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SPATIAL LOCATION OF GIANT RED SHRIMP (*ARISTAEOMORPHA FOLIACEA*, RISSO, 1827) IN THE CENTRAL-SOUTHERN TYRRHENIAN SEA

*LOCALIZZAZIONE SPAZIALE DEL GAMBERO ROSSO (*ARISTAEOMORPHA FOLIACEA, RISSO, 1827) NEL TIRRENO CENTRO-MERIDIONALE*

Abstract - *Spatial indicators are descriptors of the spatial distribution of populations and population stages, useful to identify space occupation along time. This study aims to investigate the spatial occupation of juveniles and spawners of* Aristaeomorpha foliacea *in the central-southern Tyrrhenian Sea (GSA 10) along 17 years. The mapping of spatial indicators pinpoints an higher aggregations for recruits then for spawners. Big and rather stable aggregations of both life stages have been located offshore the coasts of Calabria, between Capo Bonifati and Capo Suvero.*

Key-words: *spatial indicators, spawners, juveniles, trawl survey, spatial management.*

Introduction - The relevance of indicators to fisheries management has became more widely acknowledged in recent years as indicators might contribute to the progress of the Ecosystems Approach to Fisheries Management (EAFM) and to an holistic fisheries evaluation. Indicators are useful to complement the assessment framework established so far for a still small number of top-valued species and fisheries (Cotter *et al*., 2009). Indicators allow to account for stock dynamics and for interactions among ecological, spatial, social and economic components of the ecosystems (FAO, 1999). Spatial indicators are descriptors of the spatial distribution of populations and population stages across time, hence allowing the detection of relevant spatial occupation changes. There can often be reasons to expect that the geographic distribution of fish stocks will change in response to fishing pressures, or to variations in oceanographic conditions or climate. Spatial indicators therefore provide another way of looking at a fish stock (Woillez *et al*., 2009), especially when combined in pairwise relationships with abundance. Spatial indicators can be represented in combination with other biological or physical components of the ecosystem, providing useful information for spatial-based management. The aim of this study was to outline the spatial location and occupation of juveniles and spawners of *Aristaeomorpha foliacea*, a key biological and fishery resource in the central-southern Tyrrhenian Sea (GSA10). Spatial pattern was evaluated and represented in a time horizon of 17 years.

Materials and methods - Data were collected during MEDITS trawl surveys (Spring 1994-2010) conducted in GSA10 following a stratified random sampling design. Indices of abundance of juveniles and spawners were standardized (N/km^2) to the area inhabited by the species (200-800 m depth). Juveniles were identified using the Bhattacharya method to extract the first modal component of the length frequency distributions, whilst spawners were selected using the maturity ogive of females estimated in the study area on data from both MEDITS surveys and sampling of commercial landings obtained in the Data Collection

Framework. The spatial indicators were those proposed by Woillez *et al.* (2009) and successfully applied to evaluate the pattern of the spatial distribution of red mullet in the same GSA (Spedicato *et al.*, 2007). A summary of characteristics and properties of the spatial indicators used in this study, that were those not influenced by 0 catches, are reported in Tab. 1. Among the spatial indicators, spatial patches are particularly suitable to be used for management purposes, because they convey relevant information on:

1) the geographical positions of all major aggregations;
2) the aggregations with abundance higher than a threshold;
3) the percentage of abundance in these aggregations;
4) the percentage of area covered by the retained patches.

The Global Index of Collocation (GIC) is instead suitable to detect the stability of the spatial occupation of each population stage (or for the whole population) along the time.

Tab. 1 - Spatial indicators used in the studied area not influenced by 0 catches (from Woillez *et al.*, 2009, mod.).

Indicatori spaziali non influenzati dalle catture nulle (cfr. Woillez et al.*, 2009, mod.).*

Indicator	Symbol	Description and properties
Centre of gravity	CG	Mean location of the individuals of a population. A shift may reflect effects of fishing. CG is sensitive to high fish densities
Inertia	I	Variance of the location of the individuals of a population. Indicates dispersal but is sensitive to high densities of fish
Global index of collocation	GIC	Measures the geographic distinctness or overlap of two populations of fish
Positive area	PA	Measures the area where fish of a species occur. PA is greatly increased when fish occur at low densities over a large area
Spatial patches	SP	The number of spatial patches with abundance >(threshold) gives information about the number of significant fish aggregations in the area and the percentage of area covered by the patches

Results - The centre of gravity of the 2 life stages is generally located at the same latitude; recruits being on average positioned slightly northwards (Fig. 1). The estimation of the centre of gravity shows that the mean spatial occupation is less stable for recruits than for spawners. Recruits are slightly more aggregated, though variability is higher as highlighted by the Inertia. Different patches along the years were detected, but only 1 contains more than 50% of abundance of recruits. This big aggregation of recruits (on average 73% of the abundance) is more frequently located between Capo Bonifati and Capo Suvero and covers on average 43% of the area between 200 and 800 m (Fig. 2). Also the patch of spawners (on average 62% of the abundance) is more frequently located between Capo Bonifati and Capo Suvero and covers 34% of the area.
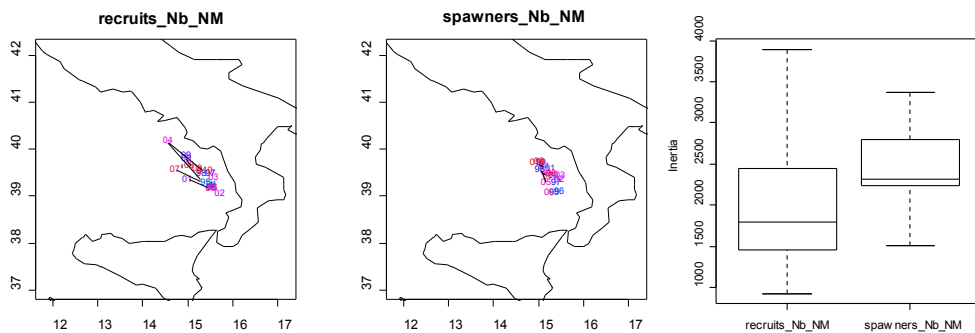
Fig. 1 - Mean location (CG) and mean dispersion (Inertia) of recruits and spawners of *A. foliacea*.
Localizzazione (CG) e dispersione media (Inertia) di reclute e riproduttori di A. foliacea.
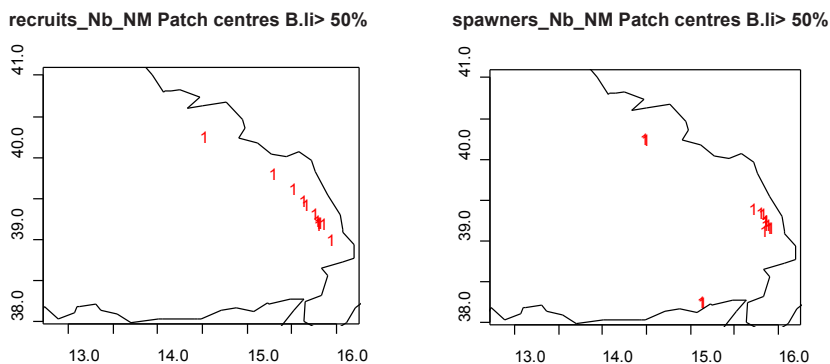

Fig. 2 - Spatial patches with more than 50% of abundance for recruits and spawners of *A. foliacea*.
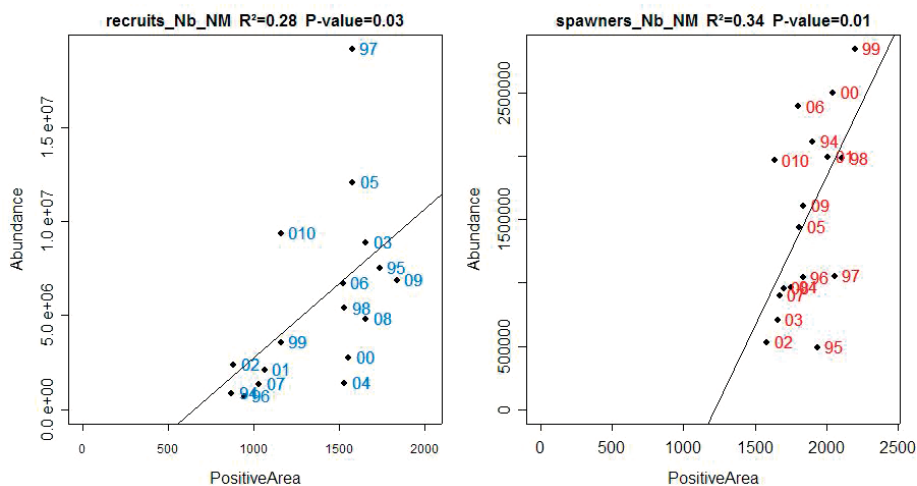*Aggregazioni spaziali contenenti più del 50% dell'abbondanza per reclute e riproduttori di* A. foliacea.

Fig. 3 - Relationship between abundance and positive area of recruits and spawners of *A. foliacea*.
Relazione fra abbondanza ed area positiva di reclute e riproduttori di A. foliacea.

For recruits, 78.7% of GIC values were between 0.8 and 1, highlighting a rather stable spatial occupation along the time, that appears also more stable for spawners for which the percentage of values in the same range increases to 99.7%. Finally, a positive significant correlation between abundance and positive area has been observed both for recruits (Pvalue=0.03) and spawners (Pvalue=0.01) (Fig. 3), thus when more abundant the population tend to spread out, regardless of the life stage.

Conclusions - *A. foliacea* represents one of the more valuable fishery resources in the central-southern Tyrrhenian Sea, distributed on the bathyal bottoms, where juveniles generally occupy the upper depth levels (Spedicato *et al.*, 1998). The time of the MEDITS survey is coincident with both the spawning and recruitment seasons of the giant red shrimp (gonad maturation peak from June to August; Spedicato *et al.*, 1999) and thus appropriate to identify peculiar spatial pattern and aggregations. With few exceptions, spatial indicators pinpoint that the mean location area of the giant red shrimp in the GSA10, is offshore the coasts of Calabria, between Capo Bonifati and Capo Suvero where wide bathyal bottoms are located and the circulation of water masses is influenced by the inflow from the Sicily Strait. Despite some years where spatial patches also appear in different locations, the coasts of Calabria between Capo Bonifati and Capo Suvero represent a stable elective zone for both recruits and spawners, with aggregations accounting respectively for ~70 and 60% of the life stage abundance. As expected the raise of the positive area with increasing density was observed (Woillez *et al.*, 2009). Worth mentioning that the continental shelf of the same geographical zone was also identified as a rather stable mean location of *M. barbatus* life stages in GSA10 (Spedicato *et al.*, 2007).

References

COTTER J., PETITGAS P., ABELLA A., APOSTOLAKI P., MESNIL B., POLITOU C.Y., RIVOIRARD J., ROCHET M.J., SPEDICATO M.T., TRENKEL V.M., WOILLEZ M. (2009) - Towards an ecosystem approach to fisheries management (EAFM) when trawl surveys provide the main source of information. *Aquat. Living Resour.*, **22**: 243-254.

FAO (1999) - Indicators for sustainable development of marine capture fisheries. *FAO Technical Guidelines for Responsible Fisheries*, **8**. FAO, Rome: 68 pp.

SPEDICATO M.T., LEMBO G., SILECCHIA T., CARBONARA P. (1998) - Contributo alla valutazione dello stato di sfruttamento del gambero rosso (*Aristaeomorpha foliacea*, Risso, 1827) nel Tirreno Centro-Meridionale. *Biol. Mar. Mediterr.*, **5** (2): 252-261.

SPEDICATO M.T., SILECCHIA T., CARBONARA P. (1999) - *Aristaeomorpha foliacea*. In: Relini G., Bertrand J., Zamboni A (eds), Sintesi delle conoscenze sulle risorse da pesca dei fondi del Mediterraneo Centrale (Italia e Corsica). *Biol. Mar. Mediterr.*, **6** (Suppl. 1): 503-516.

SPEDICATO M.T., WOILLEZ M., RIVOIRARD J., PETITGAS P., CARBONARA P., LEMBO G. (2007) - Usefulness of the spatial indices to define the distribution pattern of key life stages: an application to the red mullet (*Mullus barbatus*) population in the south Tyrrhenian Sea. *ICES CM 2007/O*: 10 pp.

WOILLEZ M., RIVOIRARD J., PETITGAS P. (2009) - Notes on survey-based spatial indicators for monitoring fish populations. *Aquat. Living Resour.*, **22**: 155-164.