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PERSEUS
POLICY-ORIENTED MARINE ENVIRONMENTAL RESEARCH IN THE SOUTHERN EUROPEAN SEAS

A multi-disciplinary approach to managing Atlantic bluefin tuna in the Mediterranean Sea

May 2015

Creating sustainability for tuna in the Mediterranean Sea

Why do Atlantic bluefin tuna migrate to the Mediterranean?

The Mediterranean Sea and the Gulf of Mexico are the two major spawning grounds for the Atlantic bluefin tuna. Major fishing activity is directed towards this species by catching mature adults that migrate into the Mediterranean in spring-summer to reproduce. Although our knowledge of the biology of tuna continues to grow, one key question remains unanswered: *Why does bluefin tuna reproduce in the Mediterranean?*

Scientists believe that tuna migrate to the Mediterranean, as it provides favorable environmental conditions for them to spawn and for their offspring to grow and survive. Models that depict the relationship between Atlantic bluefin tuna spawning ecology and environmental variability show that bluefin tuna is an "environmentally-driven spawner" since it is highly dependent on regional oceanographic conditions: salinity; current velocity; and water temperature, which account for about half of the explained variance in spatial distribution of larvae.

Salinity: When water from the Strait of Gibraltar enters the Mediterranean basin and encounters the more saline resident waters, a salinity front is formed. The position of the front varies from year to year, and appears to affect the spatial distribution of bluefin tuna spawning sites.

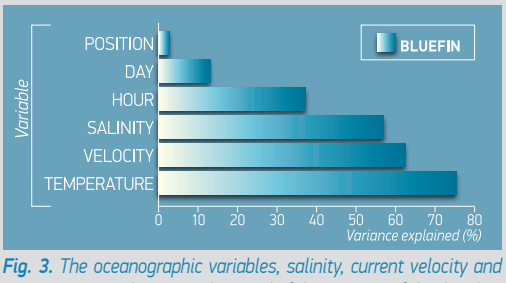

Fig. 3. The oceanographic variables, salinity, current velocity and temperature, explain more than 50% of the variance of the distribution of bluefin tuna larvae.

Environmental factors not only determine the spatial distribution of larvae, but also their survival. For example, larval survival is limited by food availability, and as they grow they need to shift from a diet of plankton to a diet of fish. Therefore, smaller tuna larvae survival rates depend on the spatial overlap with potential prey, and this overlap is partly determined by the environmentally-driven spawning decisions made by the adults of where to spawn.

PERSEUS research findings

Tuna are key top predators that play an important role in marine food webs. They are also a valuable economic resource that is heavily fished, raising concerns about the long-term sustainability of the tuna stocks.

One of the main aims of the PERSEUS research project is to provide science-based recommendations for the better governance of the marine environment of the Mediterranean and Black Seas. PERSEUS research has concluded that long-term sustainability of tuna stocks can only be achieved by integrating knowledge acquired from various disciplines and stakeholders in order to better understand, respond, and adapt to changes affecting the marine environment and its resources.

PERSEUS aims to create awareness of the process of "creating sustainability for tuna" by passing this knowledge on to policy makers and to the general public. This fact sheet summarizes the findings of the research and provides specific insights for science-based policymaking for the management and conservation of the bluefin tuna.

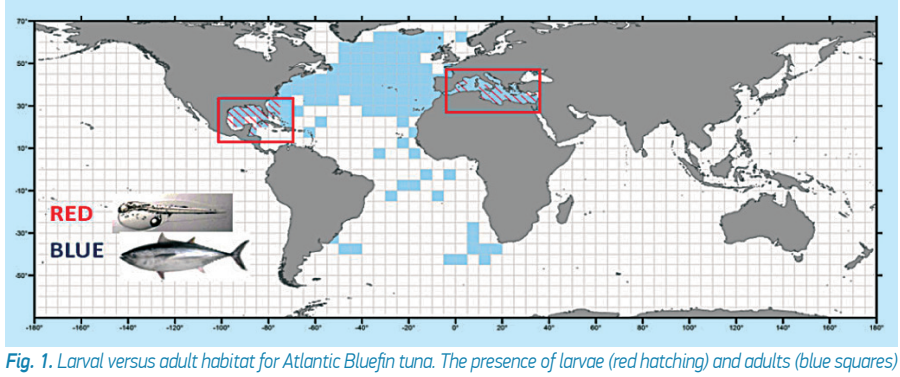

Fig. 1. Larval versus adult habitat for Atlantic Bluefin tuna. The presence of larvae (red hatching) and adults (blue squares) are mapped; larval habitats may also contain spawning locations.

Oceanography of the western Mediterranean

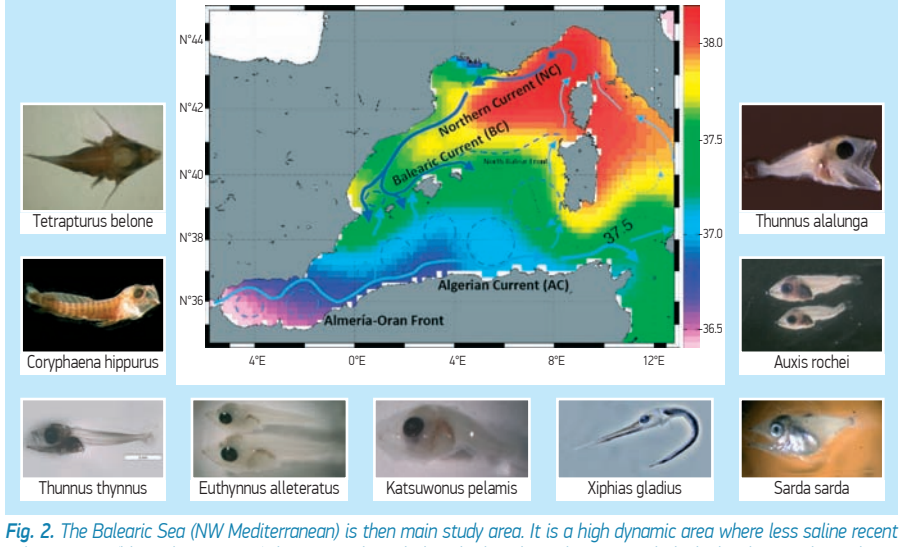

Fig. 2. The Balearic Sea (NW Mediterranean) is then main study area. It is a high dynamic area where less saline recent Atlantic water (blue colours in map) that enters through the Gibraltar channel merges with the high saline resident Atlantic water (red colours in map) forming a salinity front (green colours).

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Knowledge-based decision making

The role of oceanographic information

Biological and hydrological data from annual surveys conducted since 2001 (www.ba.ieo.es) show that oceanographic conditions play a large role in where bluefin tuna choose to spawn. Spawning grounds are related to the position of the salinity front when water temperatures reach a minimum threshold required. Thus reproduction takes place in one of two locations: south-located or north-east located, depending on the prevailing oceanographic conditions.

Managing tuna stocks

Traditional methods of assessing tuna abundance have been fishery based (i.e. Catch per unit of effort - CPUE), but due to changes in fishing patterns, fisheries will no longer provide reliable abundance data. However, Atlantic bluefin tuna larval abundance data has proven to be a useful index of spawning stock abundance. This fishery-independent index of abundance for bluefin tuna has been recently improved by incorporating larval habitat models.

Marine protected areas can reduce bycatch of top pelagic predators, including Atlantic bluefin tuna, but up until now it has been unclear how to best identify key locations for protection. PERSEUS has identified key oceanographic factors that are common for other tuna species worldwide:

- salinity
- current velocity
- water temperature

These variables can be measured and should be considered when determining areas of critical habitats that could become marine protected areas for tuna.

Long-term sustainability of Atlantic bluefin tuna

Scientists, stakeholders and decision-makers across all sectors need to consider how long-term environmental changes may affect the diversity and distribution of apex predators. The measures that may ensure sustainability for bluefin tuna today may not be the measures that we may need in the future, since nature and humans evolve and so do the requirements for sustainability. We therefore encourage the widespread participation of scientists, decision-makers, fishermen and society to enlarge our global vision of sustainability.

Decision support tools

Policymakers now have access to various decision support tools based on real-time and long-term time series data, for example SOCIB (www.socib.es) products. Technologies such as remote sensing and drifting buoys fitted with data-loggers allow us to explore and understand how the ecology of Atlantic bluefin tuna is linked to oceanographic variability, and can help us to predict and map bluefin tuna spawning areas and larval distribution.

These new oceanography products are designed based on the knowledge of how environmental variability drives the ecological processes, and can provide an excellent support tool for assessing abundance of bluefin tuna and for management and conservation of the species.

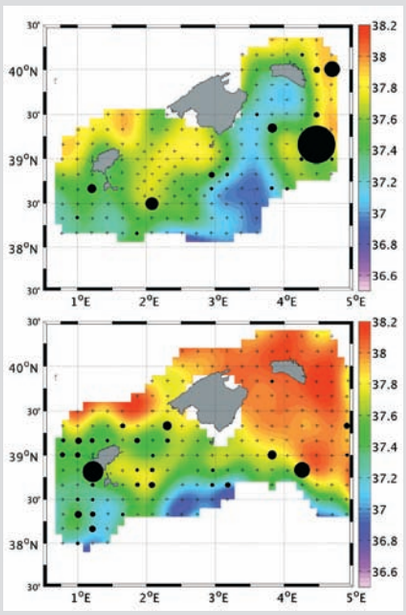

Fig. 4 & 5. *The red line approximately locates the salinity front. Black dots indicate larval densities. Starts signal sampling stations. Colours indicate salinity.*

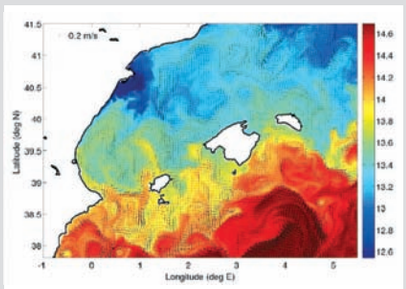

Fig. 6. *Ocean forecasting model (WMOP) providing data on surface temperature (ºC) and currents.*

This fact sheet is the result of collaborative work coordinated by the Instituto Español de Oceanografía (IEO) in cooperation with the Balearic Islands Coastal Observing and Forecasting System (SOCIB), the College of Oceanic and Atmospheric sciences (University of Oregon, USA) and NOAA (USA). This work was funded by PERSEUS and the Spanish national funded projects (Bluefin, BALEARES, 2009-07944 MAR and ATAME, 2011-29525-004-02).

This fact sheet is based on the PERSEUS deliverables: *"Analysis of blue fin tuna spawning areas in the Mediterranean Sea"* (D4.11).

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