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Comparison of Elasmobranch Catches of Trawl Surveys and Commercial Landings of the Port of Viareggio (North Tyrrhenian-South Ligurian Sea-Italy) in the Last Decade

(Elasmobranch Fisheries – Poster)

by

A. J. Abella and F. Serena

Agenzia Regionale per la Protezione Ambientale della Toscana
Via Marradi 114 57100 – Livorno Italy
f.serena@arpat.toscana.it

Abstract

A catch assessment survey to monitor the landed elasmobranchs was enforced at the Viareggio harbour, the more important fishing port of the Tyrrhenian and Ligurian seas. Monthly data of catches by species and gear, size structure of the catches and spatial information on fishing effort distribution were collected over the period 1990-2001. Data on catch rates and geographical distribution of species were also collected with trawl-surveys carried out each year in the same area in the period 1985-2001.

For the most important chondrichthyan species, the distribution of the fishing effort for every main fishing strategy was compared with catch rates of trawl surveys. The analysed species were two batoids: *Raja asterias* and *Raja clavata* and two sharks: *Scyliorhinus canicula* and *Galeus melastomus*.

The catch rates trends derived from fishery independent and fishery dependent sources resulted not in agreement probably due to spatial shifts in the effort allocation that occurred as a consequence of changes in the target of some fisheries. The current level of fishing pressure and fishing pattern seems sustainable for all the studied species. This can be related to a light fishing pressure on some grounds where certain species are concentrated, to the discard at sea of an important fraction of the individuals caught as well as to life history characteristics of each single species that make them more or less sensitive to enhancements in fishing mortality.

Introduction

The elasmobranchs are in general positioned at the top of the marine food webs and play an important role inside the ecosystems where they are present. The life history of elasmobranchs make them particularly vulnerable to fishing pressure. Their rarefaction as a consequence of removals that went beyond the sustainable levels has been stressed by many authors in several fisheries around the world (Stevens, *et al*., 2000; Musick, *et al*., 2000). There are some evidences that these phenomena have also occurred in the Northern Tyrrhenian-Ligurian Sea for *Squalus* sp., *Mustelus* spp. and *Squatina sp.* (Vacchi *et al*., 2000), even though quantitative information (such as long data series of captures) is incomplete.

Since 1990, a monitoring programme is in force aimed at the collection of data on landings of chondrichthyan and bonefish in the main fishing harbours of the area. Furthermore, trawl-surveys utilising a traditional Italian trawl net have been also performed each year since 1985. Research cruises covers the whole area where the commercial fleets operate. The availability of these data allows seeking for changes in catch rates with time. Moreover, this permits the analysis of the spatial aspects of both, the fishery and the resources that is likely to have some influence on the abundance and stock status of the main species of elasmobranchs in the area.

Material and Methods

Data proceeds from a Catch Assessment Survey on a monthly basis performed in the Viareggio harbour (the main fishery of the Northern Tyrrhenian-Ligurian Sea) from 1990 to 2001 as well as from 27 trawl-surveys carried out in different seasons between 1985 and 2001 (Relini *and* Piccinetti, 1996). The analyses of fishery dependent data were based on the available information on vessels, gear type, date, fishing area, effort, number of tows and catch in boxes by species and on a register containing the fishing vessel characteristics. The spatial information associated with the fisheries as well as that derived from trawl-surveys on distribution of species abundances were explored with ArcView GIS (ESRI. 1996). The geographical distribution of fishing effort by fishing strategy was represented and analysed by using the application MLFD (Mapper of Landed Fish Data) (Fortunati *et al*., 2001). Maps that display the effort distribution pattern by fishing gear and the distribution of catch rates for the main commercial species produced during a previous study (Abella *et al*., 2001) were used in order to compare the spatial distributional patterns of fleet and resources.

The four species that were selected due to their major abundance and commercial interest are: the blackmouth catshark (*Galeus melastomus*), the small-spotted catshark (*Scyliorhinus canicula*), the thornback ray (*Raja clavata*) and the starry ray (*Raja asterias*).

Results

Catch composition of the tows performed during the trawl-surveys includes 208 species of finfish and among them, the chondrichthyans represents the 13 % (11 sharks, one chimaera and 14 batoids). Catch composition of trawl-surveys, however, is conditioned not only by the abundance of the species, but also by the suitability of the fishing gear to capture each single species. The species diversity observed in the commercial landings is more reduced with 105 species of fish. This fact is also evident as regards to elasmobranchs with only 16 species (6 sharks and 10 batoids), which represents about 15% of the total landed fish (Table I). This more reduced diversity is mainly due to the discarding at sea of many species with no commercial value (e.g. *Etmopterus spinax*, *Chimaera monstrosa*, etc.) and of undersized individuals of commercially valuable species.

It may occur that the catch rates obtained by the commercial fleet of some particular elasmobranch species can be quite higher than those obtained through the randomly distributed scientific hauls utilising the bottom trawl net. This is mainly due to the use in commercial fishing of specific and more suitable gears, but also because fishing activity may exert a major fishing pressure on certain areas where some species are more abundant. A fitting example is the capture of *Raja asterias* with beam trawls, characterised by high catch rates.

Operational areas of vessels utilising beam trawls and bottom trawl nets in general overlap, but species composition of the catch may be quite different. *R. asterias* is generally positioned in the first place among the species assemblage caught with beam trawls while the catches with the traditional bottom trawl nets are negligible. Figure 1 shows the relative importance of the most common species in the landings of the beam trawl fishery in the Viareggio harbour. The method of Biseau, (1998) was used as an objective criterion for the identification of the species more representative of the fishery. Even if fishers do not declare this ray as a target of the fishery, traditionally addressed to the capture of flat fishes, in particular *Solea vulgaris*, the absence of *R. asterias* in the catch should make the beam trawl fishery in the area not profitable. On the other hand, catches of starry ray obtained with the traditional bottom trawl net are relatively modest.

Figure 2 shows the geographical distribution derived from trawl-surveys data of the 4 elasmobranch species with densities expressed as catch per hour towed. There is a clear spatial shift in the distribution of the species. *R. asterias* is clearly the more coastal species, with their higher densities positioned on the Italian and Corsica continental shelves, in the depth interval 0-150 m (Baino and Serena, 2000). Their higher densities were observed near the Corsica coasts where fishing pressure is lower.

S. canicula and *R. clavata* share the same grounds and are mainly concentrated in the depth interval 100-250 m, while *G. melastomus* is a bathial species, and is mainly concentrated between 400 and 800 m of depth (Baino and Serena, op. cit.).

Figures 3 to 5 show the current distribution of fishing effort of the Viareggio fleet. There are no such detailed charts of the fishing effort distribution of the other fleets that operate in the area, as those based on the Livorno and Piombino ports.

A reduced numb er of trawlers belonging to La Spezia fleet operate on the same grounds northwards to Viareggio harbour. Moreover, same small boats utilising trammel nets capture modest quantities of *R. asterias* close to the coast.

The Livorno fleet is also relatively small. Trawlers concentrate its effort mainly on the grounds south to 43° 30' at depths between 100 and 400 m. and hence there is little overlap with the operational areas of the Viareggio fleet. *R. clavata and S. canicula* are particularly abundant in these grounds exploited by the Livorno fisheries and they are the more important landed elasmobranch species.

Piombino fleet is quite small and its fishing effort is evenly distributed towards the north and the south of the mentioned port. Most of their vessels use gears aimed at the capture of small pelagic species and hence without any direct influence on the abundance of the studied species.

Figure 6 shows the trends in abundance for the 4 studied species in the area derived from trawl-surveys. A spline-smoothing plot is included. Smoothing splines are locally cubic splines that minimize a penalized residual sum of squares. The degree of smoothness was selected automatically by the software S-PLUS (Mathsoft, 1999). No clear trends were found considering the observed high variability among years and the relatively short time series. An increase in abundance seems evident in the last years for *R. clavata*, *S. canicula* and *G. melastomus*. As regards the landings data, with abundance indexes expressed as catch in kg per hour graphs, they suggest a decreasing trend in all the species (Fig. 7). This is particularly evident in the last 3 years.

It was observed that an important discard of the studied species occurs onboard. This is particularly significant in the case of *G. melastomus*. In fact, only a fraction of the bigger individuals of the species (with size over 40 cm) is landed, and exclusively in the port of Viareggio. This procedure is dependent on the very limited market demand of this species. In the case of *S. canicula*, species with a quite high commercial interest, only the individuals smaller than about 36 cm are discarded. As regards of the two batoids, while almost all the individuals of *R. clavata* smaller than 38 cm of TL are discarded, most of the small individuals of *R. asterias* caught near shore with trammel nets by the artisanal fisheries of Viareggio are landed. Small-scale fishery targets are soles and other flatfish.

Starry rays are concentrated very close to the coast (2-15 m depth) and hence not available for trawling.

It is worth noting, as can be observed in Fig. 8, that almost all the immature individuals of the two sharks are discarded while for *R. clavata* some immature individuals, with total length between 35 and 40 cm are landed. Small-scale fishery of the Viareggio port lands an important number of juveniles of *R. asterias*. In the Fig.s, the size distributions in the catches, the fraction discarded and the size of first maturity (Lm) for the 4 species are shown.

Discussion

We can ask why the studied species have been demonstrated up to now quite resilient to fishing activity. All these species are mainly caught with bottom trawl nets as a by-catch in fisheries targeting different assemblages of bonefish. Landings of *R. asterias* from the bottom trawl net fishery are negligible. In the Viareggio port, the species is mainly caught with a variant of the beam-trawl called *rapido*. The rapido is however utilised by a small number of fishing vessels. The species constitutes the main component in weight of the species assemblages caught with this gear and annual catches mainly composed by adults are about 14 tons. The starry ray is also caught with trammel nets in the small-scale fisheries, with a mean annual catch of about 6 tons, composed almost exclusively by juveniles. While the two rays and *S. canicula* commercial price may be fairly acceptable and individuals of these species (mainly adults) are stored and landed, *G. melastomus* has very scarce commercial value. The last mentioned species is an important component of the by-catch of the *Nephrops norvegicus* fishery. Most of the times all the individuals of this species are discarded, or in some cases, depending on market demand, a limited quantity of big-sized individuals is kept. The mean total amount of current landings of blackmouth catshark is about 700 kg.

Small-spotted catshark and thornback ray are in general caught simultaneously in the same grounds, mainly at depths between 100 and 250 m, on bottoms characterised by the presence of a biocoenosis dominated by the crinoid *Leptometra phalangium* and the sea urchin *Echinus sp*. The Viareggio fishery has exerted in the last years a lighter pressure on these grounds. The mean total landings of each one of these two species in the Viareggio port do not exceed one metric ton.

Figure 9 shows the frequency of activity of the fleet by depth. The fishing pressure on the grounds between the above mentioned range was progressively reduced in the ten years period 1990-1999. This reduction occurred especially in the last 5 years as a consequence of recent enforcements of controls of legal size in the landings of Mediterranean hake. This resource at this depth interval is quite abundant and for a long time has been the main target of a fraction of the Viareggio fleet. However, these grounds constitute an important nursery area of *Merluccius merluccius* (Fig. 10) and almost all the individuals of Mediterranean hake present there are under the legal size (Abella and Serena, MS 2002). The obligatory discard of the whole catch of small Mediterranean hakes due to the impossibility to land and sell them make these grounds less profitable.

Related to *R. asterias*, there is a clear overlapping between the main operation areas of the small fishing vessels of the Viareggio fleet and the grounds where the species is more abundant. The efficiency of the commonly fishing gear, the traditional Italian bottom trawl to capture *R. asterias* is however low. On the other hand, beam trawls capture relatively big quantities of individuals of the mentioned species by unit of effort, but this gear is only used by a very limited number of vessels. There is however, a relatively important removal of juveniles due to the small-scale fisheries activity.

In the case of *G. melastomus*, the species is distributed in deeper waters, mainly between 250 and 800 m. A modest number of fishing vessels of the Viareggio fleet operate on deep waters grounds with *Nephrops norvegicus* as target. The blackmouth catshark constitute an important portion of the by-catch, but most of the individuals as described above are discarded. Considering the high depth at which blackmouth catshark is caught and the observed reduced vitality of the individuals immediately after their capture, it is likely that only a small fraction of the discarded individuals of this species may survive. However, Norway lobster grounds coincide only partially with the areas where *G. melastomus* is more abundant. In fact, as shown in Fig. 2, the higher densities of this species are found in deep waters northward Corsica Island. In these areas the fishing pressure is quite reduced.

A generalised reduction of the fishing effort on the grounds traditionally exploited by the Viareggio fleet, occurred during the last 15 years due to a constant reduction of vessels (from 107 in 1985 to 78 in 2000).

There is scarce information as regards to the probability of survival for all the studied species after they are discarded at sea. Experiments performed by the authors of this paper with individuals caught and successively put inside big pools with marine water (data not published) have demonstrated high rates of survival for released individuals of *R. asterias* caught with bottom trawl nets (Mancusi *et al*., submitted). Sanchez *et al*. (2000) report survival rates for released individuals of *S. canicula* that are close to 100%.

Trawl surveys data series do not show any trend suggesting a decline in the abundance that can be interpreted as an index of recruitment overfishing (Baino and Serena, 2000). In fact, for the two catsharks and for *R. clavata* an increase in catch rates is observed, while for *R. asterias*, data suggest a steady situation. These findings do not seem to be in agreement with those derived from commercial data shown in Fig. 7, which suggests a negative trend for all the species. It is likely that the negative trends of commercial catch rates are real even if the time series is limited. However, this trend not necessarily has to be considered linked to a real reduction of the abundance at sea. It is possible that they can be explained, at least for *S. canicula* and *R. clavata* by the changes in the target of the fleet that have occurred recently and the above-mentioned recent minor fishing pressure on the grounds where juveniles of Mediterranean hake concentrate. These grounds (Fig. 10) geographically coincide with the more dense concentrations of *S. canicula* and *R. clavata* as shown in Fig. 2.

In the case of *S. canicula* and *R. clavata*, fishing operations on the grounds where they are concentrated were reduced in the last years. The size of the landed individuals is in general longer than the size at first maturity.

Assuming a good survival rate for the discarded undersized individuals, the commercial choices allow individuals to reproduce at least once in their lives.

Regarding to *R. asterias*, the species is only partially vulnerable to the traditional bottom trawl net, and hence, their removal with this gear is very limited. Beam trawls are suitable for their capture, but only a reduced number of vessels utilise this gear in the area. Moreover, juveniles concentrate very close to the shore where trawling is forbidden. The number of small individuals caught by the artisanal fisheries is very impressive, but is likely that it represents only a modest fraction of the standing stock of juveniles. The removal of a fraction of juveniles is in same way compensated by the light fishing pressure exerted on adults and this should guarantee an adequate number of spawners.

A small fleet targeting to Norway lobster exploits the grounds where *G. melastomus* is distributed. Most, if not all the blackmouth catshark that are caught in this fishery are discarded at sea, generally when they are still alive.

There is a general shortage of information as regards to the natural history of all the 4 studied species. Table II contains the main available information for the 4 species in the Mediterranean Sea. Studies of Cannizzaro *et al*. (1995) suggest slow growing rates for *R. clavata*. Moreover, the species reach the age of first maturity after many years and these facts, combined with its relative low mean life fecundity, reduce the chances of survival when fishing pressure is too high.

There are available estimates of the growth performance of *R. asterias*. It appears to be a relatively fast growing species if compared with other rays. Recent, but partial results of tagging experiments (Mancusi *et al*., submitted) suggest a faster growth rate for the species than the described in literature (Serena and Abella, *In*: Relini *et al*., 1999). This fact would contribute to a more efficient and adaptive response of this species to intense exploitation. It has been stated that life-history characteristics make each species of rays and skates (but this also apply for sharks) more or less sensitive to enhanced mortality (Walker and Hislop, 1998).

In conclusion, we can assume that the 4 studied species, due to different causes, suffer a relatively moderate fishing pressure. Even if a proper stock assessment of the species has not already done due to incompleteness of data, the absence of negative trends of abundance at sea suggest that the current levels of catches and mortality by age produced by fishing activity, are sustainable and compatible with the self renewal of the studied stocks. The discrepancies in the nature of the observed trends among fishery dependent and independent data can be explained, at least for *R. clavata* and *S. canicula* by a shift in the fisheries operational area (and target) that occurred in the last years. This fact demonstrates how important is the consideration of spatial information for the analysis of fishing effort data. The crude analysis of the trends of landings can be in this case misleading.

Among the 4 selected species *R. asterias* seems to be the more highly exploited species, because is caught with several fishing strategies that remove individuals of different age classes, including a huge number of juveniles. However, it is likely that its biological characteristics and the reduced fishing pressure on the adult fraction of the stock, which experienced a further reduction in the last years, made it more resilient to high levels of fishing activity. In fact, following the general criteria based on life history aspects to define extinction risk in marine fishes proposed by Musick (1999), this species should be included within the “medium productivity category”. This is due to its early age of first maturity (~ 3 years) and a relatively short lifespan (~ 10 years) even if it is characterised by a moderate fecundity.

In the case of *G. melastomus*, the fishing pressure exerted on this species, an important by-catch of the *Norway lobster* fishery, can be considered modest. It was estimated that total landings of blackmouth catshark in the Viareggio port are of less than one metric ton. Moreover, considering its low commercial value, all the individuals under the size of first maturity are discarded and only a small fraction of adults landed.

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TABLE I. List of recorded species from trawl surveys or from landings at the Viareggio harbour. P = Species present.

Species name	**Trawl-surveys**	**Landings**
Centrophorus granulosus (Bloch and Schneider, 1801)	*P*	*P*
Chimaera monstrosa Linnaeus, 1758	*P*	
Dalatias licha (Bonnaterre, 1788)	*P*	
Dasyatis centroura (Mitchill, 1815)	*P*	
Dasyatis pastinaca (Linnaeus, 1758)	*P*	*P*
Dasyatis violacea (Bonaparte, 1832)		*P*
Etmopterus spinax (Linnaeus, 1758)	*P*	
Galeus melastomus Rafinesque, 1809	*P*	*P*
Hexanchus griseus (Bonnaterre, 1788)	*P*	*P*
Mustelus punctulatus Risso, 1826	*P*	
Myliobatis aquila (Linnaeus, 1758)	*P*	*P*
Oxynotus centrina (Linnaeus, 1758)	*P*	
Pteromylaeus bovinus (E. Geoffroy Saint-Hilaire, 1817)	*P*	
Raja asterias Delaroche, 1809	*P*	*P*
Raja circularis Couch, 1838	*P*	
Raja clavata Linnaeus, 1758	*P*	*P*
Raja fullonica Linnaeus, 1758	*P*	
Raja miraletus Linnaeus, 1758	*P*	*P*
Raja montagui Fowler, 1910	*P*	*P*
Raja oxyrinchus Linnaeus, 1758	*P*	*P*
Scyliorhinus canicula (Linnaeus, 1758)	*P*	*P*
Scyliorhinus stellaris (Linnaeus, 1758)	*P*	*P*
Squalus acanthias Linnaeus, 1758	*P*	*P*
Squalus blainvillei (Risso, 1826)	*P*	
Torpedo marmorata Risso, 1810	*P*	*P*
Torpedo nobiliana Bonaparte, 1835	*P*	
Torpedo torpedo (Linnaeus, 1758)	*P*	*P*

TABLE II. Main biological information about the 4 studied species. (1) Relini *et al*., 1999; (2) Cannizzaro *et al*., 1995; (3) Ungaro *et al*., 1994; (4) Fischer *et al*., 1987; (5) Tortonese, 1956; (6) Jardas, 1979.

	Growth parameters (Von Bertalanffy Growth Function)						
	L_{∞}		**K**		**t_o**		Source
	Males	Females	Males	Females	Males	Females	
R. asterias	72.5	76.0	0.42	0.41	0	0	1
R. clavata	116.7	126.5	0.106	0.098	-0.412	-0.512	2
S. canicula							
G. melastomus							

	Length/weight relationship					Size of first maturity Lm		
	Males		Females		Source	Males	Females	Source
R. asterias	a=0.00577	b=0.0124	a=0.00177	b=3.3216	1	45-54	60	4
R. clavata	a=0.00358	b=3.1243	a=0.00192	b=3.3076	1	54	60	5
S. canicula	a=0.0015	b=3.210	a=0.0012	b=3.287	1	30-39	35-40	6
G. melastomus	a=0.00170	b=3.127	a=0.00130	b=3.207	3	34-45	36-45	4

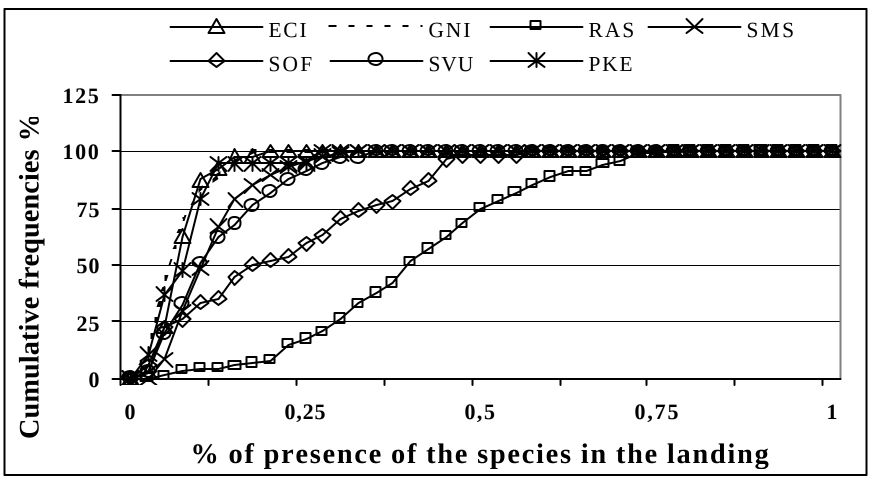

Fig. 1. Percentage of a selected number of species in the landing of each single trip using a variant of beam trawl vs. cummulated frequency (%). ECI (*Eledone cirrhosa*), GNI (*Gobius niger*), RAS (*Raja asterias*), SMS (*Squilla mantis*), SOF (*Sepia officinalis*), SVU (*Solea vulgaris*), PKE (*Penaeus kerathurus*).

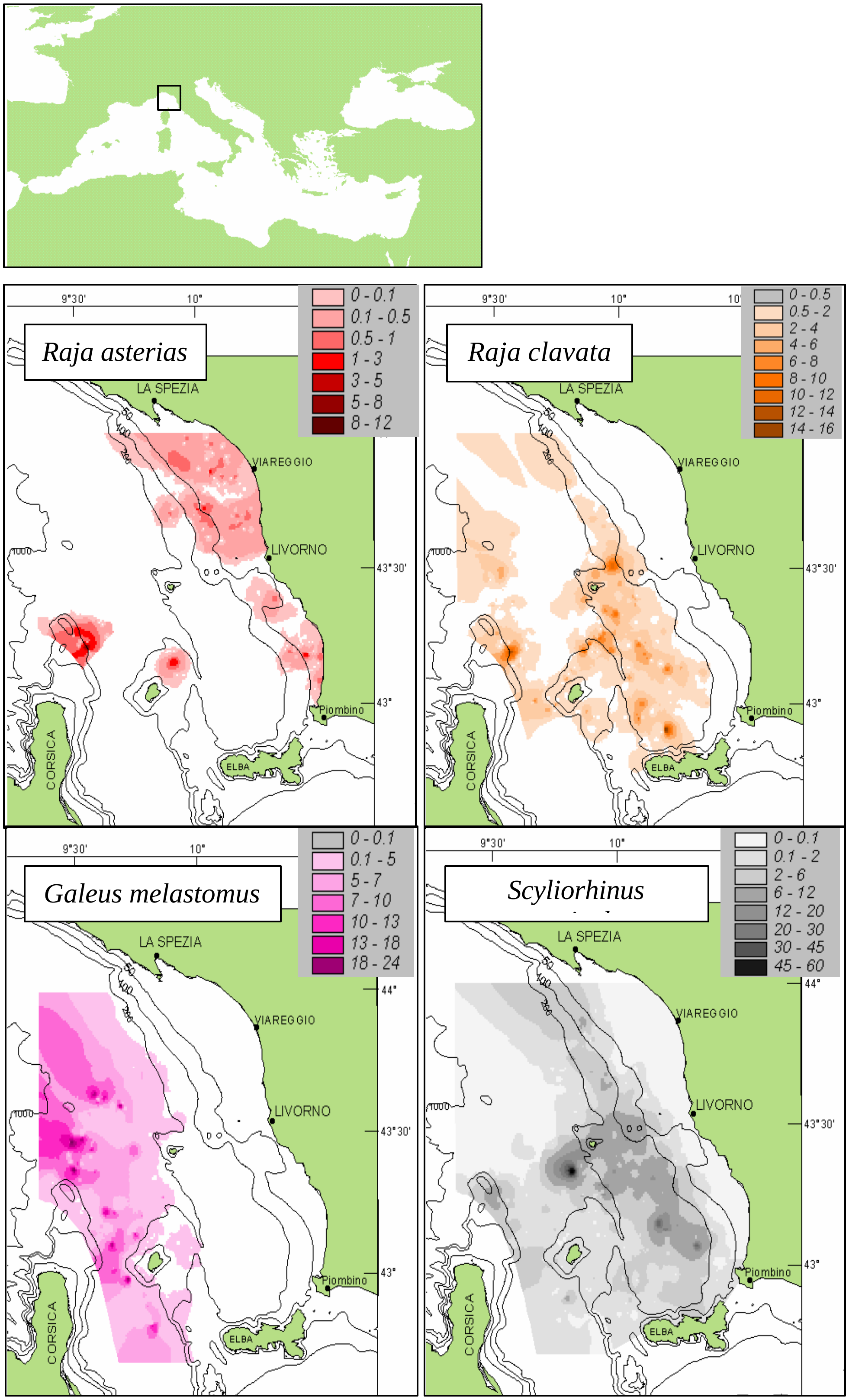

Fig. 2. Distribution of the 4 studied species derived from trawl-surveys data.

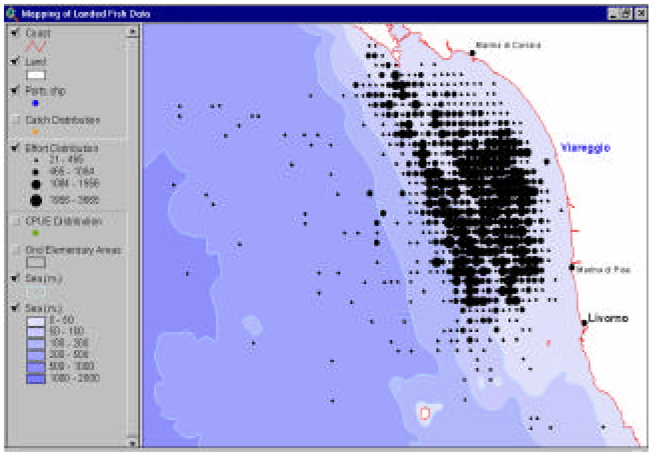

Fig. 3. Fishing effort distribution of the Viareggio fleet utilising a variant of the traditional Italian bottom trawl (volantina).

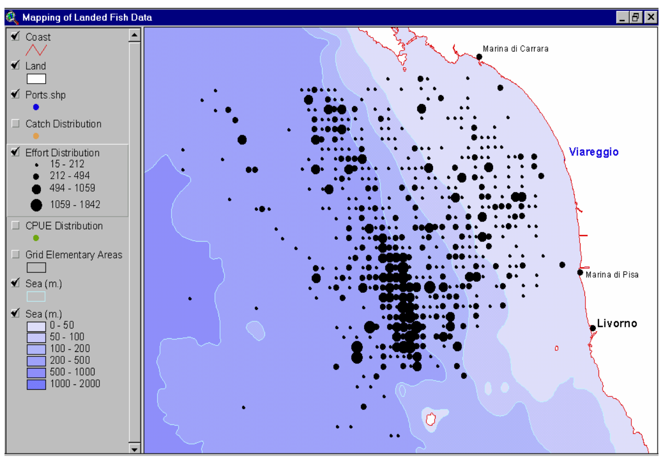

Fig. 4. Fishing effort distribution of the Viareggio fleet utilising the traditional Italian bottom trawl (tartana).

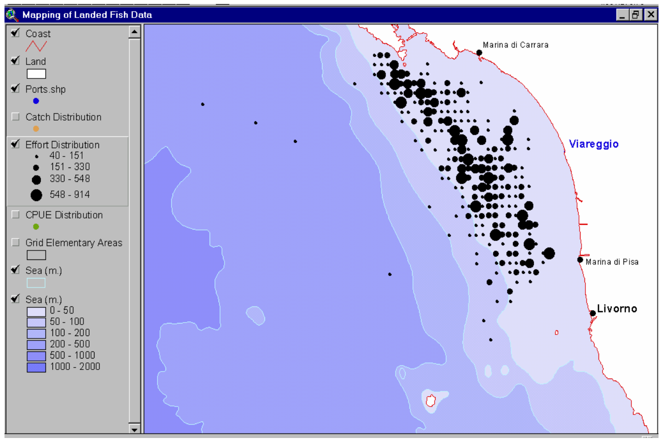

Fig. 5. Fishing effort distribution of the Viareggio fleet utilising a variant of the beam trawl (rapido).

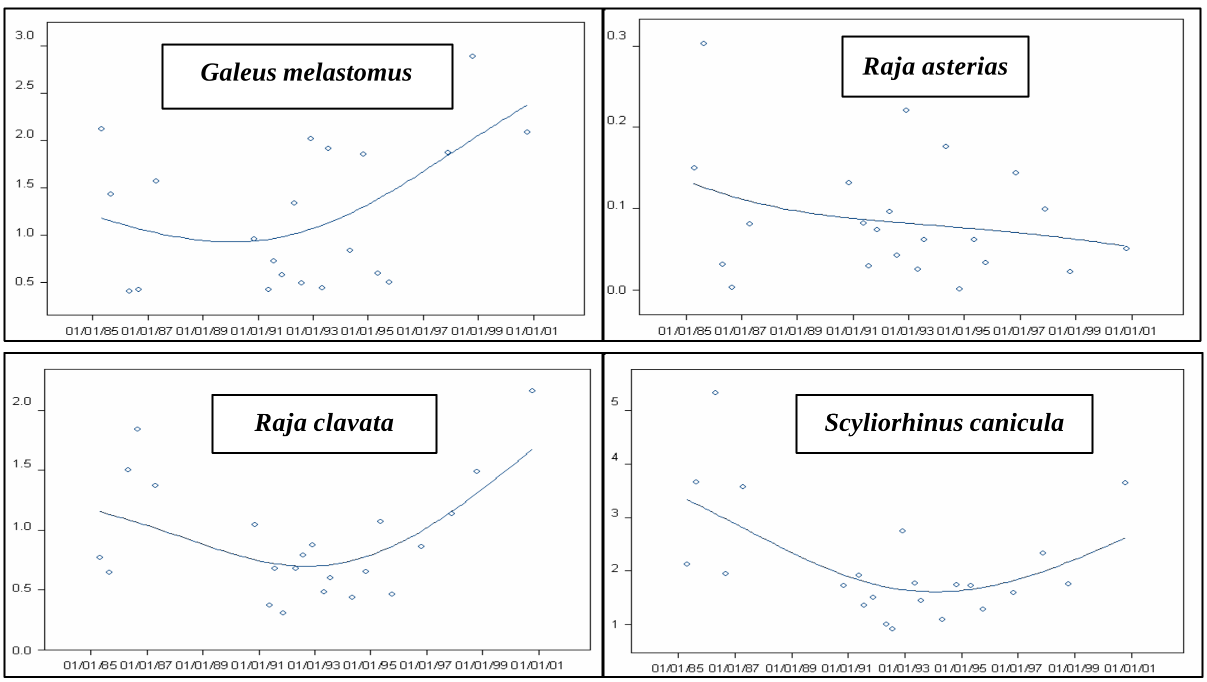

Fig 6. Trends of abundance (Kg/h) for the 4 studied species derived from trawl-surveys. A spline smoother was used.

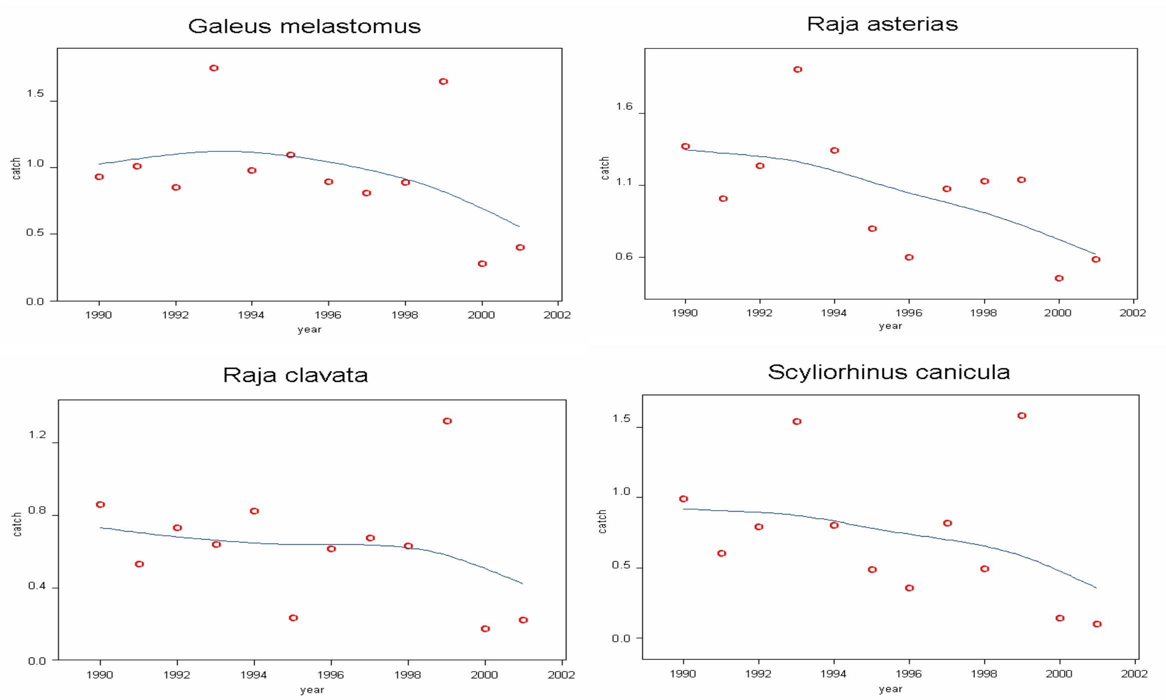

Fig. 7. Trends in catch rates (Kg/h) for *G. melastomus*, *S. canicula*, *R. asterias* and *R. clavata* for the Viareggio fleet between 1990 and 2001. A spline smoother was used.

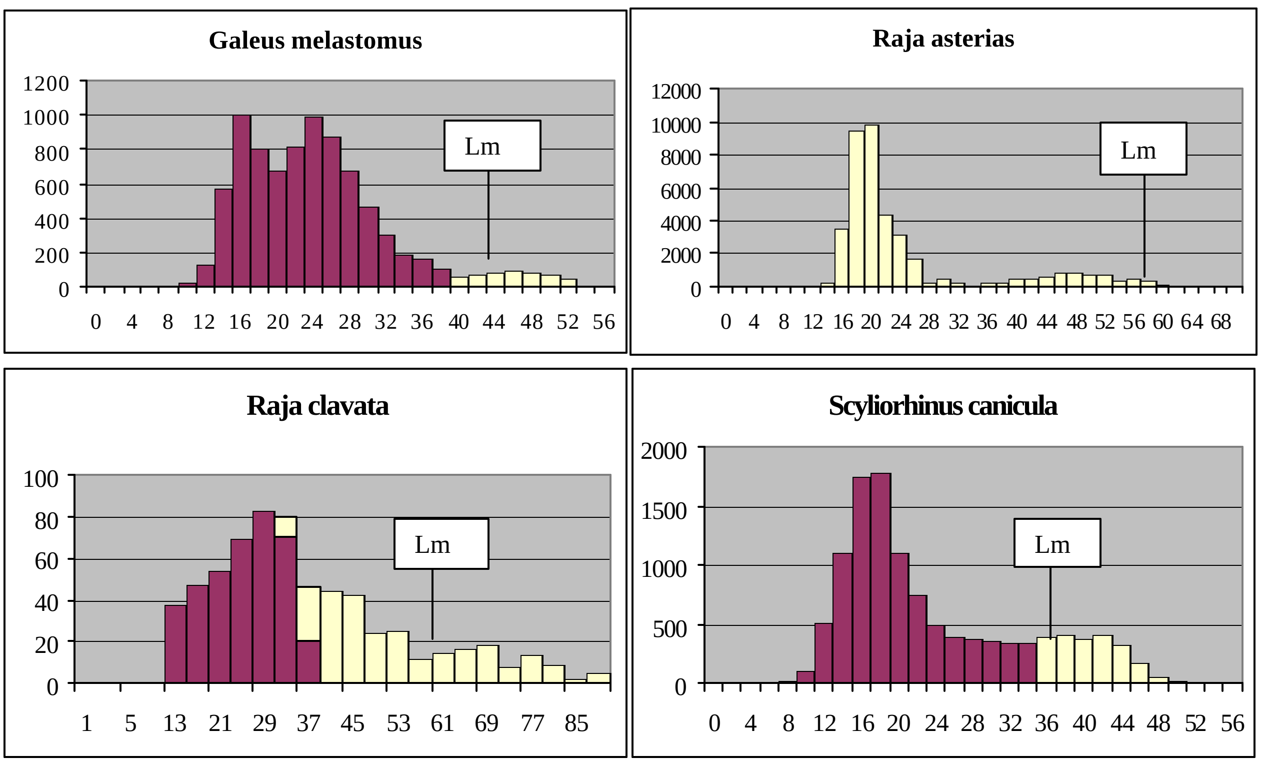

Fig. 8. Size distribution in the catches of *G. melastomus*, *S. canicula*, *R. asterias* and *R. clavata*, discarded fraction (dark bars) and size at first maturity of females (Lm).

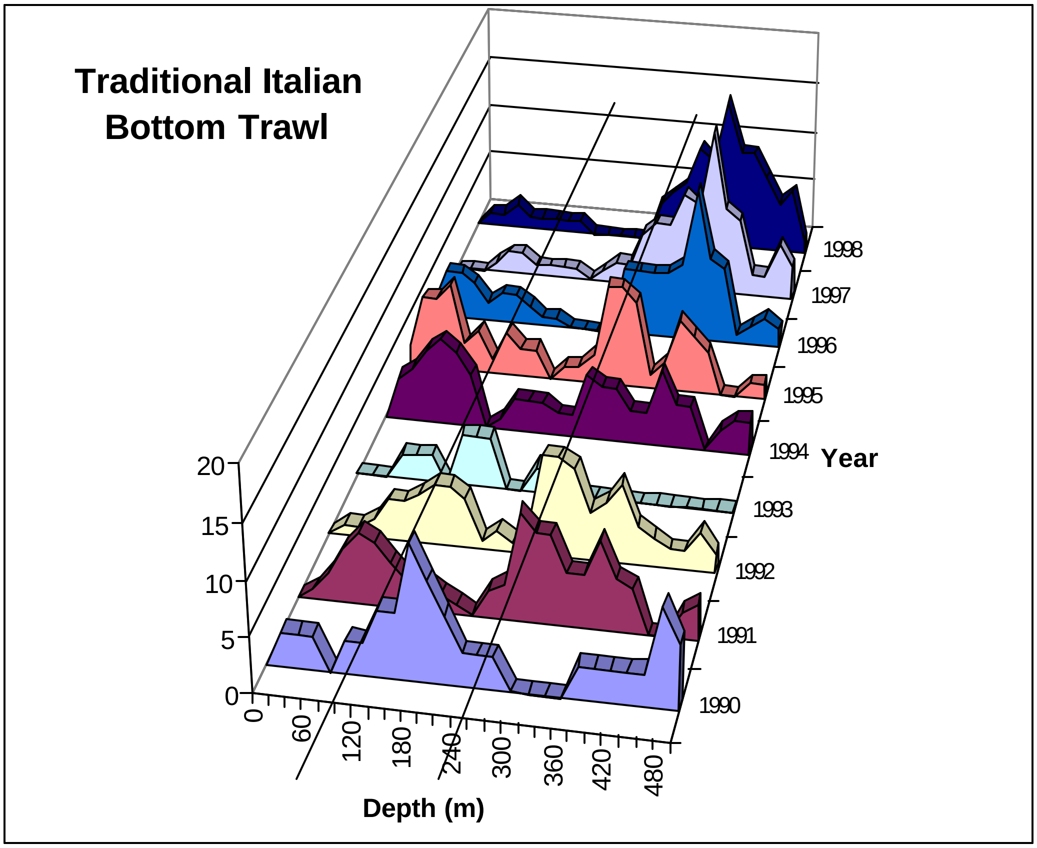

Fig. 9. Bathymetric distribution of fishing effort of the traditional Italian bottom trawl net (tartana) of the Viareggio fleet, along the period 1990-1999. The lines define the depth interval 100-250 m.

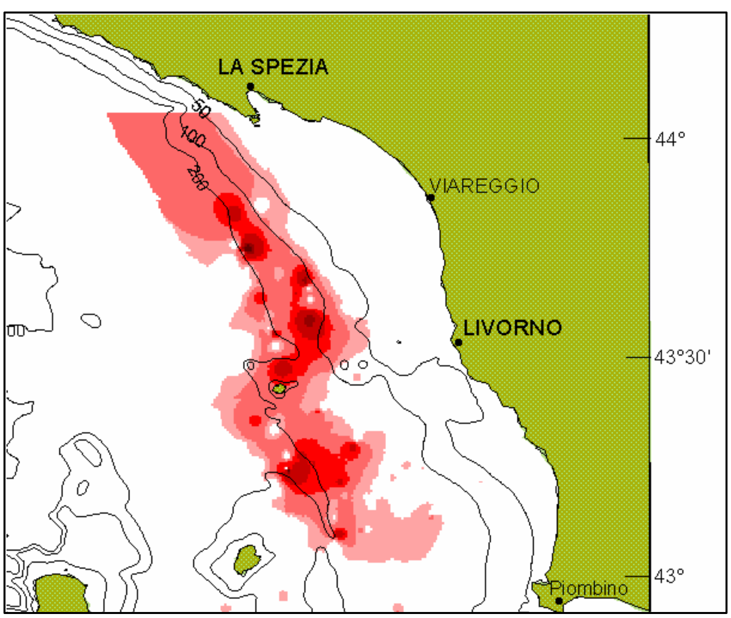

Fig.10. Distribution of nursery areas of Mediterranean hake (*Merluccius merluccius*).