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Managing fish and wildlife resources for their long-term well-being and the benefit of people.

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Submitted via Electronic Mail
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Dr. Paul Doremus
Assistant Administrator for Fisheries (Acting)
NOAA Fisheries

Re: Recommendations for More Resilient Fisheries and Protected Resources Due to Climate Change

Dr. Doremus:

The Division of Marine Fisheries Management of the Florida Fish and Wildlife Conservation Commission (FWC) has coordinated agency consideration of a request by the National Oceanic and Atmospheric Administration (NOAA) for input on Executive Order 14008: "Tackling the Climate Crisis at Home and Abroad". Specifically, NOAA has requested recommendations to address Sec. 216(c); how to make fisheries and protected resources more resilient to climate change, including changes in management and conservation measures, and improvements in science, monitoring, and cooperative research. The FWC provides the following recommendations for NOAA's consideration.

The FWC manages fish and wildlife resources for the State of Florida and represents the State on the Gulf of Mexico Fishery Management Council, South Atlantic Fishery Management Council, and the Highly Migratory Species Advisory Panel. The challenges associated with managing natural resources in a changing marine environment are complex. FWC recognizes climate change as a threat to Florida's marine ecosystems and species in Florida's State Wildlife Action Plan (https://myfwc.com/media/22767/2019-action-plan.pdf). Often managers are forced to make decisions without a full understanding of factors driving changes in fisheries, largely in part because of current scientific and management capacity to comprehensively evaluate and predict the effects of these changes. Climate change is perhaps one of the least understood drivers of natural resource production due to the multi-dimensional way the environment interacts with basic metabolic rates at the species level and how this translates throughout the food web at an ecosystem level. Future efforts to improve resiliency in fisheries and protected resources should be inclusive of this complexity and warrants a careful consideration of factors driving observed changes and how these changes are incorporated into management. In this light, we have organized our comments into several categories to address where research, resources and additional actions are needed for adaptive resource management under changing climate conditions. These categories include: 1) tracking ecosystem trends; 2) habitat considerations; 3) multi-species interactions; 4) spatial scales and connectivity; 5) human dimensions; 6) advancing stock assessments; 7) management framework; and 8) protected resources.

1. Fisheries - Tracking Ecosystem Trends

a. *Enhanced fishery-independent monitoring in the southeast United States*
Understanding broad ecosystem trends and how they influence population dynamics of fish stocks and protected species is critical to the successful management of these resources during climate change. However, at present, monitoring data to evaluate broad ecosystem trends, particularly at the lower trophic levels (e.g., primary and secondary producers), are largely spatially and temporally insufficient for incorporation into management efforts. As technologies advance and expand our capacity for monitoring, FWC advocates for additional monitoring efforts that encompass not only managed species, but also monitors ecosystem conditions across space and time. From a system-level perspective, these conditions should include habitat, primary and secondary production, and trophic information.

b. *Changes in the frequency of severe events*
Extreme events such as hurricanes, cold snaps, and harmful algal blooms are expected to increase resulting in periodic reductions in fish populations at regional and local scales. Florida experienced a series of strong hurricanes in 2004 and 2005 and most recently in 2017 and 2018, a severe red tide in 2005, the most severe drought on record in 2007, an extreme cold event in 2010, and persistent red tides in 2018. For species that are closely managed, understanding population resilience to environmental and anthropogenic disturbances (i.e., recovery trajectories across broad spatial areas) can guide which suite of management actions are available to mitigate and respond to any impacts. Some of the events described above resulted in regional closures of inshore fisheries. For example, the recreational fishery for common snook has been closed in SW Florida for five of the past 10 years because of severe events (e.g., cold kills, red tide). For federally-managed fisheries like gag and red grouper, some of these severe events resulted in reductions in catch limits (once analyses and/or stock assessments indicating fishery declines were available). Such events often affect local research assets (damage to structures, power outages, flooding), thus a broad network of cooperation among institutions is needed to step in following a severe event to assess the effects to fish populations.

2. Fisheries - Habitat Considerations

a. *Habitat monitoring and mapping*
Changing temperature regimes, depths, and intertidal flooding frequencies are likely to result in changes to habitat types at given locations. One example is the conversion of saltmarshes to mangroves in the northern Gulf of Mexico and along the Atlantic coast of northern Florida. It is not known whether these habitat types are functionally equivalent with respect to fish use. Analysis of existing datasets and experimental studies (for example create a mix of saltmarsh and mangrove controlling for elevation at restoration sites) could help determine what, if any, changes to expect in fish communities and essential habitat of economically important species. Other expected changes include migration of coastal habitats inland, changes in the position of oligohaline zones in rivers, and increased depths in areas currently occupied by seagrasses. To understand habitat impacts on fisheries and protected resources,

changes in these habitats will need to be monitored over time and resources are currently insufficient to do so. Mapping efforts are underway by NOAA NCCOS to provide baseline data, but FWC recommends additional resources be provided to expand their (and other) efforts to identify habitats that may be resilient to the effects of climate change.

b. *Magnitude of linkages between nearshore and offshore habitats and fishery/resource production* Observed effects of climate change have already impacted habitat in Florida and predicted effects indicate that impacts to sensitive habitat will increase (e.g., coral reefs, hardbottom, seagrass, mangroves). The health and connectivity of Florida's diverse habitats are at the foundation for the high productivity and use of our natural resources. Understanding the magnitude of these linkages could provide guidance for habitat protection, restoration efforts, and drivers of fishery/resource production. Incorporation of such information into stock assessments could provide valuable insight to resource managers.

c. *Changes in flooding frequencies of coastal nursery habitat*
Coastal habitats that have historically been flooded infrequently will be become more connected to their estuaries. The primary nursery habitat for some species, however, depend on remote, infrequently flooded habitats, namely snook species, black drum, and tarpon. For example, using acoustic telemetry and water level loggers, FWC has observed that emigration of juvenile tarpon from coastal nurseries is tied to storm events. Research is needed to understand how existing nursery habitats for these and other species are likely to function as flooding regimes change from a stochastic seasonal connection to daily tide. Predation pressure on these species is likely to increase with increased connectivity. Fish biologists can work with restoration practitioners to create new habitats landward of existing ones. There may also be opportunities to work with engineers and city planners to modify existing stormwater infrastructure into functional nurseries. The first step is to properly characterize nursery habitats, the appropriate flooding regimes, and degree of connectivity with open water in ways that can be easily transferred to engineers, city planners, and restoration practitioners.

d. *Additional actions to promote habitat resilience*
   i. Loss of essential fish habitat such as spawning, aggregation and foraging structural features decreases fish community productivity and resilience to the effects of climate change. Conserving and restoring essential fish habitats (Oculina Banks, SE coral reef tract, seagrass communities, Grand Banks benthic cobble habitat, etc.) damaged by human activities will enhance such productivity and resilience.
   ii. Nutrient contamination leads to reduced benthic habitat productivity and can shift whole ecosystems from benthic macrophyte based to water column microalgal based. Addressing human-caused nutrient pollution across watersheds contributing to reduced estuarine water quality should be a priority in all impaired systems.
   iii. Natural habitats, such as mangrove and oyster communities, have the ability to adapt to sea level rise to some degree. Establishing tax- and permitting-based incentives for green living shoreline installations along lower energy estuarine shorelines to avoid

conversion of these important habitat interfaces to hardened shorelines should be a core priority of any climate change resilience effort in estuaries.

iv. Work with fishers to reduce fishing gear-based habitat damage (shifting gear to targeted fisheries, minimize benthic trawl fishing in areas of hardbottom communities, etc.). In order to best address these impacts, extensive high resolution mapping of all estuarine and marine benthic habitats is required.

v. Promote facilitated transitions of habitats as they move shoreward (up slope) and inland as a result of sea level rise, and reduce or prevent physical barriers to up slope migration.

vi. Facilitate poleward migrations of native coastal communities (e.g., mangroves into saltmarsh systems).

vii. Integrate natural habitat enhancement with aquaculture facilities to improve habitat availability for fish species ("tuning" of appropriate habitat characteristics to provide ecosystem services in aquaculture facilities).

viii. Support Early Detection and Rapid Response efforts for invasive species that may impact fisheries, as climate change and SLR will increase vulnerability of many areas to invasion.

ix. Establish incentives and provide funding for land acquisition programs and land use that allow for upland and inland migration of coastal habitats. Similar to efforts that focus on establishing "wildlife corridors", prioritize targeted "habitat transition zone" acquisitions.

x. Fund long-term monitoring on projects intended to improve coastal resilience to better understand their impacts on fisheries and associated coastal species over time.

3. Fisheries - Multi-Species Interactions

a. *Identify significant trophic interactions that should be accounted for in management*
The effects of climate change are likely to impact the food web at every trophic level. Identification of significant trophic interactions, and any subsequent changes in them as climate change progresses, would help managers better understand the importance of certain food web linkages and how shifts in production at lower trophic levels influence fisheries and protected resources.

b. *Improved monitoring of bycatch, assessments of bycatch and impacts of removals through multi-species modeling efforts, and research into advancements for bycatch solutions*
As species distributions change in response to climate change, fisheries are likely going to encounter changes in their bycatch composition and rates. For areas and fisheries where bycatch is predicted to potentially increase, managers need to have the ability to assess the magnitude of bycatch and determine options for minimizing its impact.

4. Fisheries - Spatial Scales and Connectivity

a. *Climate vulnerability analyses*
Climate change is likely to have broad effects across entire ecosystems and a fundamental question remains regarding the relevant spatial scales that ecosystem

processes should be managed or accounted for. To determine this, an understanding of connectivity within and among regions is required. Climate vulnerability analyses are underway in the South Atlantic and Gulf regions, and FWC recommends additional support to expedite those efforts and expand to a broader suite of fish and invertebrate species.

b. *Changes in species distributions*
Several tropical and subtropical species are already expanding their range farther north into the southeastern United States. More cooperation and collaboration is needed with partners and other nations in the tropics where the abundance and evolution of these species have been historically centered. Cross-site studies of genetic structure and life-history traits (e.g., cold tolerance, counter-gradient growth) spanning countries in South, Central, and North America are needed to better understand how species may adapt to living at higher latitudes and in novel habitats. In some cases, range expansion may provide for new fisheries in areas where they did not previously exist. Protection or enhancement of these "new" fisheries will require identification of essential habitat and an appropriate management strategy depending on connectivity to populations farther south.

c. *Changes in species migrations*
Support for cooperative acoustic tracking networks like iTAG (Integrated Tagging of Animals in the Gulf of Mexico) and FACT. A relaxation of temperature drivers (specifically milder winters in the southeastern United States) will affect fish migrations. Examples of these migrations along the Atlantic and Gulf coasts of Florida include the winter sailfish run to southeast Florida and fall/spring runs of cobia, mackerel, and coastal sharks. Other coastal migrants include tripletail, permit, blackfin tuna, and amberjack although the extents of their migratory behaviors are less known. These movement patterns affect which cities and ports have access to the fishery. For example, tournaments targeting cobia during spring in the Florida panhandle have collapsed. It has been difficult to ascertain whether this is due to changing migration patterns (fewer fish moving south in response to cold and thus more fish remaining in the northern Gulf), overfishing of a migratory population contingent, or overfishing of the entire population. With increased acoustic research capacity, tracking fish migrations will be possible. For coastal species, we need a better idea of what proportion of the populations migrate as well as the migration start/end points, pathways, and timing. As temperature drivers relax, it is likely that the migratory portion of the population may diminish; more may become non-migratory and thus more susceptible to local pressures and population structuring. The timing of migration, and the catches that occur at specific ports, will be altered. We need baselines quickly for which to gauge future changes and to be able to modify identified Essential Fish Habitat accordingly to support appropriate management.

d. *Larval connectivity*
The extent of larval connectivity between regions, and how that might be changing with climate change, is another important area of research that is needed. Combined use of biophysical modeling, modeling of species-specific larval attributes, appropriate spatial resolution, and validation with genetics or otolith microchemistry would be useful for

managers to understand larval transfer rates between regions. Incorporation of such data into stock assessments would ultimately provide managers with additional tools to evaluate drivers of stock status.

5. Fisheries - Human Dimensions

a. *Increase resiliency of fishing communities*
Natural resources are managed for a variety of reasons, but ultimately regulations are in place to promote sustainability and the betterment of human communities reliant on these resources. As such, research is needed to better understand and more accurately assess the economic impacts of new fishing regulations, and FWC recommends increased stakeholder involvement in the decision-making process.

b. *Evaluate the causes and impacts of climate change from a social, economic, and institutional perspective*
Large-scale events that have affected entire ecosystems (e.g., Deepwater Horizon oil spill or Florida red tide event of 2017-2018) have highlighted the need for more resources to better understand the short- and long-term impacts of these events on society. Increasing stakeholder involvement in resource management may help elucidate climate impacts at the institutional level, but more research is needed on the social and economic aspects of resource management. For example, how will range shifts of economically-important species impact competition, production, and regional socio-economics?

6. Fisheries - Advancing Stock Assessments

a. *Evaluate which species or species complexes are most sensitive to environmental conditions*
To accurately assess and effectively manage fish stocks and natural resources during climate change, advancements are needed to better encompass ecosystem effects within stock assessments. FWC recognizes that ecosystem considerations have recently been included in stock assessments for red grouper, red snapper, and brown shrimp and believes this type of approach should be taken for all managed species, when appropriate.

b. *Determine which environmental conditions influence fisheries production and how those data can be used to improve stock assessments*
Data limitation for ecosystem covariates is generally lacking across time-series, which are typically utilized in stock assessments. More resources are needed to evaluate if fisheries production is being influenced by environmental conditions, and if so, which conditions are driving the observed changes.

c. *Stock assessment process*
Recognizing that the federal stock assessment process in the southeastern United States is already stretched to capacity, FWC places a high importance on additional stock assessment resources such that timely assessments can be completed, and appropriate ecosystem conditions can be considered in the process.

7. Fisheries - Management Framework

a. *Modifications to fishery management toolbox*
While the effects of climate change on fisheries production are poorly understood, fisheries managers will need to have the flexibility to adapt to these challenges and likely new management tools to respond to climate change impacts on fisheries. Management tools (e.g., federal control rules, accountability measures, etc.) that were effective in the past may not be effective under certain climate change scenarios for species that are identified as vulnerable to climate change. Risk analyses and management strategy evaluations are likely necessary to determine the robustness of current policies and management actions in a changing environment. However, prior to modifying the fishery management toolbox, the research stated in the above sections is needed.

b. *Revisions to Governance*
Modifications to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) can provide flexibility to Councils when dealing with impacts of climate change on fisheries. For example, modifying MSA language, such as the Acceptable Biological Catch (ABC) recommendation language in Sec. 302 (h)(6), could help increase regulatory flexibility and remove overburdensome restrictions. Additionally, FWC suggests modifying MSA language to extend timelines for rebuilding overfished fisheries and ending overfishing by allowing Councils to ease into rebuilding plans when possible, which can help reduce negative impacts to fishermen and fishing communities.

c. *Increased coordination and collaboration between fishery managers*
Coordination by regional fishery management councils, NOAA Fisheries, states, and other fishery management entities like the state fishery management commissions is necessary to tackling the changing and unexpected conditions because of climate change. Individual states and councils are already dealing with shifting stocks, subsequent allocation issues, and other regional fisheries challenges, which are likely to continue. As species distributions change, management authorities may potentially shift between councils. FWC recommends development of a plan for how shifts in management will be expected to occur to prevent overfishing and meet the changing needs of these fisheries. Additionally, continued cooperation and expanded efforts for fishery-independent surveys and other research programs throughout the regions can help ensure data is adequately and comprehensively captured to provide the best science available for management decisions.

8. Protected Resources

a. As sea levels rise, coastal armoring authorized to protect upland dwellings and infrastructure will likely increase. Unless these structures are carefully designed and constructed, important beach and dune habitat for coastal wildlife will be lost. New coastal armoring structures should be designed to minimize encroachment into sandy beach habitat, such as vertical seawalls, and sited as close (landward) to the vulnerable and eligible structure it is being installed to protect as practicable.

b. Access for marine turtles to existing habitats could be cut off through increased water control structures or other armoring structures. Other entry points to currently accessible bodies of water could be identified and if none are available, work could be done to re-examine wildlife passage through water control structures or other armoring structures (e.g., fish ladders).

c. As the coast moves landward due to sea level rise, what is currently inland lighting will play a larger role in coastal systems in relation to marine turtle conservation (e.g., disorientations due to artificial lights). Viewshed modeling could be conducted using various coastline/water level profiles to identify hotspot light sources. There could be development of additional alternative lighting regimes for structures usually not found near the coast (e.g., high rise office buildings, sports arenas)

d. Harmful algae blooms could develop or spread to new locations with future changes in climate and flow of aquatic systems around the state. Modeling of algae blooms and possible water flows could provide insight into which areas may be more prone to this impact and therefore need more resources to protect against the spread of the harmful organisms.

e. Continued cooperative research to understand impacts to incubating sea turtle nests from wetter and warmer beaches is needed (i.e., hatch success, temperature dependent sex determination, shifts in nesting season). This research could be completed cooperatively by the FWC, USFWS, NOAA, USGS, FDEP, EPA, local universities, local municipalities, non-profit organizations, and/or other partner agencies and groups.

The FWC appreciates the opportunity to provide input for NOAA's consideration of Executive Order 14008: "Tackling the Climate Crisis at Home and Abroad". Should you require additional assistance regarding our comments, please contact Lisa Gregg at Lisa.Gregg@myfwc.com or (850) 617-9621.

Sincerely,

Jessica McCawley
Director

jm/mg/lg/cjs/kf