Session: Modeling and Analysis

Human Dimensions

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Vulnerability to and assessment of social and economic risk are key components of the social science research recently conducted in support of Ecosystem Based Management. Jin, DePiper, and Hoagland (In Press) address the issue by employing portfolio theory, a framework originally developed to balance risk exposure in investment portfolios. The basic concept is that the optimal portfolio of a risk adverse investor should trade off the variance and higher moments of the distribution of investment values in order to maximize the probability of attaining a target financial return. As applied to fishery management, the concept entails selecting harvest levels of managed stocks that capitalize on negative or low correlations in order to minimize the risk profile of the management system. The correlations across species are composed of biological, market price, harvest technology, and management interactions in the system of interest.

The model outputs can be used both to assess historical performance and to provide guidance in support of Management Strategy Evaluation (MSE). In the former capacity, the model can assess how unbalanced the system has become by comparing the risk profile of the actual returns to the optimal portfolio for the same expected returns, but with species harvest levels chosen to minimize the risk to the system (Figure 1). Run at multiple spatial extents (full Northeast LME vs. individual Ecological Production Unit vs. individual ports or states), the model can assess where the burden of risk lies, and whether that burden propagates through the system, or is attenuated at larger system extents. As a component of MSE, the portfolio analysis can be coupled to the multispecies models under development and project the risk profile of simulated harvesting strategies in order to understand the potential risk-reward trade-offs being made. In this capacity, the results of the portfolio analysis can be used to help set harvest control rules and TACs that explicitly consider economic risk.

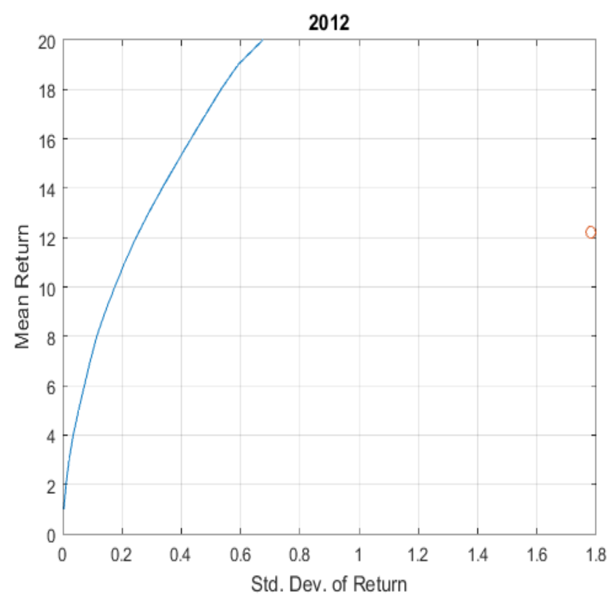

Figure 1. The efficient portfolio frontier (blue curve) versus realized returns to the system (red circle) for Rhode Island, Maine, and Massachusetts revenue generated from fishing in 2012.

This analysis can be coupled with assessments of species and fleet diversity measures, such as Effective Shannon Indices, that quantify the extent to which fleet composition has changed and assess the extent to which stovepiping, or, conversely, specialization, is occurring. Ultimately, these diversity measures can be used to anchor discussions arising from management actions such as Amendment 18 of the Northeast Multispecies FMP in the historical picture (*e.g.* Gaichas *et al.* In Review).

By definition, stock assessments of exploited marine resources and management efforts that seek to balance human and ecosystem needs are part of such a socio-ecological system. Another key component of this system is the ability of coastal communities and economies to respond to both marine ecosystem change and management decisions. A goal of NOAA Fisheries is to understand the resilience of United States coastal communities and economies and thus their adaptability to the impacts of hazards, including climate change. To meet this goal, 13 indices of social vulnerability and fishing dependence were developed for nearly 4,000 coastal communities in United States. The

Community **S**ocial Vulnerability Indicators (CSVIs) fall into four categories: 1) **s**ocial vulnerability indices represent social factors such as poverty and population composition that can affect an individual or community's ability to respond and adapt to change or disruptions; 2) gentrification pressure vulnerability indices characterize factors such as changing population demographics in coastal areas that over time may represent a threat to the sustainability of a commercial or recreational fishing working waterfront, including infrastructure (Jepson and Colburn 2013; Colburn and Jepson 2012; Clay and Olson 2008); 3) the community dependence on fishing indices represent community engagement and reliance on commercial and recreational fishing; and 4) the climate change vulnerability indices capture aspects of sea level rise risk and community dependence on species vulnerable to the impact of changing climate conditions.

The indicators have primarily been calculated using factor analysis (see Explore the Indicators at http://www.st.nmfs.noaa.gov/humandimensions/social-indicators/index). Seventy-five different variables from seven secondary data sources were used to develop the indices. The CSVIs are assembled annually using demographic data from the United States Census' American Community Survey (ACS) five-year estimates, NOAA Fisheries' annual commercial fisheries and Marine Recreational Information Program (MRIP) data, as well as a small number of publically available online databases. Ongoing data collection will allow the CSVIs to be continually updated to show long term trends. The baseline ACS data are for 2005 to 2009 and will be compared to 2010 to 2014 estimates once they are available. The CSVIs are derived from existing and measurable social factors that can influence either an individual's or community's ability to respond and adapt to change and, in particular, changes to fishing regulations. Currently, a subset of these indicators will be calculated for all United States coastal county communities. Because these indicators are derived from commonly available existing sources (primarily census data) they have wide applicability and can be readily updated. Although widely-used indices of vulnerability and sustainability have been developed at national and regional levels, this research focused on community-level indicators. Such indicators are essential to systematically assessing the social impacts of changing access to fishery resources resulting from change in regulations and environmental conditions. These indicators are being used widely within NOAA and may provide guidance for development of similar indices in other countries.

References

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