SPATIOTEMPORAL DISTRIBUTION OF HAKE (MERLUCCIUS MERLUCCIUS) IN THE N. AEGEAN SEA USING GEOSTATISTICAL ANALYSIS

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Abstract

Geostatistical techniques were used to analyze the spatio-temporal distribution of hake in the N. Aegean Sea during 1996 to 2000, based on five experimental trawl surveys. Abundance varied significantly both spatially and temporally. Spatial heterogeneity was attributed to the biology of the species, the geomorphology and the environmental conditions prevailing in the study area.

Keywords: Geostatistics, spatial distribution, hake, North Aegean

Introduction

Demersal fish assemblages have been analyzed using conventional statistics, which are based on random, independent variables that assume zero continuity and allow no extension of each data value. This makes impossible to estimate points on a map, within an area as all of these points should be given the same overall mean value. Geostatistics (1, 2), assuming that adjoining points are correlated to each other spatially, is used in earth sciences to analyse, model, estimate and map the spatial distribution of natural resources through the analysis of their spatial autocorrelation (3).

In the present study an attempt was made to map the spatial and temporal distribution of hake abundance and to study the structure of the hake population in the North Aegean using geostatistics and based on five MEDITS surveys carried out during 1996-2000.

Material and methods

Surveys were carried out with a commercial trawler following MEDITS methodology. A stratified sampling scheme with simple random sampling within each stratum was used. The stratification criterion was depth: 10-50, 50-100, 100-200, 200-500 and 500-800 m. The sampling area was divided into six subareas (Fig. 1). Extended, narrow continental shelves, basins, peninsulas, river runoff and islands characterize this area. The sampling grid covered 63 stations per survey.



Fig. 1. Spatial distribution of hake in the N. Aegean Sea in 1999.

A geostatistical model was built to analyze hake abundance (N/km^2) . We applied the spherical model that was adapted significantly to the form of the experimental semivariograms (1, 2) of our data. Point kriging was used to estimate the values of the sampling points over a polygon defined by depth contours (10-800 m).

Results and discussion

The results showed that the spatial distribution of hake in the North Aegean Sea extends to depths from 30 to 680 m.

The lowest values of hake abundance among the five surveys were observed in 1996. In this year, the highest values of hake were

recorded at the subarea D (SE of Thasos Island) and at the subarea A (across the Pelion peninsula). At the 1997 survey the highest values of hake abundance were recorded at the subareas A (near the Aliakmonas river outfall), C (inner and outer part of the Strimonikos Gulf) and F (SW of Limnos island). During the 1998 survey the highest values were recorded in subareas D (SE of Thasos island), C (outer part of Strimonikos Gulf). In 1999 survey, the highest values of hake abundance were observed among the five surveys (Fig. 1). The highest values were recorded in subareas C (inner and outer part of the Strimonikos Gulf), D (near the Nestos river outfall), A (near the Aliakmonas river outfall) and B (Toronaios Gulf). Finally in 2000 survey the highest values of hake abundance were recorded in subareas A (near the Aliakmonas river outfall), D (between Thassos and Samothraki islands), B (Toronaios Gulf) and F (with 3 different peaks).

The North Aegean Sea is one of the most productive areas of hake fishery in Greece (4). Significant differences of the spatial and temporal patches of the population were detected during the five surveys. In particular, areas near estuaries (i.e., west Thermaikos, Strimonikos Gulf, NE of Thasos island) were characterised by the highest values of hake abundance especially during 1999 and 2000. The study of the length frequency distribution of hake indicated that these areas are characterized by the presence of high densities of juveniles. The heavy rainfalls during 1999-2000 can probably explain the high concentrations of juveniles at these locations. Toronaios Gulf was characterized by a presence of juveniles during all surveys. Although the west part of Thermaikos Gulf and Toronaios Gulf are generally considered as nursery grounds (5), our results showed that Strimonikos Gulf and the area NE of Thasos are characterized by the highest density of juveniles.

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