

Density dependence in the spatial behaviour of anchovy and sardine across Mediterranean systems

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Introduction: Setting the scene...

The study area: The Mediterranean Sea is highly heterogeneous in terms of hydrography, bathymetry and productivity, including areas with strong upwelling (e.g. the Alboran Sea and the Strait of Sicily), closed basins with shallow waters and high productivity (e.g. the Adriatic Sea), coastal areas influenced by the outflow from large rivers (e.g. the North-Western Mediterranean) and less productive areas especially in the eastern part (e.g. the Aegean Sea).

The study object: Anchovy and sardine stocks are highly variable in terms of their recruitment, abundance and distribution whereas, in many areas of the Mediterranean the respective fishery suffers from a high degree of exploitation, with most stocks exhibiting declining trends in terms of abundance.

The objective: To examine the spatial aggregation pattern of anchovy and sardine populations across the Mediterranean in relation to their biomass variation. An area-based index was used for this purpose.

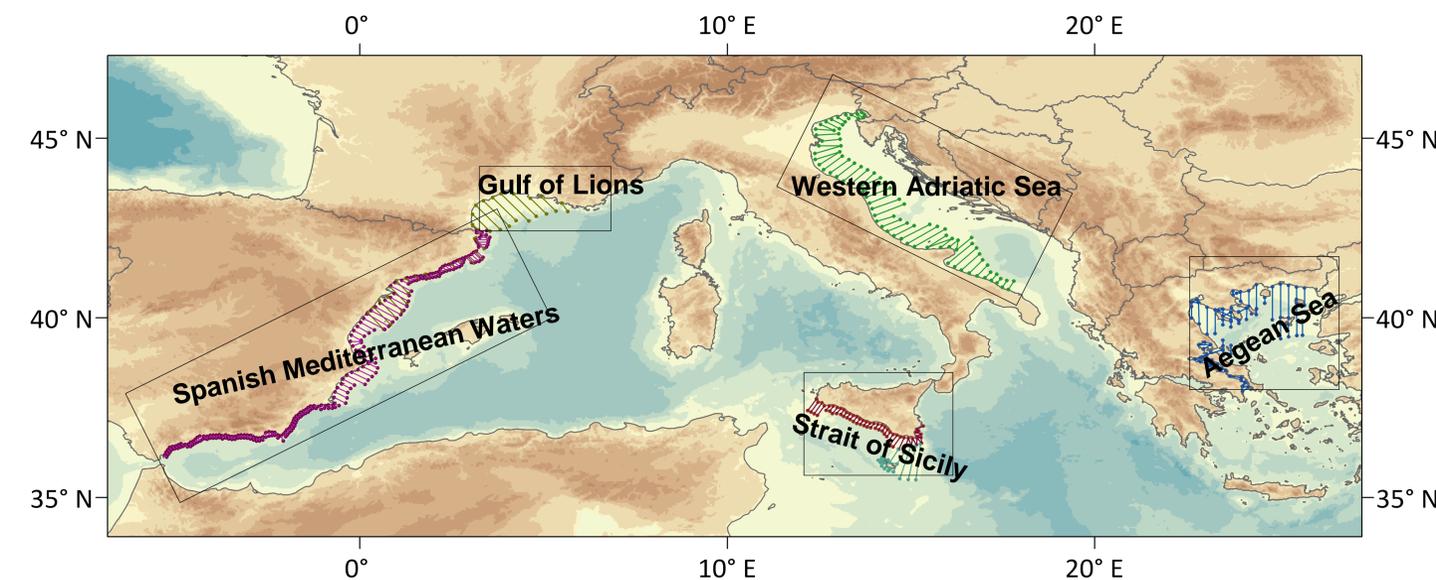
Materials & Methods

What: Acoustic data were collected by means of scientific split-beam echosounders working at 38 kHz. Species discrimination was based on echogram characteristics along with the catch composition of identification hauls (Simmonds and MacLennan, 2005).

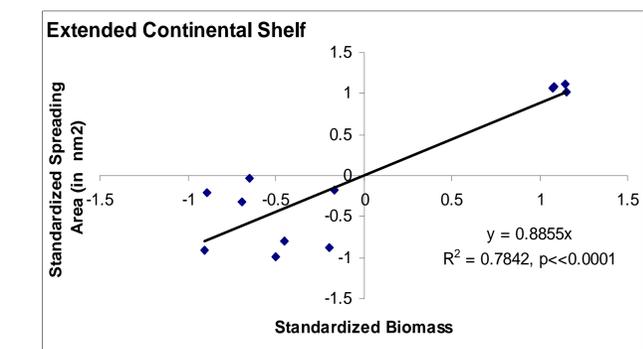
Where: at 5 different areas in the Mediterranean Sea i.e. **Spanish Mediterranean Waters, Gulf of Lions, Strait of Sicily, Western Adriatic Sea and northern Aegean Sea.**

When: during summer; late autumn in Spanish waters

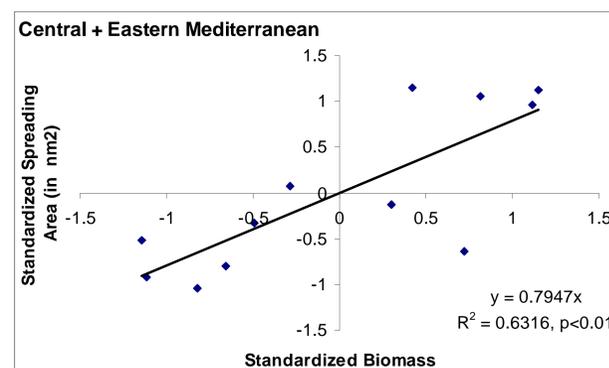
In order to capture the spatial variability of the population at different levels of fish density, acoustic survey data at the year of **highest, lowest and intermediate** abundance were used to calculate the spreading area index (Woillez *et al.*, 2009) in each study area that quantifies the area occupied by the respective stock and its aggregation. In a subsequent step, the variation in the spreading area index in relation to biomass was examined and standardized values of spreading area and biomass based on the mean estimates were used to allow comparisons.



Results - Discussion



Anchovy: A biomass increase with an increase in spreading area was revealed for areas presenting extended continental shelf (i.e., Aegean Sea, Adriatic Sea and Gulf of Lions). No relationship was found for narrow continental shelf areas.



Sardine: a biomass increase was followed by an increase in the spreading area in the case of Central and Eastern Mediterranean study areas. No relationship was found for Western Mediterranean.

Extended continental shelf areas allow anchovy summer spawning aggregations to expand as population biomass increases and density dependent phenomena are observed (Somarakis *et al.*, 2012). At the narrow shelf areas, spawning population remains in the limited, most favorable areas.

Sardine population during summer is largely dominated by **the young of the year that are known to prefer coastal, more productive waters** (Giannoulaki *et al.*, 2011). These suitable areas are strongly localized in the Mediterranean and are likely to prevent spatial aggregations to expand with biomass increase.

Thus, factors like the variation in local productivity is likely to affect the spatial behavior of the population, especially in the western part, where local conditions determine the high annual variability of the population (i.e. the Gulf of Lions). Furthermore, the local environmental conditions also limit the spatial behavior of sardine spawning aggregations in late autumn.

References

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