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Impact of the Deep-sea Trawl Fishery on Demersal Communities of the Northern Tyrrhenian Sea (Western Mediterranean)

by

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Abstract

The composition of the catch of the deep-sea trawl fleet of Porto Santo Stefano (northern Tyrrhenian Sea, western Mediterranean) was analysed. In the period 1995-1999 observations were carried out on board of commercial vessels, collecting data for about 500 trawling hours. *Nephrops norvegicus*, *Parapenaeus longirostris* and large specimens of *Merluccius merluccius* were the targets on the fishing grounds from 300 to 450 m, while *Aristaemorpha foliacea*, *Aristeus antennatus* and *N. norvegicus* on the fishing grounds from 450 to 650 m depth.

By-catch dominated the biomass caught, and was characterised by a high degree of species richness, as a consequence of the reduced selectivity of the bottom trawl gear. An important fraction of the by-catch was constituted by commercially retained species, which provided an important added value to the landings. Catch of target species was entirely commercialised. Annual average discards were about 20% of the total catch. Discard of commercial species was mostly due to species under commercial size, while discard of non-commercial species was represented by a large number of small size species of fishes and crustaceans. The results seem to indicate that this kind of fishery achieves a fairly good compromise between efficiency of resource utilisation and impact on the demersal communities.

Keywords: deep-sea fishery, trawling, demersal ichthyofauna, by-catch, discards, western Mediterranean.

Introduction

In the Mediterranean basin deep-sea fishery is an important activity performed by the bottom trawl fleets. It is carried out on the continental slope from about 250 to 800 m depth and is targeted to the exploitation of decapod crustaceans with high economic value. In the western and central Mediterranean, Norway lobster (*Nephrops norvegicus*), red shrimps (*Aristaeomorpha foliacea* and *Aristeus antennatus*), deep water rose shrimp (*Parapenaeus longirostris*) and also large size specimens of European hake (*Merluccius merluccius*) are the target species of this fishery. In Italian waters these species accounted for an important fraction of commercial trawl landings. According to the national data series recorded by ISTAT (Italian Central Institute of Statistics), 57,005 tons of Norway lobster, 43,505 of red shrimps and 136,243 of deep water rose shrimp were landed in the period 1985-1996 (ISTAT, 1988-1999).

Aspects regarding species biology and fishery of red shrimps and Norway lobster have been well documented in the Mediterranean Sea (Sardà, 1993, 1998; Bianchini and Ragonese, 1994), while the composition of the catch of these fisheries has not been analysed in detail.

The aim of the present study is to characterise the species composition of the catch, with particular attention to the by-catch, in order to evaluate the impact of this fishery on the demersal communities.

The study was performed in the northern Tyrrhenian Sea (western Mediterranean), where an important deep-sea trawl fishery is traditionally carried out by the Porto Santo Stefano and Porto Ercole fleets on muddy bottoms from 300 to 650 m depth.

Materials and Methods

In the years 1995-1999 the activity of the commercial trawl fleet was monitored at Porto Santo Stefano, the main landing point of the area investigated. This study focused on the portion of the fleet exploiting deep bottoms, located from 300 to 650 m depth. These vessels commonly employ bottom trawl nets with cod end mesh size (stretched) of about 40 mm.

Fishing activity was monitored, on a seasonal basis, by observations on board of commercial vessels. Monitoring activities did not interfere with the habitual on board *modus operandi* of the crew (e.g. allocation and duration of the haul, sorting of the catch).

Data on species composition of the catch, subdivided by the fishermen into commercially retained and discarded fractions, were collected for each haul. In the sampled period, information from about 500 trawling hours was gathered. The collected data were analysed as hourly yields (kg/h) and then studied on a seasonal basis, according to the following categories (Alverson *et al*., 1994):

Target species: commercialised fraction of the target species.

By-catch: fraction of the catch not belonging to the target species.

This latter category was subsequently divided into:

Kept by-catch: portion of the catch landed together with the target species; Discarded by-catch: individuals caught but not retained; this fraction was then divided into Discard of commercial species (specimens either damaged or smaller than the commercial size) and Discard of non-commercial species.

The Stock Use Efficiency (SUE) and the Ecological Use Efficiency (EUE) proposed by Alverson and Hughes (1996) were applied to evaluate the impact of by-catch on the total catch. These indices allow estimation of the retained fraction of the total catch, both in the case of a single target species (SUE) and in the case of a pool of commercial species (EUE):

$$\text{Stock Use Efficiency (SUE, for each target species)} = \frac{\sum \text{Commercialised catch}}{\sum \text{Commercialised catch} + \sum \text{Discarded Catch}}$$

$$\text{Ecological Use Efficiency (EUE)} = \frac{\sum_{\text{all species}} \text{Commercialised catch}}{\sum_{\text{all species}} \text{Commercialised catch} + \sum_{\text{all species}} \text{Discarded Catch}}$$

Results

In the period studied, the trawl fleets of Porto Santo Stefano and Porto Ercole accounted for 31 and 11 vessels, respectively (Tab. I). The two fleets had similar characteristics except for average engine power which was higher for the Porto Santo Stefano boats. Deep-sea trawl fishery was usually carried out by 13 vessels, 8 moored at Porto Santo Stefano and 5 at Porto Ercole.

Observations on board of Porto Santo Stefano trawlers allowed the identification of different fishing areas, on bottoms greater than 300 m depth, localised between the Isles of Giglio and Montecristo and to the south of Pianosa Island. (Fig. 1). In the fishing grounds from 300 to 450 m depth the most important target species was Norway lobster; other targets were deep water rose shrimp and large size specimens of European hake (greater than 25 cm of total length). These “Norway lobster fishing grounds” were exploited all year round; usually, two hauls were

performed on each fishing day, with mean duration of 4h.14' (±35') each.

Other fishing grounds were localised on deeper bottoms, from about 450 to 650 m, with the two red shrimps and Norway lobster as target species. The fishing activity on these bottoms (“red shrimps fishing grounds”) was mostly carried out from spring to autumn; due to the low fishing effort performed by the fleet in winter, no data were available for this season. On each fishing day two hauls were usually performed, with a mean duration of 4h.56' (±38') each.

In all, 155 species were recorded in the period studied, 86 fishes, 20 cephalopods, 41 crustaceans and 8 belonging to other taxa. Two distinct faunistic assemblages could be detected from analysis of the species composition of the catch, according to the different fishing grounds (Tab. II): the "Norway lobster fishing grounds" consisted of 147 species, while 96 species were collected in the "red shrimps fishing grounds". Even though 90 species were common to the two assemblages, most of these showed a different abundance in each fishing area.

In all seasons, the target species represented an important fraction of the total catch, from 14 to 30% (from 5.2 to 6.7 kg/h) in the shallower fishing grounds and from 20 to 46% (from 3.4 to 5.3 kg/h) in the deeper grounds (Fig. 2). Norway lobster yields showed a peak in spring at lower depths, and another in autumn at greater depths; yields of *P. longirostris*, *A. foliacea* and *A. antennatus* reached maximum values in spring, while the catches of large size specimens of *M. merluccius* were more abundant in winter (Tab. III).

By-catch dominated the biomass caught, in all seasons and in both fishing grounds. The most important fraction of by-catch was represented by commercialised species ("kept by-catch"), with hourly yields comprised between 10.5 and 23.6 kg/h in the lower depth fishing grounds and between 4.3 and 10.5 kg/h in the deeper grounds (Fig. 2). The maximum values were always observed in summer. The by-catch was mostly constituted by fishes and cephalopods, the most abundant species were blue whiting, *Micromesitius poutassou*, greater forkbeard, *Phycis blennoides*, small specimens of *M. merluccius* and horned octopus, *Eledone cirrhosa*, in the "Norway lobster fishing grounds", greater forkbeard, *P. blennoides*, blackmouth catshark, *Galeus melastomus*, and *M. merluccius*, in the "red shrimps fishing grounds" (Tab. II).

As shown by the values of the EUE index, discard constituted a considerable fraction of the total catch, ranging from 14.5 to 24.6% and from 16.9 to 30.9% in the two fishing areas, respectively (Fig. 3).

Discard of commercial species was mostly due to specimens of fishes and cephalopods under commercial size. Although this fraction was constituted by a large number of species, its biomass was mostly due to *G. melastomus*, accounting for 32% in the fishing grounds at lower depths and for 62% in the deeper fishing areas (Tab. II).

Discard of non-commercial species was the fraction with the highest species richness in both fishing grounds. It was mostly constituted by species without commercial interest, in particular belonging to fishes and crustaceans. Most of the species were of small size, lower than 10 grams of individual weight; thus, their importance was higher in terms of abundance than in biomass. In the shallower fishing grounds, the silvery pout, *Gadiculus argenteus*, accounted for 62% of the non-commercial catch, while in the deeper fishing grounds the biomass of this fraction was more equally shared among the 63 species caught.

Discard of target species was negligible, as shown by the SUE index values (Fig. 3). Effectively, the entire catch of the four species of crustaceans was commercialised. Discard of European hake was low and limited to small specimens, which would have been unmarketable; the maximum discard rate was reached in summer in lower depth fishing grounds (0.08 kg/h corresponding to the 8% of the total catch of this species).

Discussion

All fishing techniques imply an unavoidable impact on the marine communities, especially techniques producing catches of species or specimens different from those belonging to the target of each fishery. The term “by-catch” is used in the present paper, in agreement with Alverson *et al*. (1994), to refer to this fraction of the catch not belonging to the target species, although other authors have given a different definition of this term (Hall, 1996). In this sense, a part of by-catch is constituted by commercially retained species, the other fraction by non-marketable species, which are rejected at sea.

The review by Alverson *et al*. (1994) gives an idea on the magnitude of this problem, showing that each type of fishery, gear and habitat has its own by-catch problems; in particular, about 27 million tonnes of marine organisms are discarded each year, corresponding to roughly one third of the annual landings reported by FAO. Estimation of quantity and composition of the by-catch is one of the most important research priorities, not only for fishery assessment purposes (Mesnil, 1996) but also as an important tool to evaluate the biological impact of fisheries (Commission of the European Communities, 1994).

In recent decades, several trawlers of Porto Santo Stefano and Porto Ercole, the main fishing ports of the northern Tyrrhenian Sea, have specialised in carrying out this kind of fishery all year round on the continental slope. As emerged from the results of our investigation, fishing activity is performed on two main fishing grounds differing both in species assemblage and target species. Some seasonality was detected in exploitation of the different fishing grounds and in yields of the target species, the major species being Norway lobster, which is in great demand on local markets (average annual first sale price of about 22 Euros/kg). In winter the deeper fishing grounds (greater than 450 m) were less exploited due to low yields of target species (especially Norway lobster). Therefore, in winter the fishing effort was concentrated on a narrower depth range, where the highest yields of large specimens of European hake were also observed, in accordance with the reproductive biology of the species (Biagi *et al*., 1995). For *A. foliacea* and *P. longirostris* the maximum yields observed in spring were probably a consequence of the distribution pattern; in particular, in spring the larger specimens of *P. longirostris* concentrate for reproduction at depths greater than 200 m (Mori *et al*., 1986; Levi *et al*., 1995).

The results obtained in this study show that the by-catch of the deep-sea trawl fishery in the northern Tyrrhenian Sea (western Mediterranean) accounted for about 80% of the total catch on annual average, while the remaining fraction was constituted by target species. Even though exploitation is devoted to the target species, the economic value of the landing is also due to the species belonging to the retained by-catch. This is an important characteristic of the Mediterranean trawl fishery, which can be classified as multispecific (Caddy, 1993). Furthermore, on many fishing grounds landings are dominated by small size species, most of which have considerable local importance such as small specimens of horned octopus, *E. cirrhosa* exploited on the continental shelf (Belcari *et al*., 1998). For these reasons, bottom trawl gears have low selectivity in the Mediterranean area. Increasing the mesh size to more than the legal size of 40 mm would result in loss of many small species from the catch that have significant economic value (Caddy, 1993). In addition long haul duration, such as that observed in this study, can reduce mesh selectivity, thereby increasing discard rates (Murawski, 1996).

In our results, the presence of small size specimens was recorded above all in the non-commercial by-catch, the retained by-catch being mostly composed of medium-large size species (e.g. *M. poutassou*, *P. blennoides* and *E. cirrhosa*). This kind of fishery produced a non-negligible amount of discard, representing about 20% of the total catch of the different fishing grounds. An even greater proportion of discard was reported by Moranta *et al*. (2000) for the same type of fishery in the Balearic Islands, corresponding to 42% of the total biomass caught.

Discard of commercial species was mostly constituted by individuals under the commercial size of species belonging to the commercially retained by-catch. Discard was particularly frequent in cases of low commercial value species, such as the Selachian *G. melastomus*. Discard of target species was practically absent, confirming the high efficiency of their exploitation. In contrast, on the continental shelf fishing grounds of the same area the discard of target species may reach high levels, as documented for *M. merluccius* in summer (about 35%, Sartor *et al*., in press).

The low selectivity of the gear as well as the species diversity of the exploited fish assemblages are the main reason for the high species richness detected in the catches, especially as regards the discarded fraction. This may produce an "ecosystem level impact" (Hall, 1996) on a complex of species belonging to the demersal communities. Unfortunately, most of these species may be included in the "by-catch of unknown levels" as indicated by Hall (1996), because there is still a lack of information on their abundance and mortality rate which does not allow estimation of the sustainability of the impact of the fishing activity considered in the present study.

The results obtained in the present study seem to indicate a good compromise between efficiency of resource utilisation and impact on the demersal communities. However, some strategies to reduce mortality of small size specimens, such as increasing the cod end mesh size and/or other technical measure (e.g. escape windows with square meshes), could be proposed to improve the sustainability of this kind of fishery.

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References

Alverson D.L., M. H. Freeberg, J.G. Pope, S.A. Murawsky, 1994. A global assessment of fisheries bycatch and discard. FAO Fish. Tech. Pap., 339, 233 pp.

Alverson D.L., S.E. Hughes, 1996. By-catch: from emotion to effective natural resource management. Rev. Fish. Biol. and Fish., 6: 443-462.

Belcari P., P. Sartor, S. De Ranieri, 1998. I cefalopodi nello sbarcato commerciale con reti a strascico nel Mar Tirreno Settentrionale. Biol. Mar. Medit., 5(2): 318-325.

Biagi F., A. Cesarini, M. Sbrana, C. Viva, 1995. Reproductive biology and fecundity of *Merluccius merluccius* (Linnaeus, 1758) in the northern Tyrrhenian Sea. Rapp. Comm. Int. Mer Médit., 34: 237.

Bianchini M.L., S. Ragonese (Eds.), 1994. Life cycles and fisheries of the deep-water red shrimps *Aristaeomorpha foliacea* and *Aristeus antennatus*. Proceedings of the International Workshop held in the Istituto di Tecnologia della Pesca e del Pescato (ITPP – CNR), Mazara del Vallo, Italy, 28-30 April '94. N.T.R. – I.T.P.P. Special Publications, 3, 88 pp.

Caddy J.F., 1993. Some future perspectives for assessment and management of Mediterranean fisheries. Sci. Mar., 57 (2-3): 121-130.

Commission of the European Communities, 1994. Report on the meeting on data base for evaluation of biological impact of fishery. Commission Staff Working Paper, 39 pp.

Hall M.A., 1996. On bycatches. Rev. Fish Biol. and Fish., 6: 319-352.

ISTAT (Istituto Centrale di Statistica), 1988-1997. Statistiche della caccia e della pesca.

Levi D., M. G. Andreoli, R. M. Giusto, 1995. First assessment of the rose shrimp, *Parapenaeus longirostris* (Lucas, 1846) in the central Mediterranean. Fish. Res., 21: 375-393.

Mesnil B., 1996. When discard survive: accounting for survival of discards in fisheries assessment. Aquat. Living. Resour., 9: 209-215.

Moranta J., E. Massutí, B. Morales-Nin, 2000. Fish catch composition of the deep-sea decapod crustacean fisheries in the Balearic Islands (western Mediterranean). Fish. Res., 45: 253-264.

Mori M., P. Belcari, F. Biagi, 1986. Distribuzione e sex-ratio di *Parapenaeus longirostris* (Lucas) nel Tirreno Settentrionale. Nova Thalassia, 8 (Suppl. 3): 623-625.

Murawski S.A., 1996. Factors influencing by-catch and discards rates: analyses from multispecies/multifisheries sea sampling. J. Northwest Atlantic Fish. Sci., 16: 31-89.

Sardà F., 1993. Bio-ecological aspects of the decapod crustacean fisheries in the western Mediterranean. Aquat. Living Resour., 6: 299-305.

Sardà F. (Ed.), 1998. *Nephrops norvegicus*: comparative biology and fishery in the Mediterranean Sea. Sci. Mar., 62 (Suppl. 1), 143 pp.

Sartor P., M. Sartini, B. Reale, M. Sbrana. Analysis of the discard practices in the *Merluccius merluccius* (L., 1758) bottom trawl fishery of the northern Tyrrhenian Sea. Biol. Mar. Medit. (in press).

Table I – Main characteristics of the otter trawl fleets of the two ports.

Port	Number of vessels	Mean kw (± S.E.)	Mean Gross Registered Tonnage (± S.E.), tons	Mean Overall Length (± S.E.), meters
Porto Santo Stefano	31	347.6 (± 23.8)	55.4 (± 7.1)	20.4 (± 0.8)
Porto Ercole	11	219.4 (± 19.8)	55.6 (± 5.9)	21.1 (± 1.3)

Table II - List of species and mean yields in weight (kg/h) obtained in the study period I n the different fishing grounds according to the fractions of the catch.

	Norway lobster fishing grounds				Red shrimps fishing grounds			
	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species
Nephrops norvegicus								
Parapenaeus longirostris								
Aristaeomorpha foliacea								
Aristeus antennatus								
Merluccius merluccius								
FISHES								
Acantholabrus palloni								
Antonogadus megalokynodon								
Argentina sphyraena								
Arnoglossus rueppelli								
Bellottia apoda								
Benthosema glaciale								
Callionymus maculatus								
Capros aper								
Centracanthus cirrhus								
Centrolophus niger								
Ceratoscopelus maderensis								
Chauliodus sloani								
Chimaera monstrosa								
Chlorophthalmus agassizi								
Citharus linguatula								
Coelorhynchus coelorhynchus								
Conger conger								
Dalatias licha								
Diaphus metopoclampus								
Diaphus rafinesquei								
Echelus myrus								
Echiodon dentatus								
Epigonus constanciae								
Epigonus denticulatus								
Epigonus telescopus								
Etmopterus spinax								
Gadella maraldi								
Gadiculus argenteus								
Galeus melastomus								
Glossanodon leioglossus								
Gnathophis mystax								
Gobius niger								
Helicolenus dactylopterus								
Hexanchus griseus								
Hoplostethus mediterraneus								
Hymenocephalus italicus								
Lampanyctus crocodilus								
Lepidopus caudatus								
Lepidorhombus boscii								
Lepidorhombus whiffiagonis								
Lesueurigobius friesii								
Lesueurigobius suerii								
Lophius budegassa								
Lophius piscatorius								
Macroramphosus scolopax								
Maurolicus muelleri								
Microichthys coccoi								
Micromesistius poutassou								
Molva dipterygia								
Mora moro								
Mullus surmuletus								
Nemichthys scolopaceus								
Nettastoma melanurum								
Nezumia sclerorhynchus								
Notacanthus bonapartei								
Notolepis rissoi								
Ophidion rochej								
Pagellus acarne								
Pagellus bogaraveo								
Peristedion cataphractum								

(Table II: continued)

	Norway lobster fishing grounds				Red shrimps fishing grounds			
	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species
Phycis blennoides								
Phycis phycis								
Polyprion americanus								
Raja oxyrhynchus								
Sardina pilchardus								
Scorpaena elongata								
Scorpaena notata								
Scyliorhinus canicula								
Serranus hepatus								
Spicara smaris								
Squalus acanthias								
Stomias boa boa								
Symbolophorus verany								
Symphurus ligulatus								
Symphurus nigrescens								
Synchiropus phaeton								
Synodus saurus								
Torpedo marmorata								
Trachurus picturatus								
Trachurus trachurus								
Trachyrhynchus trachyrhynchus								
Trigla lucerna								
Trigla lyra								
Trisopterus minutus capelanus								
Zeus faber								
CEPHALOPODS								
Abralia verany								
Alloteuthis spp.								
Eledone cirrhosa								
Heteroteuthis dispar								
Histioteuthis bonnellii								
Histiotheutis reversa								
Illex coindetii								
Loligo forbesi								
Neorossia caroli								
Octopus salutii								
Pteroctopus tetracirrhus								
Rondeletiola minor								
Rossia macrosoma								
Scaeurgus unicirrhus								
Sepia elegans								
Sepia orbignyana								
Sepietta oweniana								
Sepiola ligulata								
Todarodes sagittatus								
Todaropsis eblanae								
CRUSTACEANS								
Alpheus glaber								
Calocaris macandreae								
Chlorotocus crassicornis								
Gennadas elegans								
Geryon longipes								
Goneplax rhomboides								
Latreillia elegans								
Liocarcinus depurator								
Macropipus tuberculatus								
Macropodia longipes								
Macropodia rostrata								
Medorippe lanata								
Monodaeus couchi								
Munida intermedia								
Munida tenuimana								
Pagurus alatus								
Pagurus prideauxi								
Parasquilla ferussaci								
Paromola cuvieri								

(Table II: continued)

	Norway lobster fishing grounds				Red shrimps fishing grounds			
	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species	Target species	Kept by catch	Discard of commercial species	Discard of not commercial species
Pasiphaea multidentata								
Pasiphaea sivado								
Philocheras echinulatus								
Plesionika acanthonotus								
Plesionika antigai								
Plesionika edwardsii								
Plesionika giglioli								
Plesionika heterocarpus								
Plesionika martia								
Polycheles typhlops								
Pontocaris cataphracta								
Pontocaris lacazei								
Pontophilus spinosus								
Processa canaliculata								
Processa nouveli								
Rissoides pallidus								
Sergestes arcticus								
Solenocera membranacea								
OTHERS								
Alcyonium palmatum								
Aporrhais pespelecani								
Astropecten irregularis								
Cassidaria echinofora								
Cavolinia tridentata								
Pennatula rubra								
Pyrosoma atlanticum								
Terebratula vitrea								
NUMBER OF SPECIES	**3**	**52**	**42**	**85**	**3**	**31**	**28**	**58**

Yields

< 0.1 kg/h
from 0.1 to 0.5 kg/h
from 0.5 to 1.0 kg/h
from 1.0 to 2.5 kg/h
from 2.5 to 4.0 kg/h

Table III - Seasonal mean yields per hour (with standard error) of the target species obtained in the different fishing grounds.

Target species	Winter	Spring	Summer	Autumn
Norway lobster fishing grounds				
N. norvegicus	2.777 (0.313)	3.456 (0.765)	2.231 (0.303)	2.969 (0.595)
P. longirostris	1.743 (0.500)	2.127 (0.965)	1.791 (0.297)	1.125 (0.333)
M. merluccius*	2,138 (0.554)	1,035 (0.252)	1,174 (0.211)	1,232 (0.173)
Red shrimps fishing grounds				
A. foliacea	- -	3.274 (0.765)	0.837 (0.535)	0.973 (0.954)
A. antennatus	- -	0.505 (0.061)	0.324 (0.301)	0.053 (0.051)
N. norvegicus	- -	1.512 (0.351)	2.260 (0.768)	3.248 (1.894)

* = large size specimens (>25 cm of total length)

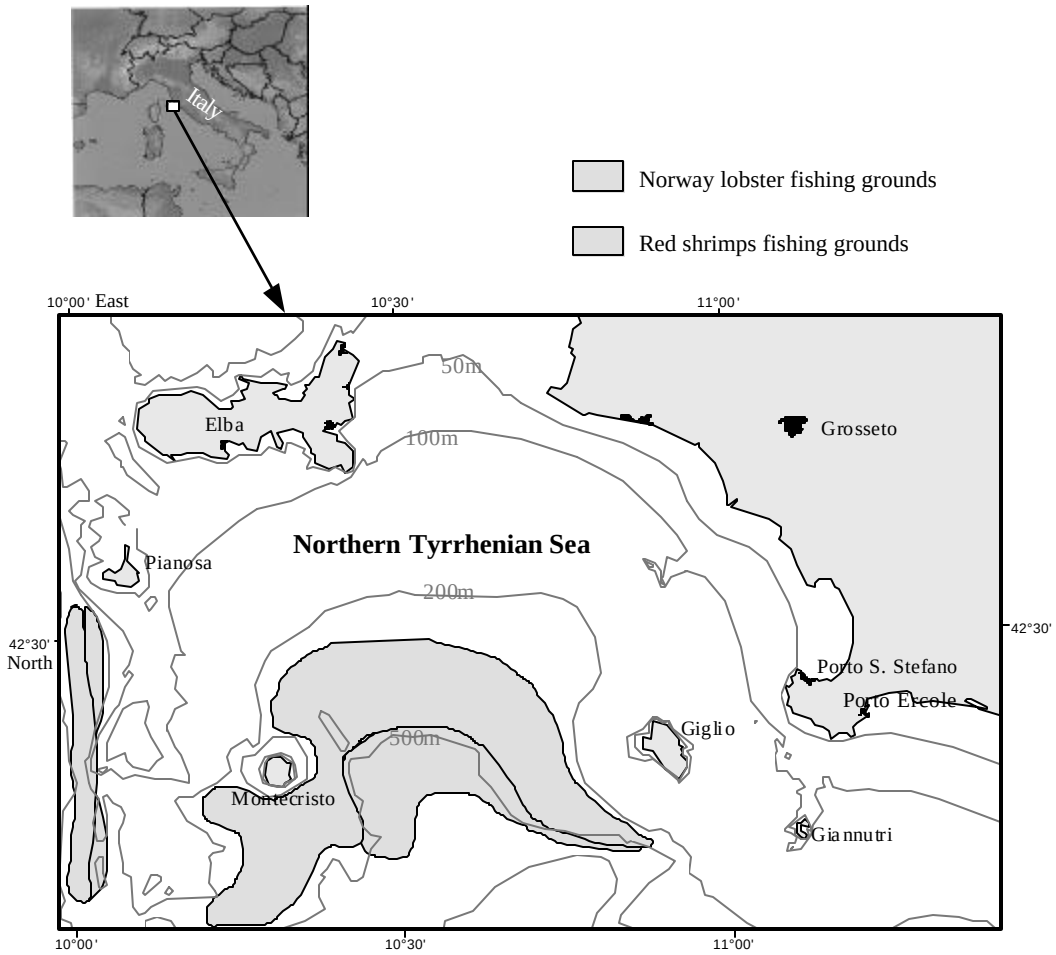

Fig. 1 - Fishing grounds of the deep-sea trawl fleets of Porto Santo Stefano and Porto Ercole.

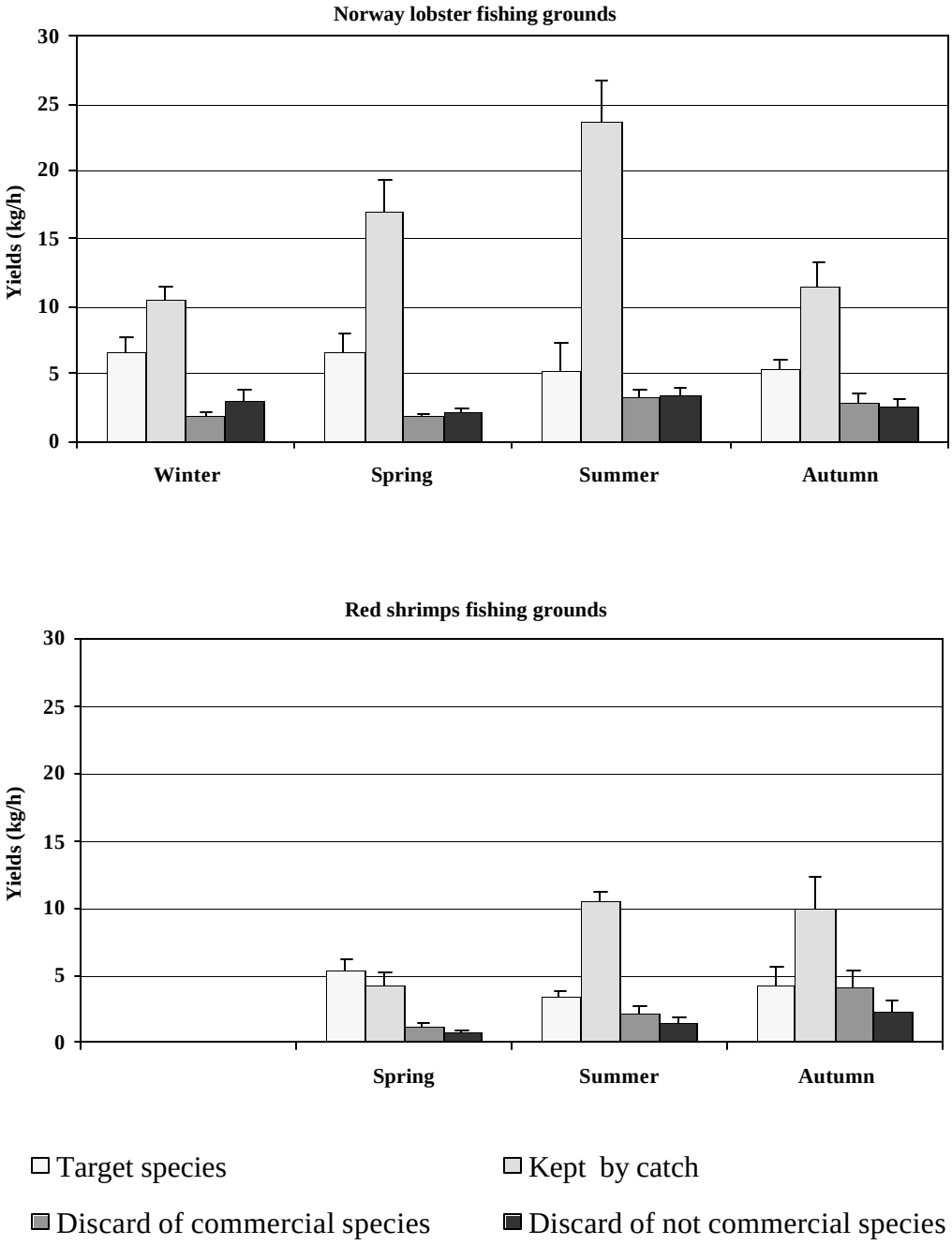

Fig. 2. Seasonal mean yields per hour (kg/h) of each fraction of the catch obtained in the different fishing grounds.

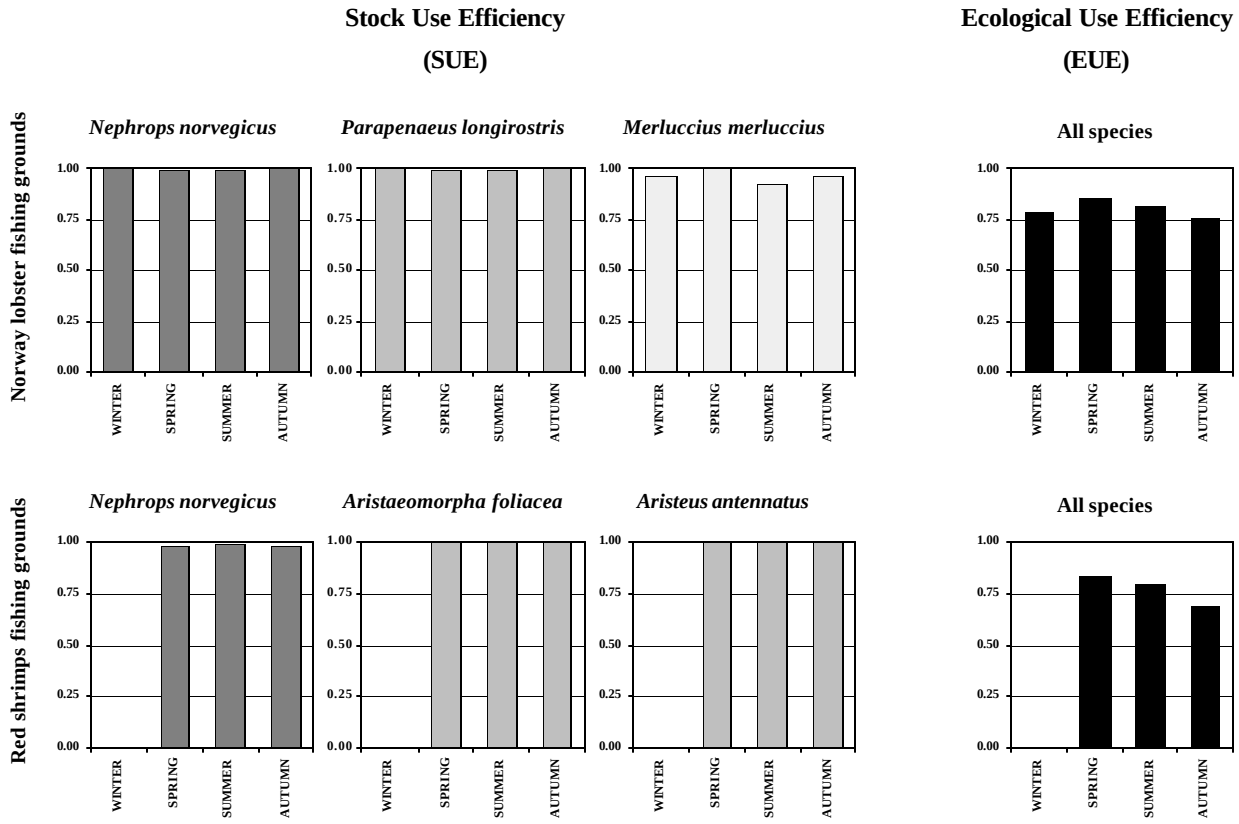

Fig. 3. Values of Stock Use Efficiency (SUE) and of Ecological Use Efficiency (EUE) computed for the catches obtained in the different fishing grounds, for each season.