Southeast Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy Through 2024

John A. Quinlan, Roldan C. Muñoz, Michael L. Burton, Joseph A. Cavanaugh, Jennifer Cudney, Jennifer C. Doerr, Karla R. Gore, Jennifer P. Leo, Audra L. Livergood, Kelli O'Donnell, Patrick Opay, and Christopher R. Sasso

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

National Marine Fisheries Service
Southeast Fisheries Science Center and Southeast Regional Office

May 2023

Southeast Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy Through 2024

John A. Quinlan[1], Roldan C. Muñoz[1], Michael L. Burton[1], Joseph A. Cavanaugh[2], Jennifer L. Cudney[2], Jennifer C. Doerr[1], Karla R. Gore[2], Jennifer P. Leo[1], Audra L. Livergood[2], Kelli O'Donnell[2], Patrick Opay[2], Christopher R. Sasso[1], and Lauren Waters[2]

[1] National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive,
Miami, FL 33149

[2] National Marine Fisheries Service
Southeast Regional Office
263 13th Avenue South
St. Petersburg, FL 33701

U.S. DEPARTMENT OF COMMERCE
Gina Raimondo, Secretary

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
Richard Spinrad, Under Secretary of Commerce for Oceans and Atmosphere & NOAA Administrator

NATIONAL MARINE FISHERIES SERVICE
Janet Coit, Assistant Administrator for NOAA Fisheries

May 2023

About this report
Implementation of the plan is contingent on available resources.

This report should be cited as:
Quinlan, J.A., R.C. Muñoz, M. Burton, J. Cavanaugh, J. Cudney, J. Doerr, K.R. Gore, J. Leo, A. Livergood, K. O'Donnell, P. Opay, C. Sasso, and L. Waters. 2023. Southeast Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy Through 2024.

Authors' Addresses:
J.A.Q and C.S. – NMFS; SEFSC; 75 Virginia Beach Drive, Miami, FL 33149
R.C.M. and M.B. - NMFS; SEFSC; Beaufort Laboratory; 101 Pivers Island Road, Beaufort, NC 28516
K.G, J.L.C., J.C., A.L., K.O., P.O., L.W. - NMFS; SERO; 263 13th Avenue South; St. Petersburg, FL 33701
J.D. and J.L.- NMFS; SEFSC; Galveston Laboratory; 4700 Avenue U, Bldg. 302, Galveston, TX 77551

Copies of this report may be obtained from:

Karla R. Gore
National Marine Fisheries Service Southeast Regional Office
263 13th Avenue South St. Petersburg, FL 33701
Tel: (727) 551-5753
Karla.Gore@noaa.gov

Table of Contents

Executive Summary

Changing climate and oceans are affecting the nation's valuable living marine resources and the many people, businesses and communities that depend on them. Warming oceans, rising seas, extreme events, and acidification are impacting the distribution and abundance of species, and the structure of marine and coastal ecosystems in many regions. These impacts are expected to increase and there is much at risk.

To prepare for and respond to climate impacts on marine and coastal resources, the NOAA Fisheries Climate Science Strategy (NCSS) identifies seven key objectives to increase the production, delivery, and use of climate-related information needed to fulfill the agency's mandates (e.g., fisheries management, protected resources conservation) in a changing climate. Beginning in 2016, NOAA Fisheries developed Regional Action Plans (RAPs) to implement the NCSS in each region based on regional needs and capabilities. The NCSS 5-year Progress Report summarizes actions and accomplishments in implementing the RAPs through 2020.

This Southeast Regional Action Plan (SERAP) identifies climate-related actions to address the seven NCSS objectives and regional needs through 2024.It identifies key needs and proposed actions across three parts of the region (South Atlantic, Gulf of Mexico, and Caribbean), several of which are inclusive of Atlantic Highly Migratory Species (HMS) where appropriate. Atlantic HMS are included in both the Southeast and Northeast RAPs. While some tasks are expected to be completed in the near-term, the document also includes aspirational, long-term goals for which activities during the next three years will lay a foundation. The document shows how regional activities address NCSS objective areas, and identifies how the activities contribute to regional science and management. Where possible, metrics are included to gauge progress with the understanding that progress depends on a variety of factors, some of which are beyond the agency's control. These activities support NOAA's effort to build a climate ready nation.

The following is a list of priority actions included in this SERAP and the NCSS objectives they address. The priorities are listed in no particular order of importance.

Build Science Infrastructure and Track Change (NCSS Objectives 6, 7)

- Build Capacity: Identify the staffing resources (full time employees, contractor services, cooperative research programs) needed to conduct the work of this Action Plan.
- Strategic Planning: Host virtual climate change workshops with partners in the region by the end of FY24.
- Support the application and development of the Climate, Ecosystems, and Fisheries Initiative in the southeast region.
- Establish a facility to settle, rear, and growout corals produced from spawning collections to support the production of novel genotypes and climate research on different life history stages of corals.
- Identify Caribbean-focused staff to participate in the SERO/SEFSC climate change team.

- Increase awareness and utility of ecosystem status reports (ESR), climate vulnerability assessments (CVAs), and other climate tools for use by managers and stakeholders.
- Host a National Conservation Training Center climate change course to increase capacity to develop and implement climate-informed advice and resource management.
- Develop a comprehensive and collaborative monitoring program to track and deliver information on changing marine and coastal ecosystems.
- Complete an ecosystem status report for the U.S. South Atlantic region.
- Promote the Acropora cervicornis Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers.
- Conduct broad-scale, multi-platform, multi-species surveys of marine mammal, sea turtle, and seabird abundance and distribution, in the Gulf of Mexico and the southeastern Atlantic. Implement surveys in the Caribbean if additional funding is available.
- Conduct CVAs for Habitats and Atlantic HMS.

Understand Mechanisms and Project Future Conditions (NCSS Objectives 4, 5)

- Research the impacts of climate-induced shifts in estuarine habitats (e.g., displacement of salt marsh by black mangroves) on the early life history stages of offshore stocks.
- Study the impacts of climate variability and changing ocean dynamics on the recruitment of economically and ecologically important fishes across the Gulf of Mexico and South Atlantic with the intent of informing fisheries management.
- Leverage long-term demographic monitoring of *A. palmata* in Upper Florida Keys to understand impacts of climate on ESA-listed coral populations and inform restoration efforts.

Inform Management (NCSS Objectives 1-3)

- Partner with the Northeast Region Coordinating Council (NRCC), NMFS headquarters, and Mid-Atlantic and Greater Atlantic Regions to conduct East Coast Scenario Planning with stakeholders to better understand and respond to climate impacts on the Atlantic coast.
- Conduct Management Strategy Evaluations (MSEs) to determine robust harvest strategies that take into account stakeholder concerns.
- Continue to incorporate climate and ecosystem considerations into Essential Fish Habitat and Habitat Areas of Particular Concern designations, National Environmental Policy Act Reviews, restoration planning, and other management actions and products.

Introduction

Climate change presents pervasive and pressing challenges for the National Marine Fisheries Service (NMFS). The effects of climate change touch on virtually every activity in which NMFS engages, as well as on its trust-resources and stakeholders. To begin addressing these challenges, NMFS released the NOAA Fisheries Climate Science Strategy (NCSS, Link et al., 2015); a roadmap designed to guide NMFS' approach to climate change so as to better fulfill its mandates for robust stewardship of the nation's living marine resources (LMRs) and the communities dependent upon them. The NCSS identifies seven objectives that, if implemented, are expected to help reduce impacts and increase the resilience of our nation's living marine resources and the people, businesses, and communities that depend on them. The seven objectives are interconnected and build from basic information needs and science capacity to science-informed decision making and management (Fig. 1).

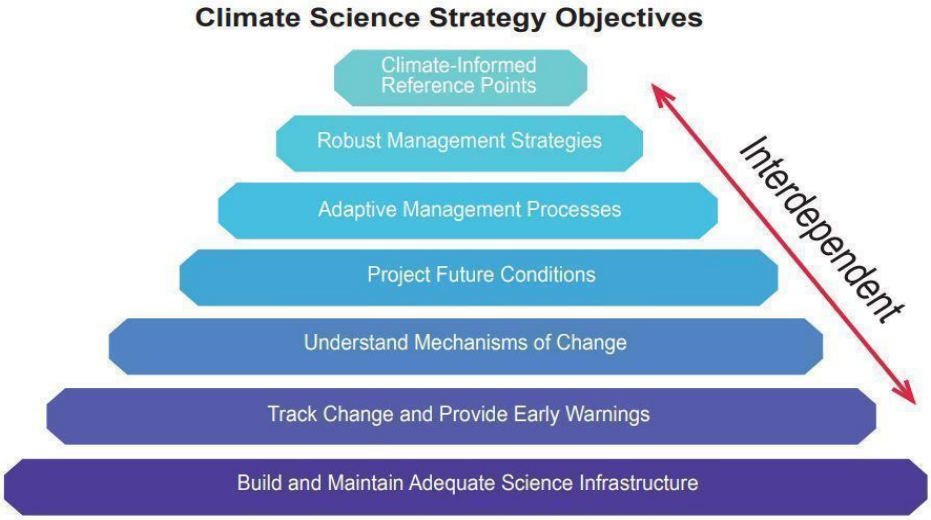

Figure 1. Climate science objectives of the NOAA Fisheries Climate Science Strategy (Link et al. 2015).

In response to the NCSS, the Southeast Fisheries Science Center (SEFSC) and Southeast Regional Office (SERO) developed Regional Action Plans (RAPs) for the Gulf of Mexico (GMRAP) and the Southeast United States Continental Shelf (S-RAP). These RAPs highlighted some of the expected changes to the regions and specified a number of actions to pursue over a five-year period to address regional climate change. At the core of this work was a recognition that understanding, and potentially predicting, how major climate drivers affect LMRs, coastal habitats, and the communities they support is critical for effective natural resource management. There were 130 actions listed in the original RAPs, 62 in the GMRAP and 68 in the S-RAP. Of these, 12 actions in the GMRAP and 11 in the S-RAP were considered high priority.

Since 2016, significant progress has been made to address the priority actions across a diverse range of climate-related activities in the Southeast region, in both the GMRAP and S-RAP, and

this progress addressed all seven NCSS objectives. The following summary highlights some of the accomplishments addressing actions in the RAPs as they relate to the NCSS Objectives.

Inform Management:
1) identify climate informed reference points for managing LMRs,
2) identify strategies for managing LMRs under a changing climate,
3) design adaptive decision processes that can incorporate and respond to changing climate conditions

- Multiple stock assessments successfully incorporated climate and environmental information (e.g., Atlantic Multidecadal Oscillation [AMO]) in bluefin tuna and swordfish assessments; red tide in red grouper and gag assessments; freshwater discharge and red tide in marine mammal unusual mortality event [UME] assessments) (Objs. 1 & 3).
- A management strategy evaluation (MSE) specialist was hired, who will use MSEs to identify harvest control rules that remain effective under anticipated changes in climate (Obj. 2).

Understand Mechanisms and Project Future Conditions:
4) identify future states of marine and coastal ecosystems, LMRs, and human communities
5) identify the impacts of climate change

- Climate Vulnerability Assessments (CVAs) are underway or completed for the Gulf of Mexico and Southeast U.S. Continental Shelf (SEUSCS) for fisheries, Atlantic HMS, marine mammals, sea turtles, and for Gray's Reef National Marine Sanctuary (Objs. 4 & 5).
- Social science indicators were developed to characterize the vulnerability and resilience of coastal fishing communities to climate change impacts such as sea level rise (SLR) and storm surge, with additional indicators under development. Work has been initiated to include information from the CVAs in social science applications (Obj. 4)

Build Science Infrastructure and Track Change:
6) track trends in ecosystems, LMRs, and LMR-dependent human communities and provide early warning of change
7) build and maintain the science infrastructure to fulfill NMFS mandates under a changing climate

- The Gulf of Mexico ESR was updated and the SEUSCS report was completed (Obj. 6)
- There was significant coordination of, and participation in, workshops to advance the use of climate science in NMFS activities (e.g., Atlantic Coast Coordination, Gulf Ecosystem Modeling, SEFSC-AOML Climate RAP Support Workshop, NMFS-OAR Climate Fisheries Initiative Workshop, GFDL-AOML Workshop, co-chaired Session 8 at the 4th International Climate Symposium (Obj. 7 & cross objs.))

Regional Challenges and Opportunities

The southeast region section of the NMFS NCSS 5-year Synthesis Report (ch. 7; Peterson et al., 2021) pointed out the challenge associated with the use of climate science to inform fisheries, protected resources, and/or habitat management. Often, day-to-day operations focus on what might be viewed as traditional issues (e.g., catch, or age and growth) and there are relatively few opportunities to introduce climate science into the LMR management arena.

However, climate science has improved southeast stock assessments (Walter et al. 2015; Schirripa et al. 2017; Sagarese et al. 2018) and has informed the analyses of UMEs. Further, the southeast has moved to present climate-related activities (e.g., CVAs, ESRs, status of climate regional action plans) to Councils and other management bodies and the SAFMC SSC recently (June 2020) recommended to the Council that several future stock assessments take the SEUSCS-CVA into account. Additionally, the Atlantic HMS Management Division has presented information on the upcoming HMS CVA to the Atlantic HMS Advisory Panel (HMS AP). Nevertheless, additional strides must be made to include more climate science into LMR management.

While temperature-driven range (or distribution) shifts are not yet as pronounced as in the Bering Sea or the Northeast United States Continental Shelf (NEUSCS), there have been important impacts (e.g., species distribution shifts, coral bleaching and disease, extreme precipitation events leading to freshwater diversions and marine mammal UMEs, increasing frequency and intensity of tropical cyclones, harmful algal blooms [HAB], and federal fishery disasters) (Capper et al. 2013; Manzello 2015; Marshak and Heck 2017; Purtlebaugh et al. 2020). These impacts offer the Southeast region opportunities to introduce relevant climate science into day-to-day operations. The most direct path forward will be to design climate research to generate products that are directly useful in specific applications such as stock assessments, UMEs, ESRs, and biological opinions (BiOps).

Biological opinions serve an important role in consultations under Section 7 (a)(2) of the Endangered Species Act (ESA). SERO Protected Resources Division (PRD) is now incorporating climate change data/projections into relevant sections of the BiOps. For instance, climate data inform the Status of Species and Critical Habitat sections as well as the Environmental Baseline and Cumulative Effects sections - all of which decide the Jeopardy/Adverse Modification determinations in the BiOps. However, SERO PRD needs a dedicated and consistent approach to incorporating climate data (e.g., vulnerability assessments, forecasts of climate stressors such as SLR, etc.) into BiOps. Ideally, this would facilitate movement toward modeling climate stressors in order to forecast impacts to critical habitat (e.g., impacts to smalltooth sawfish or red mangrove loss due to SLR adjacent to armored shorelines).

SERO Habitat Conservation Division (HCD) consults with federal action agencies as required by the Magnuson-Stevens Fishery Conservation and Management Act, Fish and Wildlife Coordination Act, and Federal Power Act and has been incorporating climate data into these consultations. For example, relative sea level rise (RSL) is used in planning restoration, mitigation, and beneficial uses of dredged material projects. In Louisiana under the Coastal Wetlands Planning, Protection and Restoration Act, HCD staff plan for 20 years of RSL when designing marsh restoration projects. For federal projects sponsored by the U.S. Army Corps of Engineers (Corps), HCD typically works with the Corps to plan for 50 or more years of RSL; for other projects, various RSL considerations are used depending upon local conditions, availability of dredged material sources, and funding requirements. Hydropower licenses typically have 40- or 50-year durations, so HCD staff need reliable projections of future hydrology in the southeastern United States to appropriately prescribe fishways and seasonal water releases from hydroelectric facilities. Lastly, the evidence linking climate to the health and

resilience of coral ecosystems is growing. HCD staff need climate information when planning coral mitigation work to ensure this important habitat persists within developed areas.

The development of a formal regional climate team was a high priority action in both the GMRAP and S-RAP. An initial Southeast Regional Climate Team (Climate Team) has been developed with personnel from the SEFSC,SERO, and HMS. The Climate Team will eventually include SEFSC, AOML, SERO participants, and others, and will feature regular meetings and communications. The Climate Team will help advise on climate management approaches and their collaborative expertise will be better able to respond to climate priorities and potentially compete for larger amounts of funding for climate science in the region. Although progress has been made, further development and expansion of the Climate Team remains a high and critical priority.

Overall, the Southeast region has made considerable progress across a number of high priority areas in both the Gulf of Mexico and SEUSCS area, resulting in 16 publications (see Peterson et al., 2021) that address NCSS Objectives. In those areas where direct funding was available (e.g., the CVAs), focused effort pushed the projects to either completion or nearing completion. The Southeast also made notable progress in unfunded areas. For instance, the incorporation of the AMO, El Niño-Southern Oscillation (ENSO), and the phenology of the seasons into stock assessments, shelf productivity investigations, the SEUSCS ESR, and examinations of growth rates across fish species were important efforts that were either base-funded or relied on funding from other sources (e.g., Stock Assessment Improvement Program).

Furthermore, the SEFSC is leveraging participation in NRDA oil spill restoration in the Gulf of Mexico access new data (mapping, habitat, biological usage) on mesophotic and deep water communities to comprehensive, large-scale management actions to be more scientifically driven.

In moving forward, the Southeast region needs to secure more direct funding for climate science; identify a relatively small number of high priority, achievable actions for its RAPs; and work to develop a larger, more integrated applied research community that addresses regional needs. There is also a need to expand the regional focus to include the Caribbean.

Despite progress, much remains to be done to address and advance the objectives identified in the NCSS. Given the increasing demands for information, tools, and capabilities for climate-informed decision-making, the release of the IPCC Sixth Assessment Report, and the Biden-Harris Administration's priority on preparing for climate change, this is an ideal time to update the RAPs to address needs, challenges, and opportunities through 2024.

Reducing the impacts of changing climate and ocean conditions on living marine resources and resource dependent communities is contingent upon both mitigation and adaptation. Mitigation measures to reduce current and future greenhouse gas emissions or remove carbon dioxide from the atmosphere are key factors in determining which future climate scenario we are headed towards and the degree and types of adaptation needed to increase the resilience of fisheries and communities.

NOAA is working to reduce green-house gas emissions from its facilities and ships (DOC 2021 Climate Action Plan) as well as taking action to increase resiliency and adapt to current and anticipated impacts of changing climate and ocean conditions on living marine resources.

This RAP discusses actions to address and adapt to current and anticipated impacts of changing climate and ocean conditions on living marine resources. Such efforts will increase the resilience of the Nation's valuable living marine resources and the people, businesses and communities that depend on them.

The remainder of this document (RAP 2.0) identifies a number of climate change-related tasks to be carried out over the next three years. While some tasks are directly achievable, others are aspirational, long-term goals for which activities during the next three years will lay a foundation. The document shows how regional activities address NCSS objective areas and identifies planned tasks that may eventually inform regional science and management. Where possible, metrics are included to gauge progress, with the caveat that some activities will progress based on external needs and resources and are not within the control of the climate team.

Development of RAP 2.0

NMFS SEFSC and SERO identified a core working group to develop the RAP 2.0. Participants in the working group were drawn from the SEFSC and SERO divisions and laboratories across the Southeast region, as well as Headquarters offices. During development, drafts were shared across all Southeast divisions, other NOAA offices, regional fishery management councils and commissions, and the general public for input, comment, and revision before finalization. Colleagues from AOML, considered important regional partners in climate research, participated in the review of this document and will be partners in future collaborations.

The document was prepared by reviewing NCSS objectives, the original RAPs, the five-year synthesis document, and holding a series of interviews/informal discussions with fishery managers and scientists across the SEFSC, SERO, and fishery management councils. The interviews were guided using a set of prepared questions (see Appendix A) that covered current climate change impacts, planned climate-related work, and data/product needs. Participants in these discussions are included in the Appendix. During the discussions it was apparent that the region is lacking baseline data, including data from comprehensive surveys, needed to clearly understand the extent of changing environmental conditions. Some other issues that are, or will be, affecting the Southeast region include habitat loss, shifting species distributions, reduced effectiveness of critical habitat units in serving endangered and threatened species, shifts in vital rates, and community and fisheries impacts related to fisheries disasters. Additional information was garnered via jurisdictional Council's input and review of the public comments in response to Executive Order 14008, Tackling the Climate Crisis at Home and Abroad, signed January 27, 2021.

The RAP 2.0 identifies key needs, reinforces internal and external engagement, and develops metrics for tracking climate change priorities for the region, science center, and regional office for the next several years (through 2024). These activities support NOAA's effort to build a climate ready nation.

RAP 2.0 is structured such that there is an initial opening review, followed by key needs and area-specific (i.e., Gulf of Mexico, Southeast United States Continental Shelf, and Caribbean) Action Plans highlighting the recommended tasks for each area within the southeast.

Two major research initiative areas are planned that could transform aspects of southeast climate science. The programs are the NOAA's Climate, Ecosystems, and Fisheries Initiative (CEFI) and one focused on improving infrastructure and capacity for FY2023 and beyond. Actions from both of these initiatives are shaded in the Action Tables below, representing additional capabilities and focus areas that will be pursued as resources become available.

The CEFI is a cross line office [NMFS, National Weather Service (NWS), Oceanic and Atmospheric Research (OAR), and National Ocean Service (NOS)] initiative that will construct, among other products, a nationally integrated Fisheries and Climate Decision Support System (DSS). The DSS will enhance the usefulness of climate information for decision makers, advance a consistent environmental modeling system - including regional teams - to cover all NMFS regions, establish a national community of practice, and improve the application of climate information in developing climate-ready living marine resource management. The DSS expects to provide a number of specialized products useful to natural resource scientists and managers such as climate-informed harvest rates, species distribution maps and recovery targets, indicators for ESRs, risk assessment and adaptation plans, and bycatch and gear entanglement avoidance nowcasts.

The Southeast region has also identified major investments in climate-related infrastructure and capability for FY23 and beyond that, if funded, would include the hiring of FTEs dedicated to the Southeast region climate effort. The proposed infrastructure and work would increase the capability of the SEFSC to conduct climate-ready surveys, couple these with NEFSC surveys for greatly improved survey interpretation, and furnish important hydrographic and biological data for the CEFI modeling framework. Improved surveys would include components of the marine ecosystem from physical oceanography to marine mammals, sea turtles, fishes, and seabirds, and would affect marine resource management along the east coast and in three of the large marine ecosystems under SEFSC's purview. Community resilience activities would enable the SEFSC to identify climate impacts to fishing communities and enhance the efficiency of NOAA social impact assessments and disaster responses.

Key Needs

Gulf of Mexico Action Plan

The Gulf of Mexico is a semi-enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Channel. It is a small basin by oceanic standards and covers an area of approximately 1,507,639 km^2. Relatively-shallow continental shelf comprises 35% of the Gulf of Mexico compared with one quarter that is over 3,000 meters deep (GMFMC 2004). Warming ocean temperatures, sea level rise, and ocean and coastal acidification are thought to be key climate change drivers that result in biological impacts in the Gulf of Mexico. Additional regional characteristics of the Gulf of Mexico can be found in Lovett et al. (2016).

The GMRAP team evaluated ongoing work and identified 38 actions to help meet climate science needs for the Gulf region. In this section and in Table 1, the approach for making progress on these activities over the next three years is described with level funding by strategically aligning existing programs to include climate science, re-directing staff as needed and appropriate, and collaborating with partners. Actions that could be accomplished over the next three years with increased funding, representing additional capabilities and actions that will be undertaken if funding allows, are also included and shaded in gray in the regional Action Tables below. As funding becomes available, prioritization and scaling of these actions will be done as needed to meet needs within the constraints of resources. Some actions in the plan are necessary prerequisites for others, and there is a need to consider sequencing activities appropriately in the event that funding becomes available. Actions are presented in relation to the seven objectives identified in the NCSS and in the first GMRAP.

Table 1. Gulf Regional Action Plan

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
	Objective 1: Climate-informed reference points			
G2.1	*GMRAP Actions 2 & 3	Collaborate in national-level workshop to increase collaborations with colleagues across the agency and external partners to develop environmental and climate process information for use in establishing climate-informed reference points.	Ongoing-with future funding needed	SEFSC, SERO, GMFMC, other NOAA Fisheries regions, HMS, Academia, state agencies
G2.2	*GMRAP Action 15	Continue to, and where appropriate, expand inclusion of environmental covariates in stock assessments.	Ongoing	SEFSC, SERO, GMFMC, HMS
	Objective 2: Robust Management Strategies			
G2.3		**Priority Action,** Develop empirical dynamic modeling (EDM)-based management procedures for shrimp in the Gulf of Mexico. These would likely rely on an index of abundance that is responsive to environmental/ climatic conditions to manage a short-lived species.	2022 -	SEFSC, Academia
G2.4		**Priority Action,** Develop operating model (OM) for Kemp's Ridley sea turtle that will be used for management strategy evaluation and other simulation analyses. This OM may include additional fisheries and climate drivers and will be used to explore management strategies for protected species.	2022 -	SEFSC
G2.5		**Priority Action,** Continue to incorporate climate and ecosystem considerations into Habitat Areas of Particular Concern designations, National Environmental Policy Act Reviews, restoration planning, and other management actions and products.	Ongoing	SERO, SEFSC, HC, PR, HMS, ST, GMFMC, NOAA

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
				Restoration Center
G2.6		Continue and expand incorporation of climate-related information and uncertainty into protected species reference points and related ESA actions (i.e. incidental take recommendations, adverse modification analyses for critical habitat units included in biological opinions; and listing, recovery, and critical habitat designation; vulnerability assessments) in a consistent manner across the region.	Ongoing	SERO, SEFSC, PR, ST, Academia
	Objective 3: Adaptive Management Processes			
G2.7		Continue outreach and participatory research focused on identifying possible climate change impacts on fishery-dependent businesses (including commercial, for-hire, recreational fishing, and seafood markets) and identifying needs and opportunities to build resilience in fishing-dependent socioeconomic systems. Collection of baseline socioeconomic data should be part of this effort. This work should be conducted in partnership with GMFMC regional experts.	Ongoing-with future funding needed	SEFSC,SERO, GMFMC
	Objective 4: Identify Future States of Marine & Coastal Ecosystems			
G2.8		Develop maps showing the expected future head of tide in priority watersheds, migration of estuarine habitats based on current and projected sea levels, the expected distribution and inland extent of Essential Fish Habitat, and expected hydrographs for rivers in which NOAA Fisheries' trust resources are affected or NOAA needs to do an EFH or ESA consultation.	Future funding needed	SEFSC, SERO, ACOE, FERC

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
G2.9		Compile data on temperature (evapotranspiration), precipitation, and river discharge for use in evaluating impacts on EFH and protected species.	Future funding needed	SEFSC, SERO, ACOE, FERC
G2.10		Study the impacts of climate change on changes in freshwater (rainfall, river flows, water use conflicts) as changes in freshwater inputs may have substantial impacts on estuarine nurseries affecting total production of fishery species (shrimp, oysters, red drum, etc.), as well as affecting EFH, habitat composition and protected species.	Ongoing with future funding needed	SEFSC PR
G2.11		Assess impacts of increasing temperatures on sea turtle sex ratios, thermogenetic spawning triggers for ESA-listed fish and elasmobranchs, sturgeon resting areas in rivers, and maintaining coral resilience. Conduct field- and lab-based experiments to identify thermally resistant genotypes of ESA-listed coral species like *Acropora palmata* to inform restoration efforts	Ongoing with future funding needed	SEFSC PR, SEFSC, CRCP, NGOs, AOML
G2.12		**Priority Action,** Study the impacts of climate variability and changing ocean dynamics on the recruitment of economically and ecologically important fishes in the Gulf of Mexico and South Atlantic. This project is investigating several potential underlying mechanisms with the intent of informing fisheries management, in particular approaches to constructing projection scenarios which are used to inform future catch levels.	2020-2023	SEFSC, AOML, Northern Gulf Institute, North Carolina State University, University of Southern Mississippi
G2.13		Develop small-scale, nested biogeochemical hydrodynamic models of particular bays, reef systems, and estuaries forced by relevant	Future funding	SEFSC, AOML, GFDL

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
		oceanographic and atmospheric processes (e.g., Gulf Stream, AMO, North Atlantic Oscillation [NAO], ENSO, local meteorological fields, river discharge). These models would allow investigation of such factors as temperature dynamics at reef scales, bay and estuarine circulation and productivity patterns, and changes to freshwater outflow and water quality from increased numbers of storms. The models could allow forecasts of impacts to reef, seagrass, and mangrove habitats, thus supporting ongoing site-specific Essential Fish Habitat research, LMR management, and habitat migration. This work is envisioned to be a component of the CEFI and will require collaboration with AOML and GFDL.	needed	
	Objective 5: Understand Mechanisms of Change			
G2.14		Study the impacts of a changing climate (increasing ocean temperature and acidification, shifts in trophic structure, increasing frequency and severity of tropical storms) on sea turtle nesting and sturgeon populations	Future funding needed	SEFSC PR

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
G2.15		Conduct controlled laboratory experiments on the effects of individual and combined environmental variables (e.g., temperature, salinity, dissolved oxygen, pH) on the physiology and behavior of selected marine taxa. More information is needed on the response of egg, larval, juvenile, and adult stages of marine species to regime shifts that feature these environmental variables. Climate change is already modifying exposure to multiple environmental factors (e.g., pH, DO, temperature, salinity) and studies are needed to determine the effects of these changes on the fitness, distribution and abundance of LMRs in the presence of this changing environment. Critical studies include growth and survival trials, respirometry experiments, swim tunnel performance assessments, etc. This suite of laboratory-based experiments is currently not funded and will likely require financial support for new and/or upgraded laboratory facilities with state of the art equipment and associated computer hardware/software.	Future Funding Needed	SEFSC, Academia
G2.16		**Priority Action,** Conduct research to understand the impacts of climate change-induced shifts in vegetative composition of estuarine habitats (e.g., displacement of salt marsh by black mangroves) on fishery productivity and incorporate data into appropriate modeling platforms to project future contributions to offshore stocks.	Ongoing. Future Funding Needed	SEFSC
G2.17		Improved understanding of distribution of sargassum in the Gulf of Mexico, southeast U.S., and Caribbean, and how sargassum distribution impacts productivity and survival of larval/juvenile fishes.	Future funding needed	SEFSC, AOML

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
	Objective 6: Track Change and Provide Early Warnings			
G2.18	*GMRAP Action 49; Strategic Planning; G2.29	Continue science research surveys in the Gulf of Mexico. Focus of these surveys includes fishes, shrimps, shallow and deep coral reefs, oil and gas platform removal, commercial and recreational fisheries, zooplankton and ichthyoplankton, and samples the ecosystem from inshore estuarine areas out to the continental shelf.	Ongoing. Additional funding would increase effectiveness.	SEFSC, SERO, BOEM
G2.19	G2.13, G2.15, G2.18, G2.20, G2.24 G2.29	Expand survey data collection of ocean variables to better align with the biogeochemical data collection standards established by the Intergovernmental Oceanographic Commission (IOC) and the BGC-Argo program.	NRDA MDBC is funding some work, but future funding needed	SEFSC, AOML, NOAA NOS/NRDA
G2.20	*Builds on GMRAP Action 38; links to S2.23; G2.29	**Priority Action,** Conduct broad-scale, multi-platform, multi-species surveys of variability in marine mammal, sea turtle, and seabird abundance, distribution, and density in order to understand how oceanographic and biological attributes contribute to observed species patterns in space and time in the Gulf of Mexico (Gulf of Mexico Marine Assessment Program for Protected Species, GoMMAPPS).	Ongoing. Future funding needed	SEFSC, BOEM, USFWS
G2.21	S2.25; C2.14	**Priority Action,** Conduct additional vulnerability assessments to help inform science and management decisions, including a Habitat Climate Vulnerability Assessment (HCVA) for the Gulf of Mexico and the Southeast U.S. Atlantic, and a comprehensive cross-regional climate vulnerability assessment for Atlantic HMS.	Ongoing, Future funding needed	SEFSC, SERO, HMS, NMFS HQ (HQ) OSF, NEFSC, GARFO, OST,

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
				Academia, others
G2.22		Assess long-term projections of sea level rise in the Gulf of Mexico and adjacent estuaries and incorporate predictive modeling to determine the extent of estuarine habitat migration.	Future funding needed	SEFSC, PR, NCCOS
G2.23		**Priority Action,** Promote the *Acropora cervicornis* Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers.	Ongoing. Additional funding would increase effectiveness	NOAA through collaborative multi agency, NGO, and university research efforts both national and international
G2.24	*GMRAP Action 37; Links with S-RAP Action 56; G2.29	Baseline Data: Create a strategy to identify new and maintain current critical baseline data identified in the Gulf of Mexico comprehensive monitoring program. Additional data will come from SEFSC activities associated with the NRDA MDBC program.	Ongoing, but future funding is needed	SERO, HMS, NCEI, RESTORE, NRDA MDBC, State partners, Academia
G2.25	Links to G2.13, G2.19	Increase temporal and geographic scope of collection of environmental data (dissolved oxygen, salinity, temperature) in order to better monitor and predict such factors as technical interactions of fisheries and protected resources, or hotspots of critical habitat and aggregation areas. This project could be addressed by the CEFI.	Ongoing, but future funding is needed	SEFSC, NRDA MDBC, State partners
	Objective 7: Infrastructure to Deliver Actionable Information			

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
G2.26	*Links with GMRAP Action 53 & S-RAP Action 60	Build Capacity: Develop climate science team including leads from both the SERO and the SEFSC to monitor the progress of the action items within RAP 2.0, and to be involved with climate change initiatives as needed.	Ongoing. Additional funding would increase effectiveness.	SEFSC, SERO, HMS, AOML
G2.27		**Priority Action,** Build Capacity: Identify and secure the staffing resources needed to conduct the work of this Action Plan (i.e., climate science researcher/coordinator, survey statistician, modelers, fisheries disaster experts and other additional skill sets) through hiring new FTEs, contractor services, or cooperative research programs.	Ongoing; future funding needed	SEFSC, SERO
G2.28		Build Capacity: Invest in existing staff professional development to build or strengthen expertise to meet climate science needs and develop short term rotational assignments and/or exchanges between NOAA programs to build capacity and share ideas.	Ongoing; future funding needed	SERO, SEFSC, HQ, HMS

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
G2.29	*GMRAP Action 49, *S-RAP Action 56; links with G2.18, G2.19, G2.20	**Priority Action,** Strategic Planning: Build on existing sampling and develop a comprehensive and collaborative monitoring program for climate and other ecosystem and ecological information necessary to meet NOAA Fisheries mission for Gulf of Mexico species and habitats, including ecosystem approaches to fisheries management (e.g., Ecosystem Based Fisheries Management) and Deepwater Horizon related monitoring, restoration, and science programs. Fully-established program will include components of the marine ecosystem from physical oceanography to marine mammals, sea turtles, and seabirds.	Future funding needed	SERO, ST, SF, HMS, PR, HC, NOAA Restoration Center, AOML, NOAA IEA, and Climate Programs, State partners, GMFMC, RESTORE Act Council, International partners, FWS, others
G2.30		Develop protocols and training for incorporating climate change information into fishery management plans (FMP) amendments. For example, work with the SEFSC, the climate team, and the GMFMC to review and incorporate the information gained from the vulnerability assessments into management decisions. This could involve including CVA analysis in each FMP for the associated species and highlighting the CVA analysis during Council discussion of particular management actions, or discussions at Atlantic HMS Advisory Panel (AP) meetings.	Ongoing. Additional funding would be more effective.	SEFSC, SERO, HMS, Councils, HMS AP
G2.31		Partner with BOEM to provide data and analysis about the potential impacts to fisheries resources, stakeholders, and protected resources, as well as ways to avoid, minimize and mitigate those impacts, in support of the marine spatial planning efforts to develop	Ongoing. Additional funding would	SERO/SEFSC, HMS, BOEM

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
		wind energy in the Gulf of Mexico. A SEFSC wind team has been formed for this process and SEFSC representatives are coordinating with the NE region to design a program for mitigating the impact of offshore wind energy development on the survey, assessment, and data enterprise in the region.	increase effectiveness .	
G2.32		**Priority Action,** Increase awareness and utility of ecosystem status reports, vulnerability assessments, and other climate tools for use by managers and stakeholders. (e.g., disseminate information from the sea level and storm surge risk assessments for the Southeast for use in making management decisions).	Ongoing. Two recent workshops helped to increase Council awareness of ESRs	, SERO, HMS, Councils, SEFSCHMS AP, public
G2.33		Increase frequency of delivery of ecosystem status reports, vulnerability assessments, and other climate tools for use by managers and stakeholders. Target delivery would be annual.	Future funding needed	SEFSC, SERO, HMS, Councils, HMS AP, CRCP NCRMP, public
G2.34		Post-disaster assessments: conduct research on disaster (e.g., hurricanes, freshwater intrusion events, harmful algal blooms) impacts and identify key areas of vulnerability for the fishing industry and fishing communities as well as protected resources.	Future funding needed	SEFSC PR, SERO
G2.35		**Priority Action,** Strategic Planning: Host virtual climate change workshop with partners in the region. Workshop will include participants from SEFSC, SERO, HMS, AOML, Councils, HMS AP, and others.	Ongoing	SEFSC, SERO, HMS, AOML, Councils, HMS AP, others

Action Number	Connection with other Activities	Action Name/Description	Time Frame	Partners
G2.36		Include NOAA's climate professionals on NOAA teams assisting federal action agencies during the feasibility and design phases of federal civil works projects to ensure incorporation of the information and actions needed to fully address climate change.	Ongoing	SEFSC, SERO, AOML
G2.37		**Priority Action,** SERO PRD to host National Conservation Training Center Climate Change course: CSP3916 Planning for a Changing Climate (4-day in person workshop focusing on Protected Resources to include HCD, SEFSC, and representatives from a few federal agencies (e.g., USFWS, NPS). Course Objectives: Planning for a Changing Climate (P4CC) will provide a good basic understanding of where/how one can include climate-informed thinking in our work using a modified Climate-Smart Cycle. Each module covers one or more of the topics in the cycle, providing a high level overview of how to review/make SMART climate-informed goals and objectives, how to pick drivers based on importance, uncertainty and controllability, how to do a climate vulnerability assessment (CVA), how to develop and use scenario planning to consider uncertainty, and identify/evaluate adaptation actions that address vulnerabilities (identified by the CVA).	2022	PRD HQ, SERO
G2.38	G2.13	**Priority Action,** Support the application and development of the Climate, Ecosystems, and Fisheries Initiative in the southeast region.	Future funding needed	SEFSC, AOML, GFDL

*Designates action items in original RAPs, accessible here: Southeastern U.S. Continental Shelf and Gulf of Mexico Regional Action Plans | NOAA Fisheries

Southeast United States Continental Shelf Action Plan

The southeast United States continental shelf (SEUSCS) and its coastal region encompasses an area from Cape Hatteras, North Carolina to Key West, Florida and has a surface area of approximately 300,000 km^2. The width of the continental shelf (< 100 m deep) varies and is greatest off Georgia (120 km) and narrowest off southern Florida (10 km). Oceanographic and temperature dynamics of the region, in particular waters of the outer (40 m – shelf break) continental shelf, are strongly influenced by the dominant oceanographic feature of the Gulf Stream, a powerful western boundary current. The Gulf Stream originates off southern Florida and brings warm water northward along the southeast coast of the U.S. Meanders and warm and cold core rings of the Gulf Stream significantly affect the physical oceanography of the continental shelf and slope. Key climate change drivers that are thought to result in biological impacts on the SEUSCS include warming ocean temperatures, sea level rise, and ocean and coastal acidification. Additional regional characteristics of the SEUSCS can be found in Gore et al. (2020).

Scientific data, information, and advice produced by NOAA Fisheries and partners across the region are critical to managing living marine resources of the SEUSCS. NOAA Fisheries SEFSC and the SERO have very strong scientific and management capabilities with expertise that crosses many disciplines. The goal of most ongoing science and research supports living marine resource management and often must address immediate, short-term needs and questions. To fully monitor and understand the impacts of the changing climate on LMRs and the habitats and ecosystems upon which they depend, the SEFSC will need to rebalance existing resources and expertise, expand collaborations with partners, and enhance science infrastructure.

The SERAP team evaluated ongoing work and identified 44 actions to help meet climate science needs for the SEUSCS region. In this section and in Table 2, the approach for making progress on these activities over the next three to five years is described with level funding by strategically aligning existing programs to include climate science, re-directing staff as needed and appropriate, and collaborating with partners. Actions that could be accomplished over the next three to five years with increased funding, representing additional capabilities, and actions that will be undertaken if funding allows, are also included and shaded in gray in the Action Tables below. As funding becomes available, prioritization and scaling of these actions will occur as needed to meet needs within the constraints of any new resources. Some actions in the plan are necessary prerequisites for others, and there is a need to consider sequencing activities appropriately in the event that funding becomes available. Actions are presented in relation to the seven objectives identified in the NCSS and in the first S-RAP.

Table 2. South Atlantic Regional Action Plan

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
	Objective 1: Climate-informed reference points			
S2.1	*S-RAP Action 1	Collaborate in national-level workshop to increase collaborations with colleagues across the agency and external partners to develop environmental and climate process information for use in establishing climate-informed reference points.	Ongoing-2024	SEFSC, SERO, SAFMC, other NOAA Fisheries regions, HMS, Academia, state agencies
S2.2	*S-RAP Action 15	Include environmental covariates in stock assessments.		SEFSC, SERO, SAFMC, HMS
	Objective 2: Identify robust strategies for managing LMRs under changing climate conditions			
S2.3		**Priority Action,** Partner with NRCC, HQ, Mid-Atlantic and Greater Atlantic Regions to conduct East Coast Scenario Planning workshops with stakeholders to better understand climate impacts on the Atlantic coast. Conduct Scenario planning based on managing species that are shifting or adjusting their range.	Ongoing	NRCC, Mid-Atlantic, Greater Atlantic, South Atlantic Councils and Regions, NOAA HQ
S2.4		**Priority Action,** Develop empirical (non-model-based or indicator-based) management procedures (MPs) for dolphinfish in the Southeast U.S. These MPs would likely rely on an index of abundance that is responsive to environmental / climatic conditions to manage a short-lived species.	2022 -	SEFSC, SERO, NCSU

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.5		Develop a Management Strategy Evaluation to assess the performance of dynamic reference points.	Future funding needed	SEFSC
S2.6		**Priority Action,** Continue to incorporate climate and ecosystem considerations into Essential Fish Habitat and Habitat Areas of Particular Concern designations, National Environmental Policy Act Reviews, restoration planning, and other management actions and products.	Ongoing	SERO, HC, PR, HMS, ST, SAFMC, NOAA Restoration Center
S2.7		Continue and expand incorporation of climate-related information and uncertainty into protected species reference points and related ESA actions (i.e. incidental take recommendations, biological opinions, listing, recovery, critical habitat designation) in a consistent manner across the region.	Ongoing	SERO, SEFSC, PR, ST, Academia
	Objective 3: Adaptive Management Processes			
S2.8		Continue outreach and participatory research focused on identifying possible climate change impacts on fishery-dependent businesses (including commercial, for-hire, recreational fishing, and seafood markets) and identifying needs and opportunities to build resilience in fishing-dependent socioeconomic systems.	Ongoing with Future Funding Needed	SEFSC, SERO, SAFMC
	Objective 4: Identify Future States of Marine & Coastal Ecosystems			
S2.9		Develop small-scale, nested biogeochemical hydrodynamic models of particular bays, reef systems, and estuaries forced by relevant oceanographic and atmospheric processes (e.g., Gulf Stream,	Future funding needed	SEFSC, AOML, GFDL

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		AMO, North Atlantic Oscillation [NAO], ENSO, local meteorological fields, river discharge). These models would allow investigation of such factors as temperature dynamics at reef scales, bay and estuarine circulation and productivity patterns, and changes to freshwater outflow and water quality from increased numbers of storms. The models could allow forecasts of impacts to reef, seagrass, and mangrove habitats, as well as likelihood and potential for habitat migration, thus supporting ongoing site-specific Essential Fish Habitat research and LMR management. This work is envisioned to be a component of the CEFI and will require collaboration with AOML and GFDL.		
S2.10		Develop maps showing the expected future head of tide in priority watersheds, the expected distribution of Essential Fish Habitat and projections for hydrographs for rivers in which NOAA Fisheries trust resources are affected or NOAA needs to do an EFH or ESA consultation (e.g., Catawba River - shad and blueback herring populations, Atlantic and shortnose sturgeon; Roanoke and Chowan Rivers - shad, striped bass).	Future funding needed	SEFSC, SERO, ACOE, FERC
S2.11		Compile data on temperature (evapotranspiration), precipitation, and river discharge for use in evaluating impacts on EFH and protected species.	Future funding needed	SEFSC, SERO, ACOE, FERC

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.12		Study the impacts of climate change on changes in freshwater (rainfall, river flows, water use conflicts) as it affects marine mammals, sea turtles, sturgeon, and sawfish. Changes in salinity may impact marine mammal, sea turtle health and habitat suitability. Changes in precipitation exacerbates water rights issues and conflicts between stakeholders and also necessitates dynamic mitigation strategies to protect sturgeon in spawning rivers especially.	Ongoing with future funding needed	SEFSC PR SERO
S2.13		Assess impacts of increasing temperatures on sea turtle sex ratios, thermogenetic spawning triggers for ESA-listed fish and elasmobranchs, sturgeon resting areas in rivers, and maintaining coral resilience. Conduct field- and lab-based experiments to identify thermally resistant genotypes of ESA-listed coral species like Acropora *palmata* to inform restoration efforts. Leverage long-term demographic monitoring of *A. palmata* to understand impacts of climate on ESA-listed coral populations and inform restoration efforts	Ongoing with future funding needed	SEFSC PR, SEFSC, CRCP, NGOs, AOML
S2.14		**Priority Action,** Study impacts of climate variability and changing ocean dynamics on the recruitment of economically and ecologically important fishes in the Gulf of Mexico and South Atlantic. This project is investigating several potential underlying mechanisms with the intent of informing fisheries management, in particular approaches to constructing projection scenarios which are used to inform future catch levels.	2020-2023	SEFSC, AOML, Northern Gulf Institute, North Carolina State University, University of Southern Mississippi
	Objective 5: Understand Mechanisms of Change			

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.15	*S-RAP Action 32	Adapt community social vulnerability indices for coastal and fishing communities in the SEUSCS region based on the outcome of species vulnerability analyses.	Ongoing	SERO, SEFSC, HMS, ST, NOS, Sea Grant, Climate Community of Practice, SAFMC
S2.16		Use archived time series of biological samples to examine effects of changing climate on species productivity and distribution (otoliths can detect latitudinal shifts; changes in phenology could be linked to changes in climate, e.g., red snapper archived samples).	Future funding needed	SEFSC
S2.17		Examine effects of climate-influenced habitat loss (e.g., *Acropora* coral) on fish stock mortality, survival, & productivity.	Future funding needed	SEFSC, NCRMP
S2.18		Study the impacts of a changing climate (increasing ocean temperature and acidification, shifts in trophic structure, increasing frequency and severity of tropical storms) and their effect on sea turtle nesting and sturgeon populations.	Future funding needed	SEFSC
S2.19		Conduct controlled laboratory experiments on the effects of individual and combined environmental variables (e.g., temperature, salinity, dissolved oxygen, pH) on the physiology and behavior of selected marine taxa. More information is needed on the response of egg, larval, juvenile, and adult stages of marine species to regime shifts that feature these environmental variables. Climate change is already modifying exposure to multiple environmental factors and studies are needed to determine the effects of these changes on the fitness, distribution and abundance	Future Funding Needed	SEFSC, Academia

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		of LMRs in the presence of this changing environment. Critical studies include growth and survival trials, respirometry experiments, swim tunnel performance assessments, etc. This suite of laboratory-based experiments is currently not funded and will likely require financial support for new and/or upgraded laboratory facilities with state of the art equipment and associated computer hardware/software.		
S2.20		Improved understanding of distribution of sargassum in the Gulf of Mexico, southeast U.S., and Caribbean, and how sargassum distribution impacts productivity and survival of larval/juvenile fishes.	Future funding needed	SEFSC, AOML
	Objective 6: Track Change and Provide Early Warnings			

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.21	*S-RAP Action 39	**Priority Action,** Complete and deliver Ecosystem Status Report for the U.S. South Atlantic to stakeholders/management bodies (e.g., Councils, HQ-HMS Management Division).	Ongoing, but initial report completed in 2021	SEFSC, AOML, NOS/NCCOS; with contributions from: University South Carolina, Duke University, NC State University, NOAA NCEI, East Carolina University, Georgia DNR, SCDNR, Florida Fish and Wildlife Conservation Commission, University of Georgia, NCDMF
S2.22	S2.35	Extend the SEFSC trap-video (SERFS) and deepwater longline surveys from the South Atlantic Bight (SAB) northward to Cape Cod (video as far as visibility allows) in conjunction with the NEFSC.	Discussions ongoing; Future funding needed	SEFSC, NEFSC
S2.23	Links to G2.20, S2.35	**Priority Action,** Conduct broad-scale, multi-platform, multi-species surveys of variability in marine mammal, sea turtle, and seabird abundance, distribution, and density in order to understand how oceanographic and biological attributes contribute to observed species patterns in space and time in the Gulf of Mexico and southeastern Atlantic (Atlantic Marine Assessment Program for	Ongoing and future funding needed	SEFSC, NEFSC

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		Protected Species, AMAPPS), in conjunction with NEFSC.		
S2.24	Links to S2.9, S2.30	Increase temporal and geographic scope of collection of environmental data (dissolved oxygen, salinity, temperature) in order to better monitor and predict such factors as technical interactions of fisheries and protected resources, or hotspots of critical habitat and aggregation areas. This project could be addressed by the CEFI.	Future funding needed	SEFSC, State partners
S2.25	G2.21; C2.14	**Priority Action,** Conduct additional vulnerability assessments to help inform science and management decisions, including a Habitat Climate Vulnerability Assessment (HCVA) for the Gulf of Mexico and the Southeast U.S. Atlantic, and a comprehensive cross-regional climate vulnerability assessment for Atlantic HMS.	Ongoing, Future funding needed	SEFSC, SERO, HMS, HQ OSF, NEFSC, GARFO, OST, Academia, others
S2.26		**Priority Action,** Promote the *Acropora cervicornis* Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers.	Ongoing. Additional funding would increase effectiveness	NOAA through collaborative multi agency, NGO, and university research efforts both national and international
S2.27	*S-RAP Action 49; S-RAP Action 56; S2.35	Continue science research surveys in the South Atlantic. Focus of these surveys includes coral reefs, fishes, marine mammals, commercial and recreational fisheries, and sea turtles.	Ongoing. Additional funding would increase effectiveness .	SEFSC, NEFSC

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.28	*S-RAP Action 47	Conduct a needs assessment for an early warning toolbox to identify which physical, biological, social, and economic indicators will track climate trends and identify thresholds that will provide early warnings of impacts to LMRs and the fishing industry and fishing communities.	Future funding needed	AOML, NOAA Climate Program, Academia
S2.29	*S-RAP Action 41, links with GMRAP Action 37	Create a strategy to obtain new and maintain critical baseline data to support climate science needs identified in the SEUSCS comprehensive monitoring program.	Future funding needed	SERO, HMS, NCEI, State partners, Academia
S2.30	S2.9, S2.19, S2.22, S2.23, S2.24, S2.29, S2.35	Expand survey data collection of ocean variables to better align with the biogeochemical data collection standards established by the Intergovernmental Oceanographic Commission (IOC) and the BGC-Argo program.	Future funding needed	SEFSC, AOML
	Objective 7: Infrastructure to Deliver Actionable Information			
S2.31	*S-RAP Action 60 and GMRAP Action 53	Build Capacity: Develop climate science team including leads from both the SERO and the SEFSC to monitor RAP 2.0 progress, and to be involved with climate change initiatives as needed.	Ongoing. Additional funding would increase effectiveness.	SEFSC, SERO, HMS, AOML

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.32		**Priority Action,** Build Capacity: Identify and secure the staffing resources needed to conduct the work of this Action Plan (i.e., climate science researcher/coordinator, survey statistician, modelers, other and additional skill sets) through hiring new FTEs, contractor services, or cooperative research programs.	Ongoing; future funding needed	SEFSC, SERO
S2.33		Build Capacity: Invest in existing staff professional development to build or strengthen expertise to meet climate science needs and develop short term rotational assignments and/or exchanges between NOAA programs to build capacity and share ideas.	Ongoing; future funding needed	
S2.34	S2.29, S2.30, S2.35	Initiate a survey to collect zooplankton, early life stage fishes, and phytoplankton in the SAB in conjunction with NEFSC. Such collections are necessary to understand potential impacts of changing climate on the trophic structure of the SEUSCS marine ecosystem.	Future funding needed	SEFSC, NEFSC
S2.35	*S-RAP action 56, links with S2.22, S2.23, S2.27, S2.30 S2.34, *GMRAP Action 49	**Priority Action,** Strategic Planning: Build on existing sampling and develop a comprehensive and collaborative monitoring program for climate and other ecosystem and ecological information necessary to meet NOAA Fisheries mission for SEUSCS species and habitats, including ecosystem approaches to fisheries management (e.g., Ecosystem Based Fisheries Management), restoration, and science programs. Fully-established program will include components of the marine ecosystem from physical oceanography to marine mammals, sea turtles, and seabirds.	Future funding needed	SERO, ST, SF, HMS, PR, HC, AOML, NOAA IEA, and Climate Programs, State partners, USFWS, others
S2.36		Develop protocols and training for incorporating climate change information into fishery management plans amendments. E.g., work	Ongoing. Additional funding	SEFSC, SERO, HMS, Councils

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		with the SEFSC, SERO, the climate team, and the SAFMC to review and incorporate the information gained from the vulnerability assessments into management decisions. This could involve including CVA analysis in each FMP for the associated species and highlighting the CVA analysis during Council discussion of particular management actions or discussions at Atlantic HMS Advisory Panel (AP) meetings.	would increase effectiveness .	
S2.37		Participate as a Cooperating / Consulting Agency in BOEM's environmental review processes for wind energy projects in the South Atlantic. We provide detailed information to BOEM regarding the potential impacts to fishery resources, including stakeholder groups, and protected resources, as well as information on ways to avoid, minimize and mitigate those potential impacts. Complete EFH consultation for the Kitty Hawk Offshore Wind Project. A SEFSC wind team has been formed for this process and SEFSC representatives are coordinating with the NE region to design a program for mitigating the impact of offshore wind energy development on the survey, assessment, and data enterprise in region.	Ongoing	SEFSC, SERO, HMS, BOEM
S2.38		**Priority Action,** Increase awareness of ecosystem status reports, vulnerability assessments and other climate tools for use by managers and stakeholders. (e.g., disseminate information from the sea level rise and storm surge risk assessments for the Southeast for use in making management decisions).	Ongoing	SEFSC, SERO, HMS, Councils, HMS AP, public

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
S2.39		Increase frequency of delivery of ecosystem status reports, vulnerability assessments, and other climate tools for use by managers and stakeholders. Target delivery would be annual.	Future funding needed	SEFSC, SERO, HMS, Councils, HMS AP, CRCP NCRMP, public
S2.40		Conduct post-disaster assessments to include research on disaster (e.g., hurricanes, freshwater intrusion events, harmful algal blooms) impacts and identify key areas of vulnerability for the fishing industry and fishing communities as well as protected resources.	Future funding needed	SERO, SEFSC
S2.41		**Priority Action,** Strategic Planning: Host virtual climate change workshop with partners in the region. Workshop will include participants from SEFSC, SERO, HMS, AOML, Councils, and others.	Ongoing.	SEFSC, SERO, HMS, AOML, Councils, others
S2.42		Include NOAA's climate professionals on NOAA teams assisting federal action agencies during the feasibility and design phases of federal civil works projects to ensure incorporation of the information and actions needed to fully address climate change.	Ongoing.	SEFSC, SERO, AOML
S2.43		**Priority Action,** In order to increase the number of people versed in climate-related processes, SERO PRD to host National Conservation Training Center Climate Change course: CSP3916 Planning for a Changing Climate (4-day in person workshop focusing on Protected Resources to include HCD, SEFSC, and representatives from a few federal agencies (e.g., USFWS, NPS). Course Objectives: Planning for a Changing Climate (P4CC) will provide a good basic understanding of where/how one can include climate-informed thinking in our work using a modified Climate-	Completed during public comment period.	PRD HQ, SERO

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		Smart Cycle. Each module covers one or more of the topics in the cycle, providing a high level overview of how to review/make SMART climate-informed goals and objectives, how to pick drivers based on importance, uncertainty and controllability, how to do a climate vulnerability assessment (CVA), how to develop and use scenario planning to consider uncertainty, and identify/evaluate adaptation actions that address vulnerabilities (identified by the CVA). In addition, the course uses small group work, in which groups work through 3 regionally relevant case studies developed specifically for this training to practice the steps.		
S2.44		**Priority Action,** Support the application and development of the Climate, Ecosystems, and Fisheries Initiative in the southeast region.	Future funding needed	

***Designates action items in original RAPs, accessible here: https://www.fisheries.noaa.gov/content/southeastern-us-continental-shelf-and-gulf-mexico-regional-action-plans

U.S. Caribbean Action Plan

The U.S. Caribbean consists of the territories of Puerto Rico and the U.S. Virgin Islands. While accounting for a combined 3,649 km^2 of land mass, the two territories account for a combined 211,429 km^2 of area within the exclusive economic zone (EEZ). The region is home to important and diverse coral reef ecosystems, and more than 1400 species of marine fishes. The area is influenced from a physical oceanographic standpoint by the Caribbean Current, which flows south of the islands, and the Antilles Current, which flows on the north side of the islands. Both current features are offshoots of the North Equatorial Current and are warm, nutrient-rich water masses. Marine fishery resources in the U.S. Caribbean EEZ fall under the management jurisdiction of either the Caribbean Fishery Management Council (CFMC) or by NOAA Fisheries under the authority of the Secretary of Commerce (Atlantic HMS). The Council created island-specific FMPs for the EEZ off each of Puerto Rico, St. Thomas/St. John, and St. Croix, which has resulted in three new management areas: Puerto Rico, St. Croix, and St. Thomas/St. John. Key climate drivers expected to impact marine resources in the region include increasing sea surface temperatures, increasing ocean acidification, sea level rise, and increasing frequency and severity of tropical storms and hurricanes. The CFMC in partnership with SERO is also developing a Fishery Ecosystem Plan (FEP) that would evaluate how best to integrate ecosystem approaches into existing fisheries management in the U.S. Caribbean. The data collection process in the FEP includes the acquisition of datasets that can provide information on changes through time, that may allow identifying and responding to climate variability and climate change impacts on Caribbean marine ecosystems/fisheries.

Owing to logistics, a RAP for the Caribbean was not produced when initial RAPs for the Gulf of Mexico and SEUSCS were developed. A brief Caribbean RAP is included here, identifying 22 actions to initiate directed climate work for the region. The Caribbean will be included in future RAPs as well. This Caribbean RAP only includes actions that would meet Objectives 4-7, as that information is needed before addressing Objectives 1-3. In this section and in Table 3, the approach for making progress on these activities over the next three to five years is described with level funding by strategically aligning existing programs to include climate science, re-directing staff as needed and appropriate, and collaborating with partners. Actions that could be accomplished over the next three to five years with increased funding, representing additional capabilities and actions that will be undertaken if funding allows, are also included and shaded in gray in the Action Tables below. As funding becomes available, prioritization and scaling of these actions will be done as needed to meet needs within the constraints of any new resources. Some actions in the plan are necessary prerequisites for others, and there is a need to consider sequencing activities appropriately in the event that funding becomes available. Actions are presented in relation to the seven objectives identified in the NCSS.

Table 3. Caribbean Regional Action Pla0n

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
Objective 1: Climate-informed reference points				
		No current or planned activities under this objective owing to insufficient baseline data.		
Objective 2: Identify robust strategies for managing LMRs under changing climate conditions				
C2.1		**Priority Action,** Continue to incorporate climate and ecosystem considerations into Essential Fish Habitat and Habitat Areas of Particular Concern designations, National Environmental Policy Act Reviews, restoration planning, and other management actions and products.	Ongoing	SERO, HC, PR, HMS, ST, SAFMC, NOAA Restoration Center
C2.2		Continue and expand incorporation of climate-related information and uncertainty into protected species reference points and related ESA actions (i.e. incidental take recommendations, biological opinions, listing, recovery, critical habitat designation) in a consistent manner across the region.	Ongoing	SERO, SEFSC,PR, ST, Academia
Objective 3: Adaptive Management Processes				
C2.3		Initiate outreach and participatory research focused on identifying possible climate change impacts on fishery-dependent businesses (including commercial, for-hire, recreational fishing, and seafood markets) and identifying needs and opportunities to build resilience in fishing-dependent socioeconomic systems.	Future funding needed	SEFSC, SERO, CFMC

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
Objective 4: Identify Future States of Marine & Coastal Ecosystems				
C2.4		Assess impacts of increasing temperatures on sea turtle sex ratios, thermogenetic spawning triggers for ESA-listed fish and elasmobranchs, and maintaining coral resilence. Conduct field- and lab-based experiments to identify thermally resistant genotypes of ESA-listed coral species like Acropora palmata to inform restoration efforts.	Ongoing with future funding needed	SEFSC, SERO, PR, CRCP, NGOs, AOML
C2.5		Develop small-scale, nested biogeochemical hydrodynamic models of particular bays, reef systems, and estuaries forced by relevant oceanographic and atmospheric processes (e.g., Gulf Stream, AMO, North Atlantic Oscillation [NAO], ENSO, local meteorological fields, river discharge). These models would allow investigation of such factors as temperature dynamics at reef scales, bay and estuarine circulation and productivity patterns, and changes to freshwater outflow and water quality from increased numbers of storms. The models could allow forecasts of impacts to reef, seagrass, and mangrove habitats, thus supporting ongoing site-specific Essential Fish Habitat research and LMR management. This work is envisioned to be a component of the CEFI and will require collaboration with AOML and GFDL.	Future funding needed	SEFSC, AOML, GFDL
Objective 5: Understand Mechanisms of Change				
C2.6		Explore how extreme events (hurricanes) change the distributions of LMRs such as Caribbean spiny lobster and queen conch.	Future funding needed	

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
C2.7		Improved understanding of distribution of sargassum in the Gulf of Mexico, southeast U.S., and Caribbean, and how sargassum distribution impacts productivity and survival of larval/juvenile fishes.	Future funding needed	SEFSC, AOML
Objective 6: Track Change and Provide Early Warnings				
C2.8		Complete and deliver Ecosystem Status Report for the U.S. Caribbean to stakeholders/management bodies (e.g., Councils, HQ-HMS Management Division).	Ongoing, 2022?	SEFSC, University of Miami, CFMC, AOML
C2.9	C2.20	Leverage the National Coral Reef Monitoring Program's (NCRMP) ongoing fish, benthic, and climate survey efforts to expand surveys to mesophotic reefs in the USVI and Puerto Rico that represent a potential thermal refuge for reef species. Leverage work by SEFSC on deep reef fish genetics and habitat utilization as well as work in mesophotic zone.	Ongoing, but future funding needed	SEFSC, NCRMP
C2.10	C2.20, G2.20, S2.23	**Priority Action,** Conduct broad-scale, multi-platform, multi-species surveys of variability in marine mammal, sea turtle, and seabird abundance, distribution, and density in order to understand how oceanographic and biological attributes contribute to observed species patterns in space and time in the Caribbean.	Future funding needed	SEFSC
C2.11	Links to C2.5, C2.13	Increase temporal and geographic scope of collection of environmental data (dissolved oxygen, salinity, temperature) in order to better monitor and predict such factors as technical interactions of fisheries and protected resources, or hotspots of critical habitat and aggregation areas. This project could be addressed by the CEFI.	Future funding needed	SEFSC, State partners

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
C2.12		**Priority Action,** Promote the *Acropora cervicornis* Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers.	Ongoing. Additional funding would increase effectiveness.	NOAA through collaborative multi agency, NGO, and university research efforts both national and international.
C2.13	C2.5, C2.9, C2.10, C2.19, C2.20	Expand survey data collection of ocean variables to better align with the biogeochemical data collection standards established by the Intergovernmental Oceanographic Commission (IOC) and the BGC-Argo program.	Future funding needed	SEFSC, AOML
C2.14	G2.21; S2.25	**Priority Action,** Conduct comprehensive cross-regional climate vulnerability assessment for Atlantic HMS.	Ongoing	HMS, HQ OSF, SEFSC, SERO, NEFSC, GARFO, OST, Academia, others
Objective 7: Infrastructure to Deliver Actionable Information				
C2.15		**Priority Action,** Identify Caribbean focused staff to participate in the southeast regional climate change team.	Ongoing	SERO, SEFSC, HQ, HMS
C2.16		**Priority Action,** Build Capacity: Identify and secure the staffing resources needed to conduct the work of this Action Plan (i.e., climate science researcher/coordinator, survey statistician, modelers, fisheries disaster experts and other additional skill sets)	Ongoing; future funding needed	SEFSC, SERO

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
		through hiring new FTEs, contractor services, or cooperative research programs.		
C2.17		Include NOAA's climate professionals on NOAA teams assisting federal action agencies during the feasibility and design phases of federal civil works projects to ensure incorporation of the information and actions needed to fully address climate change. services	Ongoing	SEFSC, SERO, AOML
C2.18		**Priority Action,** Strategic Planning: Host virtual climate change workshop with partners in the region. Workshop will include participants from SEFSC, SERO, HMS, AOML, Councils, and others.	Ongoing	SEFSC, SERO, HMS, AOML, Councils, others
C2.19	C2.20	Expand science research surveys beyond NCRMP and Southeast Area Monitoring and Assessment Program (SEAMAP)- Caribbean. Focus of these surveys will eventually include mangrove, seagrass, and coral reef habitats, sargassum, fishes, marine mammals, commercial and recreational fisheries, and sea turtles.	Future funding needed	SEFSC

Action Number	Connection to other activities	Action Name/Description	Time Frame	Partners
C2.20	Links with C2.9, C2.10, C2.13, C2.19	**Priority Action,** Strategic Planning: Build on existing sampling and develop a comprehensive and collaborative monitoring program for climate and other ecosystem and ecological information necessary to meet NOAA Fisheries mission for Caribbean species and habitats, including ecosystem approaches to fisheries management (e.g., Ecosystem Based Fisheries Management), restoration, and science programs. Fully-established program will include components of the marine ecosystem from physical oceanography to marine mammals, sea turtles, and seabirds.	Future funding needed	SERO, ST, SF, HMS, PR, HC, AOML, NOAA IEA, and Climate Programs, State partners, USFWS, others
C2.21		**Priority Action,** Support the application and development of the Climate, Ecosystems, and Fisheries Initiative in the Caribbean region.	Future funding needed	SEFSC, AOML, GFDL
C2.22		**Priority Action,** Increase awareness of ecosystem status reports, vulnerability assessments and other climate tools for use by managers and stakeholders. (e.g., disseminate information from the ecosystem status report for the Caribbean and island-specific risk assessments, allowing exploration of multiple pressures and drivers, including climate, specific to each island jurisdiction).	Ongoing	SEFSC, SERO, HMS, Councils, HMS AP, CRCP NCRMP,public

Description of Priority Actions

Additional details of priority actions introduced on page two and included in the three regional action plan tables above are provided here. GOM indicates actions applicable to the Gulf of Mexico, SA indicates actions applicable to the Southeast U.S. Continental Shelf, CAR indicates actions applicable to the U.S. Caribbean.

NCSS Objective 7 (Infrastructure to Deliver Actionable Information)

Build Capacity: Identify the staffing resources needed to conduct the work of this Action Plan (i.e., climate science researcher/coordinators, survey statisticians, modelers, fisheries disaster experts and other additional skill sets) through hiring new FTEs, contractor services, or cooperative research programs. (GOM, SA, CAR). This priority action would alleviate some of the limitation of staffing on effective southeast regional climate science by identifying the critical skills and experience required to fulfill regional climate needs. Appropriate personnel would be identified and then brought into the regional climate team via one of several vehicles ranging from contractor services, rotational assignments or full time employees.

Strategic Planning: Host virtual climate change workshop with partners in the region (GOM, SA, CAR). The Southeast Region Climate Team intends to hold a virtual climate organizational workshop with partners from the Gulf of Mexico, South Atlantic, and Caribbean in the by the end of FY24. The workshop will include participants from SEFSC, SERO, HMS, AOML, Fishery Management Councils, NOS, and others. An organizational workshop is a critical step in identifying the range of climate-related activities, issues, and interests for our geographic jurisdiction, as well as identifying and prioritizing key near- and long-term focus areas. Potential issues might include the following: Shifting species distributions: dolphinfish, black sea bass, Atlantic sharpnose shark, blacktip shark, spinner shark, southern kingfish, white shrimp; Changes in distribution of wetland foundation species: mangroves and saltmarsh; Spread of invasive species; Changes in realized or projected environmental conditions. Many of these issues were identified during development of RAP 2.0 and their treatment during a workshop will enable a more thorough presentation and robust discussion. The identification of climate-related issues and activities, and eventual engagement with a broader network of participants and stakeholders will support the implementation of the RAPs in the GOM, SEUSCS, and will assist with further development of the RAP for the Caribbean. A RAP organizational workshop would also directly address recommendations from the 2018 “Advancing AOML & SEFSC Partnerships” workshop: 1) hold AOML-SEFSC joint workshops approximately every other year, 2) increase communication between labs, and 3) organize future workshops around key focal areas (supporting the NCSS and the RAPs were identified as key focal areas). One key goal for the workshop will be to strengthen collaborative climate science and management efforts in the region.

Support the application and development of the Climate, Ecosystems, and Fisheries

Initiative in the southeast region. (GOM, SA, CAR). The Climate, Ecosystems, and Fisheries Initiative (CEFI) is a cross-NOAA program to deliver actionable environmental and species distributional information for use in LMR management. The program intends to construct high resolution regional biogeochemical hydrodynamic models and ecosystem models to produce hindcasts, nowcasts, and forecasts of biogeochemical ocean conditions under climate forcings. When fully operational these modeling systems will deliver actionable climate-informed information via the Fisheries and Climate Decision Support System. This system will support climate-informed stock assessments and provide advice to fisheries decision-makers. Within the CEFI will be a data delivery mechanism using web portals to allow easy access to CEFI data and results. One goal of the CEFI is to improve the sustainability of fisheries, protected resources, habitats and the people and communities dependent upon them. In the southeast region, the CEFI will provide modeling products and data interpretation for the Gulf of Mexico, SEUSCS, and the Caribbean. SERO and the SEFSC will support the CEFI by working nationally and with GFDL and AOML to stand up a CEFI support team and help to develop and deliver climate-ready products from the CEFI.

Identify Caribbean focused staff to participate in the southeast regional climate change team. (CAR). During the development of RAP 2.0, it became clear that representation by, and better coordination with, Caribbean managers and scientists would increase information flow and allow for better identification of climate concerns. This priority action item will formally bring Caribbean representation to the Southeast Regional Climate Team to achieve this goal.

Increase awareness and utility of ecosystem status reports, vulnerability assessments and other climate tools for use by managers and stakeholders (GOM, SA & CAR). Since the development of the RAP 1.0 for the Gulf and SEUSCS, tools have been developed to help identify climate change impacts in the region. These tools include the ecosystem status reports for the Gulf, SEUSCS, and Caribbean (under development), ecosystem-level island-specific risk assessments (Caribbean), vulnerability assessments for managed and protected species, and sea level and storm surge risk assessments for the Southeast. Although all of them contain useful information, these tools have not regularly been used by management in recent decisions. Under this action, the climate team would identify ways in which these tools can be better disseminated to managers and would begin to develop a process in which the information from these tools could be used in management decision making. The climate team recognizes that there are many new tools available to managers to understand climate change impacts in the region, but heard from many during the interviews that they aren't sure how or when to use the information. Additionally, the climate team was also made aware in interviews and public comments that respondents desire more regular transmission of environmental and climate information (at least on an annual basis), and better linkage of climate-informed science and decision support tools to tangible management decisions at the Council level. Providing regular updates such as State of Ecosystem (SoE) reports and Ecosystem Report Cards allows managers and the public to become familiar with changing conditions and facilitates incorporation of environmental information in the management process. To this end, the SEFSC is exploring the methodology to produce advanced ecosystem status reports, such as SoE reports and Ecosystem Report Cards with indicators that can be compiled and automated so

that the reports can be produced more frequently. The climate team intends to consult with other NOAA regions (e.g., Northeast, Alaska) to review best practices and lessons learned from their programs where the regular development of SoE reports and Report Cards are well established.

Host a National Conservation Training Center Climate Change course (GOM & SA). CSP3916, Planning for a Changing Climate, is a 4-day in person workshop focusing on Protected Resources to include HCD, SEFSC, and representatives from a few federal agencies (e.g., USFWS, BLM). The SERO course, in particular, will be somewhat tailored to species and habitat of the South Atlantic and Gulf of Mexico in that case studies will reflect the southeast region. This USFWS 4-day class was designed in partnership with NOAA and provides participants with the skills and tools to interpret climate data and determine how these data can be used in ESA and MSA regulatory and policy decision making. One particular emphasis for the course involves participants gaining experience in developing conservation mitigation plans for long-term and/or high-impact projects exacerbated by climate change stressors. The course style involves lightning lectures by instructors followed by break-out teams that focus efforts on applying a climate-smart conservation cycle.in managing regionally-focused projects. Regionally specific case studies will be used throughout the course to practice provided frameworks and summarize planning results. Participants will benefit from demonstrating leadership in small teams and reporting within *ad hoc* teams and to the larger class as a whole their progress in a final class presentation.

Develop a comprehensive and collaborative monitoring program for climate and other ecosystem and ecological information necessary to meet the NOAA Fisheries mission for SEUSCS species and habitats, including ecosystem approaches to fisheries management (e.g., Ecosystem Based Fisheries Management), restoration, and science programs (GOM & SA). Collaborate with NEFSC in designing fishery surveys that would better elucidate climate effects and distribution shifts in living marine resources of the SEUSCS. Funding support for the initiation of phytoplankton, early life stage fishes and other zooplankton sampling on the SEUSCS to align with ongoing sampling in the NE, expansion of the area sampled from inshore estuarine areas and habitats out to the continental shelf, and expansion of the reef fish trap surveys in the Gulf of Mexico (CRP, G-Fisher) to better detect fish distribution and abundance changes. Fully-established program will include components of the marine ecosystem from physical oceanography to marine mammals, sea turtles, and seabirds. Increased collection of environmental data and physical oceanographic data, including the expansion of survey collection of Essential Ocean Variables, will better align with the biogeochemical data standards established by the IOC and the BGC-Argo program. Data collected will include salinity, temperature, depth (CTD), pH, DO, nitrate, Chl-a, bio-optical (fluorescence and backscatter), carbonate, dissolved inorganic carbon, total alkalinity, and pCO2. Multifrequency acoustic profilers and hyperspectral radiometers will be added to CTD casts for examining zooplankton size spectra (to support modeling) and ocean color. Laboratory work, conducted in concert with AOML, will produce data on chlorophyll, HPLC (for algal pigments), DNA/RNA, and eDNA. Funding needed for this collection of tasks is $4.85 million. While this seems aspirational, much of the funding seeks to stand up long overdue sampling.

The risk associated with not funding this data collection enterprise is the inability of the SEFSC to track, understand and prepare for climate-driven change and respond to disasters. Without this action, surveys along the east coast of the United States will continue using different gear and methodology between management jurisdictions, making it difficult to manage species moving between regions as a result of climate change. Important biophysical and chemical data for supporting the CEFI will not be collected and the southeast will not have the capability to develop models that effectively link biogeochemical, hydrodynamic and ecosystem processes with enough predictive skill to be useful for fisheries assessment and management. This action also aligns with NCSS Objective 6, Tracking Change, and Objective 4, Projecting Future Conditions.

NCSS Objective 6 (Track Change and Provide Early Warnings)

Complete an ecosystem status report for the U.S. South Atlantic region (SA). The first ecosystem status report for the U.S. South Atlantic region was completed in November 2021. Ecosystem status reports (ESRs) are comprehensive syntheses of a range of ecosystem components such as physical oceanographic and environmental parameters, living marine resource trends, as well as socioeconomic and human dimensions information. They provide a broad overview of the current state of an ecosystem with respect to recent and historical trends using a suite of indicators. ESRs transfer knowledge to managers to provide context and information for a range of decisions affecting marine ecosystems, and they facilitate communication and information exchange between scientists, managers, and stakeholders. The indicators and trends examined in the U.S. South Atlantic ESR suggest that the ecosystem is stressed from changing ocean conditions and experiencing pressure from the growing coastal population. Sea levels are rising, sea surface temperatures are increasing, continental shelf waters are becoming more acidic, and nutrients such as nitrogen and phosphorus from coastal runoff have increased. Some impacts of these observed changes include increased flooding of coastal communities, potential changes to nursery habitats of marsh and beach dependent organisms, coral bleaching and mortality, and increased harmful algal blooms and oxygen depletion of water masses. Population growth in southern U.S. coastal states ranked in the top 15 in the United States from 2010-2020, and a large increase in recreational fishing effort together with a decrease in commercial fishing effort is associated with these demographic changes.

Promote the *Acropora cervicornis* Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers (GOM, SA, CAR). Currently there is a need to further develop information for mitigation efforts using coral “super genotypes.” Multiple universities, state and federal agencies, and NGOs are participating in studies examining coral species and their genotypes that show promise to be resilient to changing water quality parameters due to climate change. NOAA and partners are currently working on making these data centrally available as opposed to going to each researcher to request the data. There is also research attempting to determine if only super genotypes should be used for restoration efforts or if due to limited genotypes in certain areas, all genotypes should be used. At this point, there are still numerous questions that need to be answered. AcDC archives, and makes accessible, physiological data from *Acropora cervicornis*

genotypes to identify genotypes more likely to survive outplanting and withstand increases in temperature, ocean acidification, bleaching, and disease. Expanding use and contributions to AcDC will maximize its utility as an open-access centralized database and web tool to aid in informed restoration. AcDC provides a resource where the centralized data is located, resulting in reduction of duplicative efforts between partners, and identification of data gaps and future research needs.

Conduct broad-scale, multi-platform, multi-species surveys of variability in marine mammal, sea turtle, and seabird abundance, distribution, and density in the Gulf of Mexico and southeastern Atlantic, in conjunction with NEFSC (GOM, SA, CAR). The NEFSC and SEFSC assess abundance, distribution, ecology and behavior of marine mammals, sea turtles, and seabirds throughout the US Atlantic to place them in an ecosystem context and to understand how oceanographic and biological attributes contribute to observed species patterns in space and time, and to provide spatially explicit information usable by Federal decision makers through the Atlantic Marine Assessment Program for Protected Species (AMAPPS). The Centers use visual aerial and shipboard surveys, satellite telemetry, and passive acoustic monitoring to conduct this research. AMAPPS is funded through FY23.

Initiate a Habitat Climate Vulnerability Assessment (HCVA) (SA, GOM). A habitat climate vulnerability assessment (HCVA) can provide regional fisheries, habitat, and protected species managers with a practical tool to efficiently assess the relative vulnerability of habitats to climate change. The results of an HCVA may be used to improve essential fish habitat (EFH) designations and aid in EFH consultations, biological opinions, set habitat conservation priorities, understand cumulative impacts of fishery management actions, and provide long-term context for the management of protected and fishery species. The assessment will include a wide universe of habitat subclasses (the ongoing Northeast HCVA includes fifty-two habitat subclasses in riverine, estuarine, and marine systems), corresponding to the range of habitats used by fishery and protected species managed by NOAA Fisheries in the southeast region. The HCVA will use a similar methodology to the Northeast HCVA. The result of the HCVA will be a ranked list of the relative vulnerability of the assessed habitat subclasses. Detailed results for each habitat will be discussed in a short narrative to describe the key drivers of vulnerability. The results will be written up in an article to be published in a scientific journal, in addition to more tailored products for end users as needed. The project is anticipated to require three years to complete and require funds ($250K) for a contracted scientist to help with the development of habitat profiles and narratives, the online scoring training, data compilation, in-person workshop organization and cost, and final data synthesis and analysis.

Complete a comprehensive, cross-regional Climate Vulnerability Assessment for Atlantic HMS (SA, GOM, CAR). A comprehensive climate vulnerability assessment for Atlantic HMS will provide fishery managers with a practical tool to efficiently assess the relative vulnerability of Atlantic HMS to the impacts of climate change. This CVA could help identify research gaps and help managers prepare for changes affecting Atlantic HMS stocks and communities. Some Atlantic HMS species have been included in the previous northeast (n = 4 sharks), South Atlantic (n = 5 sharks), and Gulf of Mexico (n = 12) CVAs - these results can be analyzed and

leveraged within a more comprehensive CVA. However, several of these species have a distribution that exceeds the scope of these regionally-focused analyses. For example, sandbar shark was analyzed in the Gulf of Mexico CVA, but its full range extends from the Gulf of Mexico to southern New England and includes important nursery grounds in the mid-Atlantic. Other Atlantic HMS species important for commercial (e.g., tunas, swordfish) and recreational (e.g., billfish) fisheries have not yet been included in a CVA. Initial objectives will be to form a team, develop a species list, recruit scorers, and gather environmental data. The results of an HMS CVA could be included in strategic planning, restoration planning, EBFM initiatives, EFH, and other management actions or products (e.g., NEPA documents, research prioritization, biological opinions, risk assessments, cumulative impact analyses, ESRs).

NCSS Objective 5 (Understand Mechanisms of Change)

Identifying linkages between climate induced shifts in nursery habitat distribution and fishery species abundance in salt marsh and black mangrove estuaries across the Gulf of Mexico (GOM). The Gulf of Mexico is surrounded by extensive networks of shallow nearshore habitats. The vegetative components of these estuarine systems include seagrass and salt marsh, with black mangrove increasing in abundance in historical salt marsh areas. Although black mangrove has occurred periodically in the northern GOM, its habitat has increased nearly 25-fold in Louisiana alone since 1986. These expansions are catalyzed by milder winters, increased water temperature, and drought-induced dieback of marsh grass. Since this habitat transition is projected to persist, black mangrove may displace salt marsh as the dominant vegetation type in coastal estuaries. Salt marsh wetlands in the northern GOM are critical nursery areas and productive ecosystems for penaeid shrimp and other recreationally and commercially important fishery species. Fishery species reside in these inshore habitats for varying lengths of time, many migrating offshore seasonally due to ontogenetic shifts or in response to environmental drivers. The export of biomass from inshore habitats as fish and shrimp is a major source of productivity to offshore food webs in the GOM. In the northeastern GOM these subsidies can account for as much as 25% of the productivity in the food webs of nearshore and offshore patch reefs. The displacement of salt marsh by black mangrove has important implications for ecosystem structure and function. The current expansion could drastically change the coastal landscape, alter estuarine habitat functionality, disrupt nutrient cycling, and affect fishery production. However, nekton use of intertidal mangrove habitats in the northern GOM is relatively unknown, and comparisons of fishery species among mangrove and adjacent salt marsh habitats are only recently beginning. Large-scale transition of estuarine habitats in the form of vegetation changes or loss of highly productive habitat types could lead to direct decreases in offshore fishery productivity (e.g., brown shrimp, white shrimp, gray snapper). Current efforts to understand the wide-ranging impacts of these changes will provide data critical to the adaptive management and ecological modelling of these systems as well as stock assessments.

NCSS Objective 4 (Identify Future States of Marine & Coastal Ecosystems)

Study the impacts of climate variability and changing ocean dynamics on the recruitment

of economically and ecologically important fishes in the Gulf of Mexico and South Atlantic. (GOM & SA). The U.S. South Atlantic and Gulf of Mexico region both show indications of increasing temperatures and associated effects on lower trophic levels that may be linked to changing climate and ocean dynamics in the two regions. A collaborative effort among the SEFSC, AOML, and university partners (e.g., N.C. State University, University of Southern Mississippi) is using retrospective analysis of satellite imagery, existing biogeochemical models, and ongoing fishery surveys to better understand how changing ocean conditions will impact the productivity and distribution of ecologically and economically important fishes in the two regions. Results of this multidisciplinary effort support NOAA's overall mission to better understand and predict changes in climate, share knowledge and information with managers, decision-makers and other stakeholders, and promote the conservation and effective management of coastal and marine ecosystems and resources.

NCSS Objective 2 (Identify robust strategies for managing LMRs under changing climate conditions)

Partner with NRCC, HQ, Mid-Atlantic and Greater Atlantic Regions to conduct scenario planning workshops with stakeholders to better understand climate impacts on the Atlantic coast (SA). Over the next year, scenario planning organizations, guided by the Northeast Region Coordinating Council (NRCC), will bring together fishery participants, fishery managers, researchers, and other stakeholders to discuss climate change issues. The intent is to emerge with ideas and recommendations for how fishery management can adapt to climate change. Managers will gather stakeholder input and discuss the recommendations from the scenario planning project and determine next steps. This initiative is an exercise in preparing for the future under a variety of "what if" scenarios. On the East Coast of the U.S., some species of fish are already experiencing climate-related shifts in distribution, abundance, and productivity. A continuation or acceleration of climate change has the potential to strain our existing fishery management system and alter the way fishermen, scientists, and the public interact with the marine environment. To begin preparing for this new era of uncertainty, management bodies along the Atlantic seaboard have teamed up to launch a project called East Coast Climate Change Scenario Planning. The initiative has been organized by a core team of representatives from the New England, Mid-Atlantic, and South Atlantic Fishery Management Councils, the Atlantic States Marine Fisheries Commission (ASMFC), and NOAA Fisheries. The team has lined up three kick-off webinars to introduce stakeholders to the overall initiative, explain the benefits of participating in the process, outline additional ways to get involved, and begin collecting stakeholder input.

Conduct Management Strategy Evaluations to determine robust harvest strategies that take into account stakeholder concerns (GOM, SA).
Management Strategy Evaluations (MSEs) are simulation approaches designed to build or test management procedures (MPs) that maximize management objectives and are robust to a suite of current and future biological, environmental, fishery, and any other relevant uncertainties. Often, stakeholder input is relied upon to develop fishery-specific management objectives. In particular, the current delay between data collection, assessment, and management

implementation is longer than the lifespan of annual or short-lived species (e.g., Gulf of Mexico shrimp) and data limitation may preclude adaptive management of short-lived productive species (e.g., dolphinfish). For short-lived species whose productivity is largely environmentally-driven, empirical (or indicator-based) MPs may be a more appropriate mechanism to generate catch advice compared to more traditional model-based MPs (e.g., a stock assessment process). Empirical MPs rely on an indicator of stock status (e.g., index of abundance) to adjust TAC advice, and have the flexibility to incorporate climatic or environmental drivers of regional abundance and/or local availability. Specifically, empirical dynamic modelling (EDM) may serve to describe and forecast time-series within non-linear, dynamical systems; begging the question of whether this forecasting ability could be co-opted for use in providing management recommendations. In collaboration with SERO, SWFSC, and university partners (NCSU, UC Santa Cruz), this research will serve to advance the ability to manage short-lived fisheries resources taking environmental and climate drivers into account and in the face of non-stationarity and climate change.

NCSS Objective 1 (Climate-informed reference points)

Continue to incorporate climate and ecosystem considerations into Essential Fish Habitat and Habitat Areas of Particular Concern designations, National Environmental Policy Act Reviews, restoration planning, and other management actions and products. **(GOM, SA, CAR).** Currently very little information about climate impacts are added to amendments and other management documents produced by the Southeast Region. Information such as that included in the species climate vulnerability assessments (CVAs), the protected species CVAs, and the planned habitat CVAs will be useful to management and should be included in the documents they review and base decisions on. Additionally, the SEFSC has produced an update to the Gulf Ecosystem Status Report and has recently released a U.S. South Atlantic Region Ecosystem Status Report. This information will be useful in upcoming management decisions made by the councils and by NOAA Fisheries (for Atlantic HMS). Currently, SERO includes a description of the climate environment and the cumulative impacts of climate change in the Fishery Management Plan/NEPA documents they produce with the Gulf of Mexico Fishery Management Council. The Atlantic HMS Management includes climate change information, where appropriate, in management documents and products (e.g., FMP amendments, NEPA documents, EFH 5-Year Review). This action will begin a process to expand the information that is included and to develop a process to share this information with others and develop a protocol on how to include it and how to present this information to decision makers.

Key Metrics

NCSS Objective 7 (Infrastructure to Deliver Actionable Information)

- Virtual climate change workshop with partners in the region (GOM, SA, CAR) will be completed before the end of FY24.

- Identify Caribbean-focused staff to participate in the SERO/SEFSC climate change team by 6/30/2023 (CAR).
- Increase awareness and utility of ecosystem status reports, vulnerability assessments and other climate tools for use by managers and stakeholders. At least four outreach presentations [or some other form of outreach] will be provided by the end of 2023 (GOM & SA). In FY21 a briefing on the SA ESR was given to the SAFMC Habitat and Ecosystem AP in April and June, at the Atlantic Coast Science Coordination Workshop in August, and to the Southeast and Caribbean Regional Team (SECART) in September. A NOAA-wide rollout story on the SA ESR was released in December 2021 and a presentation given to SEFSC all-hands in August 2022.
- In order to increase the number of people versed in climate-related processes, SERO PRD will host a National Conservation Training Center (NCTC) *Planning for a Changing Climate* course. The course will include participants from various divisions and agencies, and be co-taught by USFWS/NMFS OPR/NMFS PRD staff and address case studies for the GOM and SA regions. Course participants will learn about the climate variability analysis process and climate scenario planning.

NCSS Objective 6 (Track Change and Provide Early Warnings)

- Promote the *Acropora cervicornis* Data Coordination hub (AcDC) to maximize participation and collaboration among coral restoration practitioners and researchers. Identify research needs from this dataset by 2024. (GOM, SA, CAR)
- As part of the joint SEFSC/NEFSC Atlantic Marine Assessment Program for Protected Species (AMAPPS), conduct two weeks of sea turtle tagging in both NC and MA (primarily leatherbacks) each FY. Additionally, an aerial survey was conducted in Jan - Feb 2022 and a winter/spring survey is planned for Feb - April 2023. The aerial surveys target both marine mammal and sea turtle data collection for abundance and distribution. An annual report will be submitted each FY. AMAPPS current funding ends in FY24. (SA)

- **Initiate a comprehensive, cross-regional climate vulnerability assessment for Atlantic HMS.** A comprehensive climate vulnerability assessment for Atlantic HMS will provide fishery managers with a practical tool to efficiently assess the relative vulnerability of Atlantic HMS to the impacts of climate change. This CVA could help identify research gaps and help managers prepare for changes affecting Atlantic HMS stocks and communities. Initial objectives will be to form a team, develop a species list, recruit scorers, and gather environmental data.

NCSS Objective 5 (Understand Mechanisms of Change)

- Continue to sample in new locations to broaden our understanding of effects of black mangrove range expansion at differing spatial scales during FY22 and FY23.
    - Collect nekton, benthic, sediment, tissue, and primary producer samples in salt marsh and black mangrove habitats across the northern Gulf of Mexico including Texas, Louisiana, and Florida (Spring and Fall 2023) (GOM)

- Conduct laboratory and field-based growth experiments with penaeid shrimp in salt marsh and black mangrove habitats and collect tissue samples for genetic analyses including RNA:DNA and habitat-specific differences in gene expression and growth (Spring and Fall 2023) (GOM)

NCSS Objective 4 (Identify Future States of Marine & Coastal Ecosystems)

- Study the impacts of climate variability and changing ocean dynamics on the recruitment of economically and ecologically important fishes in the Gulf of Mexico and South Atlantic. Provide information on climatic factors underlying patterns in productivity of reef fishes and coastal pelagic species to South Atlantic and Gulf of Mexico Science and Statistical Subcommittees by Oct 2024. Provide distribution maps of key reef fish species to the South Atlantic Fisheries Management Council and integrate distribution mapping with the national DisMAP (Distribution Mapping) program by Oct 2024. (GOM & SA)

NCSS Objective 2 (Identify robust strategies for managing LMRs under changing climate conditions)

- Partner with NRCC, HQ, Mid-Atlantic and Greater Atlantic Regions to conduct East Coast Scenario Planning workshops with stakeholders to better understand climate impacts on the Atlantic coast (SA).
    - Hosted three stakeholder scoping webinars for constituents on east coast. (Fall 2021) (SA)
    - Collected additional stakeholder input through survey (Fall/Winter 2021) (SA)
    - Conduct scenario planning workshop with stakeholders to develop four scenarios that address uncertainty in stock production and ocean conditions (July 2022) (SA)
    - Host two ‘scenario deepening’ webinars for stakeholders and refine draft scenarios based on comments received (August/September 2022)
    - Host sessions with fishery managers to generate ideas and build on the existing scenarios. (September/October 2022)
    - Host a Summit with fishery managers to review the scenarios and develop recommendations (2023) (SA)
- Develop empirical dynamic modeling (EDM)-based management procedures for shrimp in the Gulf of Mexico (estimated timeline – 2023)
- Simulation testing of empirical management procedures (MPs) for shrimp in the Gulf of Mexico (estimated timeline – 2023)
- Identification of potential environmental / climatic drivers of dolphinfish in the US South Atlantic (estimated timeline – 2023)
- Simulation testing of empirical MPs for dolphinfish in the US South Atlantic (estimated timeline – 2023)

NCSS Objective 1 (Climate-informed reference points)

- Incorporate climate and environmental information in one additional stock assessment by the end of 2024. (GOM, SA, CAR)

Acknowledgements

The authors would like to thank all of those (Appendix) who participated in the interview panels during the preparation phase for this RAP. We also thank Roger Griffis and Jay Peterson at the Office of Science and Technology for their help and guidance, and the leadership of SERO and the SEFSC for supporting the development of this RAP.

References

Capper, A., L.J. Flewelling, K. Arthur. 2013. Dietary exposure to harmful algal bloom (HAB) toxins in the endangered manatee (*Trichechus manatus latirostris*) and green sea turtle (*Chelonia mydas*) in Florida, USA. Harmful Algae 28:1-9. https://doi.org/10.1016/j.hal.2013.04.009.

DOC (2021). Department of Commerce 2021 Climate Action Plan for Adaptation and Resilience. Office of the Federal Chief Sustainability Officer. https://www.sustainability.gov/pdfs/doc-2021-cap.pdf

Gore, K.R., R.C. Muñoz, H.B. Lovett, S.B. Snider and J.A. Quinlan. 2020. 2017 - 2021 Southeast United States Continental Shelf Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy. NOAA Technical Memorandum NMFS-SEFSC-745,48p. https://media.fisheries.noaa.gov/dam-migration/cont_shelf_rap.pdf

Gulf of Mexico Fishery Management Council (GMFMC). 2004. FINAL EIS for the Generic Essential Fish Habitat Amendment to all the fishery management plans of the Gulf of Mexico (GOM).

Lapointe, B.E., R.A. Brewton, L.W. Herren, M. Wang, D.J. McGillicuddy Jr., S. Lindell, F.J. Hernandez, and P.J. Morton. 2021. Nutrient content and stoichiometry of pelagic Sargassum reflects increasing nitrogen availability in the Atlantic Basin. Nat. Commun. 12, 3060. https://doi.org/10.1038/s41467-021-23135-7

Link, J.S., Griffis, R., Busch, S. (Editors). 2015. NOAA Fisheries Climate Science Strategy. U.S. Dept. of Commerce, NOAA Technical Memorandum NMFS-F/SPO-155, 70p. Available at: https://www.st.nmfs.noaa.gov/Assets/ecosystems/climate/documents/NCSS_Final.pdf

Lovett, H.B., S.B. Snider, K.R. Gore, R.C. Muñoz, Editors. 2016. Gulf of Mexico Regional Action Plan to Implement the NOAA Fisheries Climate Science Strategy. NOAA Technical Memorandum NMFS-SEFSC-699. 40 p.

Manzello, D. 2015. Rapid recent warming of coral reefs in the Florida Keys. Sci Rep 5, 16762 https://doi.org/10.1038/srep16762.

Marshak, A.R. and K.L. Heck Jr. 2017. Interactions between range-expanding tropical fishes and the northern Gulf of Mexico red snapper *Lutjanus Campechanus*. J. Fish. Biol. 91:1139-1165. doi:10.1111/jfb.13406

Ortiz, A. C., S. Roy,and D.A. Edmonds. 2017. Land loss by pond expansion on the Mississippi River Delta Plain. Geophysical Research Letters 44 (8), 3635–3642.

Peterson, J., R. Griffis, P. Woodworth-Jefcoats, A. Jacobs, A. Hollowed, E. Farley, J. Duffy-Anderson, M. Dorn, T. Hurst, J. Moss, L. Rogers, K. Shotwell, T. Garfield, R. Zabel, Y. deReynier, E. Shott, L. Crozier, S. Bograd, N. Mantua, J. Samhouri, J. Quinlan, K. Gore, R. Muñoz, J. Leo, L. Waters, M. Burton, V. Saba, D. Borggaard, M. Ferguson, W. Morrison. 2021. NOAA Fisheries Climate Science Strategy Five Year Progress Report. NOAA Tech. Memo. NMFS-F/SPO-228, 157 p

Purtlebaugh C.H., C.W. Martin, and M.S. Allen. 2020. Poleward expansion of common snook *Centropomus undecimalis* in the northeastern Gulf of Mexico and future research needs. PLoS ONE 15(6): e0234083. https://doi.org/10.1371/journal.pone.0234083

Sagarese, S., R., J.F. Walter III, W.J. Harford, A. Grüss, R.P. Stumpf, M.C. Christman. 2018. Updating indices of red tide severity for incorporation into stock assessments for the shallow-water grouper complex in the Gulf of Mexico. SEDAR61-WP-07. SEDAR, North Charleston, SC. 12 pp.

Schirripa, M.J., F. Abascal, I. Andrushchenko, G. Diaz, J. Mejuto, M. Ortiz, M.N. Santos, J. Walter. 2017. A hypothesis of a redistribution of North Atlantic Swordfish based on changing ocean conditions, Deep Sea Research Part II: Topical Studies in Oceanography 140:139-150. https://doi.org/10.1016/j.dsr2.2016.08.002.

Trinanes, J., N.F. Putman, G. Goni, C. Hu, and M. Wang. 2021. Monitoring pelagic Sargassum inundation potential for coastal communities, Journal of Operational Oceanography, DOI: 10.1080/1755876X.2021.1902682

Walter, III, J.F., S.R. Sagarese, W.J. Harford, A. Grüss, R.P. Stumpf, M. C. Christman.. 2015. Assessing the impact of the 2014 red tide event on Red Grouper (Epinephelus morio) in the Northeastern Gulf of Mexico. SEDAR42-RW-02. SEDAR, North Charleston, SC. 13 pp. http://sedarweb.org/sedar-42-rw-02-assessing-impact-2014-red-tide-event-red-grouper-epinephelus-morio-northeastern-gulf

Wang, M., and C. Hu. 2017. Predicting Sargassum blooms in the Caribbean Sea from MODIS observations, Geophys. Res. Lett. 44:3265–3273, doi:10.1002/2017GL072932.

Wang, M. C. Hu, B.B. Barnes, G. Mitchum, B. LaPointe, and J.P. Montoya. 2019. The Great Atlantic Sargassum Belt. Science. 365:83-87.

Appendix A. Interview Questions and Participants

Questions:

1. Do you have ongoing climate-related work in your Branch/Division?
2. Given that the President has issued an Executive Order on climate issues, do you see your Branch or Division incorporating more climate considerations into your day to day work as a result?
3. Have you seen evidence of climate change affecting the Gulf of Mexico, South Atlantic, or Caribbean regions?
4. What specific problems do you see arising with the resources you manage as a result of climate change?
5. If you are planning climate-related activities, what are the primary areas where you see climate change influencing your Branch/Division's work over the next four to five years? Over a longer time frame?
6. Are you aware of the NMFS' Climate Regional Action Plans?
7. Would you like to see any of the challenges/problems you face become focal points for the next-generation Climate Regional Action Plans? Which ones?
8. What kinds of climate information would be most helpful for your Branch/Division in addressing those primary areas?
9. What limitations might keep your Branch/Division from using climate information more fully?
10. NOAA is planning a Climate Fisheries Initiative, which would make available high resolution biogeochemical oceanic circulation model output with climate forcing. The primary goals of this project include producing hindcasts and forecasts on subseasonal/seasonal and yearly/decadal time scales to help support living marine resource management. Do you see a need for these kinds of models/data in your Branch/Division?
11. Can you imagine how your Branch/Division might make use of these kinds of products?
12. How can we link climate processes to living marine resource management, human dimensions, and economics in the systems that you work in?
13. We are trying to build out a regional climate team, do you have people on your staff who might be good candidates for such a team?

Interviewees:

Pamela Brown-Eyo
Joan Browder
Ron Hill
Joe Serafy
Chris Sasso
Matt McPherson
Todd Kellison
Karen Mitchell
Jennifer Doerr
Trey Driggers
Christian Jones
Matt Johnson
Craig Brown
Kevin Craig
Mandy Karnauskas
Pace Wilber
Rusty Swafford
Brandon Howard
Andrew Herndon
Dennis Klemm
David Bernhardt

Nick Farmer
Jennifer Moore
Jack McGovern
Peter Hood
Maria Lopez-Mercer
Michael Jepson
Jessica Stephan
Paul Richard
Mridula Srinivasan
Roger Pugliese
Chip Collier
Chris Sasso
Jennifer Doerr

Climate Team members Participating in Interviews:

Roldan Muñoz
John Quinlan
Karla Gore
Michael Burton
Jennifer Leo
Audra Livergood
Kelli O'Donnell
Pat Opay
Joe Cavanaugh

~~~~~~
~~~~~~