Fluctuations in space and time of pelagic populations assessed with acoustic methodology (Echo-Survey) in the Adriatic Sea from 1976 to 1998

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Abstract

Data on the biomass of small pelagic fish and their spatial distribution and temporal variability are discussed. Data were collected in the period 1976-1998 in the Adriatic Sea.

1. Introduction

The aim of this paper is to discuss the spatial and temporal variability of small pelagic fish in the Adriatic Sea in the period 1976-1998.

This variability can be attributed to the variations of physical factors acting on these resources through many and complex ways (in this paper surface temperature is considered), to fishery, and to the internal complexity of the pelagic system.

2. Material and methods

The data on the biomass of small pelagic fish and their spatial distribution were collected with acoustic methodology and technology. Biological data were acquired from acoustic (Target Strength, or size of fish) and net samplings. Data on surface temperature were obtained by satellite. The set of acoustic, biological and satellite data were processed using a software package called GFRDBS (Geographical Fishery Resources Data Base System), designed by the acoustic team of IRPEM (Azzali, 1997).

The GFRDBS processes the data in a geographical context, converting Lat. & Lon. coordinates to X&Y coordinates. The Elementary Sampling Distance Unit (ESDU) of the X,Y map is 1 Nautical Mile.

The Adriatic Sea, monitored in this study, is contained in two windows (electronic maps), both with an extension of 100*180 ESDU (Figure 1 and 2). The first window includes the North Adriatic Sea, from Trieste to Giulianova. It was monitored from 1976 (Azzali et al., 1990; 1993; 1997). The second window includes the Middle Adriatic Sea (from Giulianova to Vieste) and the South Adriatic Sea (from Vieste to Brindisi), monitored from 1987.

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The surveyed areas were typically covered with a systematic zigzag grid, represented in Figure 3. Data acquired during the survey were interpolated using the inverse distance method. The interpolation converts the data (randomly spatially distributed) into a two dimensional map, that shows the spatial property of the biomass distribution. The fish density map generated by interpolation of data of acoustic survey in 1998 is showed as an example in Figure 4. Further data processing included estimation of biomass per species (sardines, anchovies, sprats, other pelagic species), estimation of fish size and other statistical calculations.

The limits of this research are: (1) the area covered by acoustic surveys (from Italian coast to Mid-Line) is around one half of the area of stock distribution and moreover entirely located in west side of the Adriatic Sea; (2) the area was surveyed only in one season (late summer or autumn) per year.
Figure 3. Standard survey grid within Mid-Line.

Figure 4. Example (1998 survey) of elaborated data.
3. Results

One basic question is the stability of pelagic biomass and of its composition per species. Figure 5 shows the trend from 1976 to 1998 of the biomass of pelagic populations as a whole in the North Adriatic Sea. It indicates that biomass fluctuates in an almost periodic way. Before 1985 the highest peaks and the longest periods of fluctuation (5 years) were found. After 1985 the peaks decrease and, in parallel, the fluctuation periods seem to shorten.

![Figure 5. Fluctuation of pelagic biomass as a whole in the North Adriatic Sea, broken line indicates the estimated mean biomass.](image)

Figure 6 shows the trend of pelagic populations divided in four groups: sardines, anchovies, sprats and other pelagic species (mainly *Scomber scomber, Trachurus trachurus*).

For single populations no regularity is observed in changes in biomass. In particular the trend of the anchovy stock had a maximum peak in the year 1978-79, a collapse in the period 1987-89 followed by a period of instability and recovery 1990-98.

On the other hand sardine stock had its minimum value around 1978, the maximum peak in the years 1982-83 followed by a period of stability (1985-1995) around a biomass level of 35 t/sqNm and a regular decrease up to 1998.
The other species (sprats, other pelagic species) have very irregular changes. Therefore it seems clear that pelagic biomass as a whole fluctuates almost regularly but its composition is affected by drastic and unpredictable changes. Moreover there is some evidence of possible interactions of species such as anchovies and sardines and sprats and anchovies. However these kinds of fluctuation would require a knowledge of the relationship between the pelagic population and climatic variations.
Figure 7. Trend of mean annual surface temperature in all the Adriatic compared to anchovies density trend (temperature data only from 1982 to 1994).

Figure 7 shows the trend of mean annual surface temperature for all the Adriatic Sea compared to the trend of anchovy density. Figure 8 shows the trend of the same parameters (mean surface temperature) per seasons, in the period 1982-1996 (Azzali et al., 1997). Although no explicit relation between biomass and climate variability appears, an observation can be made. The minimums of spring (1987), summer (1984), autumn and winter (1989) temperatures as well as the fall of annual mean temperature occur in the period of anchovy collapse (1984-1989) and perhaps the two phenomena are in some way correlated.

Figure 8. Trend of seasonal surface temperature in all the Adriatic (1982-1994).
3. Conclusions

The pelagic populations in the Adriatic Sea were studied from 1976. These studies show that these populations are affected by a large variability in time and in space. There is a need for the management of these resources first to extend the investigation to the whole area of the stock distribution, then to discover how this variability (if confirmed after having monitored the whole area) can be attributed to internal factors (interactions between species) and/or external factors (climatic variations) and fishery.

4. References