Jardas, 1996). The influence of geographical, geomorphological climatic and other environmental

factors is crucial even today; indeed peculiarities of the Adriatic ichthyofauna actually depend on these factors. Although the Adriatic Sea is part of the Mediterranean, it is an independent bio-geographical and ecological sub-unit, which is demonstrated by the composition and properties of its living communities (biocenosis).

Although the Adriatic is regarded as a well studied semi-enclosed sea, some new taxa of marine flora and fauna, including fish, are being recorded each year. Jardas (1996) listed a total of 407 fish species and subspecies, representing 117 families, from the Adriatic Sea. Since his review, additional species have been reported from the area: *Tylosurus acus imperialis* (Bello, 1995), *Plectorhinchus mediterraneus* (Lipej *et al.*, 1996), *Sphyræna chrysotaenia* (Lessepsian migrant) (Pallaoro and Dulčić, 2001), *Leiognathus klunzingeri* (Lessepsian migrant) (Dulčić and Pallaoro, 2002), *Gammagobius steinitzi* (Kovačić, 1999), *Vanneaugobius dollfusi* (Pallaoro and Kovačić, 2000), *Epinephelus aeneus* (Glamuzina *et al.*, 2000), *Pomatoschistus norvegicus* (Stefanni, 2000) and *Gobius kolombatovici* (Kovačić and Miller, 2000). Jardas (1996) did not include any of the Lessepsian migrants in his list even though the presence of two of them, *Paraxocoetus mento* and *Hemiramphus far*, was confirmed for the Adriatic Sea (near the Albanian coast) (Parin, 1986a, 1986b). During the past ten years several papers have been published on the occurrence of new fish species in Adriatic waters raising the number of fish species in the Adriatic Sea to 418 representing 120 families (including the species mentioned above), which amounts to 72% of the known species and subspecies of the Mediterranean (in total about 581 species and subspecies). The new records are mostly of thermophilic species. The movement of these species is also cited as evidence for the warming of Mediterranean waters.

The fish species and subspecies cited in the Adriatic Sea have been grouped into 2 classes, 26 orders and 120 families; of the total number of families 21 belong to the class of cartilaginous fish (Selachii or Chondrichthyes), the rest, to the class of bony fish (Osteichthyes). This number of about 418 fish species and subspecies observed in the Adriatic now so far can be regarded as correct and complete for several reasons. Firstly, it is not possible to give a definite answer to the question of whether some fish species caught in the Adriatic in fact live there or occur occasionally. For example, some rare Adriatic fish were found only once or only a few times, or the observation was dubious for some reason. Such fish are the species: *Pristis pectinata*, *Rhinobatos rhinobatos*, *Regalecus glesne*, *Lophotus lacepedei*, *Ammodytes tobianus* and some others. Secondly, most of the south Adriatic basin has not been sufficiently explored in terms of its ichthyofauna, particularly not at depths of more than 500 m. It is therefore logical to expect future explorations of the region to increase the number of known meso- and bathypelagic, and bathybenthonic fish of the Adriatic. It is very likely that new species or subspecies will be found in the region of the continental shelf, in spite of the fact that the Adriatic shelf is one of the best explored as far as the ichthyofauna is concerned. Such a possibility is indicated by some recent discoveries of new species in the Adriatic as reported above (see also Dulčić *et al.*, 1999a). Lastly, the third reason for the uncertainty about the exact number of fish species in the Adriatic relates to some unresolved systematic (taxonomic) and other status questions on some fish species (Pallaoro and Kovačić, 2000).

Only some fish families in the Adriatic can be considered as having numerous genera and/or species. Among the Selachii this is true only of the Rajidae family, including one genus (*Raja*), 4 subgenera (*Raja*, *Dipturus*, *Leucoraja*, *Rostroraja*) and 11 species. The most numerous family of the Osteichthyes is the Gobiidae with 18 genera, 45 species and one subspecies. The genera with the largest number of species are the *Gobius* and

Pomatoschistus. Also the following families are numerous: Labridae (8 genera, 2 subgenera and 18 species), Sparidae (9 genera, 3 subgenera and 18 species), Blennidae (5 genera and 17 species and subspecies) etc. On the other hand, the largest number of Adriatic fish families consist of only a small number of species. As many as 77 families (64%) include only one or two species.

2.1 Biogeographical features of the Adriatic ichthyofauna

Most species and subspecies of Adriatic fish, apart from some endemic species and subspecies, belong to the Mediterranean and Mediterranean-Atlantic biogeographical region. If Atlantic-Mediterranean biogeographical elements are considered, the greatest number of Adriatic representatives belongs to the eastern Atlantic Boreal zone (about 40%). The boreal elements give the Adriatic ichthyofauna a special character and place in the Mediterranean.

A total of 53 species have been recorded from the Chondrichthyes group alone, of which 29 are Pleurotremata species (53.7%), 23 Hypotremata species (44.4%) and one species of Chimaera. These make up about 69% of the Chondrichthyes species recorded throughout the Mediterranean (about 77 species). Some of the Chondrichthyes species are thought not to inhabit the Adriatic throughout their life cycle, but to migrate there temporarily, such as *Carcharodon carcharias*, *Pristis pectinata*, *Rhinobatos rhinobatos* and some others. In addition, some of the species recorded from the Adriatic are generally rare (*Heptranchus perla*, *Echinorhinus brucus*, *Odontaspis* spp.).

Zoogeographically, the highest number of the Adriatic Chondrichthyes fishes belong to the Atlanto-Mediterranean species group (32 species or 59.2%). These are mainly smaller Pleurotremata fishes (*Scyliorhinidae*, *Squatinae*, *Mustelus* spp., *Oxynotus centrina*, *Etmopterus spinax*) and most Hypotremata fishes (mostly Rajidae but also Torpedinidae, Myliobatidae and others). About ten species represent tropical biogeographical elements (for instance *Centrophorus granulosus*, *Squatina oculata*, *Pteromyaleus bovinus*, *Mobula mobular* and a few others) and eight the boreal elements (for instance *Mustelus* spp, some species of genus *Raja*, *Chimaera monstrosa* and some others). Certain species (about 8) deeply penetrating both the tropical and boreal biogeographical regions of the eastern Atlantic Ocean (for instance *Oxynotus centrina*, *Etmopterus spinax*, *Torpedo torpedo*, *Rhinobatos rhinobatos* and some species of genus *Raja*), there are others that even inhabit the area of the Southern Indian Ocean. Six species at most are of the amphiatlantic biogeographical area.

Cosmopolitan species are somewhat less well represented together with the species showing rather wide geographical distribution (19 species). All larger Pleurotremata fish belong to this group (*Hexanchidae*, *Odontaspidae*, *Lamnidae*, *Sphyrnidae*, some of *Carcharhinidae*) as well as *Dasyatis pastinaca* of Hypotremata fishes. These species mainly show circumglobal distribution in warm and/or temperate seas (*Hexanchus*, *Heptranchis*, *Odontaspis*, *Isurus* and some others) or bipolar distribution properties (*Lamna*, *Cetorhinus*, *Scymnorhinus*). Three species of the Mediterranean endemic Chondrichthyes have been recorded from the Adriatic as well. These are species of genus *Raja* (*R. asterias*, *R. polystigma* and *R. radula*). Atlanto-Mediterranean Chondrichthyes species recorded from the western Mediterranean, such as *Etmopterus spinax*, *Scymnorhinus lichia* and *Raja undulata*, have also been recorded from the Adriatic.

Boreal elements of the Osteichthyes group are almost all gadids and a large number of species or subspecies of other genera, such as *Sprattus sprattus phalericus*, *Merluccius merluccius*, *Salmo trutta trutta*, *Belone belone gracilis*, *Dicentrarchus labrax*, *Engraulis encrasicolus*, *Pagellus bogaraveo*, *Atherina boyreri*, *Scorpaena porcus*, *Mullus surmuletus*, *Lampanyctus crocodilus*, *Nansenia oblita* and many others. In relation to the Mediterranean, boreal fish species (in a wider sense) are included, these are distributed exclusively or predominantly in the Atlantic north of Gibraltar to the Bay of Biscay (included). This comprises the more southerly Lusitanian zone, in addition to the Boreal. Some fish which belong to the Lusitanian zone are: *Hippocampus hippocampus*, *Symphodus cinereus*, *S. roissali*, *Pomatoschistus marmoratus*, *Glossanodon leioglossus*, *Liza saliens*, *Blennius gattorugine*, *B. tentacularis* and some others. The tropical biogeographical zone in the eastern Atlantic extends south of Gibraltar, and thus includes the Lusitanian biogeographical zone. This simplified division of biogeographical zones in the Atlantic differs considerably from the classical division according to Ekman (1953), which was based on the average temperatures of the sea surface. Although it is, in actual fact, better suited for studying fish biogeography.

A more complex division of biogeographical regions for these largely widespread and to a greater or lesser extent migratory marine fish species is often quite difficult. The division, however, does not exclude the Lusitanian biogeographic zone in the north and the Mauritanian zone in south (from Gibraltar to the Cape Blanc). These two zones in relation to the Mediterranean in a wider sense belong to the boreal and tropical biogeographic zones, respectively. Some of the Mauritanian elements in the Adriatic are: *Sparisoma cretense*, *Glossanodon leioglossus*, *Gymnammodytes cicerehus* and some others. The thermophilic eastern Atlantic tropical element of the Atlantic-Mediterranean biogeographical zone is sparse in the Adriatic ichthyofauna (*Sardinella aurita*, *Thalassoma pavo*, *Sparisoma cretense*, *Sarda sarda*, *Seriola dumerili* and some others) like the element of the Amphiatlantic biogeographical zone (*Odontaspis taurus*, *Squalus acanthias*, *Dasyatis centorura*, *Pristis pectinata*, *Sardinella aurita*, *Macroramphosus scolopax*, *Epinephelus marginatus*, *Balistes capriscus* and some others).

A large number of Adriatic fish of the Atlantic-Mediterranean biogeographical zone cannot be classified in either of the above mentioned narrow groups, because of their wide geographic distribution they are common to the entire eastern Atlantic zone. They inhabit the east Atlantic zone starting from the boreal to the Tropical biogeographical zone (included). In most cases these species are Tropical-Lusitanian and represent 32% of Adriatic fish. Cosmopolitan and other more widely distributed fish species constitute about 11% of the Adriatic ichthyofauna. These cosmopolitan species are generally of a circumglobal distribution in warm and moderately warm seas. They are mostly epi- and mesopelagic shark species (*Carcharodon carcharias*, *Isurus oxyrinchus*, *Prionace glauca*, *Hexanchus griseus* etc.), and some Osteichthyes (*Ranzania laevis*, *Pseudocharanx dentex*, *Xiphias gladius* etc.). Some rare epipelagic sharks that occur in cold and moderately warm seas around the world are also present in the Adriatic ichthyofauna: *Lamna nasus* and *Cetorhinus maximus*. The number of real cosmopolitan species is more limited (*Hoplostethus mediterraneus*, *Thunnus thynnus*, *T. alalunga*, *Auxis rochei*, *Cyclothone braueri* etc.). Possible cosmopolitan species are: *Naucrates ductor*, *Trachurus mediterraneus*, *T. picturatus*, *Brama brama* and some others).

Around 22% of the Adriatic ichthyofauna are species with Mediterranean biogeographical conditions (in a wider sense) such as: *Alosa fallax nilotica*, *Belone belone gracilis*, *Blennius zvonimiri*, *Tripterygion tripteronotus*, *Syngnathus tenuirostris*, *S. phlegon*, *S. abaster*, *Spicara maena*, *Spicara smaris*, *Spicara flexuosa*, *Arnoglossus kessleri*, *A. rueppelli*, *Raja asterias*, *Raja radula*, *Raja polystigma*, *Gouania wildenowi*, *Lepadogaster lepadogaster lepadogaster*, *Callionymus pusillus*, *Evermannella balboi*, *Aphanius fasciatus*, *Antonogadus megalokynodon*, some species of the genus *Symphodus* and some gadids.

The notion of Mediterranean fish species can be approached in two ways. In a narrow sense it refers to those species that are distributed throughout the Mediterranean (only endemic species *Speleogobius trigloides*, *Gobius kolombatovici*, *Acipenser naccarii* etc), and in a wider sense those that can be found also in the neighbouring section of the eastern Atlantic, in the region of Gibraltar, or even between Portugal and Mauritania, sometimes including the Azores, Madeira and Canary Islands. Around half of the Mediterranean species, occur only in the limited Mediterranean region. Thereafter there are species that occur in both the Mediterranean, including the Black Sea (the Pontic Mediterranean species), and in the neighbouring section of the Atlantic, in the Gibraltar region. Few species are distributed throughout the entire Mediterranean and the Gibraltar region of the Atlantic (about 9%).

The Mediterranean ichthyofauna has a rather pronounced regional biogeographical character. The ichthyofauna in the eastern part of the basin is to some extent different from the ichthyofauna in the western part. Generally speaking, the largest differences are found between the ichthyofauna of the Black Sea and the rest of the Mediterranean. There are also marked differences in the ichthyofauna between the Adriatic and the rest of the Mediterranean, as well as more consistent similarities between the Adriatic and the western Mediterranean. The number of fishes represented in the Adriatic that belong to the western Mediterranean is higher (about 3.5 times) in comparison to the number of species typical for the eastern part of the Mediterranean basin. In general, the similarity between the Adriatic and the western Mediterranean ichthyofauna exceeds that between the Adriatic and eastern Mediterranean ichthyofauna. These differences and similarities are probably partly due to historical factors, and also to recent environmental conditions.

The Lessepsian migrants elements of the Indo-Pacific ichthyofauna in the Adriatic are: *Hemiramphus far*, *Parexocoetus mento*, *Sphyræna chrysotaenia* and *Leiognathus klunzingeri*. During the tertiary and up to the Pliocene there was a link between the Tethys Sea and the Indian Ocean, so that there are still today some rather indistinct historical links between the Mediterranean and the Indo-Pacific ichthyofauna. The links are constituted by genera such as *Echelus*, *Zeus*, *Cepola*, *Uranoscopus*, *Lepidotrigla*. The consequence of the same historical factors is a clear connection between the Mediterranean (or Mediterranean-Atlantic) and Pontic-Sarmatian biogeographical zones. Several gobidae species of genera *Knipowitschia*, *Pomatochistus*, *Zosterisessor*, some representatives of genus *Blennius*, and *Syngnathus taenuirostris*, *Merlangius merlangius euxinus*, *Platichthys flesus luscus*, acipenserids and some others point to the rather strong connection between the Adriatic and Ponto-Sarmatic ichthyofauna.

2.2 New fish species in Adriatic Sea and some considerations on Adriatic fishes

Jardas (1996) in his work «Adriatic ichthyofauna» listed of 407 fish species and subspecies in the Adriatic. New fish species in the Adriatic Sea, not mentioned in this list are presented in Table 1.

Table 1. New fish species in the Adriatic Sea, not mentioned in the list of the Adriatic ichthyofauna by Jardas (1996). Abbreviations: CS- changed taxonomic status, FR – first record, FCR – first confirmed record, NS- new species for science, GT - Gulf of Trieste (the northernmost part of the northern Adriatic, NA – Northern Adriatic, MA – middle Adriatic, SA – southern Adriatic. Lessepsian migrants so far recorded in the Adriatic are denoted with asterisks.

Species	Family	Data	Area	Source
<i>Apletodon incognitus</i>	Gobiesocidae	FR	NA	Hofrichter & Patzner (1997)
<i>Caelorinchus mediterraneus</i>	Macrouridae	FR, NS	SA	Iwamoto & Ungaro (2002)
<i>Cataetyx alleni</i>	Bythitidae	FR	SA	Ungaro <i>et al.</i> (2001)
<i>Diaphus metopoclampus</i>	Myctophidae	FR	SA	Fabiano & Fabiano (1977)
<i>Didogobius splechnai</i>	Gobiidae	FR	NA	Herler & Patzner (2002)
<i>Epinephelus coioides</i> *	Serranidae	FR	GT	Parenti & Bressi (2001)
<i>Epinephelus aeneus</i>	Serranidae	FR	SA	Glamuzina <i>et al.</i> (2000)
<i>Gammagobius steinitzi</i>	Gobiidae	FR	NA	Kovačić (1999)
<i>Gobius couchi</i>	Gobiidae	FR	NA	Kovačić (2001)
<i>Gobius kolombatovici</i>	Gobiidae	FR, NS	NA	Kovačić & Miller (2000)
<i>Hemiramphus far</i> *	Hemiramphidae	FR	SA	Parin (1986a)
<i>Lebetus guilleti</i>	Gobiidae	FR	NA	Herler & Kovačić (2002)
<i>Leiognathus klunzingeri</i> *	Leiognathidae	FR	SA	Dulčić & Pallaoro (2002)
<i>Lepidion lepidion</i>	Moridae	FR	SA	Ungaro <i>et al.</i> (2001)
<i>Mycteroperca rubra</i>	Serranidae	FR	SA	Glamuzina <i>et al.</i> (2002)
<i>Pampus argenteus</i> *	Stromateidae	FR	NA	Dulčić <i>et al.</i> (in press)
<i>Parexocetus mento</i> *	Exocoetidae	FR	SA	Parin (1986b)
<i>Plectorinchus mediterraneus</i>	Haemulidae	FR	GT	Lipej <i>et al.</i> (1996)
<i>Pomatochistus norvegicus</i>	Gobiidae	FR	NA	Stefanni (2000)
<i>Saurida undosquamis</i> *	Synodontidae	FR	SA	Rakaj (1995)
<i>Siganus rivulatus</i> *	Siganiidae	FR	SA	Dulčić & Pallaoro (in press)
<i>Sphyaena chrysotaenia</i> *	Sphyaenidae	FR	SA	Pallaoro & Dulčić (2001)
<i>Sphyaena viridensis</i>	Sphyaenidae	FR	SA	Kožul <i>et al.</i> (pers. comm.)
<i>Stephanolepis diaspros</i> *	Monacanthidae	FR	SA	Dulčić & Pallaoro (in press)
<i>Tylosurus acus imperialis</i>	Belonidae	FR	SA	Bello (1995)
<i>Valenciennelus tripunctulatus</i>	Sternoptychidae	FCR	SA	Dulčić (2001)
<i>Vanneaugobius dolffusi</i>	Gobiidae	CS	MA	Pallaoro & Kovačić (2000)
<i>Melanostigma atlanticum</i>	Zoarcidae	FR	SA	Ungaro <i>et al.</i> (2002)
<i>Bathypterois mediterraneus</i>	Chlorophthalmidae	FR	SA	Ungaro <i>et al.</i> (2002)

3. Bibliographic outline of scientific research on Croatian coastal fish and fishing

3.1 Historical background and some main ichthyological and fishery works

The first research into the Adriatic ichthyological fauna occurred in the 18th century and was reported in the book «Ichthyologia massiliensis» (Brünnich, 1768; cited in: Jardas, 1985).

Lists of the Adriatic fish species were made by a number of authors during the 19th and 20th centuries (e.g. Naccari, Nardo, Martens, Lanza, Carrara, Plučar, Stosich, Kolombatović, Kosić, Bini, Tortonese, Šoljan, Grubišić, reviewed in Jardas, 1985). Šoljan (1948), an internationally renowned scientist, ichthyologist and expert in fishery matters especially of the Adriatic, wrote the monograph «Ribe Jadrana» (Fishes of the Adriatic), one of his most significant works, which has been reprinted several times. He also initiated and led the scientific Expedition M.V. Hvar and contributed to the Adriatic marine research and fisheries development. Grubišić (1982) wrote a book «Ribe, rakovi i školjke Jadrana» (Fishes, crabs and shells of the Adriatic) where author present a list of some economically important fishes, crustaceans and shells. Županović and Jardas (1989) wrote a monography «Flora i Fauna Jadrana-Jabučka kotlina» (Fauna and Flora of the Adriatic Sea-Jabuka Pit). Jardas (1996) wrote the book «Jadranska ichtiofauna» where the author presented a complete list of Adriatic ichthyofauna (407 species and subspecies). Jardas (1997) prepared the monography «Ribe i glavonošci Jadrana» (Fishes and cephalopods of the Adriatic Sea). Pallaoro and Cetinić (1993a) presented a contribution to the knowledge of ichthyocenosis of the infra-littoral zone of coastal area of Makarska (mid-Adriatic). This investigation was done with coastal beach seine called «braganja» and with «fruzata» fishing. Jardas *et al.* (1998a) presented the recent ichthyofauna of the Rijeka Bay. Basioli (1984) wrote a book «Fisheries in the Adriatic». Cetinić and Swiniarski (1985) published «Alati i tehnika ribolova» (Fishing gears and fishing technique) and Swiniarski and Cetinić (1993) «Catch technology of marine organisms». Treer *et al.* (1995) wrote the book «Fisheries».

The first description of coastal fishing (with nets called «poponice») in one small cove in the island Šolta, was given in 1568 by Petar Hektorović in his halieutic poetry «Ribanje i ribarsko prigovaranje» («Fishing and fishing chats»). Hektorović described several fish species which were caught with this net (*Sarpa salpa*, *Labrus merula*, *Labrus viridis*, *Diplodus puntazzo*, *Pagrus pagrus*, *Diplodus sargus*, *Mullus surmuletus*, *Pagellus erythrinus*) and wrote about huge quantities of these caught.

Spiridion Brusina (1845-1908), the Croatian natural scientist, one of the greatest Darwinists of that time, wrote some very interesting reports on fishes, sea mammals and gastropod molluscs («Sharks of Mediterranean and Black Sea» in 1888; «About fisheries in Dalmatia» in 1888; «Sea mammals of the Adriatic Sea» in 1889; «Fish, known as «milk» in Dalmatia» in 1889; «Our sturgeons» in 1902).

Juraj Kolombatović, the renowned Croatian natural scientist was most successful in his ichthyological research, the field in which he discovered and described 9 new fish species (5 goby species, 3 blenny species and 1 species of the family Gadidae).

Petar Lorini (1903) («Father of modern fisheries in Croatia»), a teacher, a true fisheries expert and promoter in the eastern Adriatic, wrote the book «Fishing and fishing gear on the eastern Adriatic coast» which even today, after one century, is still factual and may serve as a handbook to anyone who wishes to learn about marine fisheries. It was awarded the Silver State Medal at the International Fishery exhibition in Vienna in 1902 while it was still a manuscript.

3.2 Investigations on small-scale coastal fishing

Studies on small-scale coastal fishing gear along the eastern Adriatic coast can be traced back to the 1950s. First data about the annual fluctuations of European eel *Anguilla anguilla* and

mullet catch in the River Neretva Estuary were given by Morović (1948), who also wrote (Morović, 1951) some preliminary reports about the possibilities of lagoon fishery along the eastern Adriatic coast. This author studied the annual growth of European eel and mullet (Mugilidae) in lagoons on the eastern Adriatic coast (Morović, 1954). He also compiled an annotated list of mugilids of the eastern Adriatic coast (Morović, 1957). Morović (1959) presented some observations on the relationship between length and weight of eel from the River Neretva Estuary and reported on the growth characteristics of *Mugil chelo* during the year in the lagoon Pantana in Dalmatia (Morović, 1960). Županović (1956, 1963) reported on the quantity and species composition of commercial catches by small coastal trawl («tartana») carried out along the Croatian coast in the 1951-1953 period and discussed the impact of fishing intensity on the Adriatic fishery resources.

Morović (1962, 1963) analysed experimental beach seine («migavica») catches in the area of Dugi Otok island between 1953 and 1957 and the beam trawl catches in the Split area between 1958 and 1961. The analysis of catch by bottom trammel sets in the central Adriatic coastal area started in 1960 (period 1960-1964) (Morović, 1965). These analyses, although with some interruptions, have been carried out in the same area ever since (Jardas, 1986). Morović (1962) presented the data on the sexual maturity and the period of spawning of mugilids along the Croatian coast. This same author (Morović, 1962) also highlighted the significance of Vrana Lake for fisheries purposes. The analysis of the coastal fishery catches was continued even later on the same coastal areas (Morović, 1970, 1971, 1979; Jardas, 1979a, 1979b, 1980a, 1980b, 1982, 1986; Jardas and Pallaoro, 1989; Jardas *et al.*, 1998b, 1998c).

Owing to the continued research on coastal communities of fish and commercially important invertebrates since 1960 it has been possible to observe a number of events. Grubišić (1968, 1974) assessed the fishing grounds of the eastern Adriatic and noted a large number of signs of its biological impoverishment caused by intensive fishing. Morović (1965, 1970, 1971, 1979) pointed out the sharp decline in the bottom trammel net catches in the Croatian coastal area. The same author also showed the decrease in the length and weight of specimens caught, as well as in the occurrence of some fish species in the catches. The same changes and their extent were also reported later (Jardas, 1979a, 1980a, 1980b, 1982, 1986; Jardas and Pallaoro, 1989).

All previously mentioned authors believed that the changes observed were due to overfishing, use of harmful gears, violation of legislation and poor enforcement of management measures concerning the exploitation and protection of marine fishery resources.

Increasing levels of marine pollution adversely affects the biological resources of the coastal sea of the eastern Adriatic. Pollution is particularly pronounced in the vicinity of large urban and industrial centres. The extent of the influence of pollution on the coastal biological resources is not yet adequately assessed. Jardas *et al.* (1995) presented data on ichthyofauna of Kornati and Murter Sea (eastern central Adriatic). Data on ichthyofauna were collected in the period 1960-1992, mainly during the observations on the state and changes in coastal and demersal ichthyopopulations of the areas in question, as well as during prospecting of near-shore and trawling grounds for the geomorphological, edaphic and bio-ecological properties of the seabed. The data were collected by 14 different fishing gears and by visual observations during diving. An abundant ichthyofauna was recorded from 141 localities of the areas of Kornati Islands and Murter Sea: 160 species and subspecies which make up 39.5% of all known species and subspecies of the Adriatic Sea. Growing intensity of eastern

Adriatic coastal fishery exploitation, as the main cause of the observed changes in the communities of fish and invertebrates, is clearly shown by the statistics on the recent variations of the number of fishing gears and fishing boats (Jardas *et al.*, 1988; Jardas, 1999). Changes in the communities of fish and invertebrates, as resulting from changes in quantitative and qualitative catch structure, are due to various reasons and particularly to intensive fishing.

On the contrary, long-term observations on qualitative and quantitative composition of catches realized by different fishing gears could provide information on the trend and intensity of the changes in the structure of exploited communities. Bottom trammel nets were used as the most appropriate fishing gear for such studies. They are very efficient and almost non-selective fishing gear owing to their construction properties (Grubišić, 1960; Cetinić and Swiniarski, 1985; Lorini, 1903; Swiniarski and Cetinić, 1993). Jardas *et al.* (1998c) compiled data on qualitative and quantitative analyses of coastal sea communities of the Croatian coast, particularly fish but also commercial invertebrates, starting in 1960 using bottom trammel net catches (net length: 31-36 m; height: 1.3-1.5 m; «maha» mesh size 28 and 32 mm; 10 or 11 nets were tied together). This paper reports on the changes and their extent in coastal communities (fish, crustaceans, cephalopods) between 1960 and 1994 (Kornati Islands, Split area, mid-Dalmatian Islands, Palagruža Islands, south Croatian coast-Montenegro coast). The number of seine nets increased by 1.4 since 1960, the number of gill nets by 7.6, that of trammel nets alone by 6.3, fish and crustacean pots by more than 6, the number of hooks of long-lines by 3.7 and fishing boats by 2.4 (Jardas *et al.*, 1998; Jardas, 1999).

Parallel to this obvious increase in fishing effort, the catch of fish and invertebrates stagnated from year to year in the coastal areas and it is indicated by the calculated regression coefficient $b = 19.07$ mt for the period 1980-1995 (Jardas and Pallaoro, 1997). The same trends of increase in fishing gears (fishing effort) and landings from the coastal eastern Adriatic was reported for the 1970-1978 period (Basioli, 1979a, 1979b; Jardas, 1980a, 1980b; Jardas, 1982). Moreover, calculated catch regression coefficient in that interval was negative, i.e. $b = -162.3$ mt. This trend of fishing effort and landings is one of the indicators of overfishing of exploited communities which, as has been shown, is reflected in the quantities in experimental bottom trammel net catches (Jardas *et al.*, 1998c; Jardas, 1999).

Near shore ichthyo-settlement composition and abundance as well as their changes were studied, with some interruptions, in the area of «Kornati» National Park from 1960 to 1992 (Jardas *et al.*, 1995). Three periods can be distinguished and were compared: 1960-1964, 1979-1982 and 1987-1992. It was assumed that species catch composition and abundance over the time reflected changes in the structure and abundance of exploited populations. Of fishes, the families of Labridae, Scorpaenidae and Sparidae were best represented in the catches with the species *Symphodus tinca* (21,3%), *Scorpaena porcus* (12,8%), *S. notata* (9,1%) and *S. scrofa*, *Diplodus vulgaris* (4,6%), *Spicara maena* (3,3%), *Serranus scriba* (3,2%) etc. Catch data showed that total catch (fish, cephalopods and crustaceans) were being constantly reduced. Catch weight per net had decreased by almost two thirds and the number of individuals almost a halved in the period of study (1960-1964). The presence of catches of more than 0.8 kg per net also dropped, particularly that of the catch between 1.5-2 kg and of more than 2 kg (they had already disappeared in the 1979-1982 period). The occurrence of poor catches of less than 0.8 kg and particularly of those less than 0.5 kg per net increased (Jardas *et al.*, 1995). This state of nearshore ichthyosettlements is presumably mostly due to

overfishing as fishing was totally out of control for rather a long period in the area of «Kornati» National Park.

Regarding the situation in the Croatian coastal waters, it may be said 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 bottom trammel net than the “inner areas” (Morović, 1965, 1970, 1971). This may be confirmed by the data on Palagruža Islands (Jardas *et al.*, 1996; Jardas *et al.*, 1998c; Jardas, 1999). Around these islands, far away from the mainland and any other island, the average catches were considerably higher all the time when compared to the catches in other coastal areas. However, it should be emphasized that these differences have recently decreased. The disappearance of these differences has already recorded by Morović (1971) who compared the experimental bottom trammel net catch data from the outer islands Lastovo, Sv Andrija and Palagruža with those from “inner areas” for the 1962-1965 and 1968-1970 periods. Moreover, data for the Palagruža area also confirmed these observations (Jardas *et al.*, 1996; Jardas *et al.*, 1998c).

The qualitative changes in experimental bottom trammel net catches in the area of Palagruža Islands have been recorded as an alternate presence of different dominant fish families of the coastal area: presence of Scorpaenidae has increased and that of Labridae and Serranidae and of *Chromis chromis* has declined. Throughout the study area the numerical and weight abundance of the fishes *Scorpaena porcus*, *Symphodus tinca*, the decapod crustacean *Maja crispata* and the cephalopod *Sepia officinalis* have steadily increased in the bottom trammel net catches, whereas that of the fish *Mullus* spp. and the cephalopod *Octopus vulgaris* decreased. In addition to these qualitative changes average length and weight of *Scorpaena porcus*, *Symphodus tinca* and *Mullus surmuletus* have increased probably due to density-dependent effects of communities and populations. Density-dependent effects cause reduction in inter- and intra-specific relations and consequently natural mortality favouring individual growth and development (Jardas *et al.*, 1998c).

Jardas (1979a) presented the state of the coastal communities of fishes, cephalopod and crustaceans along the eastern Adriatic coast and perspective of catch, and reported (Jardas, 1979b) on species composition and quantities caught by bottom trammel net along the eastern Adriatic. Basioli (1979a, 1979b) noted that “An increase in small-scale fisheries is not followed by catch increase”. Cetinić *et al.* (1987) presented the results of catches by «tramata» fishing (three types of fishing using ropes: «ludar», «zagonica» and «fružata») and discussed the selectivity and efficiency of these gears. Jardas *et al.* (1988) published a preliminary note on management of coastal resources along the Croatian coast by regulation of mesh size selectivity of fishing gears.

The analysis of catches by «strašin» (seine net) and its impact on ichthyocenosis is described by Cetinić and Pallaoro (1990a). The same authors reported the effect of fishing by «kogol» (seine net) on the communities in the areas of northern and central Adriatic (Cetinić and Pallaoro 1990b). Jardas and Pallaoro (1991) presented data about the effect of fishing by the trammel net called «poponica» on the fish communities on the eastern Adriatic coast. Cetinić and Pallaoro (1992) reported on the presence of Centranchidae species in the catches of «strašin», «kogol», «tartana», and «migavica». These authors also presented some exploitation characteristics and the effect of «tramata» fishing (fishing using ropes) in the areas of Savudrija, Island Korčula and Island Lastovo (Cetinić and Pallaoro, 1993). Pallaoro and Cetinić (1993b) described the qualitative and quantitative composition of «ludar» catch (fishing using ropes) on the western coast of the Istra Peninsula. Kačić *et al.* (1992) published

the results of fishery biology studies carried out in the Tarska Vala bay. Kraljević *et al.* (1993) and Kraljević *et al.* (1994) presented ichthyological analysis of catches from Mirna Estuary (Istra Peninsula) by specifically constructed tow nets with bag called «ciplarice» (mullet net-big seine net) which are only used in the area of the Mirna Estuary-Tar Cove. The catch of six coastal fishing gears were analysed for the presence of Sparidae fishes and out of 18 Sparidae species and subspecies in the Adriatic 16 were recorded (Jardas *et al.*, 1998b). With the exception of «tramata» all other target fishing gears harvested Sparidae in small quantities (traumata: 96% in number and 98% in weight; other gears ranged from 6.5% to 26.0% in number and from 2.6% to 26.5% in weight of total catch), the most commonly caught Sparidae proved to be *Oblada melanura*, *Sarpa salpa*, *Diplodus* spp., *Pagellus erythrinus*, and *Boops boops* (Jardas *et al.*, 1998b). Škorjanec (1998) analysed the effect of Norway lobster fishing with traps of different mesh size on populations in Brač and Hvar channel.

The principals of proper management of living resources of the sea, the aim of modern strategy for the development of sea fisheries and early stages of protection along the Croatian coast were discussed by Cetinić *et al.* (1998). Catch composition and occurrence of immature specimens in catches of coastal bottom otter trawl (“tartana” type) were presented by Cetinić *et al.* (1999a), who also analysed the proportion of immature specimens in the catch of the common trammel net with 56 mm mesh size and in the catch of fishing using ropes («tramata»). Preliminary data on catch efficiency of small beach seine were also given by Dulčić *et al.* (1999b).

The effects on Norway lobster population of fishing with pots of different mesh size (36, 40 and 44 mm) were investigated by Soldo *et al.*, (1999). From this study it resulted that all three kinds of pots have no particularly negative influence on Norway lobster population. The effects of this fishing practice for Norway lobster were also discussed by Homen (1983) and Obradović *et al.* (1991). Cetinić *et al.* (1999b) described the effects of «migavica» beach seine on coastal fish communities. The name of this gear, which refers to the behaviour of the net mesh during fishing, originates from the Croatian word meaning «to blink». This is the most important and widely used bottom beach seine along the Croatian coast mainly targeting picarels (*Spicara smaris*). The results of this study concluded that this gear can adversely affect the exploited fish communities.

A study on dredge catches has been carried out for the first time in the eastern part of the Adriatic Sea in 1999 (Cetinić and Soldo, 1999). This paper described the dredge used (locally known as «rampon») and assessed its selectivity toward the primary catch, the Great Mediterranean scallop, *Pecten jacobaeus*. The stock of *P. jacobaeus* in the western coast of Istra Peninsula (Northern Adriatic) available for the dredge fishing was found not to be endangered at present, and current level of harvest was considered sustainable (Cetinić and Soldo, 1999). Cetinić *et al.* (1999c) investigated the interactions between fishing with bottom trawl, Norway lobster traps and fishing nets called «prostice» (32 mm mesh size) for catching hake in Velebit channel, together with observations on local Norway lobster and hake populations.

Bosnić (2000) investigate the efficiency and effect of «bukvara» (gillnet for bogue fishing, total length up to 100 m) with different mesh sizes (22, 24, 26, 26/28 and 28 mm) on fish assemblages. Vlašić (2000) briefly described the effect of fishing with long-line on *Trigla lucerna*. Soldo (2001) investigated the effect of coastal fishing with «tartana» (coastal bottom otter trawl). Cetinić *et al.* (2001) and Soldo *et al.* (2001) reported on the effect of «psare» net

and lobster trap fishing on the population of *Palinurus elephas* and *Hommarus gammarus*. The qualitative and quantitative composition of catch was analysed, and for the target species data about length, weight, the gonad maturity stage and the alimentation were gathered. Dulčić *et al.* (2001) studied the pot fishing of Norway lobster in the Velebit channel. Jardas *et al.* (2001) reported about the cuttlefish (*Sepia officinalis*) catch by the bottom trammel net along the Croatian coast. Soldo *et al.* (2001) and Soldo *et al.* (2002) studied the lobster and hake fishing with gillnets along the Croatian coast, respectively. Cetinić *et al.* (2002) described the «tramata» fishing (fishing technique which uses vibrating ropes) and its exploitation characteristics on Sparidae species based on research work conducted from 1986 to 1999. This study showed that tramata fishing is not harmful to coastal communities of fish and invertebrates, and that, areas in which tramata fishing is currently allowed could be expanded, albeit under controlled conditions. Perić (2002) provides some preliminary results on the effect of the net called «gavunare» on the population of *Atherina hepsetus*. Data about investigations of gear effects on the fish assemblages in the Croatian coastal area are summarised in Table 2.

Table 2. Chronological summary of investigations on fishing gear effects on the fish assemblage in the Croatian coastal area.

Year	Area of investigation	Gear	Note	Author
1951-1953	Croatian coast	Small coastal trawl «tartana»	Coastal resources	Županović (1956, 1963)
1953-1957	Island Dugi otok	Beach seine «migavica»	Coastal resources	Morović (1962, 1963)
1958-1961	Split area	Beam trawl	Coastal resources	Morović (1962, 1963)
1960-1964	mid-Adriatic coastal area	Trammel bottom sets	Coastal resources	Morović (1965)
1962-1965 1968-1970	Islands Lastovo, Sv. Andrija and Palagruža	Trammel bottom sets	Coastal resources	Morović (1971)
1960-1994	Coastal area of Kornati Islands, Split, mid-Dalmatian Islands, Palagruža, southern Adriatic – Montenegro coast	Trammel bottom sets	Coastal resources	Jardas <i>et al.</i> (1998c) Jardas (1999)
1961-1989	Palagruža Islands	Trammel bottom sets	Coastal resources	Jardas <i>et al.</i> (1996)
1962-1992	Kornati Islands	Trammel bottom sets	Coastal resources	Jardas <i>et al.</i> (1995)
1985-1986	Along the Croatian coast	«tramata» fishing («ludar», «zagonica», «fružata»)	Coastal resources	Cetinić <i>et al.</i> (1987)
1980-1990	Along the Croatian coast	«strašin», «kogol», «tartana», «migavica»	Family Centracanthidae	Cetinić & Pallaoro (1992)

Year	Area of investigation	Gear	Note	Author
1980-1989	North and Central Adriatic (Croatian coast)	Seine net «kogol»	Coastal resources	Cetinić & Pallaoro (1990b)
1980-1992	Savudrija, Island Korčula,	«tramata» (using	Coastal resources	Cetinić & Pallaoro

	Island Lastovo	ropes)		(1993)
1988	Island Krk	«ludar»	Coastal resources	Cetinić <i>et al.</i> (1989)
1989-1992	Western coast of Istra	«ludar» (using ropes)	Coastal resources	Pallaoro & Cetinić (1993b)
1980-1994	Tar Cove, Mirna Estuary, Istra	Mullet nets-big seine net, tow net «ciplarica»	Coastal resources	Kraljević <i>et al.</i> (1993, 1994)
1980-1990	Croatian coastal area	«tartana»	Coastal resources	Cetinić <i>et al.</i> (1999a)
1995-2000	Tar cove, Neretva estuary, Cetina estuary, Kornati archipelago	Small beach seine	Fish juveniles	Dulčić <i>et al.</i> (1999b)
1980-1982	Velebit channel	Pots for Norway lobster	Norway lobster	Homen (1983)
1989-1992	Velebit channel	Pots for Norway lobster	Norway lobster	Obradović <i>et al.</i> (1991)
1997	Hvar and Brač channel	Pots for Norway lobster	Norway lobster	Soldo <i>et al.</i> (1999)
1992-1996	Šibenik area (central Adriatic)	Coastal beach seine «migavica»	Coastal resources	Cetinić <i>et al.</i> (1999b)
March – July 1997	Two stations (Umag, Rovinj)	Dredge («rampon»)	Pilgrim's scallop	Cetinić & Soldo (1999)
1986-1996	Along the Croatian coast	trammel bottom sets, «strašin», «kogol», «tartana», coastal beach seine, «tramata»	Sparidae	Jardas <i>et al.</i> (1998b)
1986-1999	Middle Adriatic	«tramata» fishing	Sparidae	Cetinić <i>et al.</i> (2002)
1998	Velebit channel	Traps for Norway lobster	Norway lobster	Cetinić <i>et al.</i> (1999c)

Year	Area of investigation	Gear	Note	Author
1998	Velebit channel	«prostice» (32 mm mesh size)	Hake	Cetinić <i>et al.</i> (1999c)
1999	Zadar area	«bukvare» gillnet for fishing bogue	Coastal fish assemblage	Bosnić (2000)
1999	Island Korčula	Long line hook	<i>Trigla lucerna</i>	Vlašić (2000)
1999-2000	Brač channel	«tartana»	Coastal resources	Soldo (2001)
1999-2000	Western coast of Istra, mid-Dalmatian Islands	Lobster trap, «psare» nets	<i>Homarus gammarus</i> , <i>Palinurus elephas</i>	Cetinić <i>et al.</i> (2001), Soldo <i>et al.</i> (2001)
1998	Velebit channel	Trap for Norway lobster	Norway lobster	Dulčić <i>et al.</i> (2001)
1999-2000	Mid-Dalmatian Islands	«trammel» bottom sets	<i>Sepia officinalis</i>	Jardas <i>et al.</i> (2001)
1998-2000	Along the Croatian coast	Gillnet	Lobster, hake	Soldo <i>et al.</i> (2001), Soldo <i>et al.</i> (2002)
1986-1999	Along the Croatian coast	«tramata»	Sparidae	Cetinić <i>et al.</i> (2002)
1997	Island Čiovo (northern coast)	«gavunare»	<i>Atherina hepsetus</i>	Perić (2002)
2002-2003	Northern Adriatic and channels in the mid Adriatic	fish traps, long line hook, «prostice»	<i>M. merluccius</i> , <i>M. barbatus</i> , <i>P. erythrinus</i> , <i>N. norvegicus</i> , <i>E. moschata</i>	DeMMon Project (Vrgoc, pers. com.)

3.3 Studies on inshore juvenile fish populations

Katavić (1980) studied temporal distribution of young mullets (Mugilidae) in the coastal waters of the central eastern Adriatic. Kraljević and Jug-Dujaković (1987) reported preliminary ecological and biological studies of juvenile fish species of commercial interest in the National Park «Kornati». Jug-Dujaković (1988) presented a contribution to the knowledge on ecology of juveniles of some economically important fish species in the coastal waters of Šibenik area (eastern central Adriatic). Kraljević and Pallaoro (1991) studied ichthyocenosis of shallow coves of the National Park «Kornati». Katavić (1995a, 1995b) compiled data on the qualitative and quantitative composition of fingerlings of the economically important fish species found in the Makirina cove (Pirovac Bay, eastern central Adriatic) and the Morinje cove (near Šibenik) during the spring-summer period. Abundance of food and the characteristics of ecological conditions of these sites favour fast growth of fingerlings, especially of the members of the Sparidae and Mugilidae families.

It has been found that the share of a species in the catch depends primarily on the local physical and hydrographical characteristics, as well as on the spawning season and migratory pattern of the fingerlings from the open waters to the coastal waters. In general, the available data constitute a good basis for assessing the significance of coves for the management of coastal fishery resources. It is of utmost importance to protect the natural habitats of the fingerlings, since the wealth of Adriatic fisheries and survival of the fish population will largely depend on it. Temporal fluctuations of species composition and abundance of fish juveniles in the National Park «Kornati» were studied over 12 months from January to December 1992 (Dulčić *et al.*, 1997). The community was dominated numerically by a few species: *Atherina hepsetus* (45,9 %), *Sarpa salpa* (21,2 %), *Diplodus vulgaris* (10, 5%) and *Symphodus ocellatus* (7,0 %), constituting over 84,58 % of the total catch. Results were compared to the abiotic factors leading to the conclusion that only a low amount of variation of the abundance variable field can be explained by temperature, salinity and dissolved oxygen. Dulčić *et al.* (1998) analysed the composition of juvenile fish populations in the Donji Molunat Bay (southern Adriatic) during summer. Matić *et al.* (2001) obtained preliminary results on spatial and temporal variability in the composition of inshore juvenile fish populations along the west coast of Istra (northern Adriatic). Those results provide a basis for future studies on aspects that may influence the seasonal distribution and abundance of juvenile fishes along the west coast of Istra. Dulčić *et al.* (2002) provided evidence to suggest that shallow water habitats inside sheltered coves could play an important role as nurseries for species occurring in such areas for short periods and at small sizes, as well as species that spend most or all of their juvenile phase in sheltered coves.

4. Further considerations on Adriatic fish

During the last 25 years, changes in the quantitative and qualitative composition of the Adriatic ichthyofauna have been noted. The numbers of thermophilic species have increased; several species, previously scarce or rare, have become more abundant, while others are new. There are also some examples of the disappearance or increasing scarcity of some species. It is believed that these observations can be related to oceanographic changes in the Adriatic Sea.

The impact of other potential factors is less well understood at present, but it is also likely that biological invasion (particularly as a consequence of the construction of the Suez Canal), overfishing by humans, and the consequent changes in the balance of the food chain, have had a significant impact on fish populations in the Adriatic over the last decades. There is a clear need for further research to elucidate pattern and process in Adriatic fish biodiversity.

Although the Adriatic Sea is considered to be a relatively well studied part of the Mediterranean Sea, the number of species mentioned in the Table above is witness to the significant number of new species of marine flora and fauna that are still being recorded. Particular emphasis is given to the rising number of new records of fish in the last thirty years in the Adriatic, some of which are yet to be described. This has been attributed in part to increased research, coupled with changes in techniques which allow access to previously inaccessible habitats, and observation *in vivo*. It is also clear, however, that these changes are also attributable to real changes in population dynamics during this period. Most importantly, the increase in the number of species clearly correlates with inter-annual shifts in climatic and oceanographic processes, as do events such as episodes of mass mortality.

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Review of Croatian selected scientific literature on species mostly exploited by the national small-scale fisheries*

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Abstract

The paper reviews and compiles selected scientific information on the Croatian species mainly exploited by the national small-scale fisheries. The document provides a description of each species including distribution, biological data and fishery exploitation information.

Keywords: artisanal fishing; fisheries resources; coastal fisheries; MED, Adriatic Sea; MED; Croatia

Pecten jacobaeus L.

Family: Pectiniidae

EN: Great Mediterranean scallop

HR: Jakovljeva kapica

Distribution and biological data

Although present throughout the Adriatic coastal waters *Pecten jacobaeus* occurs in commercially harvestable quantities in the Northern Adriatic only. Distribution is related to the bottom type and depth, i.e. the species occurs mostly on sandy, sandy-loamy, and sandy-muddy-loamy sea beds and does not descend below 69-72 m. The maximum size (shell length) is 15 cm, although shell lengths of 16.2 cm have been reported in the Adriatic. The upper shell is flat and brownish-red; the lower one being convex, whitish-brown and with 15-18 pronounced and angled ribs. Like most scallops, it is hermaphroditic. Based on results of investigations on the reproductive cycle, spawning was found to begin at the temperature of 13-14°C and to reach the maximum intensity in spring at 18°C. The minimum legal size for commercial harvesting of the species is 6 cm corresponding to the shell length at which sexual maturity is reached.

Exploitation

The results of the study done by Cetinić and Soldo (1999) show that this is not an endangered species in the eastern part of the northern Adriatic. The currently used commercial dredge is appropriately constructed because it does not catch overly large amounts of small, young scallops. Low catches, a limited fishing area and 3 months during which the species is not harvested together allow for continual recruitment of new generations.

* Publisher's note: interested readers may also refer to "Vrgoč, N., Arneri, E., Jukić-Peladić S., Krstulović Šifner, S., Mannini, P., Marčeta B., Osmani, K., Piccinetti, C., Ungaro, N. 2004. Review of current knowledge on shared demersal stocks of the Adriatic Sea. FAO-MiPAF Scientific Cooperation to Support Responsible Fisheries in the Adriatic Sea. GCP/RER/010/ITA/TD-12. *AdriaMed Technical Documents*, 12: 91 pp."

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Sepia officinalis Linnaeus, 1758

Family: Sepiidae

EN: Common cuttlefish

HR: Sipa

Species description

Body is oval, rounded at the posterior and bordered throughout its length by a narrow fin. The mouth is surrounded by 8 non-retractile arms and 2 long, retractile tentacles that are inserted laterally. In males the fourth left arm is hectocotylosed. The cuttlebone is rounded at the anterior and posterior, with a weak spine visible in juveniles, but embedded in chiti in adults. Being a mimetic species, the colour of the body is very variable, i.e. specimens show different colour patterns according to the substrate. Specimens are generally yellowish or marked with blotches or long vinelike bands, depending on the state of expansion of the chromatophores (Jardas, 1996).

Distribution

The Common cuttlefish is found throughout the Mediterranean basin and the eastern Atlantic Ocean, from the Baltic Sea to about 17° N. It is a demersal species and is more abundant in coastal waters on muddy and sandy bottoms covered with seaweed and phanerogames, but its distribution can be extended to about 200 m (Jardas, 1996). Common cuttlefish inhabits the entire coastal part of the Adriatic Sea and it migrates seasonally. In winter it resides mostly in the circalittoral zone where it matures sexually. In spring, it migrates to the more shallow infralittoral region to spawn and lay eggs (Jardas, 1996). In the central and northern Adriatic it occurs predominantly on sandy and muddy bottoms up to 100-150 m depth (Županović and Jardas, 1989). In the southern Adriatic, in the colder part of the year, Common cuttlefish population is densest at a depth from 50 to 60 m, while during the warmer part of the year it migrates closer to the coast for spawning and tends to concentrate between 10 and 30 m depth. In autumn, it moves to deeper waters and at this time of year it is most abundant at depths between 40 and 50 m. In spring, the population density is uniform up to 60 m, but it can be also found, in small quantities, up to 110 m (Jardas, 1996).

Biological data

As with most cephalopod species, population dynamics and stock assessment characteristics of common cuttlefish are insufficiently investigated in the Adriatic Sea. This species can reach 35 cm maximum (mantle length, ML), but usual length ranges between 15 to 20 cm. Longevity is 18 to 30 months. This is a demersal, neritic species that inhabits muddy and sandy sediments. It is particularly active during the night. In daytime it adopts a sedentary lifestyle, often burrowing into the sand.

The (mantle) length-weight relationship shows negative allometry (for the eastern Adriatic coast): females $a=0.2326$, $b=2.7307$, males $a=0.2433$, $b=2.6938$, males and females $a=0.2366$, $b=2.7195$ (Jardas *et al.*, 2001). This relationship also shows negative allometry (for the western coast of Istra): both sexes $a=0.3384$ and $b=2.584$ (Cetinić *et al.*, 2003).

The spawning period of the species extends throughout the year with peaks in spring and summer. In the northern and middle Adriatic it reproduces in April and May, but females with mature eggs can even be found in June and July. In the southern Adriatic, it spawns

from February to September, but with a peak from April to June. Diameter of eggs is from 6 to 8 mm. The length of the mantle is about 10 cm at sexual maturity. The Common cuttlefish is an active predator. It feeds mostly on crustaceans, especially decapods, and fish. In absence of food it can adopt cannibalistic behaviour (Jardas, 1996).

Exploitation

Common cuttlefish is an important commercial resource and one of the most appreciated cephalopod species. It is caught mainly with bottom and «rapido» trawl nets but trammel nets, fyke nets and specific pots are used as well. In the Adriatic Sea, cuttlefish is also, together with squid, an important target of the small-scale, artisanal and recreational fishing activities. The trammel net proved to be the most efficient gear for fishing of the cuttlefish on the sandy-rock seabed. Grubišić (1982) reported that the national recorded average annual catch is of about 212 tonnes, but he also pointed out that it is probably much higher. Dujmušić (2000) approximated the catch of common cuttlefish in 1998 as of 65 415 kg (the largest part from the Zadar area, estimated at 41 392 kg).

***Homarus gammarus* (Linnaeus, 1758)**

Family: Nephropidae

EN: European lobster

HR: Hlap

Distribution

Eastern Atlantic from north-western Norway (Lofoten Islands) south to the Azores and the Atlantic coast of Morocco. Also along the northwest coast of the Black Sea and in the Mediterranean (but lacking in the extreme eastern part, east of Crete). Not present in the Baltic Sea.

Biological data

The European lobster lives on the continental shelf between 0 and 150 m depth; usually not deeper than 50 m. Found on hard substrates, rock or hard mud. The animals are nocturnal and territorial, living in holes and crevices. Females with eggs are found throughout almost all the year. The eggs are laid around July and carried for 10 or 11 months. Maximum total body length is about 60 cm (weight 5 to 6 kg), large size specimens are usually 23 to 50 cm. Total length range of European lobster in catches of bottom trammel sets was between 19.2 and 47.1 cm, while in catches of «psare» nets from 21.0 to 49.0 cm TL. Total length range in catches of «komiška» pots (mesh size 55 mm) was from 28 to 50 cm TL (Cetinić *et al.*, 2001). Sex ratio (in catches of bottom trammel sets) was 1.89:1 in favour of males, 1.63:1 in favour of males (in catches of «psare»), and 1.13:1 in favour of males (in catches of pots) (Cetinić *et al.*, 2001).

Exploitation

Grubišić (1982) reported the national average annual catch of European lobster together with common spiny lobster at around 18 tonnes. It could be caught by bottom trammel nets, «psare» net and «komiška» pots (pots for catching lobsters). This species has a very high price on the market. The percentage of immature specimens (below 36 cm TL) was 88.09% in catches of «psare» nets and 76.74% in catches of bottom trammel sets (Cetinić *et al.*, 2001).

Nephrops norvegicus (Linnaeus, 1758)

Family: Nephropidae

EN: Norway lobster

HR: Škamp

Species description

Norway lobster is a medium to large sized crustacean decapod with well-calcified teguments, very pronounced rostrum, carapace and chelae, reduced pedunculated eyes and non-imbricated abdominal pleurae. The body is long and, more or less, laterally flat. There are 3 to 4 bones on the dorsal and 1 to 2 on the ventral side of cephalothorax. The belly is long and ends with a fan-shaped telson that enables lobster to swim. However, when moving, it walks more than it swims.

The first pair of cephalic appendices has composite eyes with a mobile peduncle. The first antennae are short and forked. The second ones are long and simple. The telson is long with two pronounced bones at the apex. The first pair of legs is well developed with strong chelae. The second and third are thinner and have chelae as well.

Norway lobster is orange coloured with orange-red bands on chelae and on the anterior part of the cephalothorax.

Distribution

According to Relini *et al.* (1999), the zoogeographic range of Norway lobster is the eastern Atlantic, from Morocco to Norway and Iceland, including parts of the Mediterranean Sea.

The species was recorded at depths of about 30 m in the northern Adriatic to 400 m in the south part of the Sea (Karlovac, 1953; Vrgoč, 1995). In the northern part of the open Adriatic it can be found off Ancona. The densest population is in the Jabuka/Pomo Pit region. There are rich settlements in the Velebit channel, Kvarner and Kvarnerić region (Crnković, 1963).

Since the distribution range of the species in the Adriatic is continuous, particular Norway lobster settlements cannot be regarded as isolated (Karlovac, 1953). Nevertheless some differences, primarily in length frequencies among the settlements around Ancona and the Jabuka/Pomo Pit, as well as among the settlements in the northeastern Adriatic channels and the Jabuka/Pomo Pit (Županović and Jardas, 1989) do exist.

Earlier, Norway lobster was seen as a boreal residue from the ice age. This hypothesis was later refuted (Karlovac, 1953). It was realised that the decisive factor for the diffusion of the species in the Adriatic was the type of sea sediment, not the temperature (Županović and Jardas, 1989). Norway lobster is a mud-dwelling species that is not restricted to a particular biocenosis, or a biocenotical zone. This is certainly related to its habit of digging burrows for shelter (Crnković, 1963).

Biological data

Nephrops norvegicus has separate sexes. Males are, in average, larger than females. Although Fisher *et al.* (1987) show its maximal size is 24 cm total length (TL), larger specimens can be caught, primarily in the northern Adriatic. Crnković (1963), for example, found specimens up

to 26.5 cm TL in northern Adriatic channels. Two different measures are used in fishery and biological research: total length and carapace length (CL). Cetinić *et al.* (1999) presented the TL-CL relationship for Norway lobster in the Velebit channel (for both sexes) with parameters: $a = -1.0035$ and $b = 3.5507$, while Šarčević (1992) reported CL-weight relationship for Norway lobster in Jabuka/Pomo Pit (for both sexes) with parameters: $a = 0.0098$ and $b=3.217$.

The growth of Norway lobster, as in other crustaceans, is a discontinuous process with a succession of moults separated by the intermoult periods. During each moult, the old exoskeleton is shed and the animal grows very quickly before the new exoskeleton hardens. A well-defined moulting periodicity was not found among juveniles, they seem to moult all year round. There is a moult synchronism in the adult population. It could be generally said that, in the Mediterranean, females have one moulting period a year (December-March), right after hatching the eggs. The moulting period of grown males is in late summer and autumn (August-October). In the Adriatic, grown males have moult peak between June and September. The frequency of gastroliths was always very low in adult females, so that little can be said about their moult cycle, except that adult females do not moult between August and January when they carry external eggs.

In the Adriatic, Norway lobster spawns once a year. The proportion of females with a mature ovary, i.e. in which ovoverdins storage is at maximum (dark green colour), peaks in spring or at the beginning of summer. The presence of berried females was found in October and November, but some specimens can be observed up to late spring. According to Karlovac (1953), Norway lobster larvae are present in the Adriatic plankton from January to April, that is late winter. The sex ratio changes through the year. The proportion of females in catch is lower when they carry external eggs because they are less active and hide more in burrows. On the other hand, the proportion grows and is higher than 1 in the mating period (Crnković, 1963; Jukić, 1971).

The sex ratio in Velebit channel was 1:1.34 in favour of females (Cetinić *et al.*, 1999). Data about the length at sexual maturity at different localities has been estimated at 95-100 mm TL (northern Adriatic, Karlovac, 1953), 35 mm CL (Velebit channel, Cetinić *et al.*, 1999). Males grow larger than females. Differences in growth dynamics among settlements could be observed. They are consequence of differences in ecological conditions of the habitats.

The parameters of Von Bertalanffy Growth Function (VBGF) are: Jabuka/Pomo Pit, males+females: $L_{\infty}=215$ mm TL, $K=0.215$ yr⁻¹, $t_0=-0.23$ (Bhattacharya method; Šarčević, 1992); Open Adriatic, males $L_{\infty}=227$ mm TL, $K=0.324$ yr⁻¹, $t_0=-0.29$ (Bhattacharya method), females: $L_{\infty}=179$ mm TL, $K=0.397$ yr⁻¹, $t_0=-0.03$ yr⁻¹ (Vrgoč, 1995). Norway lobster feeds mainly on other decapod crustaceans, and to a lesser extent with other crustaceans (euphausiids and peracarids) and fish. Parts of carapace, shells, gastropod, vertebra and fish otoliths were found in Norway lobster stomachs. It was also determined that the stomach was the least full in summer, that it is in the period when gonads grow most intensively and take up the maximal volume of the body cavity (Jardas, 1996).

Exploitation

In the Adriatic, catch of Norway lobster fluctuates significantly during day and night (circadian fluctuation), and during the year (seasonal fluctuation) (Crnković, 1970;

Županović and Jardas, 1989). Generally the catch is highest at sunrise and sunset most probably due to behaviour of the species. Norway lobster spends the greatest part of its life buried in burrows in the sea sediment and goes out only in search for food before dawn and at dusk. This kind of behaviour is more obvious in younger specimens and ovigerous females. Because of this, different parts of the population are vulnerable to fishing gear at different times of day.

Seasonal fluctuations exist for the same reason: the catch is biggest in spring, when the sex ratio is in favour of females, while in winter the catch is at a minimum. In the Adriatic Sea, Norway lobster is fished primarily with two types of gears: the majority of the catch is by bottom trawl nets and the rest by traps. Catch per pot was 19.76 g (0.57 specimens) and varied between 0.20 and 0.82 specimens per pot in Velebit channel (Cetinić *et al.*, 1999).

Palinurus elephas (Fabricius, 1787)

Family: Palinuridae

EN: Common spiny lobster

HR: Jastog

Distribution

Eastern Atlantic, from southwestern Norway to Morocco, also in the Mediterranean, except the extreme eastern and southeastern parts.

Biological data

The common spiny lobster lives on rocky bottoms, rarely on sand, in depths from 5 to 160 m, mostly between 10 and 70 m. Ovigerous females are present from September-October to February-March. Maximum total body length is 50 cm, but usually not larger than 40 cm. Total length range of spiny common lobster in catches of bottom trammel sets was between 10.8 and 43.8 cm, while in catches of «psare» nets from 10.1 to 45.0 cm TL. Total length range in catches of «komiška» pots (mesh size 55 mm) was from 20 to 39.8 cm TL (Cetinić *et al.*, 2001). Sex ratio (in catches of bottom trammel net) was 1.31:1 in favour of males, 1.24:1 in favour of males (in catches of «psare»), and 1.58:1 in favour of males (in catches of pots) (Cetinić *et al.*, 2001). The parameters of the length-weight relationship (for the Palagruža Island) are: $a=0.0459$ and $b=2.85$, indicating negative allometric growth (Dulčić *et al.*, 1995a). The parameters of the length-weight relationship (lobsters caught by pots): $a=0.0437$ and $b=2.857$, indicating negative allometric growth (females; Cetinić *et al.*, 1997). The sex ratio was established as 2.1:1 in favour of males (Cetinić *et al.*, 1997).

Exploitation

Grubišić (1982) reported that the national average annual catch of the common spiny lobster together with common spiny lobster is around 18 tonnes. It could be catch by bottom trammel sets, «psare» net and «komiška» pots (pots for catching lobsters). It has a very high price on the market. The percentage of immature specimens (below 27 cm TL) was 80.77% in catches of «psare» nets, 77.33% in catches of bottom trammel sets (Cetinić *et al.*, 2001), and 57.19% in catches of pots.

Atherina (Hepsetia) hepsetus Linnaeus, 1758

Family: Atherinidae

EN: Mediterranean sand smelt

HR: Gavun, brfun

Species description

The body is rather long, slender and moderately flattened. The mouth is protrusible, upwardly directed with small teeth; the head and body are scaly. The lower jaw has an upper expansion within the mouth (high dentary bone). Two separate dorsal fins, all rays of first and 1-2 anterior rays of second dorsal fin are unsegmented, the remaining rays segmented. The anal fin is similar to the second dorsal fin while the caudal fin is forked. There are no teeth on pterygoid bones. Dorsal finrays VII-X, I+10-12, anal finrays I+II-13. Scales in longitudinal series 59-65.

Distribution

It is common in the Mediterranean, Black Sea and Caspian Sea. It also occurs in Atlantic, from Spain to Morocco including Madeira (rather rare) (Jardas, 1996). It is common in the Adriatic Sea (especially in lagoons and estuaries) (Jardas, 1996).

Biological data

Mediterranean sand smelt is a small pelagic species in littoral areas, often near the shore (Jardas, 1996). It is gregarious, sometimes in marine lagoons and estuaries. As a carnivorous species, it feeds on pelagic copepods and benthic crustaceans. It spawns from December to May (in the Mediterranean). It can reach 3-4 years old. The maximum size is 20 cm, but usually in catches it is about 15 cm (Jardas, 1996).

Exploitation

The catch of the sand smelt in 1998 (Croatian waters) was 14 827 kg (Dujmušić, 2000). The major small-scale fishing gears exploiting this species in Croatian waters are the coastal beach seines, small mesh size (10 mm) gill nets and liftnets.

Atherina (Hepsetia) boyeri Risso, 1810

Family: Atherinidae

EN: Big-scale sand smelt

HR: Oliga

Species description

Body rather long, slender, moderately flattened. Mouth protractible, upwardly directed, small teeth. Head and body scaly. Lower jaw with an upper expansion within mouth (dentary bone high). Two separate dorsal fins, all rays of first and 1-2 anterior rays of second dorsal fin unsegmented, the remaining rays segmented. The anal fin is similar to the second dorsal fin while the caudal fin is forked. The first dorsal fin has 6-10 flexible spines.

There is no distinct lateral line, there are rather large cycloid scales. Back is bluish or greenish, translucent, with small black dots chiefly on rear edge of each scale. Belly is whitish, often iridescent. D (VI) VII-VIII (IX), I+ (9) 10-13 (15), A I+ (12) 13-15 (18). Scales in longitudinal series (39) 4-48 (49).

Distribution

The Big-scale sand smelt is very common in the whole Mediterranean (Adriatic included) and adjacent seas (the Azov and the Black Sea) and along north-eastern Atlantic coast from Scotland to Morocco and Azores (Jardas, 1996).

Biological data

Big scale sand-smelt is a small pelagic, very eurihalyne fish species which occurs near the surface in the littoral estuarine zone: in lagoons, salt marshes (77 psu), shallow brackish areas (2 psu) and inland waters which are rather unsuitable for other fish species, due to their high ionic strength and salinity (Jardas, 1996).

It is a carnivorous species feeding on zooplankton and small bottom-living animals (crustacean gammarids, polychaete worms and molluscs).

Reproduction takes place in spring months (from April to July) in brackish (2 psu) and hyperhaline waters (42 psu) (Jardas, 1996). Individuals of big scale sand-smelt were collected monthly during the spawning season from March to July 2000 in the Pantana lagoon (eastern central Adriatic, near the city of Split). Specimens ranged between 4.3 and 11.8 cm TL.

Age determination based on scale reading showed that the population has a life cycle of four years. Growth in length for both sexes was expressed through the following VBGF parameters: $L_{\infty}=17.21$, $K=0.201 \text{ yr}^{-1}$ and $t_0=-1.0285$ (Pallaoro *et al.*, 2002). The slopes (b-values) of the total length-weight regressions, which do not differ significantly between sexes, indicate isometric growth for both females ($b=2.942$) and males ($b=2.947$). The overall ratio was 1:1.03 in favour of females. Males were dominant in smaller and females in larger length classes. All individuals larger than 10.9 cm TL were females (Pallaoro *et al.*, 2002). The maximum size of this specimen is 13 cm (usually in catch 7-9 cm) (Jardas, 1996).

Exploitation

The total mortality rate of the big-scale sand smelt in Pantana Lagoon was $Z=1.891 \text{ yr}^{-1}$ and the natural mortality $M=0.867 \text{ yr}^{-1}$. The exploitation rate, $E=0.542$, revealed a high fishing pressure on the stock in the studied area (Pallaoro *et al.*, 2002). This species is a relatively important commercial fish in the Croatian coastal fisheries. Jardas (1996) reported that the annual catch of big-scale sand smelt does not exceed 30 tonnes.

According to Dujmušić (2000), the catch in 1998 (in Croatian waters) was 9 291 kg of which the most, about 6 800 kg, from the Split area.

The major small-scale fishing gears exploiting this species in Croatian waters are coastal beach seines, small mesh size (10 mm) gill nets and liftnets.

***Seriola dumerili* (Risso, 1810)**

Family: Carangidae

EN: Greater amberjack

HR: Gof

Species description

The teeth in both jaws are minute in a broad band anteriorly, tapering posteriorly. The end of the upper jaw is broad. The soft anal fin base is distinctly shorter than dorsal fin base; in adults, length of dorsal fin lobe almost equal or slightly longer than pectoral fin and 13-18% of fork length. The anterior margin of first pterygiophore of anal fin is moderately concave. Caudal peduncle grooves present; lateral line without scutes.

Distribution

It occurs in the eastern Atlantic, from Mediterranean to Gulf of Biscay and reported as a rare vagrant to British coast; Nova Scotia to Brazil, South Africa, Arabian Gulf, Australia, Japan and Hawaiian Islands. It is present along the eastern Adriatic coast, most abundant in the southern Adriatic (Jardas, 1996).

Biological data

Seriola dumerili is both an epibenthic and a pelagic species, often near reefs or at depth offshore holes or drop-offs, usually in small to moderate schools but may be solitary. It is usually found from 18 to 72 m depth, but may occur up to 360 m; small juveniles associate with flotsam in oceanic or offshore neritic waters. It feeds primarily on fish and also on invertebrates (Jardas, 1996). It could reach 188 cm TL (80.6 kg), but commonly reaches 110 cm (Jardas, 1996). The sex ratio is (eastern Adriatic) 1.06:1 in favour of males (Kožul *et al.*, 2001). The parameters of the length-weight relationship are $a=0.000123$ and $b=2.847$, indicating negative allometric growth (Kožul *et al.*, 2001). The parameters of the VBGF are: $L_{\infty}=174.6$ cm, $K=0.190$ yr⁻¹, $t_0=-0.314$, while maximum age is estimated to be 10 years (Kožul *et al.*, 2001).

Exploitation

Total mortality has been estimated to be $Z=0.41$ yr⁻¹, natural mortality $M=0.30$ yr⁻¹ and fishing mortality as $F=0.11$ yr⁻¹. The exploitation rate $E=0.27$ would indicated a low fishing pressure on the population in the investigated region (Kožul *et al.*, 2001). Grubišić (1982) reported the average annual catch (in the eastern Adriatic) at about 30 tonnes.

Spicara smaris (Linnaeus, 1758)

Family: Centracanthidae

EN: Picarel

HR: Gira oblica

Species description

A rather elongated fish with a single dorsal and a forked caudal fin. Premaxillaries are very protractile; small and conical teeth, arranged in more than 1 row in the jaws. No opercular spines, scales ctenoid. Colour is grey-brown above while silvery below.

Distribution

The picarel inhabits seagrass beds and muddy bottoms at about 15-100 m depth. It is distributed in the Mediterranean and Black Seas, and in the Atlantic from Portugal to Morocco and Canary Islands (Jardas, 1996). It is common in the eastern Adriatic, especially in the central part (Jardas, 1996).

Biological data

A sequential protogynous hermaphrodite, picarel shows sexual dimorphism only during reproductive period (Zei, 1941, 1949). Spawning takes place from February to May (Jardas, 1996). The maximum standard length is 15 cm for females, while 20 cm SL for males (Tortonese, 1986). The slopes (b values) of the total length-weight regression indicated negative allometric growth for females ($b=2.8$) and isometric growth for males ($b=3.08$) for the period April-May 1999 in the eastern central Adriatic. In a study by Dulčić *et al.* (2003) the length of sampled individuals ranged from 6.3 to 19.8 cm TL, and the weight from 2.2 to 78.3 g. The oldest female and male were 4 and 6 years, respectively. The von Bertalanffy growth function parameters for the sexes combined were $L_{\infty}=22.76$ cm, $K=0.277$ yr⁻¹ and $t_0=-0.739$. The overall sex ratio was 1:4.1 in favour of females, probably a result of protogynous hermaphroditism. Individuals larger than 17.9 cm TL were all males.

Exploitation

The picarel is very important for Mediterranean fishery production as well as for the national fishery production of Croatia (the number of fisherman in the small-scale fishery in Croatia was 9 060 in 1999). Between 1995 and 1999, the mean annual Croatian picarel landings were around 600 metric tonnes (Jardas, 1996). In 1998, the catch of picarel was 91 033 kg of which the largest part (38 805 kg) was from the Zadar area in the central Adriatic (Dujmušić, 2000). The natural mortality is high $M=0.62$ yr⁻¹, while total mortality was $Z=0.98$ yr⁻¹ and the fishing mortality $F=0.36$ yr⁻¹ (Dulčić *et al.*, 2003).

***Spicara maena* (Linnaeus, 1758)**

Family: Centracanthidae

EN: Blotched picarel

HR: Modrak, tragalj

Species description

A rather elongated fish with a single dorsal and a forked caudal fin. Premaxillaries are very protractile; small and conical teeth, arranged in more than 1 row in the jaws. Head elevated posteriorly in large specimens. Colour is bluish-grey above, sides silvery, usually with some dark spots, one of which is larger than in other picarel species.

Distribution

It occurs in the Mediterranean, Black Sea, in the Atlantic from Portugal to Morocco and the Canaries; common fish species along the Croatian coast (Jardas, 1996).

Biological data

The blotched picarel is usually found on Posidonia beds, rocks and mud down to about 100 m depth. It is a protogynous hermaphrodite species (Jardas, 1996). Reproduction is from August to October, according to the area (Tortonese, 1986). In a study by Dulčić *et al.* (2000) in the eastern central Adriatic, length size in samples ranged from 7.8 to 27.5 cm TL, while weight varied between 5.2 and 298 g. The von Bertalanffy growth equation was fitted on the basis of mean length-at-age data resulting in parameter values of $L_{\infty}=24.82$, $K=0.532 \text{ yr}^{-1}$, and $t_0=-0.089$. Weight increased allometrically for both sexes together with $b=3.12$ (Dulčić *et al.*, 2000). The blotched picarel is a relatively long-lived species. The oldest male and female were estimated to be 8 and 3 years old, respectively. The sex ratio was skewed in favour of males 1.41:1. Sex reversal was mainly observed between 17.5 and 18.0 cm TL. Females were observed up to a total length of 19.8 cm (Dulčić *et al.*, 2000). Dulčić and Kraljević (1996a) presented the values of the length-weight relationship of blotched picarel for the Croatian coastal waters: $a=0.0122$ and $b=3.037$.

Exploitation

Blotched picarel make a significant component of the beach seine catch in Croatian coastal fishery (around 60 t annually; Jardas, 1996). It represents in number 2.74 % (1.59% in weight) of the catches of tramata fishing (Cetinić *et al.*, 2002). Total (Z) and natural (M) mortality were 1.18 and 0.98 yr^{-1} , respectively. The exploitation rate $E=0.17$ indicated the picarel stock as lightly exploited (Dulčić *et al.*, 2000).

***Labrus merula* Linnaeus, 1758**

Family: Labridae

EN: Brown wrasse

HR: Vrana

Species description

Body moderately elongate. Head broad, shorter or equal to body depth. Strong canine-like teeth (rounded in old specimens). Lips with 6-9 folds. Soft part of dorsal fin higher than long and higher than spiny part. D XVII-XIX + 11-14; A III + 8-12. Colour in young is green with light spots or brownish, belly paler, yellowish, greyish or silvered, sometimes an opalescent blue-whitish longitudinal stripe on sides. Old specimens are habitually dark blue, sometimes dark green or brownish, belly paler. Soft part of dorsal, anal and caudal fins outlined with light blue; some light blue spots on head.

Distribution

It occurs in the Mediterranean and eastern Atlantic from Portugal to Morocco and the Azores (Jardas, 1996). It is common in the middle and southern Adriatic (Jardas, 1996).

Biological data

Brown wrasse inhabits the littoral zone (1-50 m) around rocks and seaweed (Jardas, 1996). It feeds on sea urchins, ophiuroids, molluscs, crabs and worms (Dulčić, 1999). It could reach 45 cm SL, but is usually 30-40 cm. It is mature at the age of when 2 years (15-20 cm SL) and maximum age is 16-17 years (when 7 years old males measure 31.5 cm and females 30 cm) (Jardas, 1996).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) to be around 7 tonnes.

Symphodus (Crenilabrus) tinca (Linnaeus, 1758)

Family: Labridae

EN: Peacock wrasse

HR: Lumbrak

Species description

Body oval, laterally flattened. Mouth rather small, more or less protrusible. Head generally longer than body depth. Snout longer or equal to post-orbital. Rather strong canine-like teeth. There are a few cephalic pores on the snout; lips with 6-9 folds. Colour reflects sexual dimorphism. Both sexes with a small dark spot at base of caudal fin and a dark blotch just above pectoral fin; absent in juveniles, more or less evident in adults. Many darker spots on body forming 3 or 4 indistinct longitudinal stripes. Females and juveniles are grey-greenish or brownish, fading to a silvery colour on the belly. Males are more brightly coloured, especially in the breeding season. Pale green, green-bluish or green-yellowish, longitudinal rows of red spots, upper part of head dark blue.

Distribution

It occurs in the whole Mediterranean, including the Black Sea and the eastern Atlantic from northern Spain to Morocco (Jardas, 1996). It is very common in the Adriatic Sea (Jardas, 1996).

Biological data

This gregarious littoral fish is found on rocky reefs covered by algae or in sea-grass meadows, sometimes in salty lagoons, at depths ranging from 1 to 50 m (Jardas, 1996). Peacock wrasse feeds on sea urchins, ophiuroids, bivalves, shrimps and crabs (Jardas, 1996). It reproduces from April to May in the Adriatic Sea (Jardas, 1996). In a study by Pallaoro and Jardas (2003) the overall sex ratio was found 1.43:1 in favour of males. All individuals larger than 28.9 cm TL were males as an effect of faster growth. The oldest females were 12 and the oldest males 13 years old. The parameters of the VBGF were estimated for females ($L_{\infty}=28.18$, $K=0.293 \text{ yr}^{-1}$, $t_0=-0.7821$) and males ($L_{\infty}=42.24$, $K=0.214 \text{ yr}^{-1}$, $t_0=-0.629$). The slopes (b values) of total length-weight regression indicated allometric growth for males $b=2.705$ ($a=0.0296$) and both sexes $b=2.8147$ ($a=0.0220$) and isometric growth for females $b=2.9901$ ($a=0.0131$) (Pallaoro and Jardas, 2003).

Exploitation

Although very common in the Adriatic, this species is of little commercial value along the Croatian coast and annual catch is about 10 tonnes (Grubišić, 1982; Jardas, 1996). Trammel net is the main fishing gear catching peacock wrasse. Estimated survival rate (Chapman and Robson equation) of males ($S=0.80$) was slightly greater than that for females ($S=0.76$) (Pallaoro and Jardas, 2003).

***Merluccius merluccius* (Linnaeus, 1758)**
(Sin. *Merluccius vulgaris* Fleming, 1818)
Family: Merlucciidae

EN: European hake

HR: Oslić, mol

Species description

Body is long and cylindrical. The widest part is behind head. Mouth is large. There are two dorsal fins. The first one is short and triangular and the second one is long. The anal fin is similar in shape and size to the second dorsal fin. The ventral fins are placed before the pectoral ones. The caudal fin is cut in a straight line. The colour is slate grey above and lighter on sides. Belly is whitish. The number of rays in particular fins as follows: D1: 8-10, D2: 35-40, A: 36-40, P: 12-14, V: 7 (Jardas, 1996).

Distribution

European hake inhabit the northeastern Atlantic from Norway to Mauritania and the entire Mediterranean. In the Black Sea it occurs along the southern coasts only (Jardas, 1996). According to available data, hake is distributed throughout the Adriatic. It is a distinctively eurytopic species.

Bathymetric distribution of the species in the Adriatic is from only several meters in the coastal area to 800 m in the South Adriatic Pit (Županović and Jardas, 1986). It is not fished in limited areas to the north of the Po delta. This nektobenthonic species is most abundant from 100 to 200 m depth. In daytime it stays on the bottom and moves to higher strata in the night (Jardas, 1996). In spring months, there are local movements of sexually immature adolescent hakes to more shallow channel waters of the central eastern Adriatic. The adult hake can mostly be found at depths between 100 and 150 m. In spring, the adults migrate to more shallow coastal waters because of spawning, the immature hake in search of food. In the winter period, after spawning, adult fish migrate to deeper water, wintering together with the juveniles (Županović and Jardas, 1989). In the southern Adriatic, the largest individuals are fished in water deeper than 200 m, whereas medium-sized fish occur within the 100 m depth stratum.

European hake prefers muddy bottoms, but it is well distributed on other types of bottom as well (muddy-sandy and sandy bottoms). It is most abundant in the open central Adriatic (the Jabuka/Pomo Pit) and further southwards (Županović and Jardas, 1986).

Biological data

According to Jardas (1996) hake can grow to 130 cm TL. However usual length is from 10 to 60 cm TL. In Velebit channel the length range of hake was observed between 11 and 63 cm TL (from catches of nets for hake called «oslićare») (Cetinić *et al.*, 1999). This is a long-lived species, it can live more than 20 years. In the Adriatic, however, the exploited stock is composed mainly of 2-year-old individuals. Jardas (1976) found out that the length-weight

relationship could be divided into three phases according to coefficient b: juvenile, adolescent and adult (Males: juvenile-adult = 2.625-3.235; Females: juvenile-adult = 3.033-2.862). In the Adriatic, hake spawns throughout the year, but with different intensity.

The spawn peaks are in the summer and winter period (Županović, 1968; Županović and Jardas, 1986, 1989). Hake is a partial spawner. Females spawn usually 4 or 5 time without the ovaries resting. Ovaries of about 70 cm long females in the pre-spawning stage can contain more than 400 000 oocytes. The earliest spawning in the Jabuka/Pomo Pit occurs in winter in deeper water (up to 200 m). As the season progresses, in the spring-summer period spawning takes place in shallower water. Recruitment of young hakes into the stock has two maxima: the first one is in spring and second one in autumn.

In the Jabuka/Pomo Pit, both of these maxima can be linked to hake's more intense summer and winter spawning period in the central Adriatic (Županović and Jardas, 1989). Nursery areas are located close to the Jabuka/Pomo Pit, between 150 and 200 m, on the upper part of slope and off the Gargano Cape (Županović and Jardas, 1989). Different data about the size at sexual maturity of hake in the Adriatic Sea, given by different authors, are shown in Table 1.

Table 1. Length at sexual maturity of European hake in the Adriatic Sea.

Authors	Sex	Total length (TL) (cm)
Zeï (1949)	Males	22-30
Županović (1968)	Males	20-28
	Females	26-33
Jukić and Piccinetti (1981)	Males	26-33
Županović and Jardas (1986)	Males	20-28
	Females	23-33
Cetinić <i>et al.</i> (1999)	Males+Females (Velebit channel)	24

Differences in the growth dynamics between males and females are reported in Table 2. Females usually attain larger size than males, who grow more slowly after maturation (during the third or fourth year of life). Consequently, proportion of males in the population is higher in lower length classes and proportion of females is higher at greater lengths. In the central and northern Adriatic, females already start dominating the population at the length of about 30-33 cm TL. Over 38-40 cm, almost all the specimens are females (Vrgoč, 2000).

Table 2. Growth parameters (VBGF) for European hake.

Authors	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)
Jukić and Piccinetti (1988)	M+F	85.0	0.12	-
Alegria-Hernandez and Jukić (1990)	M+F	92.83	0.097	-0.629
Vrgoč (1995)	M+F	83.27	0.125	-0.73
Vrgoč (2000)	M+F	77.95	0.130	
Marano (1996)	M	57	0.17	-0.83
	F	67.5	0.159	-0.436
	M+F	67.5	0.144	-0.877

Until about the length of 16 cm TL, the European hake feeds mostly on crustaceans (euphasiacea, mysidacea, amphipoda). During that period, it occurs mostly in the Jabuka/Pomo Pit and the southern Adriatic Pit region. Their migration to the eastern Adriatic channel regions is linked to the change of the feeding regime as they start feeding on fish, primarily *Sardina pilchardus*, *Sprattus sprattus phalericus*, *Engraulis encrasicolus*, *Scomber scombrus*, *Trachurus trachurus* etc. Cephalopods were found in hake stomachs as well (Jukić, 1972; Jardas, 1976).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of hake at about 200 tonnes. Dujmušić (2000) approximated the catch of hake in 1998 as of 106 411 kg (the largest catch was approximated from the Zadar area: 62 088 kg).

The mean catch by passive nets targeting hake in the Velebit channel (catch per 100 m of net) is about 1.30 kg (Cetinić *et al.*, 1999).

***Liza aurata* (Risso, 1810)**

Family: Mugilidae

EN: Golden grey mullet

HR: Cipal zlatac

Species description

The body is elongated, more or less cylindrical, the head is broad, space between eyes is about equal to the width of the mouth cleft; adipose eyelid rudimentary. The upper lip is thin, less than pupil diameter. No pectoral axillary scale. Scales on the head extend forward to the level of the posterior nostril. The colour is back grey/blue, flanks and belly pale or silvery with a golden blotch on operculum.

Distribution

Liza aurata inhabits Atlantic coasts from the Azores and Madeira northward to the British Isles and southern coasts of Norway and Sweden (but not Baltic). It is present in the whole Mediterranean and Black Sea, and has been introduced into the Azov and Caspian Seas. Elsewhere, to the south, Cape Verde Islands and Senegal and in the northern part of the Red Sea. It is common in the Adriatic Sea (along the Croatian coast), especially in the estuary areas (Morović, 1960; Jardas, 1996).

Biological data

Golden grey mullet is a pelagic species, usually inshore, entering lagoons and estuaries, but rarely moves into freshwater. It feeds on small benthic organisms, detritus, occasionally insects and plankton (Jardas, 1996). The data of a series of authors on the spawning season of golden grey mullet differ considerably. Jug-Dujaković (1988) indicated the spawning season from mid-October to December (in the Adriatic). Morović (1960) reported spawning season from December to February, while Grubišić (1982) from January to March. Finally, Kraljević *et al.* (1994) pointed it is from October to December in the eastern Adriatic.

The parameters of the length-weight relationship for the golden grey mullet from the Mirna Estuary-Tar cove (Istra) varied between years: $a=0.0088$, $b=2.951$ (1989), $a=0.0046$, $b=3.143$ (1990) and $a=0.0054$, $b=3.122$ (1991) (Kraljević *et al.*, 1994). The values of the length-weight relationship from samples collected along the Croatian coast were $a=0.0091$ and $b=2.952$ (Dulčić and Kraljević, 1996a). The theoretical maximum length was estimated (for Mirna Estuary, Tar cove) to be $L_{\infty}=398$ mm (Kraljević and Dulčić, 1996) and it is not unrealistic since the largest specimen sampled during the surveys was 418 mm. Jardas (1996) reported the maximum size of 50 cm SL (standard length). The growth coefficient was computed as $K=0.21 \text{ yr}^{-1}$. The maximum age was 11+ years; most of the specimens were between 3+ and 8+ years old. The mean condition factor was estimated to be 0.77 (Kraljević and Dulčić, 1996).

Exploitation

The golden grey mullet is the target of commercial fishery along the eastern Adriatic coast, the total catch has been reported at about 280 tonnes in 1991 according to FAO statistics and makes a significant component of Croatian coastal catches. Grubišić (1982) reported the

average annual Croatian catch at about 50 tonnes. Family Mugilidae was numerically dominant in the catches in the Mirna Estuary (Tar Cove) contributing to 93.6% of the total catch (over the period of eight years) of which *L. aurata* constituted about 89%.

The values of the total mortality (Z), natural mortality (M), fishing mortality (F) and exploitation rate (E), for the Mirna Estuary have been estimated as: $Z=0.649 \text{ yr}^{-1}$, $M=0.387 \text{ yr}^{-1}$, $F=0.262 \text{ yr}^{-1}$ and $E=0.404$ (Kraljević *et al.*, 1994). Subsequently total (Z) and natural (M) mortality rates were estimated at 1.12 yr^{-1} and 0.44 yr^{-1} , respectively.

The exploitation rate ($E=0.61$) indicates that the fishing pressure on the golden grey mullet was high in the Mirna Estuary (Kraljević and Dulčić, 1996).

***Liza ramada* (Risso, 1826)**

Family: Mugilidae

EN: Thinlip grey mullet

HR: Cipal balavac

Species description

The body is cylindrical, the head broad, a little rounded between the eyes. The space between the eyes is about equal to the width of the mouth cleft. Adipose eyelid poorly developed. The upper lip is thin, less than pupil diameter, corner of mouth cleft reaching to below posterior nostril; hind edge of pre-orbital round. Pectoral axillary scale rudimentary or absent. Scales on head extend forward to the level of the front nostril. The back is a grey/blue colour, the flanks and belly pale or silvery, usually with feeble longitudinal stripes along scale rows. Black axillary spot is at pectoral fin base.

Distribution

Thin-lip grey mullet is distributed along the Atlantic coasts from the Azores and Madeira northwards to the British Isles (except northern parts of Scotland), North Sea and southern part of Baltic, mainly appearing in summer-time in northern parts of range. It is also present in the whole Mediterranean and Black Sea. Southward is present to Cape Verde Islands and Senegal (Jardas, 1996). It is common in the eastern Adriatic (Jardas, 1996).

Biological data

It is a pelagic species, usually occurring inshore, entering lagoons and estuaries and rivers. It feeds on epiphytic algae, detritus and small benthic or planktonic organisms (Jardas, 1996). The analysis of gonad state and the occurrence of juveniles showed that the spawning season (in the eastern central Adriatic) extended at least over December and January (Sinovčić *et al.*, 1986). The length-weight relationship shows (Šibenik area, eastern middle Adriatic) negative allometry during the time of sexual inactivity ($a=0.0102$, $b=2.931$) (Sinovčić *et al.*, 1986). The parameters of the VBGF are: $L_{\infty}=52.5$ cm, $K=0.25$ yr⁻¹ and $t_0=-0.1$, the maximum age is estimated at 8+ years and the length at sexual maturity at 18 cm (Sinovčić *et al.*, 1986).

Exploitation

Natural mortality estimate is $M=0.25$ yr⁻¹, total mortality (Z) varied from 0.29 (for age class 3+ to 4+) to 1.27 yr⁻¹ (for age class 5+ to 6+) and the exploitation rate (E) varied from 0.626 (7+ to 8+) to 0.814 (5+ to 6+) indicating that fishing pressure on the thinlip grey mullet is very high (Sinovčić *et al.*, 1986). Grubišić (1982) reported the national average annual catch at about 50 tonnes.

Mullus barbatus Linnaeus, 1758

Family: Mullidae

EN: Red mullet

HR: Trlja blatarica

Species description

The body is long, strong, and laterally slightly flat. The head is relatively short, the snout is short as well, with a steep anterior profile. The eyes are positioned near the top of the head. The mouth is small, positioned low on the head. There are two barbells under the mouth aperture. They have a sensory function and are used in searching for prey. Number or rays in fins is the following: D1 VII-VIII, D2 I + 7-8, A: II + 6-7, P: 15-17, V: I+5 (Jardas, 1996). The colour is rather uniformly pink. Back is darker and belly white. Fins are without any well-defined coloration (Jardas, 1996).

Distribution

Red mullet is distributed in the eastern Atlantic, from the North Sea and England to Senegal, and in the Mediterranean. It is uniformly distributed in all parts of the Adriatic (Jardas, 1996).

Biological data

This is a benthic species mostly found on muddy grounds in the depth range from 5 to 250 m. It prefers more shallow waters of the northern and central Adriatic, i.e. depth above 100 m, while only few specimens may be caught in deeper waters. Red mullet can attain the length of about 30 cm TL (about 0.5 kg), but usual size in the catch is from 10 to 20 cm (Jardas, 1996). On average, females have larger body length than males. This is because they grow faster, which can already be noticed in the first year of their life. The length-weight relationship shows that the species grows almost isometrically (males: $a=0.0065$, $b=3.179$; females: $a=0.00847$, $b=3.082$, Županović, 1963; both sexes: $a=0.0076$, $b=3.136$, Dulčić and Kraljević, 1996a). Red mullet spawns in the Adriatic Sea in late spring and summer (Županović, 1963; Jardas, 1996). The sex ratio is extremely variable and depending on the different zones investigated. The parameters of the VBGF are: $L_{\infty}=27.0$ cm and $K=0.18$ yr⁻¹ (Jukić and Piccinetti, 1988) and $L_{\infty}=26.86$ and $K=0.295$ yr⁻¹ (Vrgoč, 2000). It is a carnivorous species, and bulk of its food is made of endo, meso and epibiontic sea organisms. Its food is constituted of Polychaeta, Lamellibranchiata and Crustacea (Jardas, 1996).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of *M. barbatus* and *M. surmuletus* together at about 266 tonnes.

Mullus surmuletus Linnaeus, 1758

Family: Mullidae

EN: Striped red mullet

HR: Trlja kamenjarka

Species description

The body is moderately compressed. The snout is longer and less deep than *Mullus barbatus*. Maxilla at most reaching below anterior eye margin. A pair of stout barbells under chin, their length greater than that of pectoral fins. Opercle without spine. Small villiform teeth on lower jaw; upper jaw toothless; teeth also present on vomer and palatines. Colour is reddish with brown edges on the scale margins, pink on the sides with three lengthwise yellow bands; the first dorsal fin yellowish with dark markings, mainly on the upper part of the fin membrane.

Distribution

Mullus surmuletus is distributed along the coasts of Europe from the English Channel (rare in the North Sea) to Gibraltar, also northern part of West Africa to Dakar and in the Mediterranean, Black and Adriatic Seas (Jardas, 1996).

Biological data

It is a benthic species on broken and rough ground but also taken in fair quantities over sand and soft bottoms at depths less than 100 m. It feeds on bottom organisms (crustaceans, chiefly shrimps and amphipods, polychaetes, molluscs and benthic fishes (Jardas, 1996). Striped red mullet could reach 40 cm Standard Length (SL), but usually 20-25 cm specimens are found. It spawns from May to July (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.025$ and $b= 3.512$, indicating positive allometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) of *Mullus surmuletus* and *Mullus barbatus* together at about 266 tonnes.

***Chromis chromis* (Linnaeus, 1758)**

Family: Pomacentridae

EN: Damselfish

HR: Crnelj

Species description

The body is oval, deep, laterally flattened. The head short, obtuse. There is a single nostril on each side, the mouth is small, protractile; jaws with small teeth. The eye is large. Small canine-like teeth in 3 rows on jaws. D XIII-XIV + 10-11; A II 10-12. Head fully scaled. Colour: very young specimens brilliant iridescent blue; young specimens with blue stripes and dorsal and anal fins outlined with blue and adults dark brown (Jardas, 1996).

Distribution

It occurs in the Mediterranean and from Portugal southwards to Angola (Jardas, 1996). It is very common in the Adriatic (Jardas, 1996).

Biological data

Chromis chromis inhabits littoral mainly in rocky areas from 3 to 35 m depth in small shoals in midwater above or near rocky reefs and above sea-grass meadows (*Posidonia*). It feeds on small or benthic species (Jardas, 1996). The main food components are Copepoda, Appendicularia, Cladocera, Gastropod larvae, Bivalve larvae, fish eggs and fish larvae (Dulčić, 1996). The parameters of the length-weight relationship are: $a=0.0164$ and $b=3.10$ (for both sexes), $a=0.0172$ and $b=3.08$ (for females), and $a=0.0138$ and $b=3.12$ (for males) (Dulčić and Kraljević, 1995; Dulčić *et al.*, 1994). The parameters of the VBGF have been estimated as $L_{\infty}=142$ mm, $K=0.26$ yr⁻¹, $t_0=-0.30$, while maximum age is 9 years (Dulčić and Kraljević, 1995). Fecundity ranged from 6 050 to 73 688 eggs (Dulčić and Kraljević, 1994). It could reach 15 cm SL, but usually from 8 to 10 cm.

Exploitation

Grubišić (1982) reported that the average annual catch (Croatian coast) is around 30 tonnes. The total mortality and natural mortality estimates are $Z=1.07$ yr⁻¹ and $M=0.72$ yr⁻¹. Fishing mortality was estimated as $F=0.35$ yr⁻¹ and the exploitation rate $E=0.35$ (Dulčić and Kraljević, 1995). The main fishing gear for damselfish is the coastal beach seine («migavica»).

Scorpaena porcus Linnaeus, 1758

Family: Scorpaenidae

EN: Black scorpionfish

HR: Škrpun

Species description

Head is large, snout slightly smaller than orbit diameter; preorbital bone usually with 2 spinous points over axilla; sub-orbital ridge with 2 or 3 spinous points; upper post-temporal spine present; other spines as for the genus. Occipital pit well developed. Pores at symphysis of lower jaw are small and separate. Supra-ocular tentacle usually about equal to orbit diameter; skin appendages well developed; no flaps on lower jaws; small dermal flaps associated with preorbital, preocular, parietal, nuchal and preopercular spines; other tentacles at anterior nostril, below sub-orbital ridge, on eye opercle flap, rarely on some body scales and some lateral line scales. D XII + 9; P 16-18. Colour is generally brownish, a light pigmented area between dorsal spines 8 and 9; fins variously spotted with brown; 3 vertical bars on caudal fin (Jardas, 1996).

Distribution

It is distributed in the Eastern Atlantic from the British Isles to Morocco, rare to Senegal; the Azores, the Canaries; Mediterranean including Black Sea. It is common in the Adriatic Sea (Jardas, 1996).

Biological data

The black scorpionfish is a benthic littoral species common among rocks and algae and may be found down to 800 m bottom depth (it could be solitary and sedentary) (Jardas, 1996). The diet includes small fishes (gobies, blennies), crustaceans and other invertebrates. It feeds on Phycophyta, Spermatophyta, Polychaeta, Mollusca, Crustacea and Pisces (Pallaoro and Jardas, 1991). It could reach the length of 25 cm, but usually of 15 cm (Jardas, 1996). The parameters of the length-weight relationship (eastern Adriatic) are: $a=0.0171$ and $b=3.034$, indicating isometric growth (Jardas and Pallaoro, 1992). The parameters of the VBGF are: $L_{\infty}=28.2$ cm, $K=0.182$ yr⁻¹, $t_0=-0.80$, while the maximum age was estimated as 11 years (Jardas and Pallaoro, 1992).

Exploitation

Grubišić (1982) reported the annual average catch in Croatia, together with that of the red scorpionfish, is of 178 tonnes.

Scorpaena scrofa Linnaeus, 1758

Family: Scorpaenidae

EN: Red scorpionfish

HR: Škrpina

Species description

Head large, snout longer than orbit diameter; preorbital bone with 3-4 spinous points over maxilla; sub-orbital ridge with 2-4 spinous points; upper post-temporal spine present. Occipital pit moderate. The pores at symphysis of lower jaw are small and separate. Supraocular tentacle usually small or absent; numerous tentacles present on the lower jaw, large skin flap associated with posterior preorbital spine and flaps on fourth and fifth preopercle spines. D XII + 9; A 18-20. Colour is variable from brick red to light pink with dark mottling or blotches; fins blotched with brown; distal part of pelvic fins usually dusky; dorsal fin with a back spot frequently present between spines 6 and 11.

Distribution

Red scorpionfish is present in the Eastern Atlantic from British Isles (rare) to Senegal, Madeira, Canary Islands, Cape Verde Islands; throughout Mediterranean except Black Sea (Jardas, 1996). It is common in the central and southern Adriatic (Jardas, 1996).

Biological data

Scorpaena scrofa is a benthic species occurring on rocky, sandy or muddy bottoms from 20 to 200 m bottom depth. It is a sedentary and solitary fish (Jardas, 1996). It feeds on fishes, crustaceans and molluscs (Šoljan and Karlovac, 1932). It could reach the length of 50 cm, usually up to 30 cm (Jardas, 1996). The parameters of the length-weight relationship (for the southern Adriatic) are: $a=7 \times 10^{-6}$ and $b=3.298$ indicating positive allometric growth (Dulčić *et al.*, 1995c).

Exploitation

Grubišić (1982) reported the annual average catch in Croatia, together with that of the black scorpionfish, is of 178 tonnes.

Solea solea
Family: Soleidae

EN: Common sole

HR: List, šfoja

Species description

The body is oval and flat; the upper eye less than its own diameter from dorsal profile of head. Anterior nostril on blind side not enlarged, its distance from front margin of head 1.5-1.9 times in its distance from cleft of mouth; anterior nostril on eyed side with a backward-pointing tube not or only barely reaching front border of lower eye. The dorsal fin begins on the upper profile of the head. Colour is greyish-brown on eyed side to reddish brown, with large and diffuse dark spots; pectoral fin on eyed side with a blackish blotch at posterior end of fin; hind part of caudal fin generally darker than the rest.

Distribution

The Common sole occurs in the eastern Atlantic (southward from Trondheim Fjord, also North Sea and western Baltic) and Mediterranean (also Sea of Marmora, Bosphorus and south-western Black Sea), and southward to Senegal (Jardas, 1996). It is common in the Adriatic, particularly in the northern and central part (Jardas, 1996).

Biological data

It is a demersal species dwelling on sandy and muddy bottoms, from the shore down to 200 m bottom depth. It feeds on polychaete worms, molluscs and small crustaceans (Jardas, 1996). Spawning takes place from January to April, with two peaks in February (Mediterranean), December-May (Bay of Biscay), April-June (North Sea). Common sole could reach 70 cm SL (Jardas, 1996). The parameters of the length-weight relationship (northern Adriatic-western Istrian coast) were estimated as $a=0.0016$ and $b=3.510$ (Cetinić *et al.*, 2003), indicating positive allometric growth. The parameters of the VBGF are: $L_{\infty}=40.1$ cm and $K=0.68$ yr⁻¹; the length at sexual maturity was estimated to be 30 cm (western Istrian coast) (Cetinić *et al.*, 2003). It could reach the maximum age of 7 years in the northern Adriatic (Croatian coast) (Cetinić *et al.*, 2003).

Exploitation

Total mortality is high with $Z=1.40$ yr⁻¹, while natural mortality values is estimated as $M=0.895$ yr⁻¹ and fishing mortality as $F=0.505$ yr⁻¹ (Cetinić *et al.*, 2003). Grubišić (1982) reported at that time the national average annual catch as about 30 tonnes.

***Boops boops* (Linnaeus, 1758)**

Family: Sparidae

EN: Bogue

HR: Bukva

Species description

The body is elongated and fusiform, moderately compressed: Eye large, diameter longer than snout. Mouth small, oblique; lips very thin. The teeth are incisiform, uniserial in both jaws. D XIII-XV + 12-16; A III + 14-16. Pectoral fin short, ending before anus. Colour is back greenish or bluish, sides silvery or golden with 3-5 longitudinal golden lines with small dark spot at the pectoral axil; lateral line is dark while fins are light (Jardas, 1996).

Distribution

Boops boops is distributed in the whole of the Mediterranean, rare in the Black Sea. In the eastern Atlantic it occurs from Norway (occasional) to Angola and oceanic islands; common from Bay of Biscay to Gibraltar. Elsewhere, it is present in the western Atlantic in Gulf of Mexico and Caribbean Sea. It is very common in the Adriatic Sea (Jardas, 1996).

Biological data

Bogue is a relatively common species in inshore waters, demersal or semipelagic above various bottoms (sand, mud, rocks, *Posidonia* beds), to 200 m (Mediterranean) or 300 m (Atlantic) (Jardas, 1996). It is a gregarious species that moves toward the surface during the night.

Bogue is omnivorous species whose juveniles are mostly carnivorous while the adults are mainly herbivorous.

It spawns from February to April (eastern Mediterranean), from April to May (western Mediterranean), from March to May (Atlantic) and in summer (Black Sea). The species is hermaphroditic (generally protogynous). The fecundity is about 350 000 eggs (at the size of 32 cm TL). Maturity is at the first year (about 13 cm length) in western Mediterranean. Bogue could reach a maximum of 36 cm TL, but usually the range is between 15 and 20 cm TL. The sex ratio has been reported in favour of males (1.25:1) (in the eastern central Adriatic), while it is about 60% females at range between 10 and 25 cm TL in the Mediterranean.

The allometric coefficient of the length-weight relationship $b=3.113$ indicates positive allometry in the eastern Adriatic ($a=0.0000644$) (Alegria-Hernandez, 1989). The parameters of the VBGF as estimated from eastern Adriatic samples are: $L_{\infty}=33.89$ cm, $K=0.167$ yr⁻¹ and $t_0=-1.296$ (Alegria-Hernandez, 1989). The oldest specimens were estimated to be 6 years old (Alegria-Hernandez, 1989). Length at sexual maturity has been estimated to be 13.2 cm for males and 14.7 cm TL for females (Alegria-Hernandez, 1990).

The bogue feeds on Spermatophyta, Thallophyta, Copepoda, Copelata, Chaetognatha, Decapoda larvae and fish eggs (Jukić, 1972; 1973). It feeds on a variety of animal groups.

Copepoda constitute the bulk (55.5%), followed by Copelata (38.3%) which characterizes it as a planktonphagous species (Jukić, 1972; 1973).

Exploitation

The values of natural mortality was calculated to be $M=0.207 \text{ yr}^{-1}$ (Alegria-Hernandez, 1986; 1989). Grubišić (1982) reported the national average annual catch at about 700 tonnes (about 2% of total catch of marine fishes) of which 500 t from the fish market of Split.

Fishing gears for catching bogue are purse seine and beach seine (during summer) and trawl and bottom trammel set (during winter). Dujmušić (2000) approximated the catch of bogue in 1998 as 81 884 kg (the largest part, 38 750 kg, was estimated to be from the Ploče and Dubrovnik area). Numerical abundance of bogue in the catch of the coastal fishing gears along the Croatian coast was 21.26% in coastal beach seine catch and 0.59% in "strašin" fishing catch (Jardas *et al.*, 1998). Bogue weight composition was 13.08% in trammel net and 0.35% in "strašin" fishing catch (Jardas *et al.*, 1998).

***Dentex (Dentex) dentex* (Linnaeus, 1758)**

Family: Sparidae

EN: Common dentex

HR: Zubatac

Species description

Body oblong, rather deep. Upper profile of head regularly convex in adults, almost straight in the young. Slight hump at forehead in the oldest specimens. D XI + 11-12; A III + 7-9. The length of dorsal spines increases to fourth or fifth then sub-equal. In young the colour is greyish, dorsally black spotted, pinkish at maturity, grey-blue in the oldest specimens; dorsal spots more or less shaded with age.

Distribution

The common dentex is present in the Mediterranean, most common south of 40° N (Spain, North Africa); Black Sea (very rare); Atlantic from Bay of Biscay to Cape Blanc and Madeira, exceptionally to the British Isles; elsewhere, southward to Senegal (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

Dentex dentex inhabits inshore waters on rocky bottoms to 200 m depth; it is more common between 15 and 50 m. Juveniles are gregarious, while the oldest individuals are solitary. It is a carnivorous species feeding on fish and molluscs. It reproduces in May (Mediterranean), and it is gonochoric fish, some specimens are hermaphrodite (Jardas, 1996). The common dentex could reach 100 cm SL, but is usually 35 or 50 cm. The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.064$ and $b=3.172$ (Dulčić and Kraljević, 1996a), indicating positive allometric growth.

Exploitation

Numerical contribution of common dentex to the coastal fishing gear catch along the Croatian coast was 0.37% in trammel net and 0.18% in tramata catches (Jardas *et al.*, 1998). Weight participation was 0.54% in trammel net and 2.05% in tramata catches (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch at about 60 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common Pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as of 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

Dentex gibbosus (Rafinesque, 1810)

Family: Sparidae

EN: Pink dentex

HR: Zubatac krunaš

General information

The body is oblong, rather deep; upper profile of head regularly convex in the young, strong hump on the forehead in the largest specimens. D XII + 10-11; A III + 7-9; two first dorsal spines are very short, the two or three following very long and filamentous in the young; first pelvic ray filamentous. Colour is reddish-silver; a little black spot behind the posterior end of dorsal fin; small dark areas at the pectoral axil and at the upper opercular margin; the caudal fin is pink with a narrow black margin.

Distribution

It inhabits the Mediterranean, more common south of 40° N and in the eastern Mediterranean (absent in the Gulf of Lion and in the Black Sea) and the Atlantic from Portugal to Angola, abundant from Cape Juby to Cape Verde (Jardas, 1996). In the Adriatic it can be found in the central and southern basins (Jardas, 1996).

Biological data

Dentex gibbosus occurs in inshore waters on rocky bottoms and sand around rocks between 20 and 220 m depth; young specimens stay closer to the shore than the adults. It is a carnivorous species (crustaceans, fish, cephalopods). Spawning takes place during spring; the species is hermaphroditic protandrous (50-70% males up to 50 cm body length) (Jardas, 1996). It could reach 100 SL, but usually from 35 to 60 cm (Jardas, 1996). The sex ratio is 1:1.21 in favour of females (eastern Adriatic) (Grubišić, 2002). The parameters of the length-weight relationship are: $a=0.088$ and $b=3.13$ (for both sexes), indicating positive allometric growth (Grubišić, 2002). The parameters of the VBGF are: $L_{\infty}=107.24$ cm, $K=0.12$ yr⁻¹ and $t_0=-0.90$, the maximum age is estimated of 16 years (Grubišić, 2002). Mean absolute fecundity of pink dentex (eastern Adriatic) is 1672×10^6 eggs, while the length at sexual maturity is estimated to be 41.5 cm (Grubišić, 2002).

Exploitation

Numerical occurrence of the pink dentex in trammel net catch from the Croatian coast was 0.02% and the weight share 0.02% (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch as about 2 tonnes. Total and natural mortality were found to be $Z=0.47$ yr⁻¹ and $M=0.23$ yr⁻¹ in the eastern Adriatic (Grubišić, 2002). The value of fishing mortality was calculated as $F=0.24$ yr⁻¹, the exploitation rate $E=0.51$ suggests that the stock was almost fully fished (Grubišić, 2002).

***Diplodus annularis* (Linnaeus, 1758)**

Family: Sparidae

EN: Annular seabream

HR: Špar

Species description

The body is oblong, the mouth terminal, 8 incisors in each jaw, molars at back of jaws in 2-4 upper and 2-3 lower series; 1-3 rows of small molars just behind incisors. D XI + 11-13; A III + 11-12. Colour is silvery grey, yellowish; one almost annular dark band around caudal peduncle just behind dorsal and anal fins; pelvis yellow, other fins light; small dark spot at the upper pectoral axil (Jardas, 1996).

Distribution

Diplodus annularis is common in the Mediterranean, Black Sea and Azov Sea, and in the Atlantic from Bay of Biscay to Gibraltar, Madeira and Canaries (Jardas, 1996). It is also very common in the Adriatic Sea (Jardas, 1996).

Biological data

Annular seabream is very common along the littoral area, on *Posidonia* beds and sandy bottoms, rarely on rocky bottoms, from 0 to 3 m (Atlantic and northern Mediterranean) or from 0 to 90 m (southern Mediterranean). It is a carnivorous species feeding on worms, crustaceans, molluscs, echinoderms and hydrozoans (Jardas, 1996). It feeds on macrobenthic algae, bivalves, marine phanerogames, Anthozoa, Polychaeta and Crustacea (juveniles), while adults on mollusca, decapoda, bivalvia, green algae and fish eggs (Matić-Skoko, 2003). Normally sexes are separate although some individuals can be hermaphroditic (protandrous). Sex ratio (in the eastern Adriatic) is 1:1.12 in favour of females (Matić-Skoko, 2003). The parameters of the length-weight-relationship are: $a=0.014$ and $b=3.073$ (Matić-Skoko, 2003). The parameters of the VBGF are: $L_{\infty}=22.6$ cm, $K=0.173$ yr⁻¹ and $t_0=-1.460$ (Matić-Skoko, 2003). The maximum age was estimated of 13 years (Matić-Skoko, 2003). Mean relative fecundity has been reported of 65389 eggs (Matić-Skoko, 2003). The length at sexual maturity is estimated to be 9.0 cm TL (Matić-Skoko, 2003).

Exploitation

Total and natural mortality (in the eastern Adriatic) were found to be $Z=0.725$ yr⁻¹ and $M=0.392$ yr⁻¹, while fishing mortality was $F=0.333$ yr⁻¹ (Matić-Skoko, 2003). The exploitation rate $E=0.459$ suggests that the stock was almost fully fished (Matić-Skoko, 2003). Grubišić (1982) reported the national average annual catch at about 30 tonnes. Fishing gears catching annular sea bream are: trawl, pots, coastal beach seine and trammel nets. Numerical participation of the Annular seabream in the catch of the coastal fishing gears along the Croatian coast was 12.50% in trammel net and 6.55% in "kogol" fishing catches and weight contribution was 5.25% in trammel net and 3.982% in "tramata" fishing catches (Jardas *et al.*, 1998).

Diplodus puntazzo (Cetti, 1777)

Family: Sparidae

EN: Sharpsnout seabream

HR: Pic

Species description

The body is oblong, the snout conical, lips thin. In each jaw, 8 incisors inclined forward (light brownish coloured); 1 or 2 series of rudimentary molars at back of jaws. D XI + 12-15; A III + 11-13. The first dorsal spin is very short. The colour is silvery grey, 11 to 13 transverse stripes, alternately very dark and paler; dark band in caudal peduncle; hind caudal edge dusky; other fins greyish, distally darker; very dark spot at the upper base of pectoral fin; general coloration fading with age and after death.

Distribution

It is very common throughout the Mediterranean, rare in Black Sea; Atlantic, common from Gibraltar to Sierra Leone, rare to the north (Bay of Biscay); absent in Madeira, present in the Canaries and the Cape Verde Islands (Jardas, 1986). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

Diplodus puntazzo lives in littoral waters on rocky bottoms to 150 m depth (more abundant around 60 m); juveniles occur near the coast and sometimes in brackish waters (deep lagoons); adults in breakers. It is an omnivorous species (algae, worms, mussels, shrimps) (Jardas, 1996). Maximum length is 60 cm SL, but usually 25-30 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0161$ and $b=2.951$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical participation of sharp-snout seabream in the coastal fishing gear catch along the Croatian coast was 0.46% in «tramata» and 0.30% in trammel net catches (Jardas *et al.*, 1998). Weight composition was 1.79% in «tramata» and 0.37% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch (in the eastern Adriatic) at about 15 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

***Diplodus sargus sargus* (Linnaeus, 1758)**

Family: Sparidae

EN: White seabream

HR: Šarag

Species description

The body is oblong, the lips thin; in each jaw, 8 incisors (exceptionally 10 in upper one); molars behind incisors and at back of jaws in several series, 3-4 (rarely 5) in upper, 2-3 (rarely 4) in lower jaw. D XI-XII (rarely XIII) + 12-15; A III + 12-14. Colour is silvery grey, inter-ocular space and snout darker; 9 transverse stripes alternately very dark and paler; dark saddle on caudal peduncle, just behind last dorsal rays; black spot at upper pectoral axil; dorsal and anal dusky, distally darker; hind caudal edge black.

Distribution

It is common in the Mediterranean and rare in the Black Sea (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Distribution

White seabream occurs in littoral waters on rocky bottoms and sand close to rocks, up to 50 m in Mediterranean, deeper in the Atlantic; young euryhaline, entering brackish waters and lagoons in spring, returning to sea at the end of autumn, where they live on *Posidonia* beds. Young specimens (to 10 cm) are omnivorous mainly feeding on algae and worms, small molluscs and hydrozoans, adults are carnivorous including worms, molluscs, crustaceans and echinoderms in their diet. It spawns from January to March (eastern Mediterranean), from March to June (western Mediterranean). This species is gonochoric or hermaphroditic protandrous. Individuals reach the sexual maturity at 2 years of age (about 17 cm). White seabream could reach 45 cm SL, but usually 20 or 25 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0149$ and $b=3.038$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical abundance of the white seabream in the coastal fishing gear catches along the Croatian coast was: 0.20% in «tramata» and 0.02% in trammel net catches (Jardas *et al.*, 1998). Weight composition was: 0.64% in «tramata» 0.37% in trammel net catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch from the eastern Adriatic (Croatian) coast at about 15 tonnes.

***Diplodus vulgaris* (E. Geoffrey Saint-Hilaire, 1817)**

Family: Sparidae

EN: Common two-banded seabream

HR: Fratar

Species description

The body is oblong, lips rather thick; in each jaw, 8 narrow incisors (light brownish coloured). D XI-XII + 13-16; A III + 12-15. Colour is generally grey, brownish to greenish; broad black band from nape to axil of pectorals and on upper margin of opercle; broad black band across caudal peduncle overlapping posterior bases of anal and dorsal fins; black spot at the upper pectoral axil, caudal fin dark, black distally; other fins dusky, darker distally.

Distribution

Diplodus vulgaris is common in all the Mediterranean, recorded in the Black Sea off Bulgaria; in the Atlantic from south of Brittany to Cape Verde Islands, Madeira and the Canaries; elsewhere, off Angola (Jardas, 1996). It is common in the Adriatic Sea (Jardas, 1996).

Biological data

The Common two-banded seabream is widespread species in littoral waters on rocky or sandy bottoms to 90 m (Atlantic), to 70 m depth (Mediterranean); juveniles occur on *Posidonia* beds and can enter into lagoons (Atlantic and exceptionally Mediterranean). This species is carnivorous feeding on crustaceans, molluscs and worms. It reproduces generally in October-November in the western Mediterranean and in December-January in the eastern Mediterranean. *Diplodus vulgaris* reaches sexual maturity at the age of 2 years (17 cm TL), it is potentially hermaphrodite. Maximum length is 45 cm TL, but usually 20-25 cm (Jardas, 1996). The parameters of the length-weight relationship (for the eastern Adriatic) are: $a=0.0138$ and $b=3.028$, indicating isometric growth (Dulčić and Kraljević, 1996a).

Exploitation

Numerical occurrence of the common two-banded sea bream in coastal fishing gear catches along the Croatian coast was 4.53% in «tramata» and 1.47% in bottom trammel net catches (Jardas *et al.*, 1998). Weight composition was 6.16% in «tramata» and 4.17% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the average annual catch (from Croatian coast) at about 15 tonnes. Dujmušić (2000) approximated for the year 1998 the pooled catch of common Pandora, common dentex, sharpsnout seabream, gilt-head seabream and common two-banded seabream as 105 458 kg (the largest part, 67 262 kg, from the area of Zadar).

Lithognathus mormyrus (Linnaeus, 1758)

Family: Sparidae

EN: Sand steenbras (also Striped sea bream)

HR: Ovčica, arkaj

Species description

The body is elongated and ovoid, well compressed. Upper profile of head gently curved, the snout is elongated and pointed. Posterior nostril is an oblique slit, just in front of eye. Scales on cheek and opercle, while peropercle is broad and scaleless. The eye is rather small. In front of each jaw, the outer series of conical teeth is slightly enlarged, followed by inner bands of shorter teeth. At the back of the jaw there are molariform teeth in 3-6 upper and 2-4 lower rows. D XI-XII+11-12, A III+10-11. The pectoral fin is short, ending well before anus. Lateral line scales 59-65 to caudal base. Colour is silvery grey, darker dorsally. There are 14-15 narrow, more or less dark. Transverse stripes. Interocular space and snout are dark brown. Dorsal and caudal fins are generally brownish, while other fins are lighter.

Distribution

The sand steenbras is widely distributed in the Mediterranean Sea (except the Black Sea), Atlantic (from Bay of Biscay to Cape of Good Hope), Red Sea and south-western Indian Ocean (Jardas, 1996).

Biological data

Lithognathus mormyrus inhabits littoral waters on sandy or sandy-muddy bottoms down to a maximum depth of 50 m (in the western Mediterranean), 80 m (eastern Mediterranean) or 150 m (Atlantic), but predominantly between 10 and 30 m (Jardas, 1996). It exceptionally enters Mediterranean lagoons. It is a protandrous hermaphrodite fish (Jardas, 1996). It is gregarious, sometimes in large schools. As a carnivorous species, it feeds on crustaceans, worms, molluscs and sea urchins (Jardas, 1996). The maximum size is 55 cm SL but usually in catches it is about 25 cm (Jardas, 1996). Spawning takes place in spring and summer. Sex ratio are given for length and age classes, indicating the males change sex mainly at the lengths between 25 and 32.5 cm, in age classes from 4 to 7, with more than 30% of the population changing sex in age class from 6 to 7 on the eastern coast of the Adriatic (Croatian coast) (Kraljević *et al.*, 1995). Males were also observed up to a length of 34.5 cm. Length-weight relationship shows no significant difference from isometric growth in winter ($b=3.05$) and a negative allometric growth in summer ($b=2.69$). The age composition has been estimated using the Bhattacharya method and additional observations of annual rings on scales. Six age classes were obtained from Kaštela Bay (age 3+: 21.7 cm, age 4+: 26.5 cm, age 5+: 28.4 cm, age 6+: 30.3 cm, age 7+: 31.6 cm, age 8+: 33.4 cm) and from Mirna Bay (age 2.5+: 19.4 cm, age 3.5+: 24.1 cm, age 4.5+: 26.9 cm, age 5.5+: 29.4 cm, age 6.5+: 31.3 cm, age 7.5+: 32.8 cm). Von Bertalanffy's growth function fitted to these mean length-at-age data resulted in the following parameter values: $L_{\infty}=36.2$ cm, $K=0.297$ yr⁻¹ and $t_0=-0.08$ (yr) for Kaštela Bay and $L_{\infty}=37.3$ cm, $K=0.262$ yr⁻¹ and $t_0=-0.39$ for Mirna Bay (Kraljević *et al.*, 1995). In a study conducted in the Northern Adriatic (west Istrian peninsula) the total length in the samples ranged from 19.4 to 37.6 cm (Kraljević *et al.*, 1996). The length-weight relationship was described for males ($a=0.0106$, $b=3.023$) and females ($a=0.0094$, $b=3.063$).

Fish aged 3-12 years were present in the samples (Kraljević *et al.*, 1996). Growth parameters were: $L_{\infty}=40.05$ cm, $K=0.196$ yr⁻¹ and $t_0=-0.945$. The overall male to female ratio was 1:1.62. Sex inversion occurred mainly at lengths between 24.1 and 35.2 cm, in age classes 4-8, males were observed up to a length of 34.5 cm TL (Kraljević *et al.*, 1996). Parameters of the length-weight relationship for the sand steenbras along the Croatian coast were: $a=0.0115$ and $b=3.022$ (Dulčić and Kraljević, 1996a). The length range in the catches of "tramata" fishing was from 21.1 to 41.6 cm TL, while the parameters of the length-weight relationship were: $a=0.0155$ and $b=3.022$ (Cetinić *et al.*, 2002).

Exploitation

Total and natural mortality were found to be $Z=0.77$ yr⁻¹ and $M=0.42$ yr⁻¹ in the Northern Adriatic (Croatian coast) (Kraljević *et al.*, 1996). The exploitation rate $E=0.45$ suggests that the stock was almost fully fished (Kraljević *et al.*, 1996). Grubišić (1982) reported that the annual catch of sand steenbras along the Croatian coast never exceeded 5 tonnes, while in the study area (Mirna Estuary) it ranged between 0.02 to 4.47 tonnes per year for the period 1983-1991 (Kraljević *et al.*, 1994). Numerical occurrence of the sand steenbras in the coastal fishing gear catches along the Croatian coast was: 0.50% in trammel net catches, and 0.38% in "tramata" fishing catches (Jardas *et al.*, 1998). Weight composition in the coastal fishing gear catches was: 1.22% in trammel net catches, and 0.82% in "tramata" fishing catches (Jardas *et al.*, 1998).

Oblada melanura (Linnaeus, 1758)

Family: Sparidae

EN: Saddled seabream

HR: Ušata, očada

Species description

Body elongated and ovoid; eye large and its diameter twice suborbital depth. Snout is short, mouth small; in each jaw an outer series of 8-10 frontal incisors followed by lateral small conical teeth. Colour is silvery grey, in back darker. It has fine longitudinal dark lines along rows of scales. On the caudal peduncle there is a large black saddle surrounded by a white ring. D XI+13-14; A III + 12-14. Lateral line scales 64-67 to caudal base.

Distribution

The saddled seabream is common throughout the Mediterranean (very rare in the Black sea) and the Atlantic (from the Bay of Biscay to Angola, Madeira, the Canaries and Cape Verde Islands) (Jardas, 1996). It is very common in the Adriatic Sea (Jardas, 1986).

Biological data

Oblada melanura inhabits littoral waters above rocky bottoms, and *Posidonia* beds to 30 m depth (Jardas, 1996). Spawning takes place from April to June, it is a gonochoric species but some individuals are hermaphroditic protogynous (Jardas, 1996). The spawning period in the Adriatic is from June to July (Cetinić *et al.*, 2002). It is omnivorous species (mostly small invertebrates). The slopes (b values) of the total length-weight regressions, which differ significantly between sexes, indicate positive allometric growth for females ($b=3.123$) and isometric growth for males ($b=3.017$) in the eastern Adriatic (Pallaoro *et al.*, 1998). The VBGF parameters have been estimated (both sexes) as $L_{\infty}=34.13$, $K=0.208 \text{ yr}^{-1}$, $t_0=0.750$. Females grow slower ($K=0.201 \text{ yr}^{-1}$) than males ($K=0.233 \text{ yr}^{-1}$). The overall sex ratio was found 1:1.20 in favour of females. Males dominated in the length range 11-20 cm, females in length classes 21-33. All individuals larger than 29.3 cm were found to be female. Cetinić *et al.* (2002) reported parameters of the length-weight relationship ($a=0.0099$, $b=3.081$) for individuals caught by tramata fishing.

Exploitation

In 1998 the Croatian catch of the saddled seabream was 106 411 kg of which the largest part, 62 088 kg, was from the Zadar area (Dujmušić, 2000). Jardas (1996) reported that the annual catch of this species in the eastern Adriatic is around 200 tonnes. Saddled bream is the dominant species in the catches of tramata fishing in both number (81.79%) and weight (70.16%) (Cetinić *et al.*, 2002). Total and natural mortality have been estimated as $Z=1.08 \text{ yr}^{-1}$ and $M=0.47 \text{ yr}^{-1}$, then fishing mortality as $F=0.61 \text{ yr}^{-1}$. The exploitation rate $E=0.56$ indicated a high fishing pressure on the stock in the area studied (Pallaoro *et al.*, 1998).

***Pagellus erythrinus* (Linnaeus, 1758)**

Family: Sparidae

EN: Common pandora

HR: Arbun, rumenac

Species description

The body is long, oval and laterally flat. The eye diameter is much shorter than length of snout. Pectoral fins are pointed, of the same length as the head. The caudal fin is big and forked. The number of fin rays is the following: D: XII+9-11, A: III+8-9, P: 15, V: I+5. The colour is pink-red with silvery glint. Sides are paler and belly is whitish. There are several small bluish spots on back and sides of grown specimens. The inside of mouth is whitish or greyish. Sometimes a dark red mark is present at the base of the last dorsal rays (Jardas, 1996).

Distribution

The common pandora is distributed in the eastern Atlantic, from Scandinavia to Senegal, and the entire Mediterranean. It is rare in the Black Sea (Jardas, 1996). It is spread throughout the Adriatic, more common in the eastern Adriatic channels than in open waters (Jardas, 1996). This species can occur up to 150 m depth, mostly among coastal sandy sediments. However, Županović and Rijavec (1980) showed that the distribution of the species in the central Adriatic is strictly limited by the 100 m isobath. According to this, the common pandora seems to be a typical species of the circalittoral zone. The edaphic factors do not seem to play a decisive role in distribution of this species, but primarily the kind and amount of accessible food and hydrography (Županović and Rijavec, 1980). Seasonal migration of pandora inside shallow waters was observed in the insular zone of the central Adriatic (Županović and Rijavec, 1980).

Biological data

Pagellus erythrinus can grow up to 60 cm TL (about 3 kg), but its usual length in the catch is from 10 to 30 cm. It is a protogynous hermaphroditic species. Because of this, proportion of females among the small specimens is 100% (to about 13 cm TL) decreasing with the increase of length. Males are dominant over 16 cm. Above 23 cm TL their proportion is 100% (Rijavec and Županović, 1965). Females are always dominant in the population. Length at sexual maturity and sex inversion is given in Table 3.

Table 3. Length at sexual maturity and sex inversion for common pandora.

Authors	Area	Sexual maturity	Sex inversion	
			Length (TL, cm)	Age (yr)
Zei and Županović (1961)	Central Adriatic		17	3-4
Rijavec and Županović (1965)	Central Adriatic	11-12	16-17	
Županović and Rijavec (1980)	Central Adriatic	11-12	16-17	2-3
Vrgoč (2000)	Northern and Central Adriatic	12.5	16	

Two inflection points can be seen in the length-weight relationship of the common pandora. The first one, between 11 and 12 cm TL corresponds to the first stage of females' sexual maturity. The second point is situated between 16 and 17 cm, and is a linked to the sex inversion (Županović and Rijavec, 1980). Table 4 reports the length-weight relationship parameters.

Table 4. Length-weight relationship parameters of common pandora.

Authors	Area	<i>a</i>	<i>b</i>
Rijavec and Županović (1965)	Central Adriatic	0.134	2.981
Županović and Rijavec (1980)	Central Adriatic	0.134	2.981
Dulčić and Kraljević (1996a)	Croatian Coast	0.0139	2.944
Cetinić <i>et al.</i> (2003)	Western coast of Istria	0.0232-«prostice» net 0.0249-«listarice» net	2.787-«prostice» net 2.758-«listarice» net

The estimated growth parameters (VBGF) for common pandora are presented in Table 5.

Table 5. The growth parameters of common pandora in the Adriatic Sea.

Authors	Sex	L_{∞} (cm)	K (yr ⁻¹)	t_0 (yr)
Rijavec and Županović (1965)	M+F	37.88	0.20	
Rijavec (1975)	M+F	30.91	0.239	
	M+F	30.0	0.245	
Županović and Rijavec (1980)	M+F	37.88	0.20	-0.093
	M+F	37.7	0.201	
	M		0.165	
	F		0.30	
Jukić and Piccinetti (1988)	M+F	60.0	0.20	
Vrgoč (1995)	M+F	29.32	0.229	-1.004
Vrgoč (2000)	M+F	31.05	0.205	

Common pandora spawns once a year in the Adriatic Sea; in spring and at the beginning of summer (Jardas, 1996). By analysing hydrographic changes and common pandora population abundance, regular movements from shallow coastal water toward deep sea (limited to within 100 m isobath) were observed, in the period from October to April and in the opposite direction from May to October. The movement toward deeper sea in the winter-spring period has reproductive nature and the opposite one in the summer-autumn period is of trophic origin (Županović and Jardas, 1989).

The species is essentially carnivorous and feeds on crustaceans, worms and other marine invertebrates. By analysing its diet in the Kaštela Bay, Jukić (1972) found that the bulk of the food was made of invertebrates from epi- and endofauna: Polychaeta, Crustacea Decapoda and Lamellibranchiata, whereas other groups of organisms like, for example Isopoda, Ophiuroida, Pisces and Cephalopoda could rarely be found in stomachs. Rijavec and Županović (1965) came to similar conclusions in channels of the central Adriatic.

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) at around 50 tonnes. Total mortality was calculated as $Z=1.50 \text{ yr}^{-1}$ (Rijavec and Županović, 1965), $Z=0.63 \text{ yr}^{-1}$ (Rijavec, 1975), $Z=1.50-1.57 \text{ yr}^{-1}$ (Županović and Rijavec, 1980), $Z=1.10 \text{ yr}^{-1}$ (Jukić and Piccinetti, 1988) and $Z=0.83 \text{ yr}^{-1}$ (Vrgoč, 2000). Natural mortality was calculated as $M=0.44 \text{ yr}^{-1}$, while fishing mortality $F=0.38 \text{ yr}^{-1}$ (Vrgoč, 2000).

***Pagrus pagrus pagrus* (Linnaeus, 1758)**

Family: Sparidae

EN: Red porgy (also Common seabream)

HR: Pagar

Species description

The body is oblong moderately deep, preopercle scaleless. In front of jaws there are 4 upper, 6 lower canine like teeth; at the back, smaller and obtuse canines, becoming molars in the posterior third; the two outer series of molars the strongest. D XI-XII + 9-10; A III + 7-8. Colour is silvery pink; head darker from nape to rictus; sometimes minute blue spots on upper sides, especially in young; a dusky area often present at the pectoral axil; caudal fin dark pink, with distal part of lobes white and central margin of fork dark; other fins pinkish.

Distribution

It inhabits the Mediterranean, common in warmer waters, rarer in the north; absent in Black Sea; Atlantic from British Isles (records only) to 15°N (rare south of 20°N), Madeira and the Canary Islands (Jardas, 1996). It is relatively common in the Adriatic Sea (Jardas, 1996).

Biological data

Pagrus pagrus is a species of inshore waters on hard or sandy bottoms (young individuals are found on *Posidonia* beds), demersal on shelf and continental slope to 250 m depth, mainly to 100 m. It is a carnivorous species (mainly crustaceans, molluscs and fish) (Jardas, 1996). Spawning takes place from April to June, sexual maturity is reached at about 24 cm. Sex ratio is about 75% (Atlantic) and 93 % (Mediterranean) of females. The parameters of the length-weight relationship are: $a=0.0001$ and $b=2.946$ (for the eastern Adriatic) indicating almost isometric growth (Kraljević, unpublished data). The parameters of the VBGF are: $L_{\infty}=74.41$ cm, $K=0.109 \text{ yr}^{-1}$ and $t_0=-1.53$, and the maximum age is estimated as 24 years (Kraljević, unpublished data).

Exploitation

Numerical and weight composition of red porgy in the trammel net catch from the Croatian coast were estimated as 0.04% and 0.05% respectively (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch as about 5 tonnes. Total and natural mortality were found to be $Z=0.46 \text{ yr}^{-1}$ and $M=0.25 \text{ yr}^{-1}$ in the eastern Adriatic (Kraljević, unpublished data). The value of fishing mortality was calculated as $F=0.21 \text{ yr}^{-1}$, while the exploitation rate $E=0.46$ suggests that the stock was almost fully fished (Kraljević, unpublished data).

Sarpa salpa (Linnaeus, 1758)

Family: Sparidae

EN: Salema

HR: Salpa

Species description

The body is oblong, the head is short. Snout obtuse, mouth sub-terminal and small; upper jaw slightly prominent. In both jaws incisors uniserial, upper ones notched, lower ones depressed on their outer face and ending in a single triangular point and all incisors with well visible roots inside of mouth. D XI-XII + 14-17; A III + 13-15. Pectoral fin is short ending before anus. Colour is grey-bluish with 10-11 fine longitudinal golden lines along rows of scales. Caudal fin is dark grey, other fins light.

Distribution

It is a common species throughout the Mediterranean (rare in Black sea), in the Eastern Atlantic from the Bay of Biscay (rare) to Sierra Leone including Madeira, Canary Islands Cape Verde (common); it is also present from Congo to South Africa (Jardas, 1996).

Biological data

Sarpa salpa inhabits littoral waters near rocks with algal coverage, beds of *Posidonia*, *Zostera*, and *Caulerpa* (warm waters) and also on sandy mud to 70 m depth (Jardas, 1996). It is an omnivorous species, young salema are mainly carnivorous (crustaceans) and adults are almost exclusively herbivorous. The Rhodophyta taxa seem to be most important component of the diet. Food of animal origin is very poorly represented in the diet and mainly composed by epibionts, presumably taken by chance (Antolić *et al.*, 1994). Sex ratio (in the eastern Adriatic) is 2.03:1 in favour of males (Mardešić, 2002). The parameters of the length-weight-relationship are: $a=0.0177$ and $b=2.897$ (both sexes), $a=0.0087$, $b=3.108$ (males) and $a=0.0103$ and $b=3.051$ (females) indicating positive allometry for sexes separately and negative allometry for both sexes combined (Mardešić, 2002). The maximum age is 14 years (Mardešić, 2002). The parameters of the VBGF have been estimated as $L_{\infty}=40.84$ cm, $K=0.221$ yr⁻¹ and $t_0=-0.693$ (Mardešić, 2002).

Exploitation

Numerical occurrence of salema in the catch of coastal fishing gears along the Croatian coast was 8.09% in «tramata» and 0.26% in coastal beach seine catches (Jardas *et al.*, 1998). Weight composition was 17.46% in «tramata» and 1.01% in coastal beach seine catches (Jardas *et al.*, 1998). Grubišić (1982) reported the national average annual catch at about 154 tonnes.

Sparus aurata Linnaeus, 1758

Family: Sparidae

EN: Gilthead seabream

HR: Komarča, lovrata, orada

Species description

The body is oblong, rather deep. Preopercle is scaleless. In both jaws, in front there are 4-6 canines with behind them and at back 2-4 rows of teeth, more obtuse, gradually becoming molars, the two outer rows much stronger. D XI+13-14, A III + 11-12. Lateral line scales 73-85 to caudal base. Colour is silvery grey, large dark patch at the origin of the lateral line, overlapping upper part of opercle and underlined by a reddish area. There is a golden curved bar across forehead, bordered by two dark zones, especially in adults.

Distribution

Sparus aurata occurs in the eastern Atlantic from British Isles to the Cape Verde and Canary Islands. It is common throughout the Mediterranean, although less frequent in the eastern and the south-eastern part and very rare in the Black Sea (Jardas, 1996). It is relatively common in the eastern Adriatic (Croatian waters) (Jardas, 1996).

Biological data

The gilthead seabream is a euryhaline and eurythermal species and a relatively common fish of inshore waters on littoral sandy bottoms and *Posidonia* beds, up to depths of 30 m (juveniles) and 150 m (adults) (Jardas, 1996). Adult specimens usually enter estuaries and lagoons and seasonally migrate out of them. It is a hermaphroditic protandrous species (Jardas, 1996). *Sparus aurata* is carnivorous and feeds on molluscs, mainly mussels, crustaceans, fishes, but it is additionally herbivorous (Jardas, 1996). It spawns from October to December (Jardas, 1996). The maximum standard length of the species is 70 cm, but usually in catches is between 30 and 35 cm SL (Jardas, 1996). The age and growth of the gilthead seabream were determined from specimens collected in the Mirna Estuary (northern Adriatic) from 1990 to 1993 (Kraljević and Dulčić, 1997). Mean length at age data, as obtained through scale readings, were used to estimate the growth parameters of the von Bertalanffy function: $L_{\infty}=59.8$ cm, $K=0.15$ yr⁻¹, $t_0=-1.71$; $W_{\infty}=5554$ g, $K=0.09$ yr⁻¹ and $t_0=-2.64$. The length-weight relationship was estimated in the form $W=0.0112L^{3.052}$ (Kraljević and Dulčić, 1997). Twelve age classes, ranging from 1 to 12 years were defined by scale readings. The mean condition factor was estimated as 1.322 (Kraljević and Dulčić, 1997). In samples from the eastern Adriatic (Croatian coast) the total length ranged from 15 to 70 cm and the weight from 40 to 5900 g (Kraljević *et al.*, 1998). Sixteen age classes, ranging from 1 to 22 years were defined by scale readings (Kraljević *et al.*, 1998). Weight increase is positively allometric with size ($b=3.087$). The mean condition factor was estimated as 1.36. Von Bertalanffy growth parameters are: $L_{\infty}=84.98$ cm, $K=0.073$ yr⁻¹, $t_0=2.823$; $W_{\infty}=12879.4$ g, $K=0.062$ yr⁻¹ and $t_0=-2.728$ (Kraljević *et al.*, 1998).

Exploitation

It is a target of commercial fishers along the Croatian coast (about 56 t per year according to 1994 FAO statistics), it varied from 0.4 to 1.6% of the Mediterranean total catch of this species for the period from 1983 to 1992. The Croatian total catch of common pandora, common dentex, sharpsnout seabream, common two-banded seabream and gilthead seabream together in 1998 was 105 458 kg of which 67 262 kg from the Zadar area (Dujmušić, 2000). Natural mortality was estimated as $M=0.32 \text{ yr}^{-1}$ (Pauly's formula, 1980) and $M=0.41 \text{ yr}^{-1}$ (Rikhter and Efanov's formula, 1976) in the Mirna Estuary (northern Adriatic) (Kraljević and Dulčić, 1997). The age at which 50% of the gilthead seabream population is sexually mature is 4 years (Kraljević and Dulčić, 1997). Even though this species is of great interest and is a target of the commercial fishery, its presence in the total catch of sparids from gill nets (0.2%; Jardas *et al.*, 1998) and "ludar" (only 0.05%; Cetinić and Pallaoro, 1993) is very low. The length range of the gilthead seabream in the catch of "tramata" fishing was from 13.4 to 45.4 cm, while the parameters of the length-weight relationship were: $a=0.0128$ and $b=3.093$ (Cetinić *et al.*, 2002). Numerical presence of the gilthead seabream in the coastal fishing gear catches along the Croatian coast was 0.28% in trammel net, 0.01% in coastal beach seine and 0.04% in "tramata" fishing catches (Jardas *et al.*, 1998). Weight composition was 2.24% in trammel net, 0.21% in the coastal beach seine and 0.24% in "tramata" fishing catches (Jardas *et al.*, 1998).

Spondyliosoma cantharus (Linnaeus, 1758)

Family: Sparidae

EN: Black seabream

HR: Kantar

Species description

The body is ovoid, rather deep; the upper profile of the head depressed above the eye. The snout is short. Scales on cheek and opercle, preopercle scaleless. In each jaw there are 4-6 rows of conical and rather slender teeth, the outer enlarged, especially in front of jaw. D XI+11-13, A III+9-11. Lateral line scales 66-75 to caudal base. Colour is silvery grey with bluish, greenish and pinkish tints; interorbital space and snout darker; on sides, longitudinal golden lines more or less discontinuous.

Distribution

In the eastern Atlantic it occurs from Scandinavia to Angola, Madeira, Canary Islands and Cape Verde Islands. It is very rare in the Black Sea, but common in the Mediterranean Sea and in the eastern Adriatic (Jardas, 1996).

Biological data

Black seabream is a relatively common species of inshore waters on rocky or sandy bottom and *Posidonia* beds at depths down to 50 m (juveniles) and 300 m (adults).

It is gregarious and sometimes found in large schools.

The black sea bream is a hermaphroditic, protogynous fish. It spawns from February to May (Jardas, 1996). Growth of the black seabream from the Croatian coast was studied using data from scales, length and weight of 745 fish. Total length ranged between 6.2 and 46.5 cm, while weight varied between 3 and 2165 g (Dulčić and Kraljević, 1996b).

The von Bertalanffy growth function was fitted on the basis of mean length-at-age data resulting in parameter values of $L_{\infty}=47.7$ cm, $K=0.178$ yr⁻¹ and $t_0=-0.27$. Weight increased allometrically for both sexes together ($b=3.12$) and in females alone ($b=3.14$), while it increased isometrically in males ($b=2.99$) (Dulčić and Kraljević, 1996b).

The black seabream is a long-lived species. The oldest male and female were estimated to be 14 and 9 years old respectively. The sex ratio rapidly becomes skewed in favour of females (3.12:1). Sex reversal was mainly observed in age classes 7 and 8. Females were found only up to a total length of 37.7 cm (Dulčić and Kraljević, 1996b). Dulčić *et al.* (1995b, 1995c) presented the length-weight relationship from southern Adriatic samples with parameters: $a=0.000436$ and $b=3.093$. Cetinić *et al.* (2002) reported parameters of the length-weight relationship ($a=0.0112$, $b=3.052$) for individuals caught by tramata fishing.

The fecundity of the black seabream from the eastern central Adriatic (Croatian coast) was assessed by the volumetric method using 59 ovaries in pre-spawning stage from fish between 18.5 and 33.5 cm TL (Dulčić *et al.*, 1998). Estimates of total potential annual fecundity varied between 31 670 and 554 070 eggs per female. Relative fecundity is constant, reaching a maximum of 850 eggs g⁻¹ in the 30.5-31 cm length class (Dulčić *et al.*, 1998).

Exploitation

Black seabream forms a significant component of the gill net and fish trap catch in Croatian coastal fishery and it is a very appreciated fish species for consumption (especially on the island of Vis).

There are no recent data on catch levels; Grubišić (1982) reported that it was then around 60 tonnes per year. Black seabream was assessed to represent in number 0.13% (0.33% in weight) of the catch by tramata fishing (length range 22.1-38.3 cm) (Cetinić *et al.*, 2002). Numerical composition is 0.39% in trammel net and 0.36% in coastal beach seine catches.

Zeus faber Linnaeus, 1758

Family: Zeidae

EN: John dory

HR: Kovač, Šanpjero

Species description

The body is deep, strongly compressed, caudal peduncle is as long as it is deep; head deep, its dorsal profile flat or convex over eye, no serrations on bony ridge above eye. Mouth large and very protractile, with small conical teeth in jaws (Jardas, 1996). Pectoral fins short, pelvic fins at least twice as long. D IX-XI + 21-25; A III-V + 20-24; P I + 6-7. Body covered with very small, rudimentary scales, appearing naked; scutes present along belly, with spines. Colour is golden green-grey or silvery bronze, with a large yellow-edged black spot on flank; membranes of spinous anal and pelvic fins black, spinous dorsal fin dark (Jardas, 1996).

Distribution

Zeus faber occurs in the Atlantic from Norway to Madeira, also Mediterranean, Black Sea and Adriatic Sea. Elsewhere, south to the Azores and southern Africa, also Australia, New Zealand, Japan and Korea (Jardas, 1996).

Biological data

John dory lives near the bottom or in midwater, from inshore down to 400 m depth, mainly from 50 to 150 m; it is solitary species which feeds on fish, Crustacea and Cephalopoda (Jardas, 1973). It could reach a maximum of 66 cm SL, but usually 20-50 cm. In the open Adriatic sea males could reach the maximum length of 43 cm, while females 52 cm SL, and in the channels area males could reach 42 cm, while females 51 cm (Županović and Jardas, 1989). Sex ratio (in Jabuka/Pomo Pit) is 2.27:1 in favour of males, while in channels of the central Adriatic is 1:2.31 in favour of females (Županović and Jardas, 1989). The parameters of the length-weight relationship are: $a=0.0164$ and $b=2.941$, indicating isometric growth (Županović and Jardas, 1989).

Exploitation

Grubišić (1982) reported the average annual catch (Croatian coast) at around 25 tonnes.

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Small-scale fisheries in Emilia-Romagna (GFCM GSA 17): preliminary note

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Abstract

In 1999, along the Emilia-Romagna coastline (130 Km; northern Adriatic Sea, GFCM Geographical Sub-Area 17) 1,170 vessels owned the necessary permit for professional fishing. Nearly a half of them were classified as “small-scale fisheries”, namely less than 12 metres long, using passive fishing gears within a family-run, artisanal organization from a technical and administrative point of view. It should be noted, however, that there are other small tonnage vessels, which also fish with trawl nets. As far as static gears are concerned, the most commonly used ones are gillnets, trammel nets, pots for *Nassarius mutabilis*, pots and fyke-nets for cuttlefish (*Sepia officinalis*). Given the socio-economic importance of such activity and the problems related to integrated coastal zone management, Lega Pesca (the Italian national union of fishing cooperatives) commissioned a specific research project to be carried out by the Research Cooperative M.A.R.E. of Cattolica (RN), which started in September 2003 and is due to end in December 2004. Some preliminary considerations are presented herein.

Key-words: artisanal fishing; fishing vessels; socioeconomic aspects; *Sepia officinalis*; *Nassarius mutabilis*; MED, Adriatic Sea,

1. Geographical context

The coastline of the Emilia-Romagna Region of Italy stretches for nearly 130 Km (northern Adriatic Sea, GFCM Geographical Sub-Area 17) from the southern delta branch of the Po river situated in Goro, Province of Ferrara to the port of Cattolica (Province of Rimini). The coast is low and sandy and all ports are situated in river mouths or artificial canals, with the exclusion of the ports of Goro (FE) and Marina di Ravenna (RA), which are located inside lagoon areas. There are two maritime districts along this coast, the Ravenna northern district and the Rimini southern district. The majority of fishing vessels are based in the nine regional ports.

2. Structural data and regulatory definition of small-scale fisheries

In 1999 the fishing fleet of Emilia-Romagna comprised 1170 fishing boats, divided into six types of activities (fishing techniques). The vessels that fell into the “small-scale fisheries” category were almost the half the total number of vessels (Table 1). It should be mentioned that according to European Union regulations on the classification of fishing typologies, the item “small-scale fisheries” only comprises vessels with an overall length (LOA) of less than

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12 metres and which use passive gears and these do not have permission for pelagic or bottom trawl nets. These vessels are family-run and artisanal from an administrative and technical point of view (IREPA, 1999).

3. Small-scale fisheries: general overview

Small-scale fisheries in Emilia-Romagna actually include two fishing systems: one with static gears and one with trawls. Some vessels, however, use both systems.

Indeed, if we are to consider the fishing situation more in detail, we need to mention that, at least from a traditional point of view and as far as family-run non-industrial vessels are concerned, “small-scale fisheries” also include vessels with a gross tonnage of less than 10 GRT, engine power lower than 150 HP, which fish with trawl nets. Moreover, in certain periods of the year, these vessels are authorized to fish within 3 nautical miles from the coast, making an exception to EC Regulation 1626/1994. The management of trawling on this coastal strip from Cattolica (RN) to Trieste (TS) was also subject to special regulations in the past (Froglia *et al.*, 2000).

The data gathered from the harbour offices of Rimini and Ravenna show that in 2002 the total number of vessels authorised for this type of fishing was 206 (Table 2), of which 89 had an overall length of less than 12 metres. This shows that small-scale fishery with trawl nets, especially in the Ravenna district, is still quite important, providing a source of income in wintertime for enterprises owning small vessels; the harsh weather and the moving of most fish species offshore from the coastal area are a considerable limit to the fishing activity of these vessels, which also use passive fishing gears in certain seasons. Over the last few years, there has been a general reduction in this type of activity.

As regards “small-scale fisheries” using static gears, this practice has evolved and has been consolidated over the last fifteen years. Small wooden vessels have been replaced by fibreglass motorboats and on-board equipment, both for fishing and for navigation, has also been modernized.

However, it should be noted that a passive fishing gear system is owned by almost 70% of the vessels recorded in the vessel register for the two districts, according to the size groups illustrated in Table 3. Only a few vessels hold a permit for static gear fishing, about 15% in total (Table 4). The vessels defined as “multi-purpose” (“polyvalent”), meaning those boats that have permission to fish with different gears, are a common feature of the entire Italian fishing fleet (Cannas, 2001). Another relevant aspect of the socio-economic situation in the Region, which is related to the workers employed in small-scale fisheries, is the outstanding importance of Manila clam (*Tapes philippinarum*) cultivation in the northern district, especially inside the Sacca di Goro Lagoon. Here many small-scale fishing vessels have permission to operate as support units to the clam cultivation plants in the area where Manila clam is cultivated.

Passive fixed gear fishing is highly unusual both in terms of seasonality and of distributional areas. In spring almost all cuttlefish (*Sepia officinalis*) fishing boats use pots and fyke-nets. Fishing of gastropod *Nassarius mutabilis* is mainly carried out in the district of Rimini and, further to the south, in the Regions of Marche, Abruzzo and Molise (Piccinetti *et al.*, 1998). This fishery, especially in autumn and winter, is mainly concentrated in the district of Ravenna. In summer, however, especially in the period when bottom and pelagic pair trawling and floating trawls are suspended, static fishing gears are common in the whole Region.

The information available on the fishing effort for each species is quite limited and, to date, there has not been any in-depth analysis of the various fishing methods and fishing grounds.

Lastly, although under the Ministerial Decree 14/09/1999 (Discipline of small-scale fisheries), for some years now efforts have been made to stimulate the setting up of consortia of small-scale fishing enterprises aimed at guiding, coordinating and managing the small-scale fishery activity, such bodies have not yet been established in Emilia-Romagna.

4. Lines of research

In the light of the geographical and socio-economic features as well as the lack of information mentioned above, Lega Pesca (the Italian national union of fishing cooperatives <http://www.legapesca.it/>) thought it necessary to promote a research project aimed at facing some of the problems related to static gear fishing in Emilia-Romagna. The main goal is to collect and process, in part through innovative systems such as the Local Information Systems, socio-economic information as well as data on the fishing effort. This project was entrusted to the Research Cooperative M.A.R.E. of Cattolica (RN).

In brief, besides the basic bibliographical research, there are three main study areas:

- Research on regulation frameworks (UE, Italy, Local level);
- Data collection from fishing cooperatives and fish markets;
- Data collection from 24 sample vessels for one year.

The fishermen involved in this project will be asked to compile a data sheet on daily basis to provide information on the type of gear(s) they have used, their number (in the case of pots and fyke-nets) or on the length in metres of net they have deployed at sea as well as the number or metres they have drawn onboard, the fishing area and its distance from the coast, the species caught and the quantity. Moreover, they will also be asked to give indications as to the number of working hours offshore and on shore as this latter is a considerable part of their job.

Later, a data collection plan will be elaborated in order to carry out a more detailed socio-economic assessment.

Table 1. General overview of the fishing sector in Emilia-Romagna in 1999 (Source: IREPA, 2001).

Typology	No. vessels	GRT	kW	No. workers	No. workers/vessel	Catches (tonnes)	Catches/vessel (tonnes)	Proceeds (€)	Proceeds/vessel (€)
Bottom trawl	142	3,935	28,705	479	3.4	5,383	37.9	26,909,679.86	189,504.79
Pelagic trawl	52	2,620	16,962	275	5.3	18,469	355.2	13,751,771.47	264,457.14
Hydraulic dredge	60	592	6,277	120	2.0	3,703	61.7	7,986,004.77	133,100.08
Small-scale fisheries	488	994	17,998	488	1.0	4,986	10.2	15,614,861.11	31,997.67
Polyvalent	428	3,284	39,794	942	2.2	8,873	20.7	24,311,009.83	56,801.42
Total	1.170	11,425	109,736	2,304		41,414		88,573,327.03	

Table 2. Number of vessels holding a permit to carry out “special fishing” in Emilia-Romagna, 2002.

	Ravenna district	Rimini district	Total Emilia-Romagna
Total number	151	55	206
LOA <12 m	70	19	89

Table 3. Size groups of vessels holding a permit for static gear; Emilia-Romagna, 1999.

LOA (m)	No.	%
≥ 12	183	23.2
6.00-11.99	464	58.7
<6.00	142	18.0
n.a.	1	0.1
Total	790	100.0

Table 4. Numerical distribution of vessels with a permit to use only static gear, vessels with a permit to use both static gears and other fishing systems and vessels with a permit for static gears and to act as “farm units”; Emilia-Romagna, 1999.

District	Static gear permit only	Permit for use of static gears and other fishing systems	Permit for use of static gears and “clam cultivation support units”	Static gear permit total
Ravenna	77	192	279	548
Rimini	50	187	5	242
Total	127	379	284	790

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