TEMPORAL EVOLUTION OF DEMERSAL SPECIES ABUNDANCE IN THE NORTHERN TYRRHENIAN SEA

A. Ligas [1], P. Belcari [2], D. Bertolini [1], S. De Ranieri [2], D. Micheli [2], B. Reale [1], M. Sartini [3], P. Sartor [1]* and M. Sbrana [1]
[1] Centro Interuniversitario di Biologia Marina ed Ecologia Applicata "G. Bacci" - psartor@cibm.it
[2] Dip. di Scienze dell'Uomo e dell'Ambiente, University of Pisa, Via Derna 1, 56126 Pisa, Italy
[3] Aplysia Soc. Coop.r.l., Via Menichetti 35, 57121 Livorno, Italy

Abstract
The 1991-2006 time series of trawl survey data of five demersal species were analysed by means of Min/Max Auto-correlation Factor Analysis (MAFA). The influence of some environmental variables and some fishing effort indices was evaluated as well. The results highlighted the presence of two most important trends in the multiple time series data set.
Keywords: Demersal, Time Series, Trawl Surveys, Tyrrhenian Se

Introduction
A central challenge in fisheries ecology is to understand why species abundance changes over time [1]. Fishing exploitation is considered one of the main factors determining demersal resources dynamics, although both abiotic and biotic variables influence population abundance. In this context, the time series of experimental trawl survey data are useful to investigate trends and variations of the stocks, their spatial distribution, their relative abundance, etc. The present study aimed to investigate the temporal variations of the populations of five demersal species in the northern Tyrrhenian Sea through the analysis of the time series obtained from trawl surveys. Moreover, the study is focused to investigate the effect of some potential explanatory variables, such as fishing effort indices and environmental factors. The species considered for the study are the horned octopus, *Eledone cirrhosa*, the European hake, *Merluccius merluccius*, the red mullet, *Mullus barbatus*, the Norway lobster, *Nephrops norvegicus* and the deep-water rose shrimp, *Parapenaeus longirostris*; these species represent more than 50% of the biomass landed by the trawlers exploiting the fishing grounds in the northern Tyrrhenian Sea.

Materials and Methods
The study was performed in the northern Tyrrhenian Sea, where important traditional trawl fisheries are present. During the investigated period (1991-2006), two experimental trawl surveys per year have been carried out in the framework of national and international projects on the assessment of demersal resources. The time series of mean biomass (kg/km^2) were calculated. To investigate the effect of environmental factors, time series of mean monthly values of sea surface temperature (SST, °C), wind speed (W, m/s), and North Atlantic Oscillation index (NAO) were used (http://podaac.jpl.nasa.gov/index.html). Indices of fishing activity and capacity were computed from the Porto Santo Stefano trawl fleet, the main fishing harbour in the area: the total number of days at sea performed by the fleet per month, and the mean gross tonnage (GRT) of the fleet per month. The data were analysed by means of the MAFA (Min/Max Autocorrelation Factor Analysis), a statistical method to extract common trends from multiple time series, and to analyse relatively short data sets [5]. Cross-correlations between the variables and the trends were computed to evaluate the significance of the relationship between the variables and the estimated trends [2].

Results and discussion
The results obtained by means of Min/Max Auto-correlation Factor Analysis (MAFA) highlighted the presence of two main trends (Fig. 1) in the multiple time series data set.

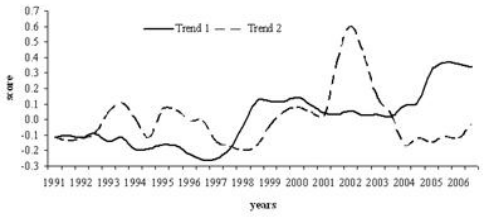

Fig. 1. Common trends extrapolated from the multivariate time series data set by means of MAFA

The first trend described an increasing pattern, while the second showed a general rather constant behaviour, even though characterized by a sharp peak in 2002. As highlighted by the cross-correlations (Tab. 1), the first trend was significantly related to the time series of the deep-water rose shrimp, *Parapenaeus longirostris*. The Norway lobster, *Nephrops norvegicus*, time series was negatively related to this trend, indicating that this species followed an opposite pattern. The European hake, the red mullet and the horned octopus time series were significantly related to the second MAFA trend.

Tab. 1. Cross-correlations between variables and MAFA trends. Response variables: MM = *Merluccius merluccius*, MB = *Mullus barbatus*, EC = *Eledone cirrhosa*, NN = *Nephrops norvegicus*, PL = *Parapenaeus longirostris*. Explanatory variables: Wind = wind speed (m/s), NAO = NAO index, SST = sea surface temperature (°C), Days at sea = number of days at sea per month, GRT = mean gross tonnage. Significance level for correlations ± 0.35. Significant values are highlighted in bold

		Trend 1	Trend 2
Response variables	MM	0.18	**0.43**
	MB	0.11	**0.75**
	EC	-0.02	**0.82**
	NN	**-0.42**	-0.30
	PL	**0.98**	-0.14
Explanatory variables	Wind	-0.31	-0.23
	NAO	0.16	-0.03
	SST	-0.06	0.07
	Days at sea	**-0.41**	0.30
	GRT	-0.16	**0.70**

As concerns the explanatory variables, only the fishing effort indices showed significant correlations with the MAFA trends. The time series of the number of fishing days per month was negatively correlated to the first trend, while the mean GRT time series was related to the second trend. Therefore, the available evidence suggests that fishing effort resulted more important than environmental factors in influencing the trends. The number of fishing days per month time series was negatively related to the first trend. In the investigated period the trawl fleet of Porto Santo Stefano decreased of about the 50% in terms of number of vessels, producing an almost proportional decrease of fishing effort [3]. The reduction of fishing effort was mainly due to the Common fishery policy for the Mediterranean, which promoted the effort reduction through incentives to demolition. The mean size of the trawl vessels of Porto Santo Stefano has increased until 2000s; however, in the last years, it has followed a decreasing pattern, in response to the global crisis which invested fisheries, and to the sharp increase of the diesel oil costs [4].

References
1 - Ciannelli L., Fauchald P., Chan K. S., Agostini V.N., Dingsør G.E., 2008. Spatial fisheries ecology: recent progress and future prospects. *Journal of Marine Systems*, 71: 223-236.
2 - Erzini K., Inejih C.A.O., Stobberup K.A., 2005. An application of two techniques for the analysis of short, multivariate non-stationary time-series of Mauritanian trawl survey data. *ICES J. Mar. Sci.*, 62 (3): 353-359.
3 - Sbrana M., Viva C., Belcari P., 2006. Observation on the fishery of the deep water rose shrimp *Parapenaeus longirostris* (Lucas, 1846) (Crustacea: Decapoda) in the northern Tyrrhenian Sea (western Mediterranean). *Hydrobiologia*, 557: 135-144.
4 - Valdemarsen J.W., 2001. Technological trends in capture fisheries. *Ocean Coast. Manage.*, 44: 635-651.
5 - Zuur A.F. and Pierce G.J., 2004. Common trends in Northeast Atlantic squid time series. *Journal of Sea Research*, 52: 57-72.