Findings and Recommendations on the NOAA Fisheries Draft Climate Science Strategy

Developed by the Climate & Marine Resources Task Force for MAFAC

April 2015

Thank you to the writers of the NOAA Draft Climate Science Strategy. It is a thoughtful and concise blueprint for capturing key components of assessing climate change on Living Marine Resource (LMR) marine and riverine environments.

The mandates on NOAA are significant to the entire world in terms of identifying and adapting to climate change. Beyond even the mandates is the responsibility we (as both commentators and world citizens) all have in helping NOAA do its work to effectively *gather and communicate* those findings to the sectors – whether federal, state or local – that will be most impacted by marine and riverine changes. The enormity of that responsibility is certainly overwhelming to anyone who really cares about how the world will adopt positive adaptive strategies to mitigating and living with climate change.

The Climate & Marine Resources Task Force of MAFAC met on March 11, 2014 to discuss and amend the NOAA Fisheries Draft Climate Science Strategy. The following detailed comments were derived from that meeting, as well as subsequent work by Task Force members. We appreciate the opportunity to provide these comments to the Ecosystems Approach Subcommittee of MAFAC for review. We hope these will be adopted and approved by the entire MAFAC Committee at its April 2015 meeting.

The Climate & Marine Resources Task Force commends the NOAA Fisheries Service for undertaking the development of a climate science strategy. The need to focus scientific resources in the face of climate change and variability is urgent. Having a clear strategy to address scientific questions is paramount.

The Task Force had extensive discussions and questions for NOAA Fisheries staff on the development and content of the Strategy. They suggested that additions and clarifications be made in the NOAA Fisheries Climate Change Science Strategy to improve it to serve the needs of agency better.

The Task Force's comments are organized into three sections: (A) comments on the entire scope of the proposed strategy, (B) comments organized, as is the strategy in Chapter 2, by the objectives established by NOAA, and (C) specific comments on recommended socioeconomic research to meet strategic objectives.

A. Comments on the entire scope of the proposed Strategy

1. Urgency and risk

The document could be strengthened by emphasizing urgency upfront. Related to the urgency of the issue is the risk of inaction. There is a great degree of risk associated with not acting and in not

preparing now for changes that are coming as a result of climate change. The reader needs a clear statement of purpose and need at the beginning of the document. In order to make a clear statement to this effect, a preface is needed which highlights the urgency of the issue and the risk of inaction.

2. Communicate climate science results

A high priority should be placed on developing new approaches to communicating the results of climate change-related research undertaken by NOAA Fisheries to the diverse community of expert and non-expert stakeholders with whom NOAA fisheries interacts, particularly sector and community leaders and managers. The best research will be inadequate if it does not lead to wider and deeper understandings of the challenges confronting fisheries and marine ecosystems. Related to communications, the text of the Strategy should also be written in clearer, plain(er) language. This will ensure that the public, if an intended audience, can easily understand it and its need.

3. Socioeconomic dimensions

Three of the seven objectives make reference to "LMR-dependent human communities." As the old saying has it, one does not manage fish, one manages people who fish. There are, in other words, socioeconomic dimensions to be understood in meeting all seven objectives. The draft strategy offers somewhat less information about how socioeconomic objectives will be reached, so Section C of these comments provides suggestions to conduct some of the social science research that will be needed. Additionally, there are many communities of stakeholders that are not in the commercial sector. The Strategy should encompass these other sectors (recreational, sport, charter, subsistence and sustenance fishing). These fisheries and their dependent communities will also be hugely impacted by climate change.

4. Link objectives to management questions and decisions

In the Executive Summary, the document should briefly describe how the seven objectives were identified and developed and their connection to mission priorities, management questions and decision processes. The internal discussion and deliberation was explained by staff to the Task Force, however the reader does not have the same benefit and the link to management challenges is not clear, as written.

5. Provide greater emphasis on habitat issues

The document would benefit from clearer focus and greater relevance to habitat programs and assessments (EFH, section 7 consultation for example); habitat issues get relatively little treatment in the objectives or examples.

6. Resilience and Risk

Understanding resilience and actions to reduce risks could use more focus in the document. For example, there are some actions that should provide climate mitigation benefits, but more scientific information is needed to fully understand the benefits. Additionally, how does NOAA Fisheries propose to better account for the interactions of climate and non-climate stressors in all its program areas? Non-climate stressors may exist which combine or exacerbate climate change

Comment [RL1]: I respectfully disagree. The issue we are mainly concerned about is a temporal issue – climate change and variability in time. There is obviously a spatial issue but an increased focus on this aspect dilutes the core need for the document. This is meant to be a directed document of relatively narrow scope – if it is to be useful. The inclusion of peripheral issues will serve to diminish the importance of the temporal climate-driven patterns that are the main focus.

Comment [RL2]: This is redundant to the Objectives outlined in the document – including 1, 2, 3, and 4. These objectives address entirely the "examples" provided.

Objective 1 "identify reference points" is the first bullet point.

Objective 4 "Identify future states …" is the second bullet point.

These "examples" are too specific for a guidance document. Risk is highlighted as the motivation for the document. Resilience is addressed as the alternative reference points (Obj. 1) and robust strategies (Obj. 2) and adaptive decision making (Obj 4).

stressors. These points are mentioned in the document; however they are largely underrepresented.

In particular, the Strategy should address the scientific needs related to actions that would increase resilience of living marine resources (LMR) and LMR ecosystems to climate change risks and increasingly dynamic/chaotic system responses. Examples are provided in section B, Objective 2 of this document. A couple of additional examples include:

- Testing of alternative limits to harvest regimes within marine protected areas including no harvest, reduced harvest, periodic cessation of harvest (10-12 year cycles), and selective reduction in take of species (or guilds) determined to regulate marine biological communities, for example forage fish species, and top predator species (i.e., applied research into management of marine reserves to mitigate climate and non-climate stressors to whole ecosystem). With respect to this, the Marine Protected Area Federal Advisory Committee (MPA FAC) developed a thoughtful white paper that addresses the topic of resiliency and climate change and it should be consulted.
- Identification and understanding the mitigation of non-climate stressors that impact habitats, populations of species, and LMR ecosystems, and how reductions to non-climate stressors can be achieved in order to improve LMR resilience.

7. Tools to prioritize science needs[1, 2]

The needs in science are of two types: 1) Data needs, and 2) Synthesis, incorporation, and modeling needs. Only modeling is addressed here.

NOAA Fisheries will need to acquire additional science and technical capacity for:

- modeling,
- climate-based assessments,
- vulnerability assessments, and
- decision analysis tools to reduce uncertainty.

Each of these activities should be a relatively high priority for NOAA as well as NOAA Fisheries and partners. Two areas that help in this regard (and that could use additional highlighting and could be expounded upon in the document) are 1) examples of tools to prioritize science information needs (i.e., identify critical research needs and data gaps); and 2) more explicit examples of tools to integrate analyses into and influence decision-making.

[1] The lay reader may not understand the purpose of the examples included within this section without additional text indicating that, depending on the types of climate impacts or issues being examined, these are all appropriate decision analysis tools to reduce or eliminate climate related scientific or management uncertainties, and the document needs to emphasize that the extra capabilities we are in need of are continual – because we need to do this iteratively, over time.

[2] It is helpful to avoid "linear" models of science delivery if one wants to argue the case for consistent effort, stable programs, and continued funding.

NOAA should consider a phased approach: what aspects of its science capacity must improve immediately, and what aspects can be improved over time (e.g. prioritization may link to a fish stock's ecological or economic importance). NOAA must accept limitations. Information will always be imperfect, and sometimes, imperfect information is acceptable. NOAA needs to think about the costs and benefits of obtaining information, and the utility of the data it gathers. Not every aspect of every ecosystem must be fully understood. Not every stock assessment has economic value. Moreover, the more data NOAA tries to assemble, the more likely there will be a time lag in the analysis of the data. Simply put, NOAA does not have the resources to analyze unlimited data. To the extent that partners can undertake work, NOAA

Three types of tools which help with the points above and that can be expanded include:

a. decision tree or matrix (e.g. a simple four quadrant matrix to focus initially on NOAA Fisheries climate science management needs within areas of strong jurisdiction or authority; as well as to cultivate outside partnerships or to assist partners with their information needs)
b. models and process studies, with projections displayed as animations or "movies" (people easily understand these)
c. experimental approaches (shellfish/aragonite example)

Examples that could help with these points and that are missing and could be added:

a. Adaptive Management (A/M) examples (show the process as circular rather than linear)
b. Bayesian Belief Networks (BBN) or other structured decision-making/learning tools
c. Expert Elicitation/Delphi approaches. This could involve an A/M process with follow up research, monitoring, and adjustment. A key aspect of this approach is to document the process, expected outcomes, actual results and lessons learned.

Comment [RL3]: The challenge for the group will be to keep such examples at a high level.

8. Partnerships

The document should acknowledge other Federal partners (e.g. USGS, USFWS), as well as others (e.g. First Nations, academic researchers) so as to ensure these partners realize they are being asked to be on board with this strategy. Fortunately, NOAA does not need to do all the work by itself. NOAA also funds or provides grants to cooperative institutes, academic institutions, and other non-governmental organizations. These entities should also be consulted in the development of scientific priorities. All of these entities should pursue new ways of sharing information, such as by developing a global database. This type of inclusive approach to climate change information management will lead to more cost effective and more transparent results that may also be perceived as less biased. (See also notes under Objective 7 below).

9. Link to the National Climate Adaptation Framework and its objectives

The Strategy could identify better linkages to the National Fish, Wildlife & Plants Climate Adaptation Strategy and its objectives[3]. The objectives in this adaptation strategy are proactive and relate directly to management decisions. By mapping the seven objectives onto the NCAS

[3] A concise Highlights document to the National Fish, Wildlife & Plants Climate Adaptation Strategy can be found here: http://www.wildlifeadaptationstrategy.gov/pdf/Strategy-Highlights-Brochure.pdf

seven objectives the document would be strengthened in several areas that are touched on in other sections below. For instance, the NCAS seven objectives are consistent with NOAA Fisheries' EFH, ESA Section 7, and NEPA responsibilities and also address interactions of climate stressors, non-climate stressors, and habitat alterations, including loss of critical habitats and habitat connectivity.

10. Make the science strategy operational not just aspirational
The document would help on the strategy side of the equation by relating overall objectives to operational step guidance, rather than being limited to aspirations. The operational guidance could discuss how the strategy will be operationalized by stepping down to the regional (and partner) level in order to deliver clear results. The results should be focused on reducing climate risk and uncertainty. If including such operational guidance is not appropriate for this draft, then these steps should be outlined in a follow up guidance document that also outlines a clear time line for incorporation of objectives 1 to 7.

11. Capacity and Limitations
NOAA must understand its CAPACITY to process the scientific information related to climate change, an exercise that requires an understanding of existing capabilities, and a projection of future needs. For example, new data observation systems, laboratories, or computer modelling capabilities may be needed, and budgetary changes will be necessary. It should be noted that climate change information can be considered an investment that helps to avoid future expenses.

To assist with this exercise, NOAA should review the recommendations in Chapter 3 of the draft strategy, identify which recommendations involve dollar costs and their specific budgetary requirements, develop timeframes for implementing the recommendation, and tie each recommendation to one of the seven objectives. Also, as currently written, the Draft Strategy seems to reflect the desires of the science team; however, to ensure that the document reflects the perspective of the whole agency, the NOAA managers and leaders need to engage in a review of this Draft Strategy.

Unfortunately, in a climate changed world, historic data becomes quickly outdated, and while it may be the best available data, it may still be inadequate. Data need to be collected in a way that is appropriate for the spatial and temporal extent of the problem. Existing data collection should be carefully evaluated and less frequent collection or analysis of data for one program might create opportunities to invest in new scientific information elsewhere. Internal and external peer review might help to identify appropriate changes in data collection and analysis. In addition, any redundancies in the data collection need to be eliminated. Finally, NOAA needs to remain open to the use of data collected by other public and private entities, even for regulatory decisions, if that information is the best available.

B. Comments organized by the objectives established by NOAA in the Strategy

Objective 1: Identify appropriate, climate-informed reference points for managing LMRs

- Describe how the process of determining "biological reference points" actually works. In general, such concepts are not linear but are circular and incremental, similar to the generalized process of scientific inquiry. Biological reference points are actually not points but rough estimates of system capabilities or limits. It may be better to call them "climate informed reference conditions."
- Identify key reference points for important habitats such as riverine systems and coastal/marine connections.
- Identify reference points for management associated with range shifts in LMRs, particularly in regards to species range edges.
- The tracking of only individual species reference points is not ecosystem based management (EBM), but rather multi-species based management. Accurately portray EBM; the indicators must also include those for all critical LMR functions and processes, or must use a suite of abiotic or abiotic indicators that collectively represent these processes.
- Identify anadromous species as a key reference point.
    - Identify shifts in predation and competition for forage food for anadromous species.
- Identify subsistence communities as key reference point in relation to dependency on marine and anadromous species.
- Identify appropriate reference points needed for international treaty requirements.
- Ensure current and any future reference points take into account both the common and distinct needs of commercial, subsistence, and recreational fisheries.

Objective 2: Identify robust strategies for managing LMRs under changing climate conditions.

- Address different rate of climate stressors. The fact that not all climate stressors (ocean acidification, SLR/storm surges, alteration of upwelling, changes in ocean currents, etc.) are happening at the same rate or in continuity/periodicity has tremendous implications for LMRs and LMR ecosystems. This is alluded to at least twice in the document, but would be strengthened by incorporating follow-through on these matters, such as risk assessment prioritization, indicator development, and response strategies. Spell this out to provide needed context for both National and Regional climate risk evaluations and species vulnerability assessments.
- Support the emphasis on the use of Management Strategy Evaluation as a way to identify robust management measures in the context of a changing climate.
- Identify strategies to include non-marine resource use and impacts in marine integrated ecosystem assessments (i.e., agriculture competition for fresh water; climate change is exacerbating old conflicts so a new paradigm must be created).
- Consider strategies for local communities to identify and protect critical habitat for coastal, estuarine and riverine spawning areas, especially strategies which may also mitigate risks from climate change. Examples include:
    - Protection and restoration of eelgrass and seagrass beds (benefits or mitigates ocean acidification).

Comment [RL4]: No, this is not the case. BRP are point estimates – not sure about linear… points are points.

Comment [RL5]: Out of the scope of the document – this cannot be everything to everyone.

Comment [RL6]: Too specific, Objective one already encompasses this.

Comment [RL7]: If you want to open this up as an EBM document then the entire thing needs to be reformulated. The inclusion of climate indices and climate understanding is not EBM.

Comment [RL8]: Species are not reference points.

Comment [RL9]: How, why? The focus on a single taxa is going to confuse the scope of this document. I would hope that this could be kept at a high level.

Comment [RL10]: Communities are not reference points.

Comment [RL11]: I am not seeing the need for this. Different indices act at different time-scales and are of different magnitudes. This is what makes them different. If they acted at the same rates then they would be correlated. We would then not need to measure many, but only need to have information about a few.

Comment [RL12]: Sure, put this in your inset box as an example. Give one specific and relevant example where this was successfully used. The group thinks these are some sort of panacea, they are not.

Comment [RL13]: Out of scope.

- Protection and restoration of coral reefs and coastal mangrove or other lowland forests (benefits or mitigates for SLR and storm surges).
- Protection of coastal wetland habitats and critical hydrological linkages benefits or mitigates chemical, thermal, and nutrient flows from lands to coastal and marine waters adding to climate impacts, e.g. from surface water thermal elevation and predicted growth of "dead zones."
- Protection (with partners) of coastal forests, streams, lakes, estuaries, and riparian areas (benefits or mitigates known non-climate stressors that impact e.g. Pacific salmonids).

- Research aspects of population structure of fisheries to support strategies that distribute fishing effort across sub-stocks, age classes, and genetically distinct populations in an effort to preserve the potential for fish populations to adapt.
- Develop the capacity to critically examine the costs and benefits, including health and mitigation costs, incurred in substituting natural environments, i.e., wild stock vs. farmed stock and adaptations to climate fluctuations.
- Utilize modeling technology that can realistically illustrate cause and effect of shifting regimes.

Comment [RL14]: Fishing and management are performed on unit stocks. We don't have the information or competence to address this.

Objective 3: Design adaptive decision processes that can incorporate and respond to changing climate conditions.

- ~~Identify interim and long-term strategies for sectors /communities to get timely and adequate information for making adaptive changes.~~
- Accurately portray the adaptive management process. The current adaptive (management) framework in the document is portrayed as a linear process of altering biological reference points. This is not consistent with adaptive management process. AM is continual, circular, and evolving.
- Incorporate local and traditional knowledge (LTK) and TEK (traditional ecological knowledge) for adaptive and pre-emptive practices as well as identifying cumulative impacts:
  - Research existing oral and written histories.
  - Create continual dialogues with Native American tribes.
  - Increase LTK and TEK data collection.
  - Research adaptive measures from world history
- Research existing adaptive practices from around the world.
- Create greater dialogue on the significance of impacts of *marine* changes on *non-coastal* terrestrial ecosystems, i.e., how ecosystems integrate and what this means to in-land adaptive measures.
- Conversely, create greater dialogue on climate change impacts on marine systems to non-coastal terrestrial ecosystems.
- Develop modern methods of data recording and transfer to real time information systems.
- Undertake "research on the research," that is, actively investigate how the information generated by the research strategy is being used, including how perceptions of risks are

Comment [RL15]: These are in place?!

affected by improved measures of risk.

Objective 4: Identify future states of marine, coastal, and freshwater ecosystems, LMRs, and LMR-dependent human communities in a changing climate.

- Since this is the most critically needed outcome of research and analysis, the steps listed on page 36 as "important strategies" is an important start.
- Build on these strategies by identifying better ways to integrate with many systems throughout the world and translating to fisheries, marine, and community managers everywhere.
- Develop measures of vulnerability to change in communities and industries and extend to creating models of what the socioeconomic responses to the ecological and management changes may be.

Objective 5: Identify the mechanisms of climate effects on ecosystems, LMRs, and LMR-dependent human communities.

- On p. 39 of the draft strategy it is noted, "NOAA Fisheries' current capacity to conduct process-based research will not meet the demand for understanding how aquatic species, ecosystems, and LMR-dependent human communities may respond, acclimate or adapt to climate change." This says it all and is the critical message for garnering necessary support for NOAA to increase its capacity.
- Particularly needed are the data and analysis of changes in LMR-dependent communities, including both coastal communities and fisheries related industries that will lead to improved understanding and prediction of social and economic changes resulting from the ecological effects of climate change.

Objective 6: Track trends in ecosystems, LMRs, and LMR-dependent human communities and provide early warning of change.

- Increase, establish, and invest in community-based or citizen science monitoring systems, with uniform protocols (e.g. Alaska Community Based Monitoring Systems, or CoCoRaHS, the Community Collaborative Rain, Hail, and Snow network), and identify key geographic areas (marine and riverine) to target their establishment.
- Develop uniform protocols for community-based monitoring to feed into integrated data sets.
- Identify key disease indicators to track and monitor (i.e. *Ichthyophonus* in herring, salmon and other species).
- Identify key environmental indicators of change in important habitats and their impacts on marine environments.
- Integrate a model for identifying major signs of long-term change in distinct geographic socio-ecological systems combined with larger systems.

Objective 7: Build and maintain the science infrastructure needed to fulfill NOAA Fisheries mandates under changing climate conditions.

- Increase partnerships (as noted) with other federal agencies, state governments and agencies, coastal and riverine communities, environmental NGOs, tribal governments, universities, international organizations, etc., to integrate existing science.
- Increase the budget of NMFS's Social Science Branch and expand its NS8 responsibilities to include social indicators relevant to climate change.
- Identify *new* constructs for continual data collection, analysis and data sharing among sectors.
- Use socio-economic data already collected and distributed by public agencies to track socio-economic changes.
- Include research of resources use in subsistence communities. Subsistence resource us is essential to the discussion of *real economies* based on their extreme remoteness from straight cash economies.

C. Additional Comments on Socioeconomic Research to Meet Strategic Objectives

There is a variety of socioeconomic research strategies that should be considered to address these objectives described in Section B:

1. Vulnerability Analysis

Analysis of the vulnerability of LMR-dependent communities depends first on defining them. Landings data, combined with data on the regional economies such as contained in the NOAA Economics-National Ocean Watch (ENOW)/ National Ocean Economics Program and the social indicators developed by NMFS's Social Science Branch can provide first-order measures of fisheries dependence for most commercial fisheries.

These data can also be used to approximate measurement of recreational fishing dependent communities, though survey data on marine recreational fishing will be needed to provide additional detail.

National studies can be done using this data down to the county level to identify relative levels of LMR dependence. As the data used for these studies is regularly produced, the construction of vulnerability indexes along these lines will provide both a picture of current vulnerability but allow tracking of changes over time.

Subsistence fisheries in native communities need to be included in this analysis. Data sources for these investigations, such as Census data, will have to be supplemented with field research. Subsistence fishing is primarily an issue in Alaska, but subsistence fishing as an important part of the diet among native communities is in fact common in the continental US and in the Pacific islands.

Subsistence fisheries are also not confined to native communities. Low income people in U.S. coastal communities, particularly in urban areas, frequently supplement their diet with fish. These consumers are relatively under studied outside the public health field.

2. Industry Analysis

Investigations of climate change impacts on fisheries focus on changes in the ecosystems that will affect possible levels of catch, but there will also be changes in the commercial fishing industry in response to the ecological and biological changes. The ecological and biological changes will interact with changes in the industry to create new economic structures in harvesting, processing, and distribution. Little is known about how these changes will take place largely because the climate-induced changes are only recently beginning to show up in the economic systems. This raises two questions:

a. What changes are occurring?

   The strains on the commercial fishing industries resulting from overfishing and restrictions required for stock management have resulted in a variety of adaptations to changing conditions in timing of activity, gear and other technology, and markets. These changes point to possible directions of responses related to climate change and need to be more systematically understood. Given the variety of industrial organizations within U.S. fisheries, this research will need to be carried out over several years.

   It should also be noted that many of these same questions about how adaptation will occur might apply to subsistence fisheries. Local and traditional knowledge is critical to understanding past changes and adaptation in subsistence societies that may help understand responses to climate change. Other more formal theoretical frameworks will have to replace industrial organization, such as community development, for this research.

b. What changes should occur?

   Changing fisheries will response to climate change will raise the policy question: what should government's role be in assisting LMR-dependent communities and the fishing industry itself. Previous efforts have mostly focused on compensating losses and shifting people out of the fishing industry to reduce effort. Future changes may require more active intervention in reshaping industries and communities. A first step in such efforts will be identifying social preferences and values within fishing communities.

   The most applicable economic framework for potential policy in this area is the work on innovation and economic networks, often called "cluster theory". This field moves beyond traditional impact analysis of the type that has typically been done in relation to management plans by focusing on how networks of industry, government, educational, and other institutions work to encourage a sustained level of innovation in economic activity through new technologies, products, and markets. Working with other government agencies that regularly operate in this space, such as the Economic Development Administration in DOC and the Rural Development Administration in USDA, NOAA should investigate how and where government (Federal, state, and local) policies can foster innovative adaptations in industries and communities.

3. Understanding perceptions and preferences for risk of decision makers and stakeholders in fisheries management.

The *Research Strategy* implicitly defines the problem of fisheries adaptation to climate change as a problem in risk management with the intention of greatly increasing the measurement and understanding of the risks from climate change and to the fisheries. This is an essential element in fulfilling NOAA Fisheries' missions, but improved measures of risk have been shown to be inadequate to assure effective responses. The example of climate change as a larger issue in society demonstrates this problem clearly.

To the extent that NOAA wishes to fully understand the challenges of climate change, the concept of risk needs to be extended to the perceptions of risk and to preferences for risk among the decision makers and stakeholders involved in the policy process. Developments in the understanding of how people perceive risks and how risks are communicated such as prospect theory and status quo bias over the past two decades have altered understandings of the economics of risk and shown that even the best measurement of risk may not be sufficient.

Over time, NOAA should engage researchers with backgrounds in the social analysis of risk to monitor the development and communication of risk data within the fisheries management community (government, industry, and other stakeholders) to understand how different participants see the risks associated with different projections of climate change, impacts, and responses. The goals of this research will be to understand how people respond to changes in measured risks in order to improve communication of the risks and to identify gaps between the outputs of the research strategy as a whole and decisions incorporating the results of that research.