Executive Workshop Report:

"Climate Variability and Fisheries Workshop: Setting Research Priorities for the Gulf of Mexico, South Atlantic, and Caribbean Regions," October 26-28, 2015 St. Petersburg Beach, FL

Academic, government and industry researchers, including fisheries resource managers, economists, social scientists, fishing industry representatives and non-governmental organizations, predominately from the three US fishery management regions and the NOAA National Marine Fisheries Service (NMFS), convened in St. Petersburg Beach, Florida in October 2015 for the "Climate Variability and Fisheries Workshop: Setting Research Priorities for the Gulf of Mexico, South Atlantic, and Caribbean Regions." The workshop objectives were:

1) Share the state-of-the-science and examples of apparent climate change and its potential impacts on fisheries resources (all relevant species and habitat in the broadest sense including protected resources such as marine mammals, turtles, and corals) in each region;
2) Discuss how climate variability may impact fish distribution, catch, socioeconomics, and management;
3) Identify and prioritize research and monitoring needs related to climate variability and fisheries for each region;
4) Consider needs common to all regions, and discuss strategies for applied, collaborative research across geographies and disciplines;
5) Learn from others working on the links between fisheries and climate in other regions; and
6) Identify opportunities for addressing priority needs.

Two workshop outcomes are: 1) an Executive Summary report on priority research and monitoring needs across the regions (this report) and 2) a report on the state-of-the-science regarding climate variability and its potential impact on fisheries resources and management across the regions (future). This workshop was particularly timely due to the release of the NOAA Fisheries Climate Science Strategy (U.S. Federal Register August 26, 2015) and NOAA's goal to develop regional action plans to implement the strategy.

The meeting was organized by a steering committee composed of IOOS representatives (Southeast Coastal Ocean Observing Regional Association - SECOORA, Gulf of Mexico Coastal Ocean Observing System – GCOOS, and Caribbean Coastal Ocean Observing System- CariCOOS), NOAA NMFS, South Atlantic Fisheries Management Council (SAFMC), South Carolina Department of Natural Resources (SCDNR) and private industry. The steering committee helped to develop the workshop agenda (http://secoora.org/webfm_send/1611). Mitchell A. Roffer, Roffer's Ocean Fishing Forecasting Service, Inc. (ROFFS™) was the lead Principal Investigator and SECOORA was the host organization. Funding support was provided by NOAA NMFS, SECOORA, NASA and ROFFS™.

Through a series of facilitated plenary and breakout discussions, participants considered regional and cross-regional impacts of environmental change on fisheries. Attendees participated in four cross-regional and cross-disciplinary breakout groups. Each workshop attendee was strategically assigned to a breakout group to ensure each group included an even distribution of disciplines and regional representation. The participants identified their own region and discipline as either fisheries or protected species scientist, fisheries manager (includes policy), oceanographer (biological or physical), climate scientist, social scientist, economist, industry representative or other. Experienced facilitators and note takers were assigned to each breakout group. These four breakout groups met three times to identify both research and monitoring/observing needs, and discussed the specific questions related to fish populations and fisheries as indicated below. After each breakout discussion, participants voted for their top research and top observation priorities for the next one to three years.

Breakout 1: Research and Monitoring/Observing Needs to Track, Understand and Project Climate-related Changes in Fish Populations.

Topic: Given that fish populations (including all marine resources and habitat) are going to respond to climate variability and change, what is the critical information we need to address climate-related impacts related to productivity, recruitment, migration, behavior and physiology, as well as spatio-temporal changes?

Top Priorities

1. *Research:* Research on climate/environmental related vulnerabilities/thresholds/tolerances/ impacts on all aspects of fish life history (phenology) and habitat.
2. *Monitoring/Observing:* Fishery independent monitoring and links between environmental conditions and the fish with better catch data. This includes expanded tagging ("having the fish tell us") activities.

Breakout 2: Research and Monitoring/Observing Needs to Track, Understand and Project Climate-related Changes in the Fisheries.

Topic: How will the fisheries respond to climate change? This addresses the information needed to track, understand and project climate-related changes in fisheries including fishermen behaviors, responses, socio-economic effects with climate-related effects on fish stock availability, vulnerability, catchability and selectivity.

Top Priorities

1. *Research:* Comprehensive social and economic evaluation of why fisherman are operating the way they are including end to end costs, net revenue, and ripple economic effects. This subject contains the question: What are recreational and commercial fishers perceptions of climate change and are they adapting?
2. *Monitoring/ Observing:* High spatial and temporal resolution catch and effort data for both recreational and commercial fishing. This includes the development of relatively inexpensive reporting solutions for smaller vessels, e.g. electronic notebooks and tablets.

For the third breakout session each group considered another over-arching topic of identifying information and decision-support needs to support climate-informed management. Two questions were posed, discussed and voted on as indicated below.

Breakout 3: Other Information and Decision-Support Needs to Support Climate-Informed Fisheries Management.

Topic: Based on anticipated changes in fish populations and fisheries, effective resource management in a changing climate will be challenging.

Question 1: Are there additional climate-related data needs (physical, biological, socio-economic) that have not been identified already?

Top Priority

1. Vulnerability Assessments (species; fisheries; communities; standard approaches and methods).

Question 2: Are there new science-based management tools or approaches needed, e.g. models, assessments, observation tools, management frameworks, or adaptive strategies?

Top Priority

1. Incorporate more environmental covariates in stock assessment models and in a timely manner. Create flexibility in fisheries management, i.e. adjust goals relative to environmental variability.

After the top cross-regional priorities were selected at the workshop, the participants were divided by regions for two additional breakout sessions. The objective of these breakouts was to consider top research and monitoring/observing needs by region, and begin to identify strategies for addressing these needs. Each region addressed three topics, which are indicated below.

Regional Breakout 1:

1. Given all the research and monitoring/observing needs identified in previous sessions, and your knowledge and the science information needs of management in your region, what are three top research needs, and three top monitoring/ observing needs, to track, understand and project climate-related impacts on fisheries and resource-users in this region?

2. For each "bin," has this need been adequately characterized by earlier discussion, or is there more detail we should add about what exactly is needed in this region?

3. How do we tackle these priorities? What do you see as opportunities to start addressing these needs in your region? Are there key efforts to build on? What's possible and how do we get there?

Regional Breakout 2:

1. Did any additional needs specific to this region occur to you overnight? Or are there additional details you'd like to add to one of the needs discussed yesterday?

2. Who are the key partners who need to be involved in this region (including key partners who might not be at this meeting), and how can they collaborate to fill the needs we've identified?

3. As we implement the research and monitoring we've identified as needs, how do we get that information applied? How do we connect to management?

The results of these regional breakouts are listed below.

South Atlantic Region Ranked Priorities

Research

1) Characterize physical parameters in three dimensions, including Gulf Stream and eddy features and relate this information to where fish are found.
2) Incorporate environmental data, derive innovative new models, and incorporate episodic events (e.g. red tide mortalities) into/for the stock assessments.
3) Evaluate 20 "priority" (e.g. red snapper) umbrella indicator species in terms of bio-climatic variability.

Monitoring/Observing

1) Increase biological monitoring specifically to include zooplankton – ichthyoplankton, pelagics, marine mammals, invasive species, and birds including using a variety of tagging experiments and listening surveys.

2) Enhance ongoing physical oceanographic monitoring to include three-dimensional sampling where the marine resources occur including in the Gulf Stream and eddy features.
3) (Tie) Increase remote sensing with broad coverage from satellites (high spatial and temporal resolution), autonomous underwater vehicles, acoustics, and drones.
3) (Tie) Characterize reef fish species distribution and habitat in three dimensions along with tagging.

Partnering

1) Fishery management councils
2) Academic institutions
3) States: fish and wildlife services, departments of natural resources, departments of environmental protection, Sea Grant
4) Federal: NOAA including IOOS, NASA, EPA, National Park Service, US Fish and Wildlife.
5) IOOS Regional Associations (SECOORA, GCOOS, and CariCOOS)
6) Fishermen and fishing communities
7) South Atlantic Landscape Conservation Cooperative
8) For-profit consultants and other non-profit organizations

Opportunities to leverage

1) South Atlantic Fishery Management Council Fisheries Ecosystem Management Plan II
2) NMFS research and stock assessments
3) IOOS research and operational projects
4) Other collaborative research (e.g. NASA – NOAA/NMFS/SEFSC highly migratory species and climate change projects, SECOORA – SCDNR - SAFMC Chevron trap habitat classification project, NASA – NOAA marine biodiversity networks in Florida Keys, BP oil spill restoration research projects, and NCSU circulation modeling)
5) State monitoring and assessment projects
6) Joint fishing industry-academic research (e.g. SK Funds projects)

How Do We Connect to Management?

No specific information regarding connection to management was provided by this group. Since there were many fisheries managers participating in the workshop, no additional work to engage managers was discussed.

Gulf of Mexico Ranked Priorities

Research

1) Better habitat and species modeling including thermal and other tolerances, as well as physiological data from research.
2) Improve stock assessment models using environmental data, socio-economic data, recruitment mechanisms, biological reference points (B_{SSB}), and missing landings data from Mexico and Cuba.
3) Fish community vulnerability assessments.

Monitoring/Observing

1) Physical and chemical oceanography.
2) (Tie) Biological oceanography.
2) (Tie) Socio-economic data.

Partnering and Opportunities to Leverage

1) Restore/NRDA partners including various agency and state partners, e.g. National Academy of Sciences

2) Private endowed groups
3) Sea Grant (national and state)
4) Citizen science for monitoring
5) Cooperative academic research groups
6) Galveston Bay Commission
7) Other Bay entities around the Gulf of Mexico
8) IOOS
9) Bureau of Ocean Energy Management (BOEM)
10) Gulf of Mexico Fishery Management Council
11) Gulf States Marine Fisheries Commission
12) The Bureau of Safety and Environmental Enforcement (BSEE)
13) Industry
14) Fishing communities
15) Other federal agencies, e.g. USGS, USFWS
16) Water Management Districts, e.g. Florida, Texas
17) Water Institute of the Gulf
18) Army Corps of Engineers

How Do We Connect to Management

1) Develop case studies as a teaching tool to assess fishery management responses.
2) Collaborate with managers for needed oceanographic products.
3) Direct presentations at Gulf of Mexico Fishery Management Council.
4) Informational white papers.
5) Develop more innovative communication tools, particularly for risk communications.
6) Get involved in the Ecosystem Based Fisheries Management process.
7) Need different government structure in some cases to integrate and apply information, but understand tradeoffs.
8) Build stronger climate relationships with fisheries scientific committees.
9) Connect dispersed data via IOOS DMAC.

Caribbean Sea Ranked Priorities

Research

1) Need holistic baseline data for all species including forage/ecosystem services species.
2) Derive common goals and coordinate efforts.
3) Formulate a unified strategy for dealing with climate, fish and management issues.

Monitoring/Observing

1) Dedicated annual cruise as part of a broader observation strategy to include oceanographic survey, local partners, time series of data that already exists and to create new time series.
2) Higher resolution coastal ocean models that are climate forced.
3) Build local capacity, e.g. NSF – EPSCOR.

Partnering and Opportunities to Leverage

1) EPA (Clean Water Act, Biocriteria, and Environmental Quality Boards)
2) National Coral Reef Program
3) Puerto Rico Fisheries Research Laboratory
4) UVI-EPSCOR University of Virgin Islands
5) LCC – Climate Resilience Hub
6) The Nature Conservancy
7) IOOS
8) US Fish and Wildlife Service

9) Congressional support
10) National Park Service
11) USGS
12) NOAA (NOS, NMFS)
13) Various Department of Natural Resources
14) Virgin Islands Coral Reef Monitoring Project
15) Fishers and other users of the resource
16) International “aspects” and partners

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This is the end of Executive Summary text. Questions regarding this summary should be directed to:

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