NATIONAL AQUARIUM

aqua.org

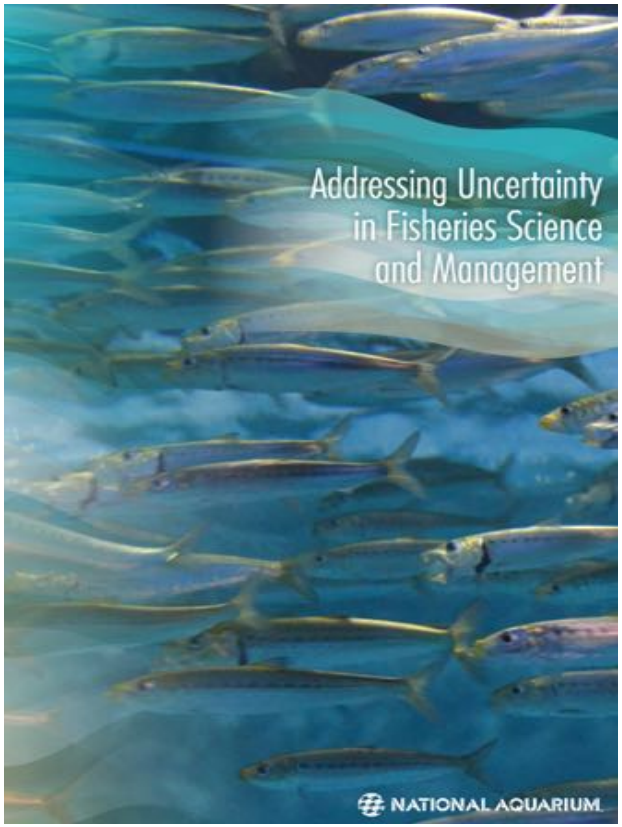
Addressing Uncertainty in Fisheries Science and Management

Eric Schwaab, Senior VP and Chief Conservation Officer

May 7, 2015

FROM: *ADDRESSING UNCERTAINTY IN FISHERIES SCIENCE AND MANAGEMENT*

DECEMBER, 2014



A project to understand sources and treatment of uncertainty; and to advance best practices for reducing or managing with uncertainties in fisheries management systems

THE EXPERT PANEL

- **Dr. Steven Cadrin**, *Associate Professor of Fisheries Oceanography, School for Marine Science and Technology, University of Massachusetts-Dartmouth*
- **John Henderschedt**, *Executive Director of the Fisheries Leadership and Sustainability Forum*
- **Dr. Pamela Mace**, *Principal Advisor Fisheries Science, New Zealand Ministry for Primary Industries*
- **Dr. Steven Murawski**, *Professor, University of South Florida*
- **Dr. Joseph Powers**, *Professor of Stock Assessment, School of the Coast and Environment, Louisiana State University*
- **Dr. Andre Punt**, *Professor and Director, School of Aquatic and Fisheries Sciences, University of Washington*
- **Dr. Victor Restrepo**, *Vice President of Science, International Seafood Sustainability Foundation*
- **Dr. Richard Methot**, *Science Advisor for Stock Assessments, NOAA Fisheries (special advisor)*

REPORT OVERVIEW:
FOUR OVERARCHING THEMES

- Identifying and Communicating Sources and Treatments of Uncertainty
- Best Practices for Reducing Uncertainty
- Special Case: Managing Fisheries in the Context of Environmental Change
- Risk-Based Management Decisions: Prioritizing Responses to Uncertainty


NOAA

SOURCES OF UNCERTAINTY

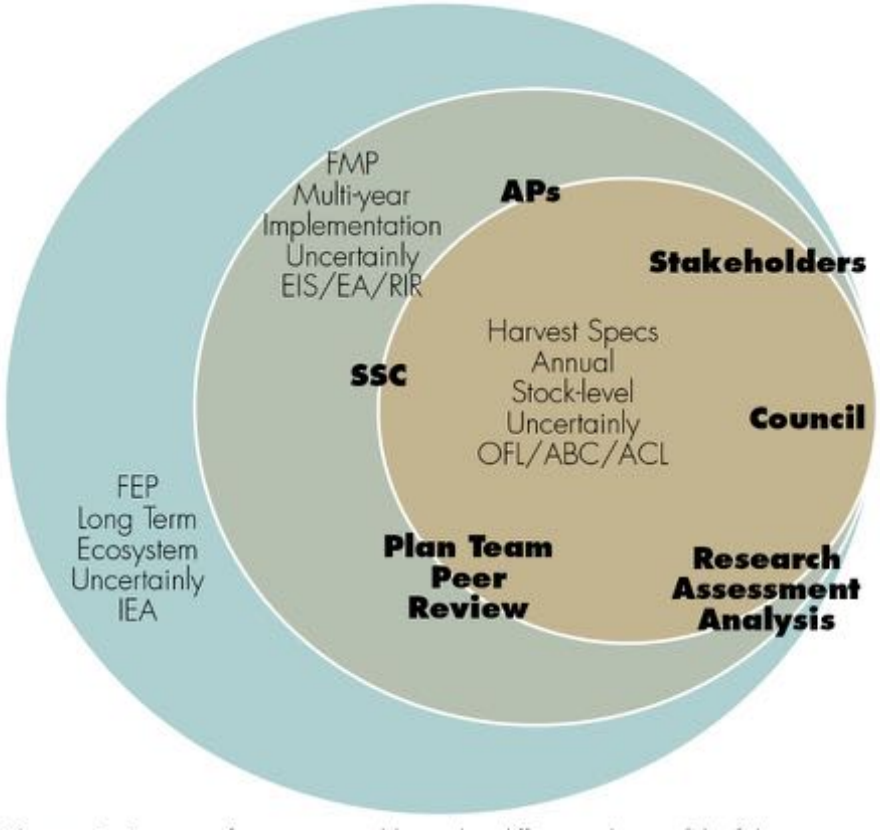
Table 1. General types of uncertainty and management under the current legislative framework. Incorporation of uncertainty into the fisheries management process varies by region.

	Sources of Uncertainty	Examples	Methods to manage for/ Point of response within management process	Methods to reduce
Scientific	**Data: Measurement or sampling**—fishery-dependent and independent data	Accuracy and precision of catch data; quality of biological sampling; survey design and frequency	Use of historical averages; uncertainty buffers; extrapolate observer data; explicit adjustment made in ABC[1]	More intensive sampling; Logbooks; observers; electronic monitoring; improved surveys
	Assessment: Model, structural, forecasting—modeling methods, variables, parameters, generation of catch targets based on best available science	Assumptions of natural mortality; catchability; stock-recruit relationships; age at maturity; Retrospective inconsistencies; lack of contrast; measurement, process, modeling error	Management Strategy Evaluation; buffer between OFL[2] and ABC; buffer between ABC and ACL; explicit adjustment made in ABC	Frequent monitoring and measurement; retrospective model evaluation Long time-series of measurement data; fully calibrated stock size estimates; direct measurement of selectivity; adaptive management
	Ecosystem: Process or population—natural variability and directional change	Natural mortality; growth rates; recruitment	Ensure incorporation into stock assessments; explicit adjustment made in ABC; potentially in ACL[3]	Frequent monitoring and measurement; ensure understanding of modeling processes
Management	**Outcome or Implementation**—Limiting catch at or below desired limit	Catch amounts; catch rates; catch composition; unreported discards; misreporting	ACT set below ACL; explicit adjustment made in ACT[4]	Effort limitation; real-time data collection and processing; in-season quota-based management framework; improved enforcement tools

IDENTIFYING UNCERTAINTY

RECOMMENDATION 1: *Clearly and explicitly communicate sources, treatment and impacts of uncertainty*

RECOMMENDATION 2: *Define stakeholder roles and responsibilities*



COMMUNICATING UNCERTAINTY: CREATING TRUST DESPITE UNCERTAINTY

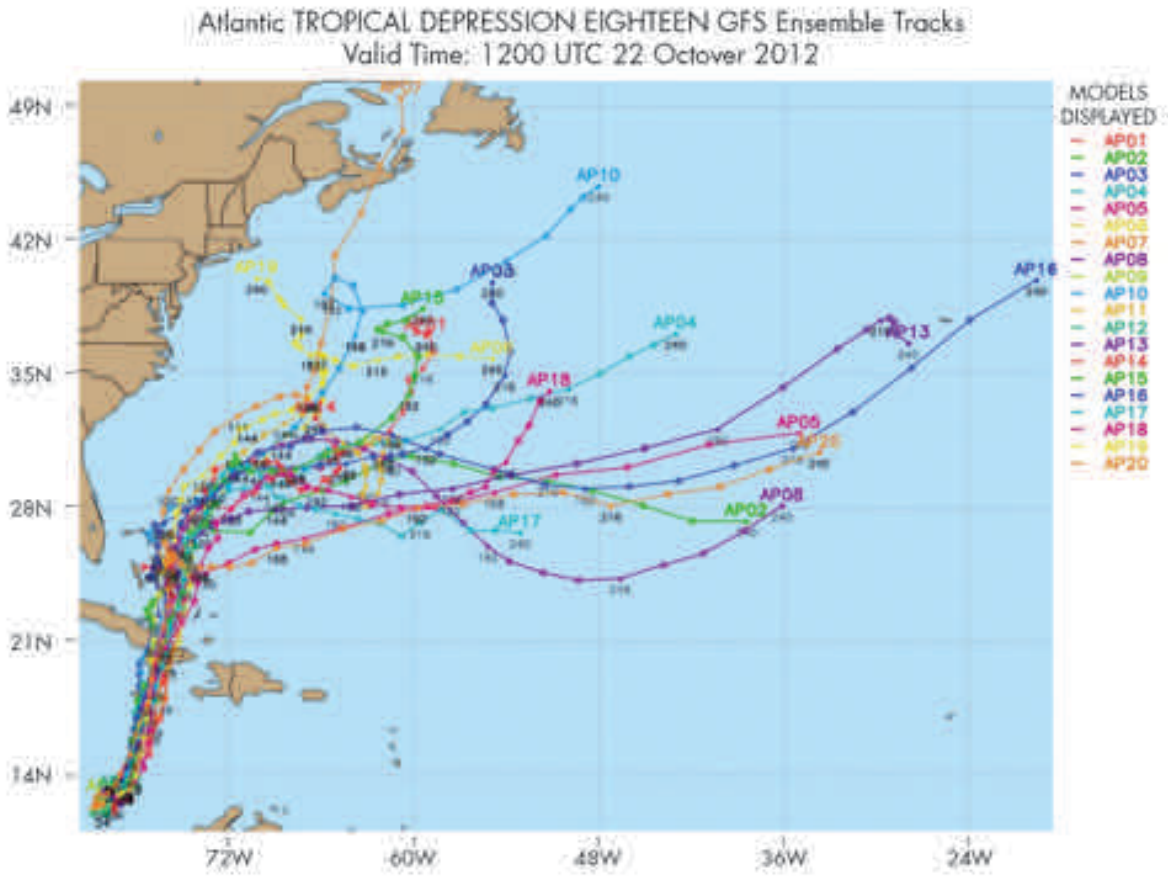


Figure 3. Tropical Depression tracks resulting from 20 weather prediction models. This late-season storm developed into Hurricane Sandy in 2012. This was not the schematic presented to the public, however. Weather models typically are presented in a manner that is easily understood by daily viewers. Image credit: Clark Evans.

COMMUNICATING UNCERTAINTY: CREATING TRUST DESPITE UNCERTAINTY

REDUCING UNCERTAINTY

Expand and support efforts to reduce uncertainty wherever possible through strategic allocation of investments in fisheries dependent and independent data, modeling and assessment processes.

REDUCING UNCERTAINTY

RECOMMENDATION 3: *Evaluate and prioritize investments. Good planning maximizes value*

RECOMMENDATION 4: *Good investment in science will yield value to stakeholders*

RECOMMENDATION 5: *Prioritize improved catch accounting*

RECOMMENDATION 6: *Focus on cooperative research*

RECOMMENDATION 7: *Explore new technologies*

RECOMMENDATION 8: *Address frequency of stock assessments*

RECOMMENDATION 9: *Evaluate methodologies for data poor stocks*

NOAA Ship *Miller Freeman*, David Csepp, NOAA

REDUCING UNCERTAINTY

RECOMMENDATION 3: *Evaluate and prioritize investments. Good planning maximizes value*

RECOMMENDATION 4: *Good investment in science will yield value to stakeholders*

RECOMMENDATION 5: *Prioritize improved catch accounting*

RECOMMENDATION 6: *Focus on cooperative research*

RECOMMENDATION 7: *Explore new technologies*

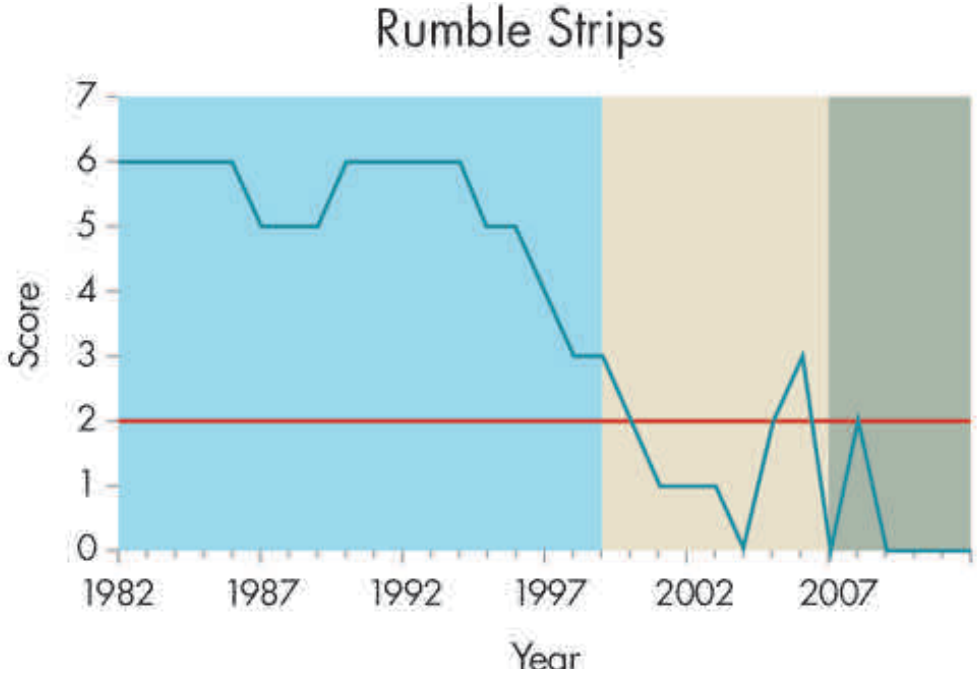
RECOMMENDATION 8: *Address frequency of stock assessments*

RECOMMENDATION 9: *Evaluate methodologies for data poor stocks*

NOAA Ship *Miller Freeman*, David Csepp, NOAA

REDUCING UNCERTAINTY

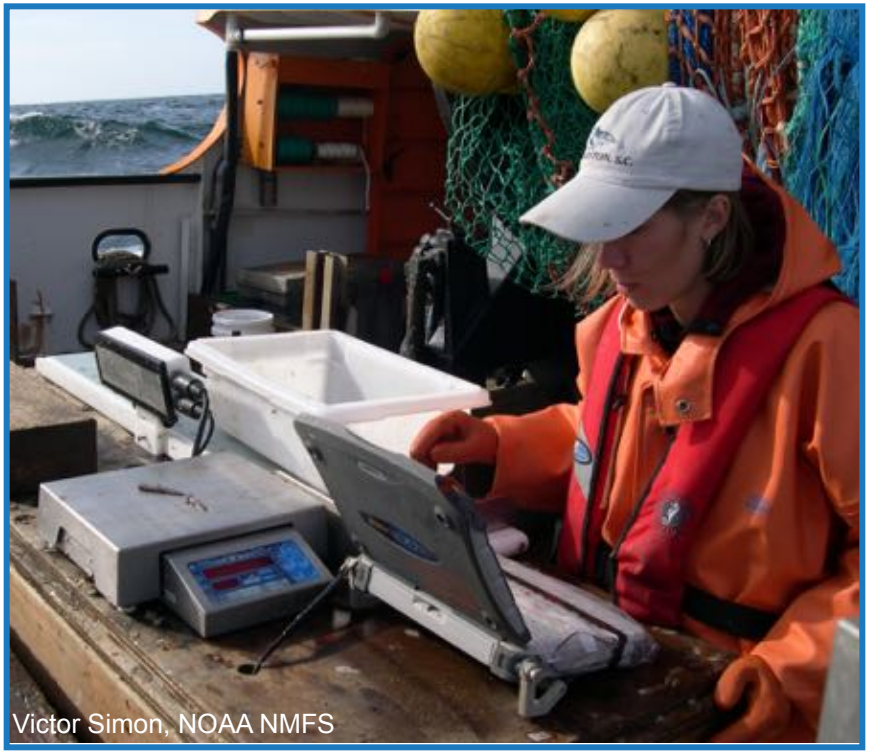
RECOMMENDATION 8: *Address frequency of stock assessments*



"Adopt clear check points and sets of indicators that trigger use of new information in advance of a complete stock assessment"

Best Practice: MAFMC Rumble Strip Approach

MANAGING FISHERIES IN THE CONTEXT OF ENVIRONMENTAL CHANGE



Victor Simon, NOAA NMFS

RECOMMENDATION 10: *Expand fisheries oceanography research. Understand mechanisms, trends and effects*

RECOMMENDATION 11: *Integrate ecosystem science into single species assessments and incorporate triggers*

RECOMMENDATION 12: *Prepare for environmental shifts through education, control rules and reference points*

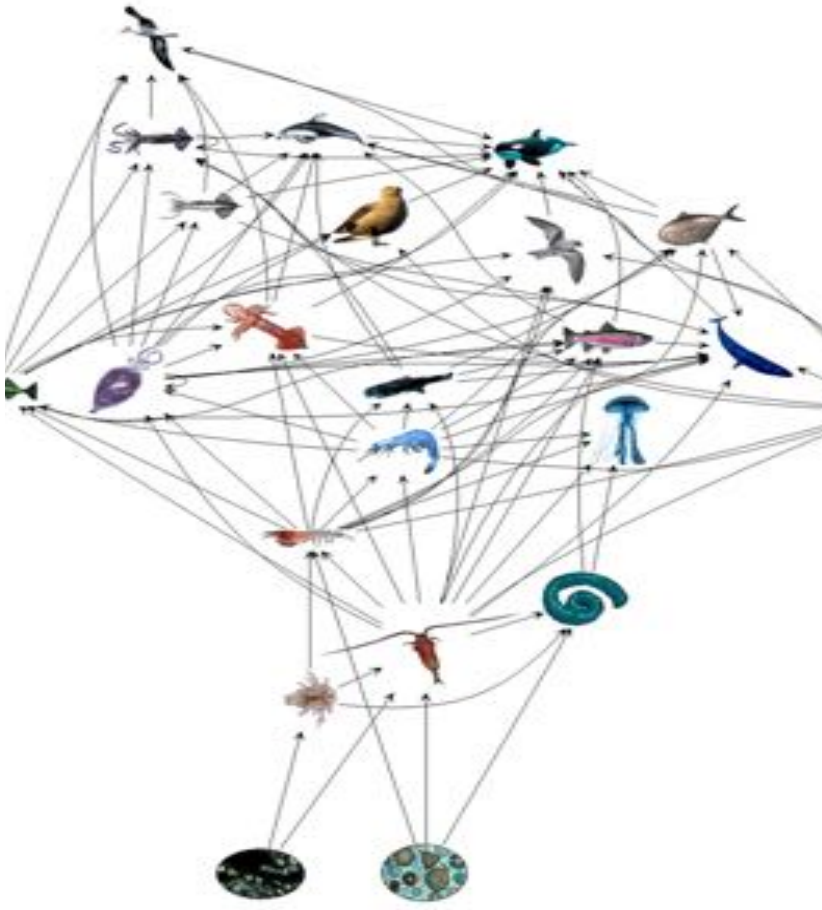
MANAGING IN THE CONTEXT OF ENVIRONMENTAL UNCERTAINTY

Comprehensive Fisheries Oceanography and Other Programs

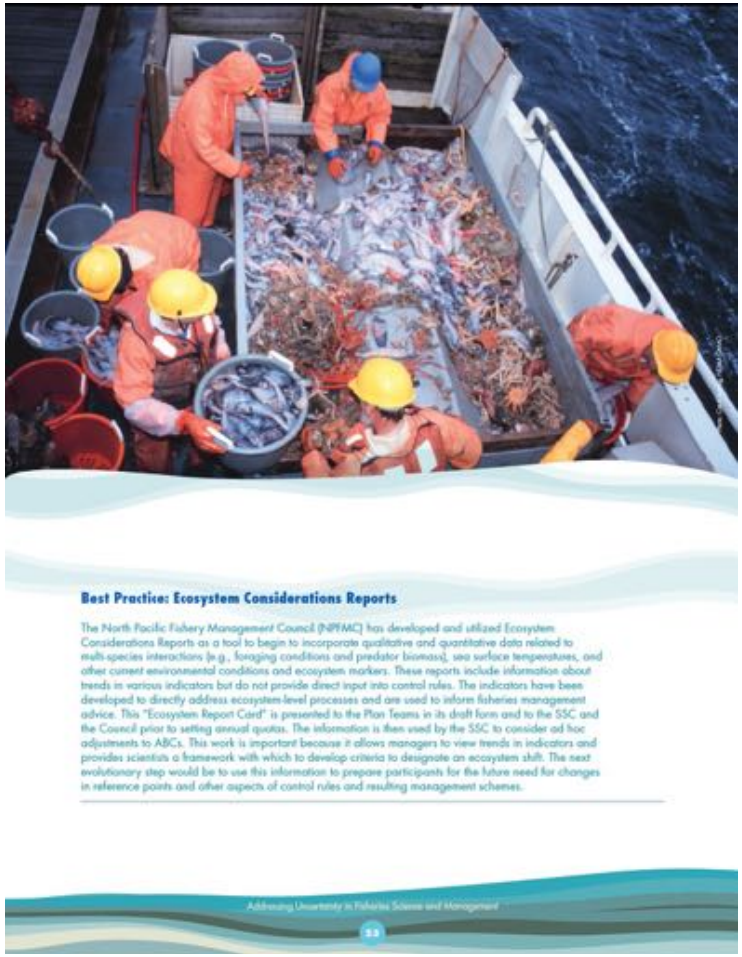
- Global Ocean Ecosystem Dynamics (GLOBEC)
- Comparative Analysis of Marine Ecosystem Organization (CAMEO)
- Fisheries and the Environment (FATE)
- Integrated Ecosystem Assessments (IEA's)
- Habitat Blueprint Focus Areas

BEST PRACTICE: MANAGING IN THE CONTEXT OF ENVIRONMENTAL UNCERTAINTY

- Comprehensive Fisheries Oceanography Program
- Ecosystem Consideration Reports
- Maximum ABC Reference Point
- Allocation of Fishery Resources Based on Physical Distribution of Target Stocks
- Harvest Control Rules that Incorporate Environmental Change



MANAGING IN THE CONTEXT OF ENVIRONMENTAL UNCERTAINTY



Best Practice: Ecosystem Considerations Reports

The North Pacific Fishery Management Council (NPFMC) has developed and utilized Ecosystem Considerations Reports as a tool to begin to incorporate qualitative and quantitative data related to multi-species interactions (e.g., foraging conditions and predator biomass), sea surface temperatures, and other current environmental conditions and ecosystem markers. These reports include information about trends in various indicators but do not provide direct input into control rules. The indicators have been developed to directly address ecosystem-level processes and are used to inform fisheries management advice. This "Ecosystem Report Card" is presented to the Plan Teams in its draft form and to the SSC and the Council prior to setting annual quotas. The information is then used by the SSC to consider ad hoc adjustments to ABCs. This work is important because it allows managers to view trends in indicators and provides scientists a framework with which to develop criteria to designate an ecosystem shift. The next evolutionary step would be to use this information to prepare participants for the future need for changes in reference points and other aspects of control rules and resulting management schemes.

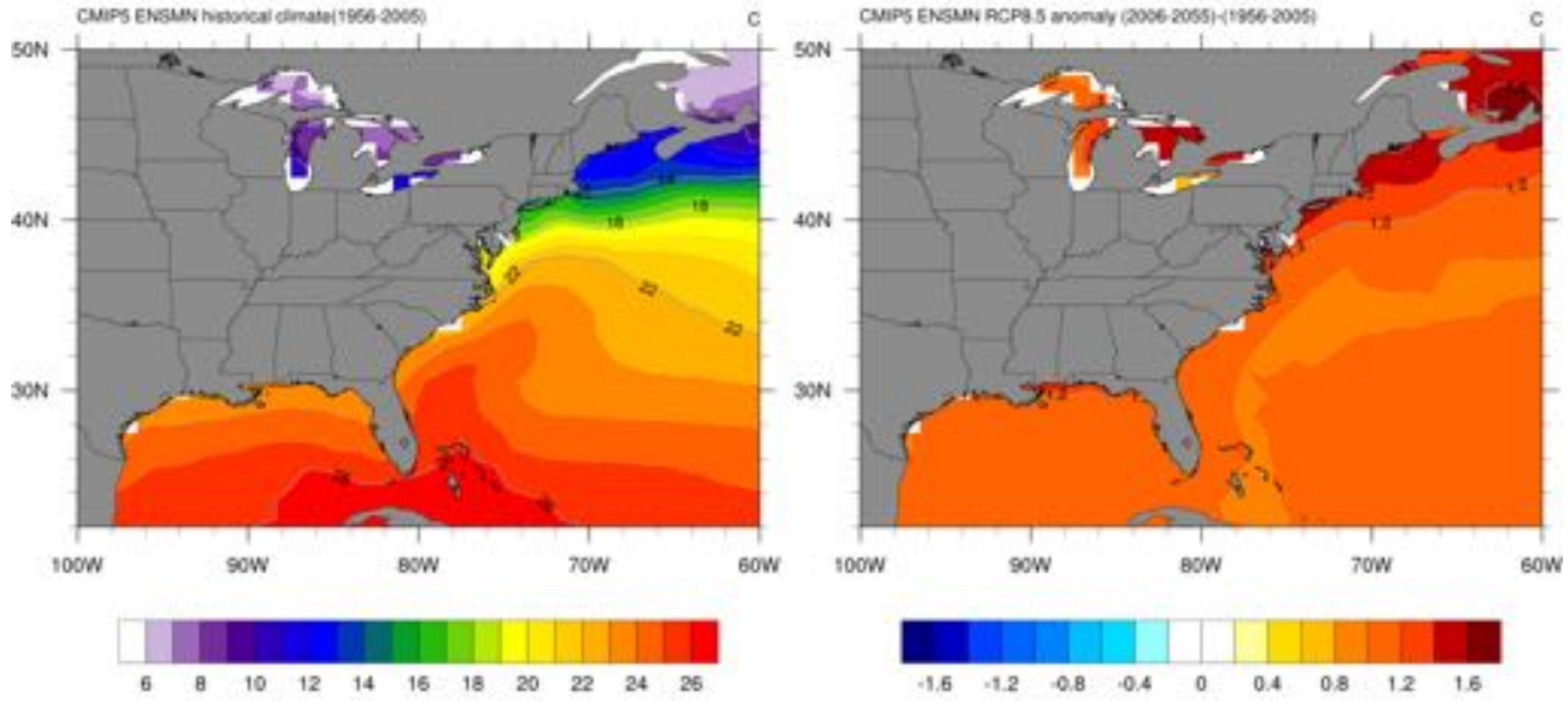
Best Practice: Ecosystem Considerations Reports

The North Pacific Fishery Management Council (NPFMC) has developed and utilized Ecosystem Considerations Reports as a tool to begin to incorporate qualitative and quantitative data related to multi-species interactions (e.g., foraging conditions and predator biomass), sea surface temperatures, and other current environmental conditions and ecosystem markers. These reports include information about trends in various indicators but do not provide direct input into control rules. The indicators have been developed to directly address ecosystem-level processes and are used to inform fisheries management advice. This "Ecosystem Report Card" is presented to the Plan Teams in its draft form and to the SSC and the Council prior to setting annual quotas. The information is then used by the SSC to consider ad hoc adjustments to ABCs. This work is important because it allows managers to view trends in indicators and provides scientists a framework with which to develop criteria to designate an ecosystem shift. The next evolutionary step would be to use this information to prepare participants for the future need for changes in reference points and other aspects of control rules and resulting management schemes.

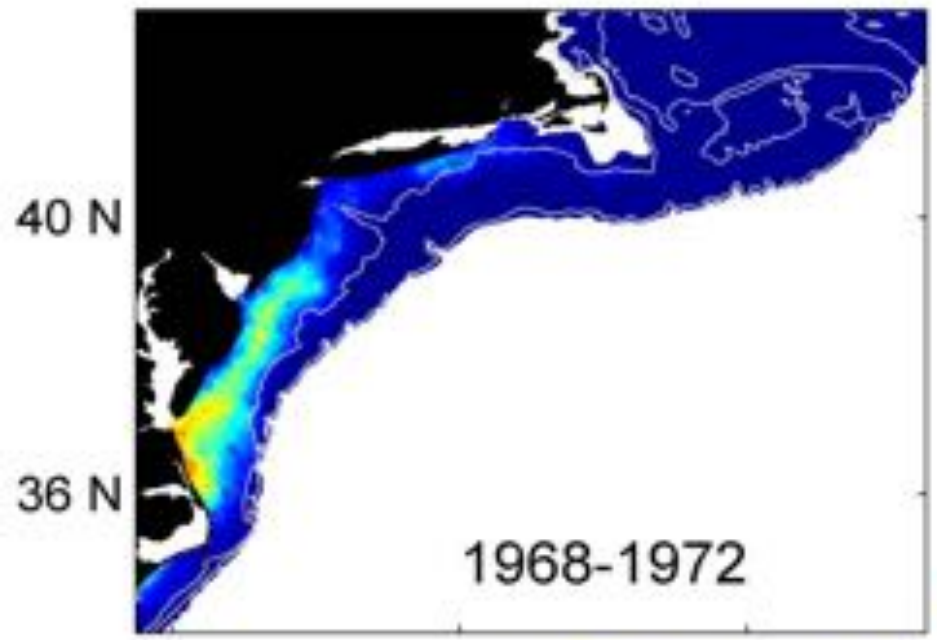
FACING CLIMATE CHANGE:
PAST AND FUTURE CLIMATE STATES

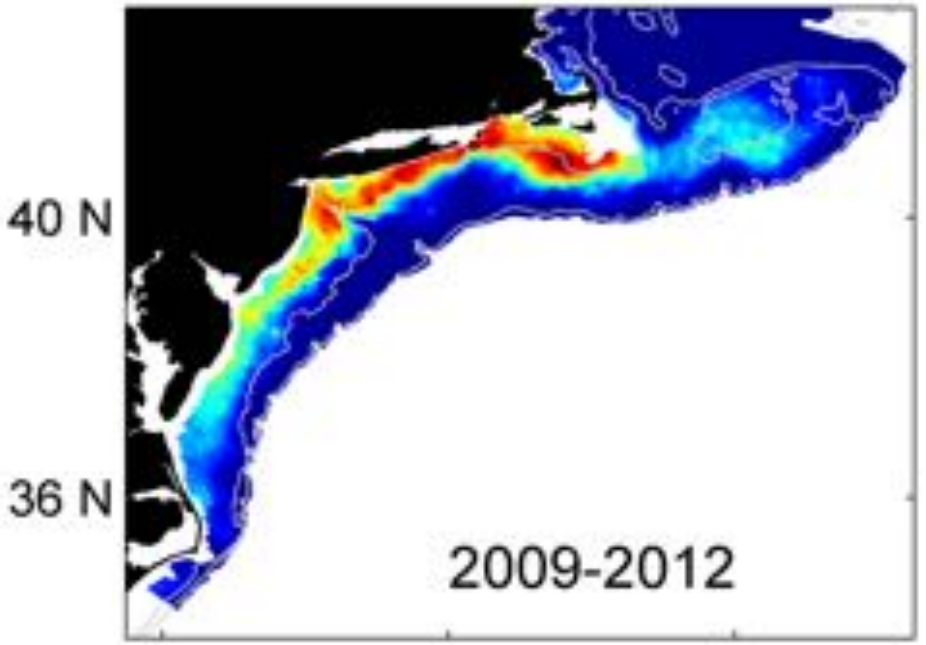
Climate Projections – Surface Temperature

Sea Surface Temperature ANN



FACING CLIMATE CHANGE:
SUMMER FLOUNDER DISTRIBUTION





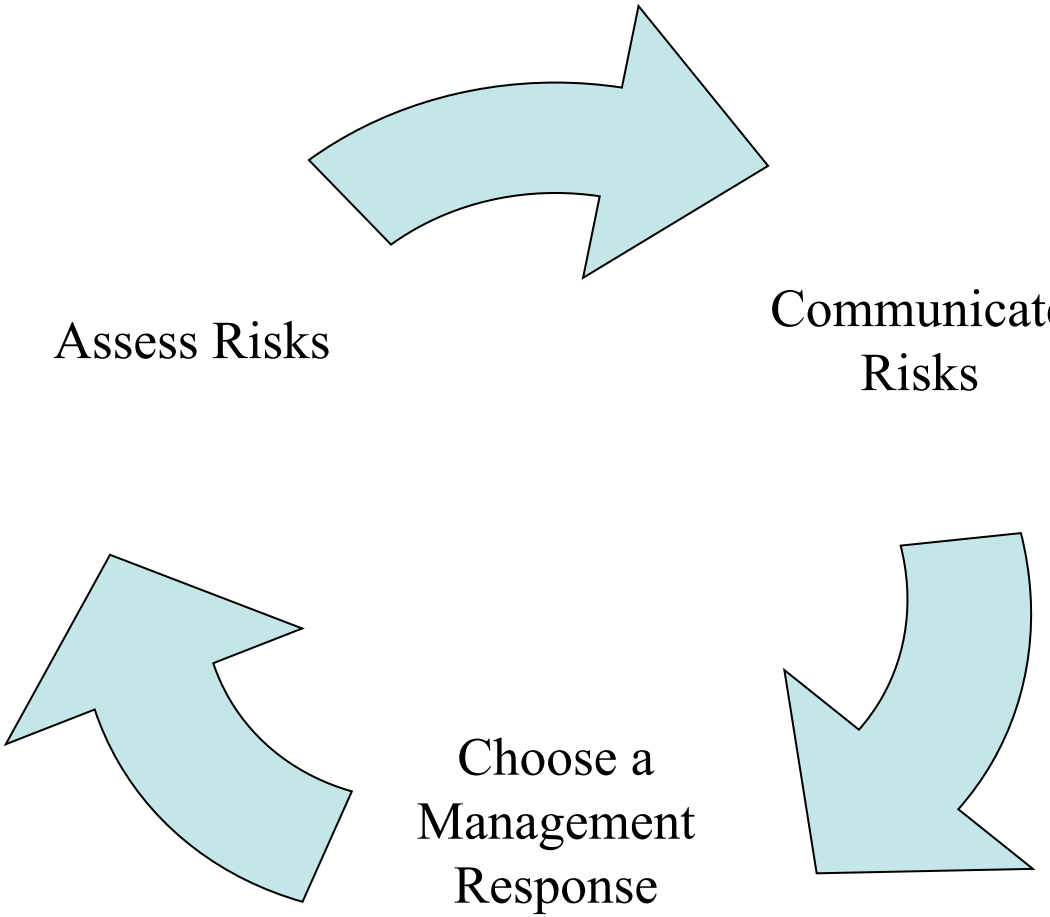
RISK-BASED MANAGEMENT IN THE CONTEXT OF UNCERTAINTY

RECOMMENDATION 13: *Adopt explicit risk policies*

RECOMMENDATION 14: *Adopt formal procedures to communicate risk*

RECOMMENDATION 15: *Test control rules for robustness to uncertainty*

Importance of Risk Policies



RISK-BASED MANAGEMENT:
BEST PRACTICES

Quick Reference: Nine Characteristics of a Successful Risk Policy

- Reflective of unique regional management context
- Considers short-term/long-term tradeoffs
- Iterative and performance-based
- Comprehensive and holistic
- Provides direction for improvement
- Responsive to availability of information and reaction time
- Resilient in the face of change (including environmental change)
- Transparent and objective with clear roles and responsibilities
- Balances structure and flexibility

(Adapted from Fisheries Leadership and Sustainability Forum, 2012)

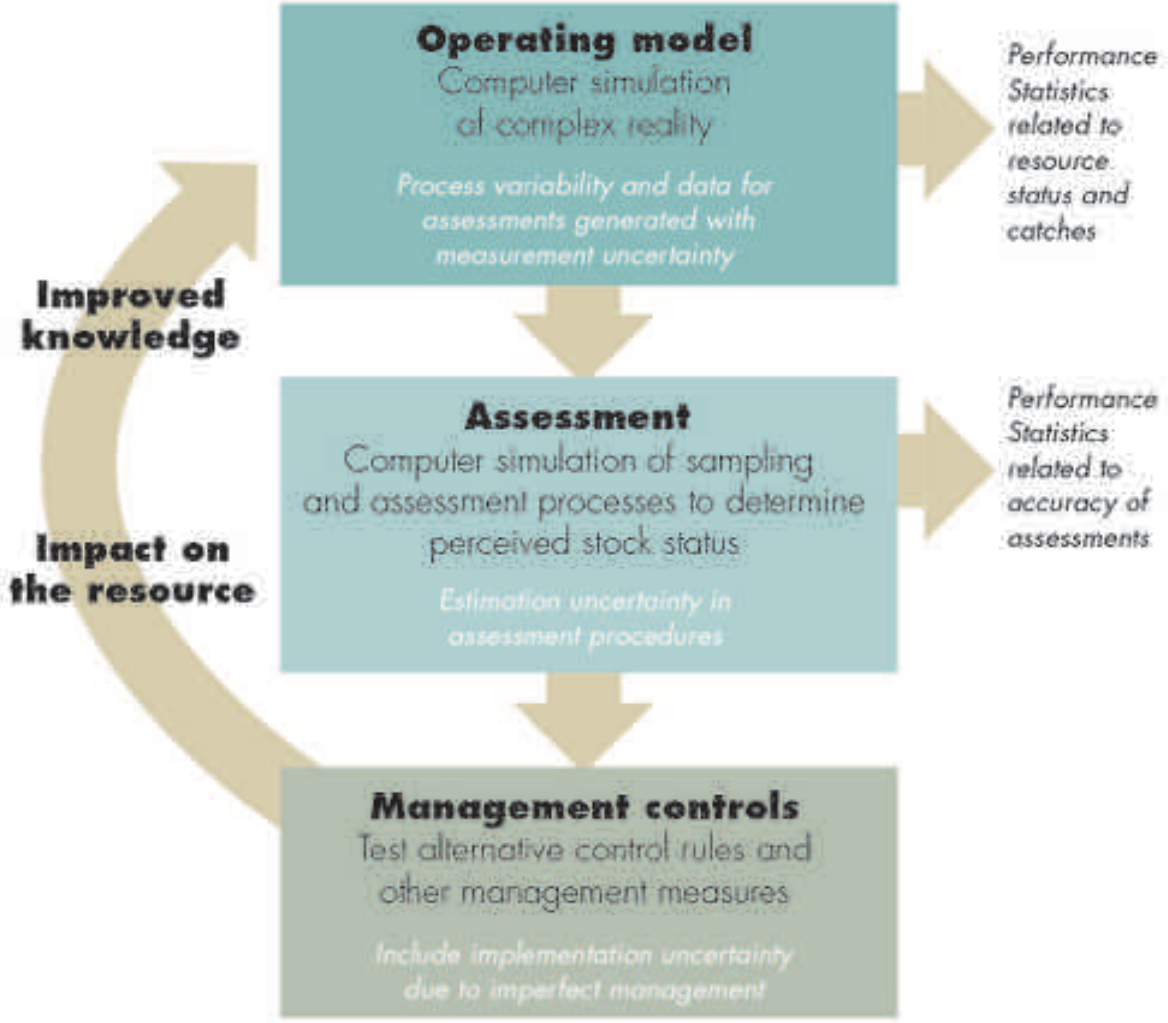
RISK-BASED MANAGEMENT:
BEST PRACTICES

- *Tiered Approach Based on Availability of Data to ASSESS RISK*
- *Development of Structured Ways to RESPOND TO RISK Outside of the ABC Process*
- *Decision Tables to COMMUNICATE RISK*


Ralph Kresge, NOAA

RISK-BASED MANAGEMENT: MANAGEMENT STRATEGY EVALUATION

RECOMMENDATION 16: *Promote use of Management Strategy Evaluation.*



RISK-BASED MANAGEMENT: MANAGEMENT STRATEGY EVALUATION

Quick Reference: What is Management Strategy Evaluation?

It is a quantitative modeling tool involving the following steps:

- Determination of objectives and definition of desired outcomes (via workshops)
- Development of possible management strategies
- Testing of management strategies
- Evaluation of management effectiveness of various tested strategies against stated objectives and desired outcomes
- Periodic review of the overall management program

FACING CLIMATE CHANGE:
PACIFIC SARDINE CASE STUDY

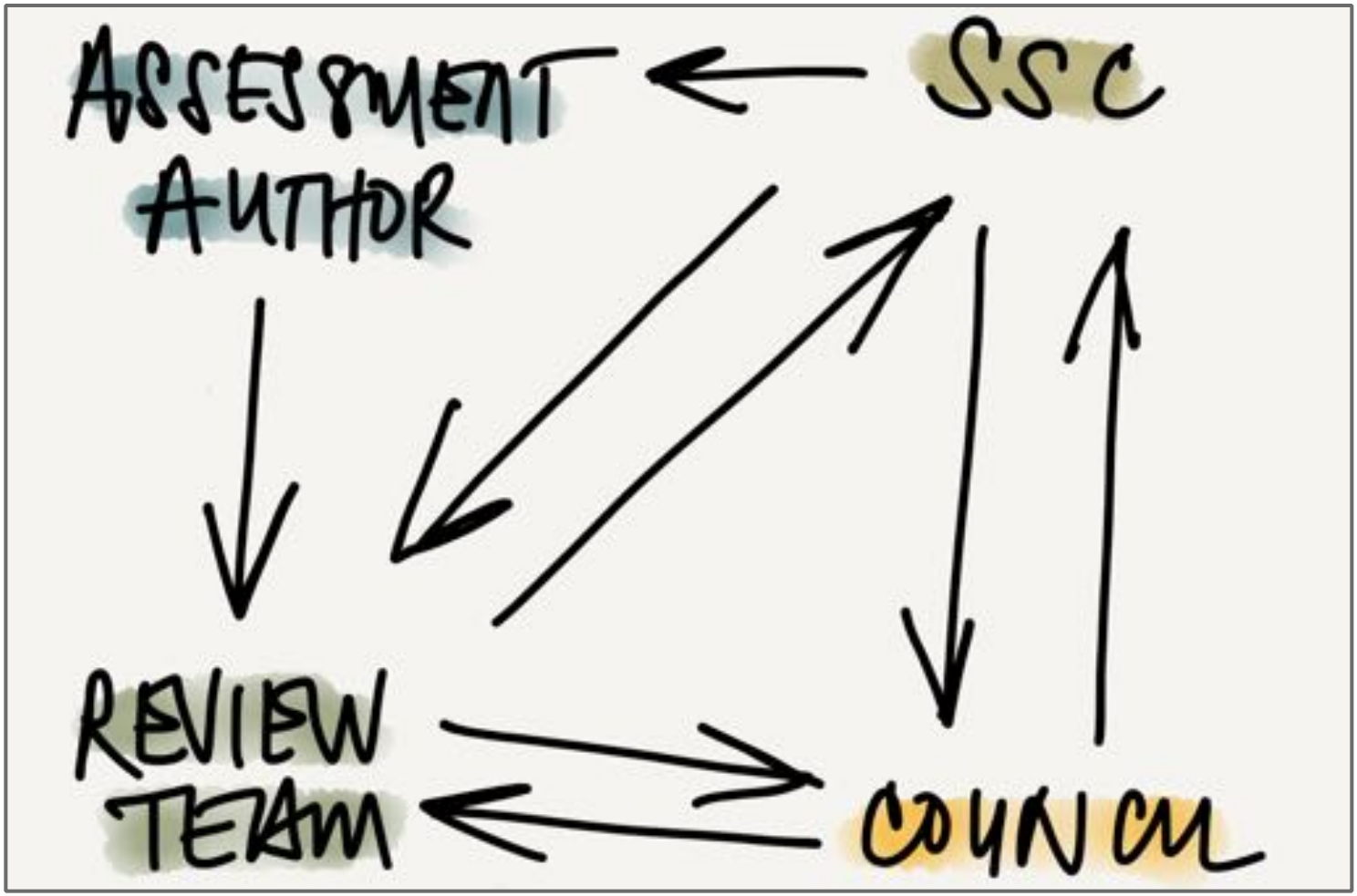
Challenges

- Combined stocks
- Multiple stocks with overlapping distributions
- Widely varying recruitment, in response to environmental drivers
- Lack of data from southern catches
- Environmental change uncertainty
- How to choose a management strategy?

Lessons Learned

- MSE workshops improve communication about uncertainty
- MSE can reduce impacts to stakeholders, consider effects of environmental change, select preferred management option
- Harvest control rule to incorporate environmental effects

RISK-BASED MANAGEMENT:
NEED FOR AN ITERATIVE PROCESS



ADDRESSING UNCERTAINTY IN FISHERIES SCIENCE AND MANAGEMENT

QUESTIONS AND COMMENTS. THANK YOU.

eschwaab@aqua.org

aqua.org/fisheries