Session: Climate Research

Collaboration & crowdsourcing applied seascape ecology to support ecosystem-based fisheries management

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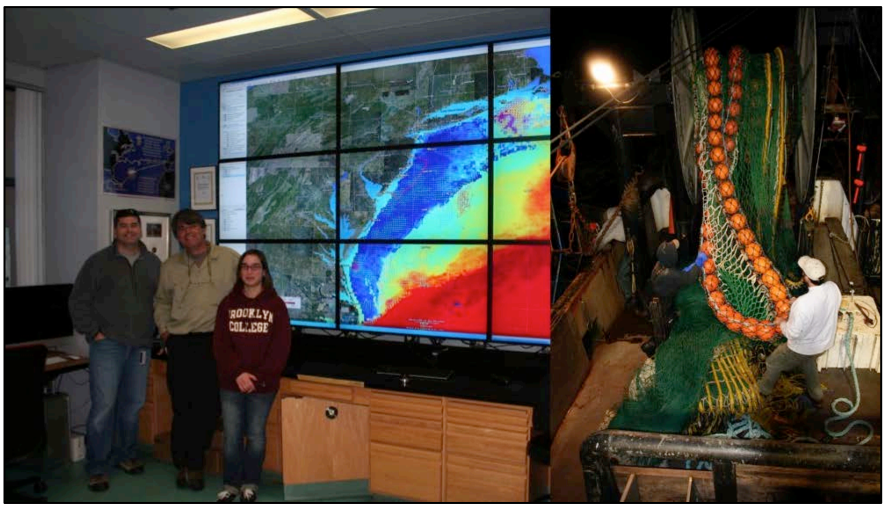

Marine ecosystems are changing rapidly in response to changes in global climate. Accurate ecosystem-based assessments of sustainable harvest levels are essential, because fish production is projected to decrease as a result of climate change and fish provide important nutrition to more than one-third of the human population on the planet (Sumaila & Chueng 2010; World Bank 2013). The axiom of "methodological individualism" states that mechanisms driving population and ecosystem dynamics operate at the level of individual organisms (Turchin 2003). With climate change, the past is no longer prologue to the future and accurate assessments of present and future ecosystem state require explicit consideration of physical and biological mechanisms underlying dynamics. Research programs supporting sustainable fishing in rapidly changing ecosystems require near real-time observation, hypothesis testing and model parameterization at least two levels of ecological organization and associated space-time scales.

Fisheries scientists currently rely on broadscale (10s of km, seasons) fishery-independent surveys of regional seas to monitor population and ecosystem properties including trends. Fisheries-dependent data is primarily used to monitor the fishing process. Fisheries-dependent understanding of the ecosystem is usually discounted. Socioeconomic statistics aggregated broadly across industry sectors are also beginning to be used to more fully integrate human ecological and economic processes into holistic ecosystem-based assessments. Organizational and financial constraints prevent scientists from sustaining integrated observations and hypothesis testing at lower levels of organization and finer space-time scales where mechanism operate to give rise to population and ecosystem dynamics and our observations of them. However, fishers make observations and test hypotheses continuously at lower levels of organization and finer scales where various processes control births, deaths and the movements of organisms. Furthermore, the decisions fishers make to sustain their operations in the face of emerging ecological, economic and regulatory constraints are the mechanisms underlying aggregated effort, landings and economic statistics. Broadscale academic knowledge of the properties of higher levels of ecological organization and the practical, fine scale (10s meters, hours to days), near real-time, ecological and economic knowledge of fishers are fully complementary. There is a strong scientific rational for placing interdisciplinary partnerships of fishers and scientists at the foundation of collaborative ecosystem research designed to inform sustainable harvest policies, particularly during a period of rapid ecosystem change. This rational is made even stronger by the possibility of performing collaborative research in real time within the information-rich context of integrated ocean observation systems (IOOS) that sustain (near) real-time observations and observation-assimilative modeling of physical and lower trophic level biological processes. Crowdsourcing collaborative seascape ecology using 21st century networking and data-sharing communications tools within the context of operational IOOS should allow for scaling-up accurate and timely ecosystem field science relevant to fisheries policy and management. However, the traditional organizational structure of fisheries science and governance, differences in the culture and incentives of government and academic scientists and fishers, and an atmosphere of mutual distrust, makes constructive industry-science research partnerships extremely difficult to form.

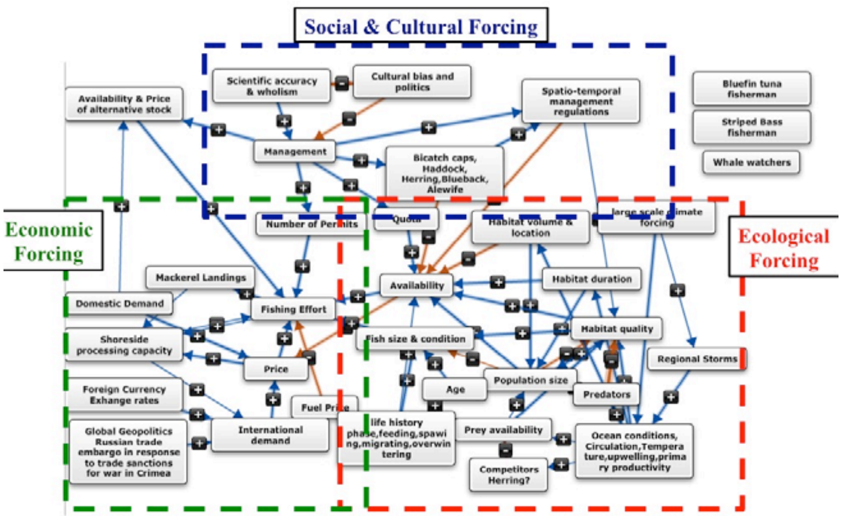

Figure 1. Draft Ecosystem "horrendogram" showing the complexity of the Atlantic mackerel fishery system developed through fuzzy logic modeling and continuous constructive engagement with fishing industry partners in collaborative research

Here, we describe the early development of an ecosystem field research program that uses modern tools of information sharing, networking and crowdsourcing to harnesses the power of collaborative industry-science partnerships within an operational IOOS in the Mid-Atlantic Bight Management region. Real-time monitoring, collaborative modeling and empirical investigation are being conducted in three nested space-time scales. Whole fleets and ocean dynamics are monitored in real time at broadest scales using vessel tracking, vessel track and dealer report data along IOOS ocean observations and models. Working with NEFSC study fishing fleets outfitted with sensors and tow-by-tow electronic reporting, we are collaboratively developing and evaluating prototype biophysical models. The models are being developed to quantify environmentally dependent changes in the availability of stocks to the fishery and to fishery-independent assessment surveys, and to reduce collateral ecosystem damage associated with fishing operations (such as bycatch).

Opportunistic field research with individual study-fleet collaborators working in specific fisheries provides both partners with empirical understanding of species-environmental relations and dynamics at resolutions currently too fine to be sampled on research surveys or modeled. The empirical understanding can be used by fishers to more efficiently avoid bycatch while harvesting allotted quotas, and by scientists to develop next-generation, seascape-scale models to inform assessment and management. Continuous interactions among scientists and industry partners at each level of organization allows for two-way transfer of fishery-dependent and scientific understanding. This produces mutual understanding of the real-time dynamics of ecological, economic, and sociopolitical aspects of fishery systems and engenders trust. Finally a crowdsourced approach to seascape ecology can be used as a research tool by collaborative, multidisciplinary and multi-institutional working groups of experts tasked with integrating ecosystem considerations in stock assessments. This is the approach currently being developed and applied by members of the NEFSC Climate, Ecosystem, Habitat considerations in Assessment Steering Group (CEHASG) for the 2017 stock assessment of Atlantic mackerel.

References

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