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Effects of commercial trawl fishing in the Strait of Sicily on the diversity of demersal resources

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Abstract

The effects produced by commercial trawl fishing on the diversity of demersal resources in two zones of the Straits of Sicily subject to different fishing effort were analysed. Data were available from a total of 79 hauls, carried out annually in autumn 1997 and 1998 between 200 and 400 meter depth and pertained to the bathyal muddy bottoms biocenosis (Perès and Picard, 1964) on the whole.
Data on fishing effort, recorded since 1995, come from the Harbour Office and have been verified from interviews to crews and captains of Mazara del Vallo trawl fisheries.

Excluding pelagic and rare (appearing in <= 5% of hauls) species from the analysis, diversity indices, cluster analysis, K-dominance and size spectra were investigated.

The cluster analysis (employing the Bray-Curtis similarity matrix among species) shows the presence of two distinct groups of hauls corresponding to the areas with different fishing effort.
High values of the main diversity indexes seem to characterize the hauls subject to a more intensive fishing effort. K-dominance curves for the two areas show that, in "Zone 1" the main part of the catch is concentrated on commercial species (*Merluccius merluccius*, *Parapenaeus longirostris*), while in "Zone 2" the catch is mainly characterized by massive species, Elasmobranchs and Crustaceans with low or null commercial value.

Introduction

In the last two decades there has been great concern that some ecosystems were being impacted by fishing activities (Dayton *et al*., 1995) and that the pattern of fishing effort characterises diversity and structure of the demersal community (Jennings and Cotter 1999).

The aim of this papers it to value, on spatial scale, the possible effects of the trawl commercial activities on the demersal communities of two zones subject to different fishing effort.

The Strait of Sicily is a very intensively fished area. The Mazara del Vallo trawl fleet (about 180 trawl vessels; mean GRT = 23.421), one of the most big in the Mediterranean Sea, swept from about 30 years the trawlable grounds of the Strait of Sicily looking for unexploited fishing grounds moving farther from the Sicilian coasts.

Actually the eastern border of the Mazara del Vallo trawl fleet is represented by the ideal line that links Malta with the Libyan coast; easternward the fishing grounds are nearly totally unexploited.

Material and Methods

Effort data, available since 1995, come from the Harbour Office and have been verified from interviews to crews and captains of Mazara del Vallo trawl fisheries. Two "Zones" (Fig. 1) were identified which are characterised by different intensity of fishing effort; "Zone 1" is intensively exploited by commercial fishery of Mazara del Vallo (Fig.2), while "Zone 2" is a completely untrawled area.

Data on demersal communities in the two zones were available from two trawl surveys (Autumn 97, Autumn 98) carried out in the Strait of Sicily by the commercial vessels *Santa Anna* with an "Italian Otter Trawl" (28 mm mesh size at the codend). In order to compare the two zones only the hauls within the depth range 200 – 400 meter and belonging to the bathyal muddy bottoms biocenosis were selected and analysed. Table 1 indicates the number of hauls in each zone and year.

Abundance and biomass standardised to 1 Km^2 for each haul and for each species (excluding pelagic, undetermined and rare species) were utilised to calculate the Diversity indices (Shannon H', alpha, Simpson) and perform a Bray-Curtis Cluster Analysis (Single Link). Moreover, K-dominance curves were calculated for the two zones, based on mean species biomass. Finally, data were pooled across fourteen commercial species to analyse the size spectra. Specimens lengths were divided into 10-cm size classes and the natural logarithm of the mean abundance was plotted against the ln of the midlength of the corresponding size class.

Results and Discussion

No temporal trend in fishing effort was observed over the time-period considered, although there were small seasonal fluctuations in Zone 1 (Fig. 2).

A total of 83 species were analysed in the two surveys examined. Although the number of species collected is quite similar in the two "Zones" investigated, abundance/km^2 and biomass/km^2 in the trawled area were significantly lower than in the untrawled one (Mann-Withney U test, $p<0.001$) (Tab. 1).
In both zones, species abundance and biomass were higher in Autumn 1998 than in Autumn 1997 , even though the differences were not significant (Mann-Withney U test, $p>0.05$ for all).
Because of the high concordance of the results in all the analysis carried out for the two years we discuss the data and present figures relatively of Autumn 1998.

The Bray-Curtis analysis shows two different clusters representing the hauls realized in the Zones with different fishing impact (Fig. 3) .

The quite similar number of species in the two zones linked with high value of abundance in "Zone 2" explain the low diversity indices recorded in the unexploited area (Fig. 4). This result, in contrast with other experiences carried out on the benthic community (Tuck *et al*. 1998), could be explained with the moderate impact of the fishing activity on the trawled area (Zone 1); the low level of trawling disturbance probably creates an "acute impact" (in time and space) on the demersal community that increases the diversity values (Connell, 1974).

Elasmobranches seem to be particularly affected by fishing activities; K- dominance shows that they represent a very important fraction of the top 20 ranked species in “Zone 2” while they become quite negligible in “Zone 1” (Fig. 5). On the contrary the species with a high commercial value assume an important role in the demersal assemblage on the exploited zone.

Recent studies (Gislason & Rice, 1998, Rice & Gislason, 1996) investigating the relationship between size-spectra and fishing mortality, suggested that abundance-size spectrum seems to be a metric sensitive to changes in fishing activity. Accordingly to theory, the slope of the size spectrum in the exploited community is steeper and the intercept is higher with respect to same parameters of the unexploited one.

The size structure of the demersal population in “Zone 1” is affected by selective removal of larger fish. The main part of the specimens (more than 60 %) results comprises in the first two classes while in "Zone 2" the catches appear distributed in a more wide range of length classes. (Fig. 6).

Patterns in diversity and demersal community structure seem strictly related to the fishing effort. The analysis of the diversity indices does not seem the best way to investigate the impact of the fishing activity on the demersal communities; in fact, significant lower diversity values are not, at all, clearly linked to a trawl disturbance. On the contrary, the structure of the demersal assemblages and the analysis of the size spectra result more sensitive to detect changes in the demersal communities.

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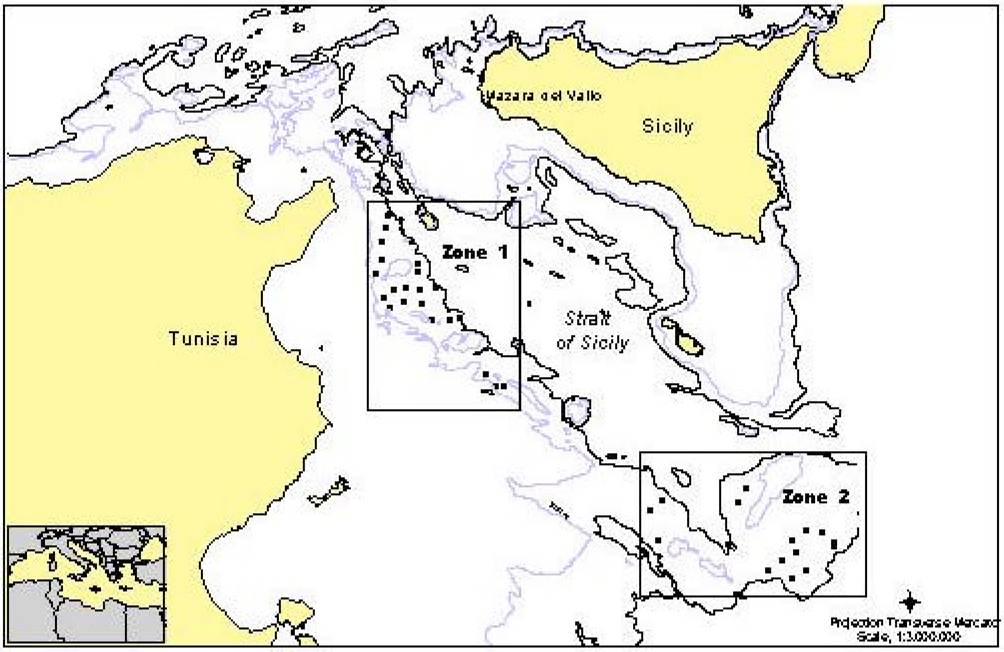

Fig. 1 – Map of the Strait of Sicily showing the location of the hauls in the two zones investigated.

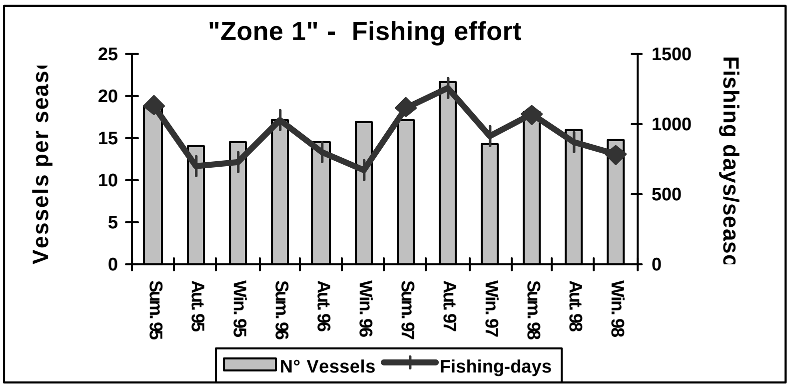

Fig. 2 – Fishing effort in the Strait of Sicily from ’95 to ’98.

		ZONE 1		ZONE 2	
Autumn 97'	**N° Hauls**	22		18	
	Total Species	67	-	69	-
Autumn 98'	**N° Hauls**	24		16	
	Total Species	70	-	61	-
		Mean	**St. dev.**	**Mean**	**St. dev.**
Autumn 97'	**Abundance/km²**	19.235	16.455	46.389	23.522
	Biomass/km²	292	251	1.143	552
Autumn 98'	**Abundance/km²**	29.363	21.104	61.390	24.855
	Biomass/km²	407	348	1.381	583

Table 1 – N° hauls, total species, Abundance/km^2, Biomas/km^2 per zone per season. Mann-Whitney U test $p<0.001$ for between zone comparisons; $p>0.05$ for between time period comparisons.

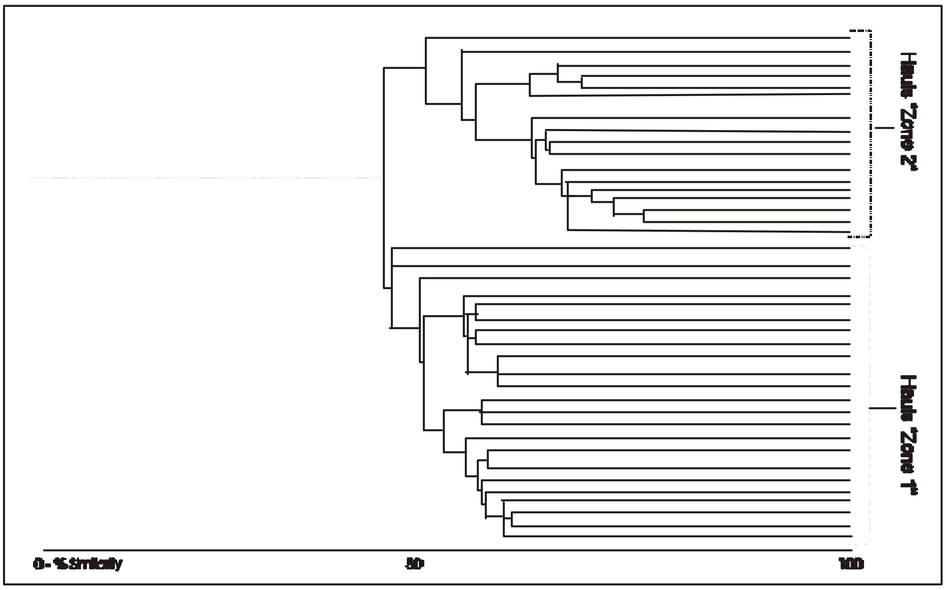

Fig. 3 – Bray-Curtis cluster analysis (Single link).

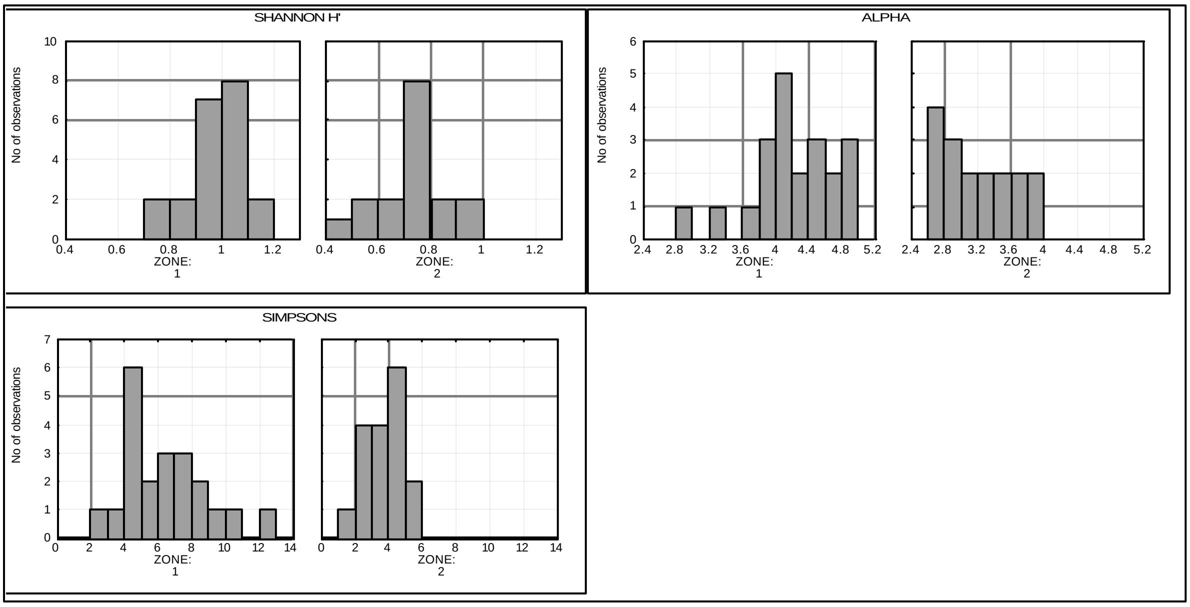

Fig. 4 – Histograms of diversity indices in each zone. Mann-Whitney U test, all $p<0.001$ for between zone comparisons.

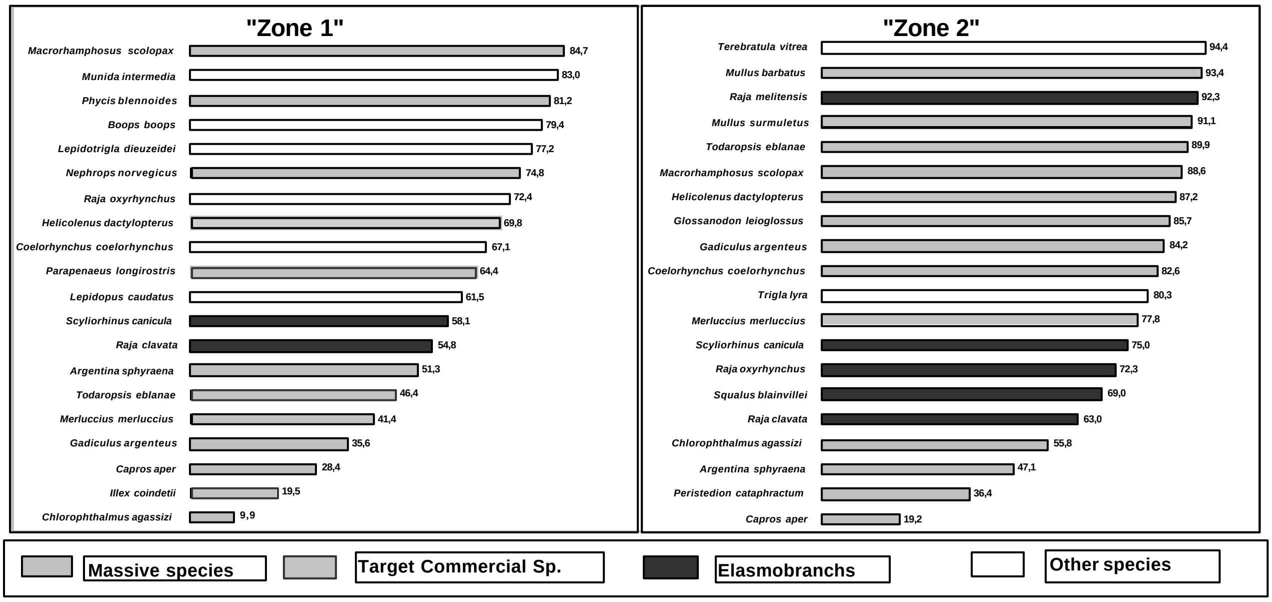

Fig. 5 – K-dominance of biomass for the top 20 ranked species.

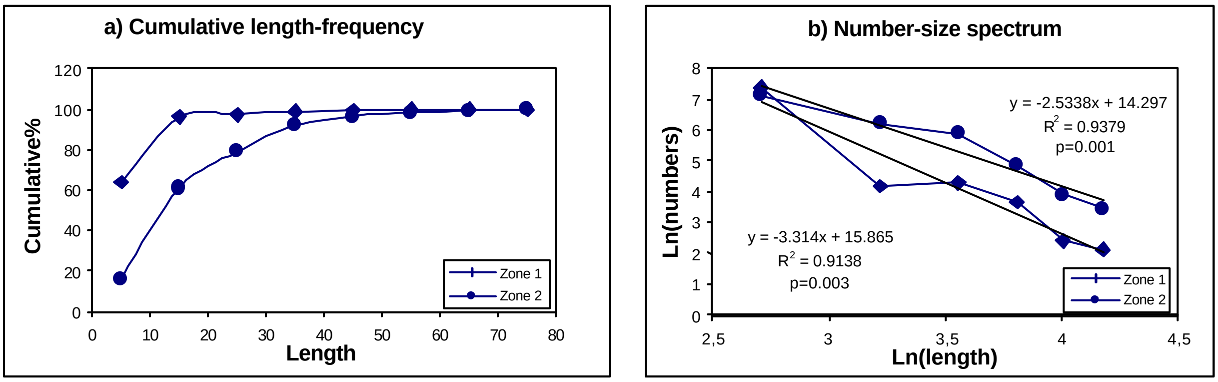

Fig. 6 – Size structures obtained pooling fourteen commercial species and elasmobranches. (a) Cumulative Lenght-frequency distribution. (b) Number-size spectrum with linear model fit.