MODELLING THE SPATIAL DISTRIBUTION AND ASSESSMENT OF *NEPHROPS NORVEGICUS* (L.) BY GEOSTATISTICS

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An extenisve survey was carried out in order to accurately map the distribution and assess the harvestable biomass of *Nephrops norvegicus* by geostatistics. The survey site is located off Tarragona (NE Spain), at shelf and slope depths (84.5 to 713 m) on commercial fishing grounds. The area surveyed was 939.5 km^2. Sampling was carried out from 6 to 16 May 1994 over 72 stations, using a specially designed otter trawl (Maireta System, SARDÀ *et al.*, 1995). In order to retain small individuals, a 12 mm cod-end stretched mesh was fitted to the trawl. Opening of the trawl was measured by a SCANMAR acoustic system, stabilizing at 16 m width and 2 m height. Tows were made parallel to the depth contours and lasted 15-30 min. Start and end locations were measured by G.P.S., and area swept by the trawl was computed exactly. The survey was carried out over 24 h periods, but only preliminary results for day-time samples are presented here.

In order to accurately map and further estimate the density of Norway lobster individuals, the geostatistical technique was applied (MATHERON, 1971; JOURNEL and HUIJBREGTS, 1978, CONAN *et al.*, 1992). The linear geostatistical method is a two stage optimal interpolation method. First, the spatial structure of dependence is examined by computing experimental semivariograms. A semivariogram is a form of autocovariance function which analyzes the spatial dependence among samples. In the case of spatial independence among samples, the mathematical expectation of the semivariogram function is the variance of the population. The existence of spatial astructuration in the population is revealed by a monotonously increasing semivariogram up to the distance (called range) in which the effects of spatial dependence are negligible, the stabilizing around the sample variance (called sill). Experimental semivariograms computed for Norway lobster samples in the study area showed a structure of variability stabilizing around 5-7 km, for all biological categories selected (adult males and females, juvenile males and females), in accordance with previous results from nearby areas (CONAN *et al.*, 1992). In order to proceed to the actual mapping or spatial prediction stage, the experimental semivariogram must be modeled by a theoretical semivariogram function which complies with certain mathematical conditions (MATHERON, 1971). A spherical model was fitted (sill = 3.742, range = 7.2 km, figure 1). The fit was very similar for all biological categories considered, thus only results for total density of *Nephropss* are presented. The mapping was conducted by estimating the density of individuals over an arbitrarily fine grid on the polygon defined by presence of positive samples (200 to 600 m depth, except for a shallower zone on the shelf of the Ebro delta). The (linearly) optimal interpolator is obtained is obtained solving the point kriging system of linear equations at each point of the grid. The resulting map is presented in figure 2. The geostatistical technique of block kriging (MATHERON, 1971) was implemented over the mapped area to obtain estimates of the density of *Nephropss* individuals and total biomass. The kriging or estimation variance obtained when solving the system of equations was used to set confidence limits to our estiamtes. Average density computed by kriging was 341.5 ± 218.3 ind/km^2 and total number of individuals was 320,905.8 ± 205,065.2 or 6,420 ± 4,010 kg.

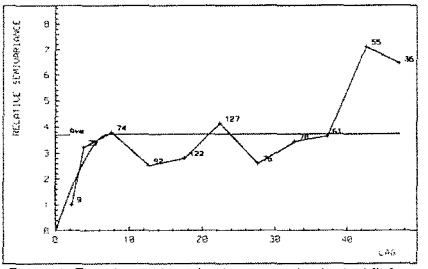

Figure 1: Experimental semivariogram and spherical fit for total number of Norway lobster:

Geostatistics, as a tool for mapping the distribution of a species and assessing the potential of the resource, proves adequate for benthic resources presenting a complex pattern of spatial structuration, such as *Nephrops norvegicus*. Confirming previous results (CONAN *et al.*, 1992), Norway lobster populations are structured in patches of high density of around 7 km in diameter. A preliminary analysis of the night-time samples reaveals the same pattern and location of high-density patches, although at much lower density (due to the light-dependent catchability of the species). Adult and immature (< 26 mm CL) individuals show the same pattern of spatial distribution and high-density patches overlap extensively for biological categories, which could be of importance in the management of the resource. Due to the complex biological cycle of the species (seasonal variability of catchability, especially of berried females) and its burrowing habits, the application of geostatistics is limited by other factors than those properly pertaining to the spatial modelling stage and should be utilized within a concepyual biological model for the species.

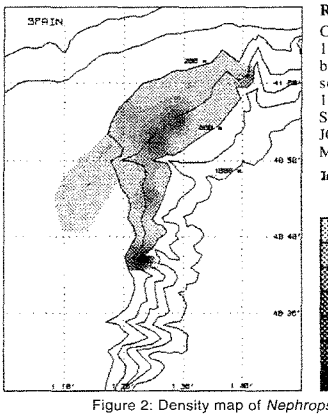

Figure 2: Density map of *Nephrops norvegicus* produced by kriging

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