Session: Modeling and Analysis

Management Strategy Evaluation (MSE)

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Management Strategy Evaluation (MSE) is a resource-intensive stakeholder-driven analytical process for exploring the consequences of alternative management approaches on a set of objectives. Simulation testing is at the heart of the process. Data assembly and analysis can rely on existing datasets and tools but often requires additional simulation model development and testing. A typical application of an MSE consists of using operating model(s) that incorporate sufficient complexity to simulate variability in a state process (*e.g.*, fish population, ecosystem or economic dynamics), and an estimation model to perform virtual data collection, analysis and management advice. The effects of alternative management strategies (*e.g.*, data collection systems, assessment methods, harvest control rules, adapting management to a changing climate, protected resource take reduction strategies, *etc*.) can then be examined relative to multiple objectives associated with the system (*e.g.* catch, abundance, economic gain, annual variation in catch, emergent ecosystem properties, conservation level achieved, biodiversity *etc*.). The MSE process is iterative and is most effective when stakeholders are involved throughout. Outcomes from an MSE may be applied directly in management, or may be more exploratory in nature. MSE has a high return on investment, providing decision support products that address key uncertainties with substantial buy-in from stakeholders.

While MSE is a key process for integrating scientific information into management (Theme 4), all Program Review themes apply to some extent. Considerable time is spent coordinating with managers and facilitators to develop stakeholder processes, in travel to and participation in stakeholder workshops within the Northeast Region, and to otherwise plan the analysis so that key objectives are specified properly and all involved understand the process at each step (Themes 1, 4, 5). Analysis, including development of appropriate datasets (Theme 2), analytical tools (Theme 3), and experimental designs to address key uncertainties (Theme 3) represents the major scientific component of MSE. Compiling and communicating often complex MSE simulation results can require development of visualization tools and attending meetings with managers and stakeholders, often iteratively throughout a given MSE project (Themes 4 & 5).

Theme 1: Strategic Planning and Management Context

MSE at NEFSC encompasses multiple specific projects that respond to the current needs and priorities of the Mid-Atlantic and New England Fishery Management Councils and the Atlantic States Marine Fisheries Commission, as well as other potential management organizations. MSE projects commonly last one or more years.

Initial MSE planning at NEFSC has been to coordinate MSE efforts. An internal NEFSC MSE Working Group was convened in August 2015 and has members representing protected species, fish stock assessment, ecosystems, economics, and policy. The group is currently developing an NEFSC MSE work plan Group members are also involved in the first full NEFSC MSE (see Theme 4), which is being used as a case study to outline best practices for further MSE projects within NEFSC. The current NEFSC MSE project inventory (see page 3) lists 17 analyses in various stages of development addressing data collection (1), stock assessment (10), and ecosystem (6) issues. The NEFSC MSE Working Group communicates with the NMFS National MSE working group (the same person currently chairs both) to share information across Centers and to similarly build capacity on a national level.

Theme 2: Ecosystem Data

Ecosystem data are critical to performing ecosystem-level MSEs, especially for developing and parameterizing operating models. Due to its history of investment in ecosystem monitoring, data collection, and analysis, NEFSC is particularly well positioned to conduct MSEs at the single species, multispecies, and ecosystem levels of organization (assuming that time series are maintained). We refer reviewers to other presentations to get the full range of data products available at NEFSC.

Theme 3: Ecosystem Modeling and Analysis

We focus on modeling and analysis for ecosystem-level MSE, noting that the NEFSC has well-developed resources for MSE related to fish stock assessment. As reviewed in the modeling presentation, NEFSC has developed a wide range of tools that can be applied in MSE. In particular, Atlantis and Rpath are designed for use as full ecosystem operating models, and multispecies models such as Kraken, SCAA, and Hydra can be used as multispecies operating models. Atlantis, Kraken, and Hydra have already been used for simulation analyses evaluating species and ecosystem responses to both human and environmental forcing (see Theme 5). Hydra has been used as an operating model to evaluate the performance of several multispecies assessment models in development (see poster by Gamble *et al*). Each assessment model was evaluated for its skill in recovering the Hydra-simulated biomass time series under multiple data quality scenarios. While assessment model performance varied by species, a simple model ensemble performed better across error scenarios than any individual model for nearly all modeled species.

Hydra was also used as an operating model to evaluate performance of a multispecies/ecosystem-based management procedure and tradeoffs between management simplicity, yield, and biomass status for the 10 species in the system. Overall we found that there are aggregate catch limits that can maximize yield and value while conserving biomass. However, community composition and value trade -off over a range of fishing effort. These simulations are intended as a starting point for further discussion with scientists, managers, fishermen, and other stakeholders in support of ecosystem-level MSE. Similarly, analyses and modeling work in the region has identified potential ecosystem-level thresholds related to both fishing and environmental drivers, has analyzed how ecosystem-level thresholds may change in response to climate change, and has evaluated the potential impacts of ocean acidification on multiple management objectives.

Theme 4: Incorporation into Management

An MSE for Atlantic herring (specifically, exploration of ABC control rules that consider herring's role as forage within the ecosystem) has been initiated with the New England Fishery Management Council (NEFMC). The herring MSE steering committee includes Council staff, NEFMC Herring Committee and advisory panel members, GARFO staff, and the NEFSC MSE FTEs. A facilitated two day stakeholder workshop was held 16-17 May in Portland, ME this year to develop a list of MSE management objectives and performance measures and to identify key sources of uncertainty to be considered in the analysis. About 70 people attended representing the fishing industry (commercial herring, lobster, tuna, and groundfish, as well as recreational and for hire), environmental NGOs, Council members and staff, and state, federal, and academic scientists. Development of simulation tools is proceeding this summer. MSE products are expected to contribute to the Council decision-making process for Herring FMP Amendment 8 by November 2016.

Theme 5: Communications and Peer Review

Potential ecosystem-level MSE operating models have been peer-reviewed both in the literature and with a past CIE review for the NEFSC ecosystem modeling enterprise. Several scenario analyses that may contribute to MSE have been published, and more are currently in review or in prep. The NEFSC MSE WG reached out to Councils and the Commission through Northeast Regional Coordinating Council. Specific MSEs for individual species are in progress, and MSE is being considered as a more general tool for evaluating ecosystem approaches to fisheries management by the Mid-Atlantic Council. An MSE stakeholder process fosters communication among scientists, managers, and stakeholders. Formal Council MSE review processes may require development, or review may fit within current processes.