Ecosystems Approach to Assess Multispecies Fisheries Risks from Exploitation and Environmental Changes

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Over the past two decades, we have been using ecosystem approaches in all aspects of our research activities, i.e., the thinking, design, sampling, analysis, and modeling. Our projects include "*Effects of Everglades Restoration and Climate Changes on Fisheries Productivity of Biscayne Bay*", "*Spatial Predator-Prey Atlantic Coast Ecosystem Simulation (ACES) Model*", "*Comprehensive Reef fish Monitoring for the Florida Keys Coral Reef Ecosystem*", and "*Assessment of Tarpon, Bonefish, Permit Sportfishing*". We highlight one example here of where we used the concept of ocean heat content (OHC, thermal energy stored in the water column) to help track the movements of large pelagic fishes. Over the past four decades OHC has been the primary metric used by oceanographers and hurricane researchers to predict hurricane intensity. Expressed in joules per cm^2, OHC is estimated by integrating heat content from the sea surface to the depth of the 26 ^oC isotherm. OHC is used by hurricane modelers to make storm intensity forecasts. Currently, OHC is estimated by the SMARTS (Systematically Merged Atlantic Regional Temperature and Salinity) climatology model that blends various satellite remote sensing (altimetry and SST) and ocean observing systems data. In recent years, hundreds of individual pelagic and coastal fishes have been tagged with pop-up satellite archival tags (PSATs) equipped with temperature-depth-location sensors. Using a novel approach that combined the two data sources, we estimated the OHC from PSAT data, and then evaluated the accuracy and usefulness of this additional data source for estimation of global OHC maps for producing enhanced hurricane intensity forecasts. In this exercise, it became evident that dynamic OHC maps were superior for revealing pelagic fish habitat than those maps based strictly on sea surface metrics (i.e., temperature or altimetry) alone. We were able to demonstrate how to use the OHC maps to refine movement tracks of large pelagic fishes, and further, to show how the fishes tracked specific features of the ocean, such as fronts and eddies, guided by OHC (see Figure).

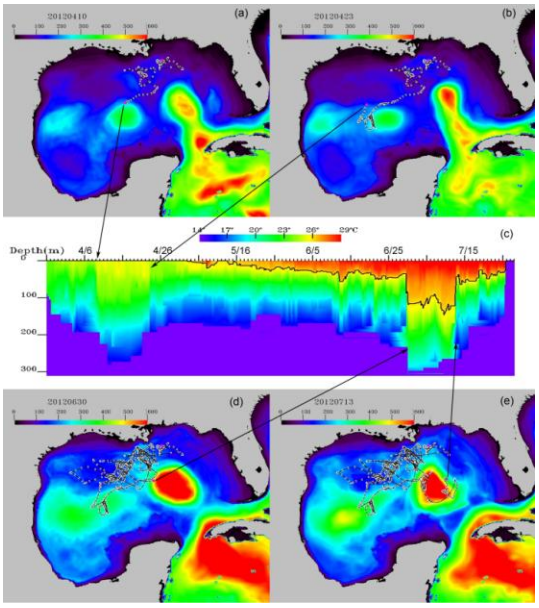

Figure: Ocean eddy and front utilization by a yellowfin tuna (*Thunnus albacares*) during 2012 in the Gulf of Mexico: (a) track position overlain on the OHC map for April 10th; (b) track position overlain on the OHC map on April 23th; (c) tuna depth and temperature profile; (d) tuna track position overlain on the OHC map for June 30th; and (e) tuna track position overlain on the OHC map on July 13th.