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COMPARISON OF KRIGING ESTIMATES OF NORTHERN SHRIMP BIOMASS OBTAINED FROM TWO DIFFERENT TRAWLERS IN THE SEPT-ILES FISHING GROUNDS IN 1990

by

YVAN SIMARD

Institut Maurice-Lamontagne, Ministère des Pêches et des Océans,
C.P. 1000, Mont-Joli, Québec G5H 3Z4

RESUME

La biomasse de crevette nordique (Pandalus borealis) de la zone de Sept-Iles à l'automne 1990 est estimée au moyen du krigeage ordinaire de la géostatistique stationnaire, séparément pour des échantillons récoltés par deux chalutiers différents utilisant des chaluts à crevette légèrement différents. Les estimés sont calculés en distinguant deux enveloppes, l'une située à l'est de la zone et l'autre à l'ouest. Les échantillons provenant du M/V Alfred Needler produisent des estimés globaux supérieurs, qui se chiffrent à 9.2 ± 1.9 kt, 4.5 ± 1.1 kt et 13.6 ± 2.2 kt, respectivement pour les enveloppes ouest, est et pour leur somme. Les estimés comparés du M/V Marie-Simon sont de 6.0 ± 1.0 kt, 3.5 ± 0.7 kt et 9.5 ± 1.2 kt. Le trop faible nombre d'échantillons récoltés ainsi que leurs localisations dans des endroits différents d'un chalutier à l'autre ne permettent pas de déterminer si la différence observée est reliée à un échantillonnage différent de l'organisation spatiale ou à une différence d'efficacité d'échantillonnage.

ABSTRACT

The northern shrimp biomass (Pandalus borealis) of the Sept-Iles fishing grounds in the fall of 1990 is estimated by means of ordinary kriging from stationary geostatistics, separately for the sets of samples collected by two different trawlers using slightly different trawls. The estimates are computed separately for two envelopes, one on the east of the study area, the other on the west. The samples collected from the M/V Alfred Needler produced larger global estimates, which were 9.2 ± 1.9 kt, 4.5 ± 1.1 kt and 13.6 ± 2.2 kt, respectively for the west envelope, the east envelope and for their sum. The corresponding estimates for the Marie-Simon were 6.0 ± 1.0 kt, 3.5 ± 0.7 kt and 9.5 ± 1.2 kt. The too low number of samples collected combined with their different locations from one trawler to the other, do not allow to distinguish if the observed difference was related to a different sampling of the spatial organization of the biomass, or to a difference in the sampling efficiency.

METHODS

Sampling

From mid-August to the end of September 1990, the northern shrimp biomass was sampled at 64 stations in the western Gulf of St.Lawrence (Fig. 1) by the trawlers M/V Alfred Needler (50 m) and M/V Marie-Simon (20 m,). The Needler (18 stns.) was using a URI 81-114 trawl and the Marie-Simon (46 stns.) was using a Western IIA trawl. The stretched mesh aperture of the trawls was 38 mm and the codend was lined with a 19 mm mesh net. At each station, the trawls were towed for 30 minutes at 2.5 - 3.0 knots. All sampling was carried out during daytime because of possible vertical migrations of the shrimp off the bottom at night (Barr 1970, Apollonio et al. 1986), that could change their capturability. The catches were converted to biomass of northern shrimp per bottom surface unit (kg/km^2). Although the samples were not punctual but covered an average area of 14.5 m per about 2.5 km (≈ 0.035 km^2), they were considered as point samples centered at the starting tow coordinates for further analysis.

Geostatistical estimation

Ordinary point kriging of stationary geostatistics (see Journel and Huijbregts 1978, Clark 1979, Isaaks and Srivastava 1989) was used to interpolate punctual estimates at the nodes of a regular grid (mesh of 5 X 5 km), bounded by the contour of the estimation envelopes (Fig. 1). The punctual estimates were then averaged, and these means were weighed by the surface of the estimation envelopes to obtain the global estimates. Finally, the variances of these estimates were computed using the estimated spatial model, which was the same for both sets of samples, according to the combination of the average elementary sampling error (Journel and Huijbregts 1978). For more details on the methods see Simard (1991).

RESULTS AND DISCUSSION

The variograms computed from each data sets were quite erratic and did not indicate any systematic difference, except a higher variability in the case of the Needler samples. This may however be due to the too low number of samples collected by this latter trawler compared to the Marie-Simon. The variogram model fitted to the pooled data set (Simard 1991) reasonably fitted the two separated variograms computed here and was used for kriging. This spatial model included a high nugget effect (the variability was almost pure random) and a small structure represented by a spherical model. The model was **gamma(h) = 1200000 $(kg/km^2)^2$ + Spherical (sill= 700000 $(kg/km^2)^2$, range= 20 km)**. The kriging ellipse was 50 km and the maximum number of sample points used for interpolation was 8.

The two kriging estimates of the global biomass of northern shrimp in the whole study area differed by 43% (Table 1). The Needler estimate was higher than the Marie-Simon, but its confidence interval was also larger because its low number of samples. The comparison for each envelope separately indicated that the Needler estimate was 1.53 times larger than the Marie-Simon estimate in the west envelope, but only 1.26 times in the east envelope. Was this difference spurious, or related to the difference in the average density of shrimps in the two envelopes (Table 1) or to the difference in the spatial organization of the samples relative to the spatial organization of the shrimp biomass ? These questions cannot be answered by the present limited data set. The present difference in the global estimates of the two trawlers is however large enough to command more investigation in the future. This is asking for a carefull control of the spatial variability at different scales, since the shrimp biomass is most often well organized spatially and that the unresolved small-scale variability and sampling error with trawls is never negligeable (Simard 1991).

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Table 1. Estimated mass of shrimp (t) in the study area during the fall of 1990, according to discrete summation of the kriging punctual estimates (kg/km^2) at the nodes of the interpolation grid. The relative errors are computed as in Simard 1991.

TRAWLER	WEST ENVELOPE				EAST ENVELOPE				TOTAL			
	mean kg/km^2	X area km^2	= mass t	SE %	mean kg/km^2	X area km^2	= mass t	SE %	mean kg/km^2	X area km^2	= mass t	SE %
M/V Alfred Needler												
Traditional variogram	1907.53	4800	9156	20.5	2584.40	1725	4458	25.5	2086.47	6525	13614	16.1
M/V Marie-Simon												
Traditional variogram	1243.50	4800	5969	16.2	2052.81	1725	3541	20.9	1457.46	6525	9510	12.8

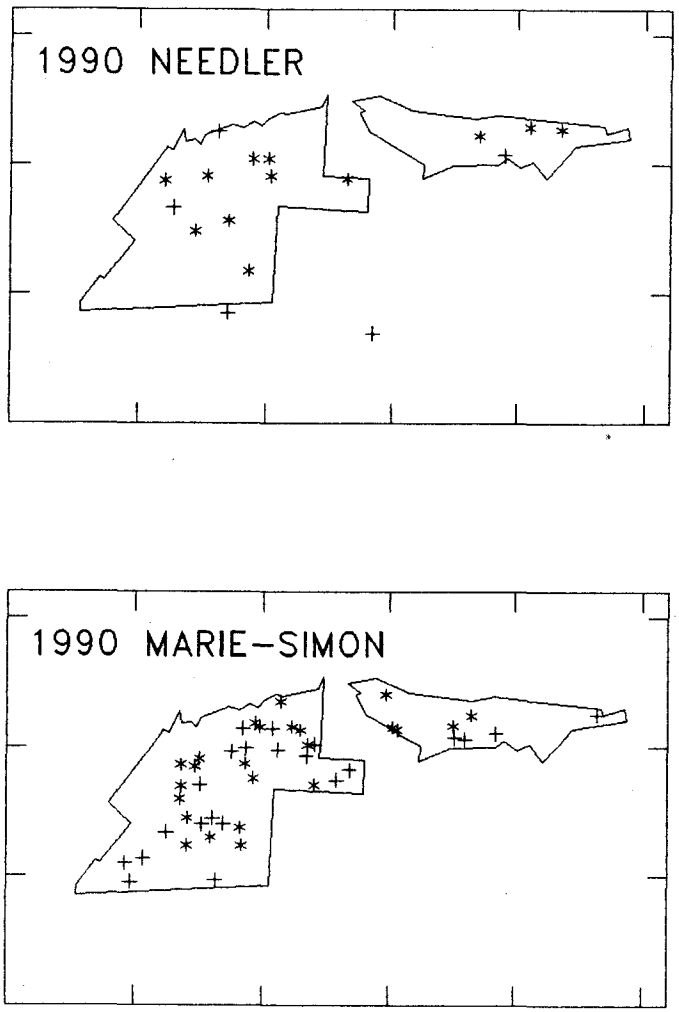

Figure 1. Map of the western Gulf of St.Lawrence with the east and west envelopes of biomass estimation of the Sept-Iles northern shrimp fishing ground. Tic spacing on the borders are 50 km. *: > 1000 kg shrimp/km^2; +: < 1000 kg shrimp/km^2.