Slouching Towards Bethlehem: Partnerships between government, academic and the fishing industry experts should be the foundation of applied ecosystem research in the sea. A case study with Atlantic Butterfish.

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Summary
The axiom of "methodological individualism" states that mechanisms driving population and ecosystem dynamics operate at the level of individual organisms (Turchin 2003). Ecosystem research supporting assessment and management therefor requires observation, hypothesis testing and model parameterization at at least two levels of organization and associated scales. Fisheries biologists rely on broad scale surveys of regional seas to describe dynamic properties of populations and ecosystems. Integrated observation and hypothesis testing at the scales at which mechanisms determine dynamics and our observations of them are usually not sustained. Fishers make observations and test hypotheses at the fine scales at which processes controlling births, deaths and movements of individual organisms operate. The practical ecological knowledge of fishers of fine scales and fisheries scientists knowledge of coarser scales are therefor complementary. There is a strong scientific rational for placing interdisciplinary partnerships of fishers and scientists at the foundation of applied ecosystem research. However differences in culture, incentive, and the atmosphere of fisheries governance systems make these partnerships very hard to form. To identify some of the characteristics of successful partnerships we evaluate one that integrated ecosystem considerations into an operational stock assessment. The characteristics included adoption of an OpenSource philosophy in the formation of a research group that included fishing industry-academic-government partners. Formal integration of fisher knowledge into model development and evaluation which led to the discovery of a clearly defined assessment problem and the development of a solution with a significant impact on harvest policy was essential.

Introduction

Fisheries landings and regional surveys provide time series of population and ecosystem level properties that inform assessments upon which harvest policies are based. Fisheries scientists rarely integrate sustained observations at finer scales required to elucidate mechanisms underlying observations and higher level dynamics. Furthermore most fisheries biologists have limited understanding of socioeconomic and natural forces driving fishery landings. Because fisherman operate daily at the space-time scales of the mechanisms underlying population and ecosystem dynamics and understand the fishing process, there is a strong scientific rational for placing cooperative partnerships at the foundation of applied ecosystem research. Doing so should enhance the timeliness, accuracy and relevance of the science to assessment as well as provide a myriad of collateral economic, political and social benefits. Here we evaluate the activities of a cooperative research partnership that successfully integrated an ecosystem consideration into an operational stock assessment and influenced harvest policy. We review the structure, activities and outcomes of phases of the project to identify factors contributing to its success.

Materials and Methods

Background: Atlantic butterfish is a northwest Atlantic pelagic fish that makes temperature dependent migrations between habitats in the nearshore during summer and offshore in the winter. It historically supported an important fishery. Based on abundance indices from a fall federal bottom trawl survey, the 2009 assessment concluded that the stock size was decreasing even in the absence of a directed fishery. It was assumed that fishing disguards were poorly estimated and high natural mortality could not be explained by predator food habits data. To rebuild the stock, a low quota was set (1500 mt) and disguard limits were placed on the longfin squid trawl fishery. A call for proposals was issued to develop methods for bicatch avoidance in the trawl fishery. During the same period academic and government collaborators demonstrated that a regional scale dynamic habitat model for butterfish could constructed using federal survey data and ocean data integrated into an ocean observing system (IOOS; http://maracoos.org; (Manderson et al. 2011)). These collaborators were funded to develop a habitat model for "real time" bicatch avoidance.

Discovery phase

The academic and government collaborators invited fishing industry partners into the group to develop and evaluate a habitat model for bicatch avoidance. Three model development meetings branded "Butterfish Smackdowns" were held in different ports. Data and modeling tools were brought to meetings so that fisherman and scientists could build and evaluate competing models on site. Following the model development meetings, the group constructed a "consensus" model. Several meetings were subsequently held to evaluate the "consensus" model qualitatively by comparing habitat simulations to the field experience of expert fishers. We then performed a field evaluation of the model onboard a fishing trawler using habitat "nowcasts" to route sampling. Differences in the objectives of the science and fishing industry partners emerged (testing the model vs testing the assumption that the underlying survey provided a representative sample of butterfish habitat) that were quickly resolved "on the fly" by formally incorporating sampling sites chosen by the fisher in the design. This new design permitted simultaneous evaluation of the habitat model and survey observations used to train the habitat model as well as the stock assessment model.

Product development phase

Results of the evaluation caused the group to shift focus from bicatch avoidance to habitat dependent observation error in the federal trawl survey. To maximize the likelihood we would develop a technical solution of the caliber required for assessment and to create an atmosphere encouraging consideration of the solution in the assessment we continued to apply an "open source" philosophy of collaborative participation, transparency, inclusive meritocracy and distributed development to add the necessary expertise to the group. We also branded the "OpenOcean" study group. Prior to the 2014 assessment we held two working meetings of the 20 member group. In the first meeting we clearly defined the assessment problem and a path to a technical solution that could be formally integrated into the assessment. In the second meeting we resolved technical issues required for final product development. During the period between meetings considerable effort was made by core members to complete the product and in outreach activities in the management community.

Application of the tool in the assessment

A term of reference specifying review of the product was added to the assessment terms of reference. Working papers describing the back ground and details of the technical solution were prepared using OpenOcean study group "as lead author" so as to provide equal ownership among group members. Indices estimating proportions of butterfish thermal habitat surveyed on federal and other surveys included in the assessment were provided in in a timely manner so assessors could integrate them into preliminary models.

Results and discussion

Ultimately the habitat based estimates of availability the study group provided were used to inform survey catchability estimates and scale population size in the 2014 assessment. This allowed for estimation of natural mortality and calculation of fishing reference points. As a result the quota in 2014 of 3,200 mt was increased in 2015 to 22,530 mt. Several actions contributed significantly to the groups success. First, fishing industry, academic and government partners were enguaged in all project phases creating a "3 legged stool" that prevented formation of alliances between constituents of any of 2 groups against the 3rd. Second, adoption of an "open source" philosophy was critical to gathering into the group expertise in habitat ecology, oceanography, ocean modeling, stock assessment, fisheries, management and outreach required in the different phases. Third, and critically important, was the formal integration of fisher knowledge into the model development and evaluation during the "discovery phase". In the fall evaluation experiment integration of fisher knowledge in the sampling design allowed us to observe large concentrations of butterfish outside the survey used to train the habitat model and the assessment model. It also demonstrated that the consensus habitat model was effective for describing dynamic distributions of butterfish at broad geographic scales but not at fine scales ≤ 20 km because it was trained with the federal survey. We probably would not have recognized the importance of the issue of stock availability in the assessment or that a modified habitat model could be used to estimate variations in availability had we not formally integrated the fishers knowledge of the fine scale structure of the ecosystem and the behavior of butterfish into the design. Engagement of the lead assessment modeler in the group, as well as outreach activities that created an atmosphere i conducive for having the review of our product added as a term of reference in the assessment were also critical to project success.

References

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