Mesoscale structure and dynamic of the tropical tuna’s associated environment in the Indian and Eastern Pacific Oceans; comparative approach

Abstract
Tropical tunas are known to be strongly influenced by different environmental conditions, such as thermal fronts. These pelagic species are targeted by several fishing gears, specially by purse seiners also equipped with highly instrumented fish aggregating devices (FADs) whose massive deployment are recently suspected to modify tuna’s natural preferences.

This work aims to quantify the importance of the mesoscale environmental structures in the habitat definition of three major tuna species, yellowfin (Thunnus albacares), skipjack (Katsuwonus pelamis) and bigeye (Thunnus obesus). The purse seiner’s fishery worldwide represents 20% and 13% of the world total production for the Indian (IO) and the Eastern Pacific Oceans (EPO) respectively. Single set catch records from both oceans were used to separately evaluate the characteristics of their fishing grounds for three set types: free school (FS), log (LOG) and FADs and several fish-sizes.

We used a Boosted Regression Tree (BRT) method to construct a modelling scheme for the IO and the EPO to explore the effect of the environment on the catch level and the relative species dominance. Prior to these analyses, a new statistical expert-based method was developed to detect and classify thermal fronts. We observed that “strong” intensity fronts are mostly found in coastal regions whereas “weak” intensity fronts are located in the open ocean. This suggests that frontal intensity helps to spatially differentiate mechanisms of frontogenesis that may attract tunas. Another mesoscale component evaluated was the distance of tuna’s catch positions to anticyclonic and cyclonic eddy structures. In this case we observed important differences depending on the fish-size. In addition to these mesoscale components, other categories of variables were also included in the modelling scheme as classic, temporal and fishery-related ones. All BRT models showed that the catch level was better explained by the environmental conditions on FS than on FADs and that differences regarding tuna distribution were more important among fish-sizes than among species.

We quantified here, for the first time, the influence of the mesoscale in structuring tuna’s habitat. For both oceans, small-sized individuals were strongly related with the proximity to mesoscale eddies (<200 km) whereas the large-sized individuals were found at greater distances. A strong influence of mesoscale fronts was observed in the EPO mainly in the coastal regions where “strong” fronts become important. In this area different environmental conditions on the fishing grounds define at least three specific sub-regions. Contrarily, in the IO the fishing grounds were relatively homogeneous mainly in terms of some classic variables as sea surface temperature (SST) and sea surface chlorophyll (SSC).

Key words
Tropical tunas, Indian Ocean, Eastern Pacific Ocean, Mesoscale, Purse seiner, Species, Fish-size, Fishing mode.