Climate Science White Paper Overview (second draft)

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Long Branch, NJ
MAFMC Visioning Project

- Constituents across all fishery sectors want Council to integrate ecosystem considerations, including environmental influences on fish stocks due to climate change and variability, into fishery stock assessments and Council management policy.
Climate Science and Governance Workshops

Council convened two workshops with science and management partners (NMFS, Councils, States) to discuss potential scientific and management challenges Atlantic Coast fishery managers face as a result of climate variability and change.
Climate White Paper

- Purpose is to identify major issues and options for ways forward relative to addressing climate impacts on fisheries science and management.
- First draft presented in February to stimulate Council/public discussion and comment.
- Will form the basis for climate related guidelines to be included in the Council’s EAFM Guidance Document.
April Council Meeting

- Brief overview of climate white paper and review comments received on Climate White Paper (first draft)
- Climate impacts overview (Pinsky)
- Briefing on the Rutgers NSF project on climate impacts and management responses (Pinsky and McCay)
Past/Future Climate States
First regional climate change projections

- Shelf-wide temperatures warming since 1960 (projected to continue)
- Ocean acidification measurable and PH decreasing
- Precipitation and stream flow increasing (salinity decreasing)
- Sea level rising (infrastructure impacts)
Impacts on Fishery Resources

• Changes in stock productivity (recruitment, growth, maturity, fecundity)

• Changes in species interactions (natural mortality)

• Changes in species distribution (stock definition; availability to fisheries and surveys)
Take Away messages

• CC is impacting marine ecosystems and living marine resources, now
• There are a lot of ways we can have climate savvy fisheries science and fisheries management
• But we need to, and we can, act now
SSC Comments

- Climate change and ecosystem response will not always be a slow, gradual process.
- Physical changes in the environment may be linear and/or gradual, but ecosystem shifts in response to those changes may be sudden and abrupt.
SSC Comments

- Future ecosystem states in the face of climate change are very difficult to predict based on current models.
- Invest in monitoring ecosystems rather than focusing solely on modeling future ecosystem states (given the great deal of uncertainty about the future states of nature and our limited ability to predict them).
SSC Comments

Additional buffers in the OFL/ABC framework might be necessary, especially for stocks that are particularly sensitive to climate change.
Future changes in productivity of individual fish stocks are inevitable and these changes will have cascading effects on biological reference points and, for overfished stocks, rebuilding programs.
**SSC Comments**

Two of the most critical aspects of maximizing climate resiliency of fish stocks are maintenance of stock biomass and rebuilding age structure to help compensate for adverse effects of climate change.
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<thead>
<tr>
<th>What</th>
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<td>Evaluate alternative management measures relative risks of climate change</td>
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<td>Ecosystem Status</td>
<td>NEFSC Ecosystem Report</td>
<td>Continue ecosystem observing programs and reporting</td>
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### Ways Forward

#### Risk Assessment – Northeast Fisheries Climate Vulnerability Assessment

- Exposure to climate change in NEUS is high to very high.
- Sensitivity higher for diadromous and shellfish; lower for groundfish and pelagics.
- Vulnerability to changes in productivity.

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<tr>
<td>Low</td>
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<td>8 Coastal</td>
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<tr>
<td>Medium</td>
<td>Medium</td>
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<td>High</td>
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<tr>
<td>Very High</td>
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- Low: 1 Shellfish, 8 Groundfish, 2 Shellfish, 1 Pelagic
- Medium: 5 Shellfish, 5 Groundfish, 5 Elasmobranchs, 2 Shellfish, 1 Pelagic, 8 Shellfish, 7 Diadromous, 3 Coastal
- High: 5 Shellfish, 6 Groundfish, 4 Elasmobranchs, 8 Shellfish, 1 Diadromous, 1 Shellfish
- Very High: 1 Shellfish, 1 Diadromous, 8 Shellfish, 7 Diadromous, 3 Coastal
Questions and discussion
Science Issues

Distribution shifts

- Utility of NEFSC survey data will be affected due to differential availability (fraction of population within survey area may change or become more variable – spatial availability issue)
- Survey abundance estimates will be affected because timing of migrations will change (temporal availability for synoptic surveys)
- NEFOP sampling frame will have to adapt to changing patterns of species/fisheries overlap and subsequent changes in discard patterns
Science Issues
Changes in Productivity

- Manifested at both ecosystem and species level
- Species level productivity changes result from changes in natural mortality, survival, growth and recruitment
- Need to be addressed at stock assessment level (TOR through NRCC process)
- Manifested at level of BRP specification (OFL/ABC)
Management Issues

- Allocations by area based on historical catch distribution problematic (e.g., fluke)
- Seasonal allocations (e.g., scup)
- Trip limits by season/area need to re-evaluated and made more adaptive
- Allocation among directed vs incidental fisheries affected due to changing species assemblages and discarding patterns
- Inter-jurisdictional mgt. issues will become more acute both between neighboring Councils and internationally (e.g., Canada – gadoids, mackerel and dogfish)
Management Issues
What’s needed?

- An adaptive management approach that will allow Council’s to detect and react to changing environmental conditions which affect ecosystems and fisheries (on same time scale)

- A more plastic system of allocation that allows current management system to adapt to changing climate conditions and ecosystems

- Active engagement of mgt. partners to review which fisheries require closer cooperative management across jurisdictions/FMPs (joint Council meetings??)
Summary Points

- Science more robust relative to understanding and mitigating distributional changes than predicting productivity changes
- MAB exhibits greatest intra-annual variation in temperature of any ocean environment on the planet
- Climate change likely to increase that variance (at least uncertainty about future oceanographic states)
Harvest Control Rules
Climate Sensitive Species

- Reference point modification based on changes in productivity (F and B)
- Modify ABC/OFL buffer for species particularly vulnerable to climate impacts
- Magnitude of ABC/OFL buffer reflects scientific uncertainty
- Evaluation for each species required starting with NOAA vulnerability paper
Climate-Ready Management

- Crossing the Science/Policy interface
- Expression of tolerance for risk is a management policy consideration for the Council (informed by science)
- Council needs to consider and incorporate climate related impacts into its current Risk Policy (EAFM)
Example

- If BRPs are adjusted to account for environmental variability/change, no additional OFL/ABC buffer required, or....
- Buffer might be reduced if OFL is sufficiently risk averse and scientific uncertainty has been reduced through incorporation of new information
Management/Governance

- Workshop held in 2014
- 70 participants including Atlantic Coast Councils, ASMFC, NOAA fishery managers
- Discussed a wide range of issues and potential ways forward to integrate climate considerations into existing management and governance
Management Workshop Outcomes

- *Veni, Vedi,.....??*
- Excellent first order discussion of management challenges arising from climate impacts
- Wide range of responses from modifications to existing system to wholesale restructuring (i.e., consolidation of existing management bodies)—a lot more discussion needed
Pinsky and Mantua (2014)

- Key aspects of climate impacts on marine ecosystems
- Review past attempts at incorporating climate into fisheries management
- Promising new approaches
Adapting Management to climate change and variability

- Traditional fish assessment/management approaches assume stable relationship abundance and population growth
- Managers can maximize yield by controlling abundance
- Climate variations effects considered “noise”; mgt. robust to inter-annual fluctuations
Fundamental Challenge

- Forcing from multi-decadal climate variation and change will directly and indirectly affect ecosystems in many (potentially profound) ways.

- Manifested as threshold or transient responses which have no historical analog; **NOT simply variation around some stationary distribution observed in the historical record**.
Climate Induced Challenges

- Rapid ecosystem state shifts and slower evolving trends pose serious challenges to sustainable fisheries management.
- To date most ecosystem approaches to fisheries management have not explicitly considered climate change and variability... **but the Council will!**
Climate impacts

1. changes in temperature
2. net primary production and food webs
3. oxygen minimum zones
4. acidification
5. ocean circulation
6. sea level rise
Malin and Bonnie

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Climate impacts cont.

7. Frequency and magnitude of extreme events
8. Disease incidence
9. Land-sea interactions
10. Availability of habitat building species (coral/kelp)
Leading to broad changes in...

- Spatial distribution
- Recruitment
- Abundance
- Phenology (timing)
- Evolution

Specific impacts and mechanisms depend on details of ecosystem and species
Broad characterizations

- Changes in temperature and acidification are not uniform around the globe
  - Argues in favor of regionally specific adaptation approaches
  - Need focused Council discussion defining our “Region”
Broad characterizations

- Difficult to understand impacts of climate outside of cumulative effects on fish stocks from multiple stressors including directed fishing, bycatch, loss of habitat and loss of prey

- e.g. - Fishing truncates age structure, reduces intraspecific diversity, and can cause range contractions
Effects of overfishing

- These factors tend to reduce resiliency of fish stocks to climate impacts and tend to magnify population fluctuations
Climate Effects on Fisheries

- Can’t be fully understood without accounting for mediating effects of social, economic and regulatory factors
- If fish distributions shift, fisheries must follow them

(land in new ports or travel further)
Adaptation responses limited/shaped by

- Regulations and economics which may directly limit options which are feasible

- Social preferences may alter which options are appealing and/or realistic for fishermen, communities
Other challenges

- Changes in the physical aspects of the environment are generally linear, but
- biological systems likely to react non-linearly and have potential for dramatic responses to small changes in climate and other forcing
- Ecological shifts may be rapid but sporadic and in other cases may be gradual (but noisy) – e.g. distribution
Good News

- Range limits of marine organisms generally conform to species physiological thermal limits (in comparison to terrestrial organisms)
- Implies that climate impacts on species distributions may be more predictable in the ocean.
Climate Adaptation Approaches

- Take care of the basics by reducing other stressors on fish stocks – prevent or reduce overfishing, stock depletion, habitat loss, loss of prey, and bycatch (we do this now)

- Populations facing the fewest number of stressors are likely better able to support robust fisheries in the face of climate change (keep stocks healthy!!)
Prepare for emerging fisheries

- Shifting species distributions will reduce/end fishing opportunities in some areas and create new ones in others
Emerging fisheries

- Give high priority to stock ID for newly emerging species/fisheries
- Exploitation rates of newly emerging species should be conservative; reductions in net population growth rate compromises ability of species to colonize new areas.
Account for Climate in Stock Assessments

- Consider environmental factors in SA
- Monitor for regime shifts and species productivity as basis for evaluating appropriateness of BRPs
- Specify BRPs which correspond to current or anticipated productivity regime
Challenges

- Current SA models assume stock productivity is stable over time.
- Adding environmental covariate useful but difficult to separate effects of climate from fishing because they act simultaneously.
- Distribution shifts impact survey indices due to changing availability of stock to the survey.
ABC control rules

- For climate sensitive stocks, apply larger buffer between OFL/ABC (scaled to uncertainty)
- Decreases risk for climate sensitive stocks but also reduces fishing opportunities
- Need to identify which species are particularly sensitive – risk assessment and vulnerability analyses
Area based management

- Long term distributional shifts affect area based measures (e.g., scup GRAs)
- Will require new or modified approaches and more frequent evaluation;
- Make measures dynamic based on monitoring temperature in real time (e.g., sea turtle presence based on T)
Coordination Across Management Boundaries

- Species distribution shifts across management boundaries a major challenge
- Raises complex issues of coordination and equity
- In economic terms, reduces discount rate creating incentives to increase exploitation rate before a stock exits a region
Interjurisdictional issues

- Preparing international sharing agreements (mackerel, dogfish) and coordination with domestic management partners (NEFMC, SAFMC, ASMFC) critical

- Need to evaluate current FMPS and existing measures
Interjurisdictional issues

- Limited access/property rights may tend to exacerbate the problem
- Transferable fishing rights or trading ability are key considerations
- Important to have rules/sharing agreements in place prior to major shifts (avoid train wrecks)
Regional Climate Scenarios

- Need to evaluate management responses over a broad range of plausible climate changes scenarios
- Requires down scaling of global climate models to NE region and application of climate velocity models to evaluate range of scenarios the Council might face (Pinsky/Seagraves COCA Proposal)
Regional Climate Scenarios

- Looking for management approaches that perform well over a broad range of scenarios or...
- Approaches that are least likely to perform poorly
- ITQ’s outperformed status quo scenarios based on simulations of a wide range of acidification scenarios on US West Coast
Regional Climate Scenarios

- Although MAFMC has no stocks under rebuilding, climate change and variability will greatly impact any future stock rebuilding plans.
Ecosystem Monitoring

- Impacts from CC may come as surprise
- Comprehensive ecosystem monitoring critical for detecting changes
- Multiple lines of evidence are often necessary to detect climate driven ecosystem shifts
- Need to consolidate current data in centralized data location
Social/Economic resiliency

- CC will require adaptive responses including increase travel time to fishing grounds, fishing for new species or transition out of certain fisheries altogether.
- Highly specialized, non-mobile fishing communities are highly vulnerable.
- Fishing communities targeting diversity of species in better position.
Mid-Atlantic region

- Climate variability and stock availability already high
- Fishing communities that have adapted to climate variability appear to have more flexibility to cope with longer term CC.
- Efforts underway to identify fisheries/communities that have high social vulnerability
Management actions that enhance flexibility of fishing fleet(s) will aid adaptation to climate change and variability.

Problem: we’ve done just the opposite by implementing limited access and area based fishing quotas/rights in many fisheries.
Major tension between....

- Measures enacted to ensure long term sustainability (e.g., limited access)

Versus

- Long term adaptive capacity of current fishing fleet/fisheries
Possible solutions

1. engage stakeholders (Visioning)
2. transferrable fishing quotas
3. adjust BRPs as environment changes
4. Adjust targeted conservation areas
5. Prepare agreements for distribution shifts
Possible solutions

6. Evaluate management against broad range of climate change scenarios
7. Integrate ecosystem monitoring and evaluation into management cycle
8. Reduce barriers to individual-level adaptation.
E. Coast managers discussed wide range of possible responses to climate change

Ranged from major consolidation or reconfiguring of current governance structure to modifications within existing management system
Staff Recommendation

- Council should form WG or Standing Committee to deal exclusively with climate related issues
- EAFM Guidance document to include a general framework to guide deliberations of the group in development of responses to cc
Questions?
Questions?