Modeling Atlantic bluefin tuna spawning habitat and larvae dynamics in the Mediterranean Sea

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Atlantic and Mediterranean bluefin tuna (Thunnus thynnus) is considered severely overexploited and the International Commission for the Conservation of Atlantic Tunas (ICCAT) in charge of the management of this species has established a recovery plan for the coming few years. To assist in this task, it is urgent to develop new modern tools to provide reliable prediction of spatial dynamics of this species. As for any other marine exploited species, one first key issue is to understand the causes of variability in fish larvae survival rate and then the strength of the oldest cohorts recruited in the adult population. Various mechanisms in interaction with the oceanic environment have been proposed to explain the variability in larvae mortality during the last Century. Several of them have been combined to provide a spawning habitat index that is used in a spatial population dynamics model initially developed for tropical tuna species. They include a spawning temperature window for an optimal growth, a minimum depth allowing large mature fish to dive and thermoregulate, the coincidence of spawning with presence or absence of food for larvae (match/mismatch), the coincidence of spawning with presence or absence of predators of larvae, and the redistribution of larvae by the oceanic circulation with natural mortality related to new habitat. The necessary inputs for this model are temperature, currents, primary production and zooplankton biomass. We applied this approach for Atlantic-Mediterranean bluefin spawning habitat and larvae dynamics using a highly realistic environmental forcing. Physical fields are from the GLORYS reanalysis from MERCATOR-OCEAN and using satellite and in situ data assimilation, and primary production is derived from satellite data. Zooplankton (prey of larvae) and micronekton (predator of larvae) are predicted using these forcing fields. The spawning and larvae model is sufficiently robust to explain existing observations and general knowledge on Atlantic bluefin tuna reproduction on spawning grounds and seasonality in the Mediterranean Sea between May and August. This habitat can be predicted in real time and requires additional validation from field studies.