Ocean Modeling Forum Holds Second Meeting of Pacific Sardine Working Group

The Ocean Modeling Forum (OMF) has convened a working group to improve the use and usefulness of models in informing the management of Pacific sardines on the west coast of North America. The aims of the OMF Sardine Case Study are to model the impact of alternative harvest control rules for the Pacific sardine off the west coast of North America (U.S., Mexico, and Canada) on the target stock, the fisheries that depend on this resource, and the dynamics of the west coast ecosystem. As a pilot study for the OMF, this effort will involve a series of workshops to identify how existing modeling frameworks can be improved, modified, or associated for use in the management of Pacific sardine, including making modifications in response to a recent Pacific Fisheries Management Council (PFMC) review.

The OMF's Sardine Case Study participants convened initially at the launch of the OMF in the Spring of 2014. OMF hosted the Case Study participants for the second time to focus exclusively on sardines in November 19-20, 2014, in Seattle, Washington.

Sardine Model Review

Case Study participants first reviewed the relevant sardine models, including discussing the **evolution and improvements of the relevant models** following their review and evaluation by the PFMC in 2013. The models presented at the November meeting were:

- Single species/sardine model. *Modeler: Felipe Hurtado-Ferro, University of Washington*
- IBM-NPZD-Oceanography. *Modeler: Enrique Curchitser, Rutgers University.*
- MICE (model of intermediate complexity). *Modelers: André Punt and Kelli Johnson, University of Washington.*
- "EcoPath". *Modelers: Tim Essington and Laura Koehn, University of Washington.*
- Atlantis. *Modeler: Isaac Kaplan, NOAA.*

Case Study Questions/Activities

One outcome of the meeting was the identification of the **questions and activities to be addressed** by the Sardine Case Study using the candidate models, with the general aim to investigate how complex models can be used to improve upon the Harvest Control Rules, through model runs that explore key environmental and management parameter horizons. The aim of the group is to use the relevant models to address these questions by the conclusion of the case study.

The **five research questions/activities** identified by the case study members are:

1. What are the consequences across a range of sardine Harvest Control Rule parameter values (BIOMASS, FRACTION, CUTOFF, DISTRIBUTION, TEMPERATURE) for
    a. Sardine stock, yield, revenue (and their spatial distribution)
    b. Fished predators

      c. Unfished predators
- **Approach:** Use the Atlantis model to evaluate consequences for the ecosystem across a profile of performance indicators derived from more simple single species or MICE models, and ask whether those consequences change under different environmental conditions?

2. Under what circumstances does sardine productivity decline rapidly such that management response is unable to catch it? How does variance change under the same circumstances? Given the temporal nature of changing productivity, what are the effects of current management strategies?
   - **Hypothesis:** Such rapid declines in productivity are observed in years of very high or very low temperature.
   - **Approach:** Explore environmental characteristics of the years of positive and negative growth rates

3. Under what circumstances are sardines available to Canadians? When are sardines observed in Canadian waters?
   - **Hypotheses:** Sardines move farther north in years of a strong ENSO/warm ocean; sardines are observed farther north in years of low fishing pressure; sardines are observed farther north when the population age structure includes more older/repeat spawner/"experienced" individuals.
   - **Approach:** Model sardine migration as a function of temperature and size in the IBM model, and run Atlantis with the forced migration function altered to match the output from the IBM model.

4. How important is predator-dependent mortality?
   - **Hypothesis:** predator-dependent mortality is more important when productivity is already at low levels owing to climate.
   - **Approach:** Use the IBM model to produce time trajectories of natural mortality by stage.

5. What is the role of space versus taxonomic richness in determining functional responses, minimum biomass, etc.?

The group then identified additional model improvements to make that would allow the exploration of these questions, and developed a workplan for the period before the next Case Study workshop, in February 2015.

Other Meeting Outcomes

The group began discussing approaches for using multiple models in forecasting, and in ocean and fisheries management, including multi-model inference. The relevance of each approach for the sardine case study was discussed.

The case study members also participated in an exercise to identify and list individual, personal incentives for their participation in the Case Study, and resolved to revisit those

incentives throughout the course of the Case Study to ensure the activities were aligned with their incentives.

Future Meetings
- February 12—13, 2015 (Seattle, WA)
- June 2015 (date/location TBD)

The Ocean Modeling Forum

Researchers have expansive knowledge and tools that can be used for Ecosystem Approaches to Management. Yet even with many tools and techniques at their disposal, information available is often specific to one location and not integrated with other types of data, making decisions about how to manage marine resources more challenging. To tackle this challenge, André Punt from the University of Washington's School of Aquatic and Fishery Sciences and Phil Levin from NOAA Northwest Fisheries Science Center, with support from the Packard Foundation, developed The Ocean Modeling Forum (OMF). OMF brings together modeling experts, scientists, ocean managers and policy makers to work through case studies and determine how to use existing models and analytical techniques holistically. Their goal is to determine what is the most usable and useful information for ocean managers and policy makers in making informed decisions that will yield positive outcomes for our oceans.

OMF will coordinate a set of ad hoc working groups to address ocean-management topics of high importance using modeling methods. It will advance the implementation of the Ecosystem Approach to Management, which has been widely accepted by scientists, managers and policy makers. OMF will involve scholars from a range of scientific disciplines to address topics in an integrated and collaborative manner. Participants in specific projects will be identified by the leadership group and will involve key scientists, stakeholders and managers. The first case study by OMF will model the impact of alternative harvest control rules for the Pacific sardine off the west coast of North America (U.S., Mexico, and Canada) on the target stock, the fisheries which depend on this resource, and on the dynamics of the west coast ecosystem. This effort will initially involve conducting a series of workshops to identify how existing modeling frameworks can be modified to evaluate potential harvest control rules in terms of their ability to satisfy fishery and ecosystem goals.

The Sardine Case Study was launched in spring of 2014, and convened its first official meeting in November 2014, in Seattle, Washington. Additional meetings are scheduled for February and June of 2015.