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**CLIMATE CHANGE ACTION PLAN
FOR THE**
Florida
Reef System
2010-2015

Foreword –

It is my privilege to introduce the Climate Change Action Plan for the Florida Reef System. While Climate Change only recently became head line news, those of us who study, manage, or make a living dependent on Florida's coral reef ecosystem have witnessed alarming changes for the past 30 years. These observations coupled with directed scientific research have determined several of the compounding stresses that negatively impact our reef ecosystem. We have endeavored to take independent and discrete actions to address these local stresses across

Florida and have achieved several successes from management intervention.

Unfortunately, more recent consensus on the scientific evidence and associated projections for a rapidly warming ocean and atmosphere paints an alarming picture of future conditions under which our coral reef system must cope. It is imperative that we work across political, social, and jurisdictional boundaries to provide our coral reef systems, and the economies they support, the best opportunity for a sustainable future.



© Larry Lipsky

This Action Plan is the culmination of 5 years of collaborative effort amongst a broad spectrum of coral reef scientists, managers,

and user groups with some of the best and most informed individuals in their respective fields. The plan recognizes the need for a holistic approach across the geographic range of Florida's coral habitats given the inevitability of warmer, more acidic, oceans, and rising sea levels. It is grounded in the concept of "resilience", or ability of the ecosystem to resist or bounce back from impacts. Collectively the actions are designed to enhance our coral reef systems ability to combat the stresses associated with climate change thereby giving them the best chance to adapt while continuing to provide their vital services to our society. A question we often hear is "what can we do about climate change?" This Action Plan provides practical examples and guidance on specific actions that we can take now while global initiatives to stem the rate of climate change are formalized. To be successful, we have to manage the impacts of climate change both at the local and regional scale, while global solutions are advanced.

All plans ultimately succeed or fail based on how they are executed. It will be up to us as individuals to ensure success. It will not be without costs, hard work, or sacrifice but seldom is a good thing achieved without them. I urge everyone to read this plan with an open mind and to become actively involved in its execution. The sustainable future of South Florida's Reef System depends on it.

Sincerely,

Billy D. Causey, Ph.D.
Southeast Regional Director
NOAA's Office of National Marine Sanctuaries

Introduction

Following the outline of the state from the Dry Tortugas all the way to Martin County, Florida's 300-nautical-mile reef system comprises the only barrier reef in the continental United States of America. The reefs are critical habitats for the plants and animals that live there—from lobster to parrotfish. Reef-related expenditures also generate 71,000 jobs annually with \$6.3 billion in sales and income for Monroe, Miami-Dade, Broward, Palm Beach, and Martin Counties alone (Johns, Milon & Sayers, 2004; Johns, Leeworthy, Bell & Bonn, 2001). As such, this reef ecosystem is a national treasure.

The Florida Reef System is under stress. For the last several decades, localized challenges or stresses (i.e. overfishing, land-based sources of pollution, and direct habitat degradation from human activities) have been recognized as the primary causes of the accelerating decline in the health of the world's coral reefs. This is as true in Florida as it is in places like Australia and the Caribbean.

But now there are new challenges including climate change that creates new stresses such as extremely high and low water temperatures and carbon dioxide-induced ocean acidification. These compound existing challenges. It is no longer enough to manage sections of Florida's Reef System as if they were separate from the rest of the reef. In the past, this fragmented management structure—while not ideal—was relatively effective, but as the population of South Florida continues to grow, reef users multiply, and the effects of climate change and local stresses begin to tell on the reefs, the need for more coordinated, holistic action has become very clear.



Snorkelers explore a shallow coral reef in the Florida Keys © Bill Keogh

To meet that need, reef managers, scientists and reef users from across South Florida have developed this **Climate Change Action Plan for the Florida Reef System 2010-2015** (Action Plan) as a product of the Florida Reef Resilience Program (FRRP). The Action Plan is intended to guide coordination of reef management across many jurisdictions and serve as a more detailed, Florida-specific companion to the climate change goal and objectives in “NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015” (NOAA CRCP 2009).

This Action Plan adds to the NOAA CRCP 2009 framework with Florida-specific actions designed to accomplish three main goals; increasing resilience through active management, enhancing communications and awareness, and conducting targeted research. The specific recommendations in this Action Plan have been developed by the FRRP or culled from recommendations made by other local, state, national, and global initiatives on coral reef climate change adaptation. *(These initiatives and resources are listed in Appendix 3 and are referenced as numbered subscripts throughout the text.)*

Management of Florida's Reef System

It is important to understand that reefs are part of the foundation of South Florida's environment, culture and economy. Without the reefs giving life to the sea, fisheries, diving, snorkeling, and tourism will dwindle. The loss of Florida's coral reefs would irrevocably change the South Florida way of life especially in the Keys, which are not as economically diversified as the southeast Florida mainland.

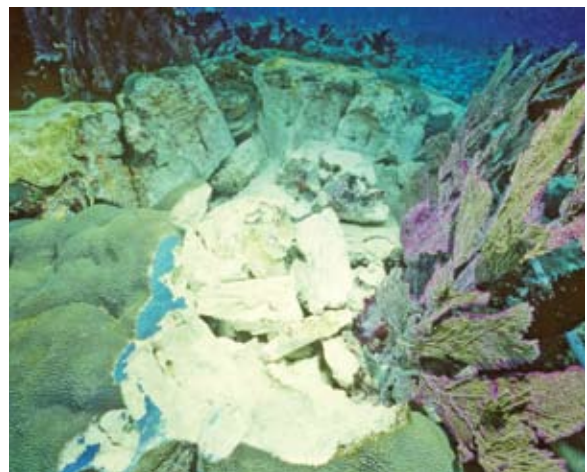
Two major factors will dictate the future health of the reef: the rate and extent of climate change and the resilience of Florida's coral reef ecosystem to that change. While the issue of climate change mitigation is largely a matter for international, national, and state policy, the resilience of Florida's coral reefs is under the direct influence of local management strategies and reef users' activities.

Fortunately, reef managers actively protect Florida reefs so that they can continue to be strong environmental and economic drivers. The realization of climate change related threats makes the need for resilience-based management of the Florida Reef System even more important, but also presents new challenges and demands a more coordinated and regionally effective plan.

It is not a matter of simply consolidating reef management under one agency, but rather building on the expert knowledge and abilities of local, state, and federal reef managers by coordinating their actions across the entire Florida Reef System. To secure the future of Florida's coral reefs it is essential that all agencies responsible for managing the reefs, other marine natural resources, adjacent lands, and watersheds do everything possible to restore and maintain the resilience of the ecosystem.

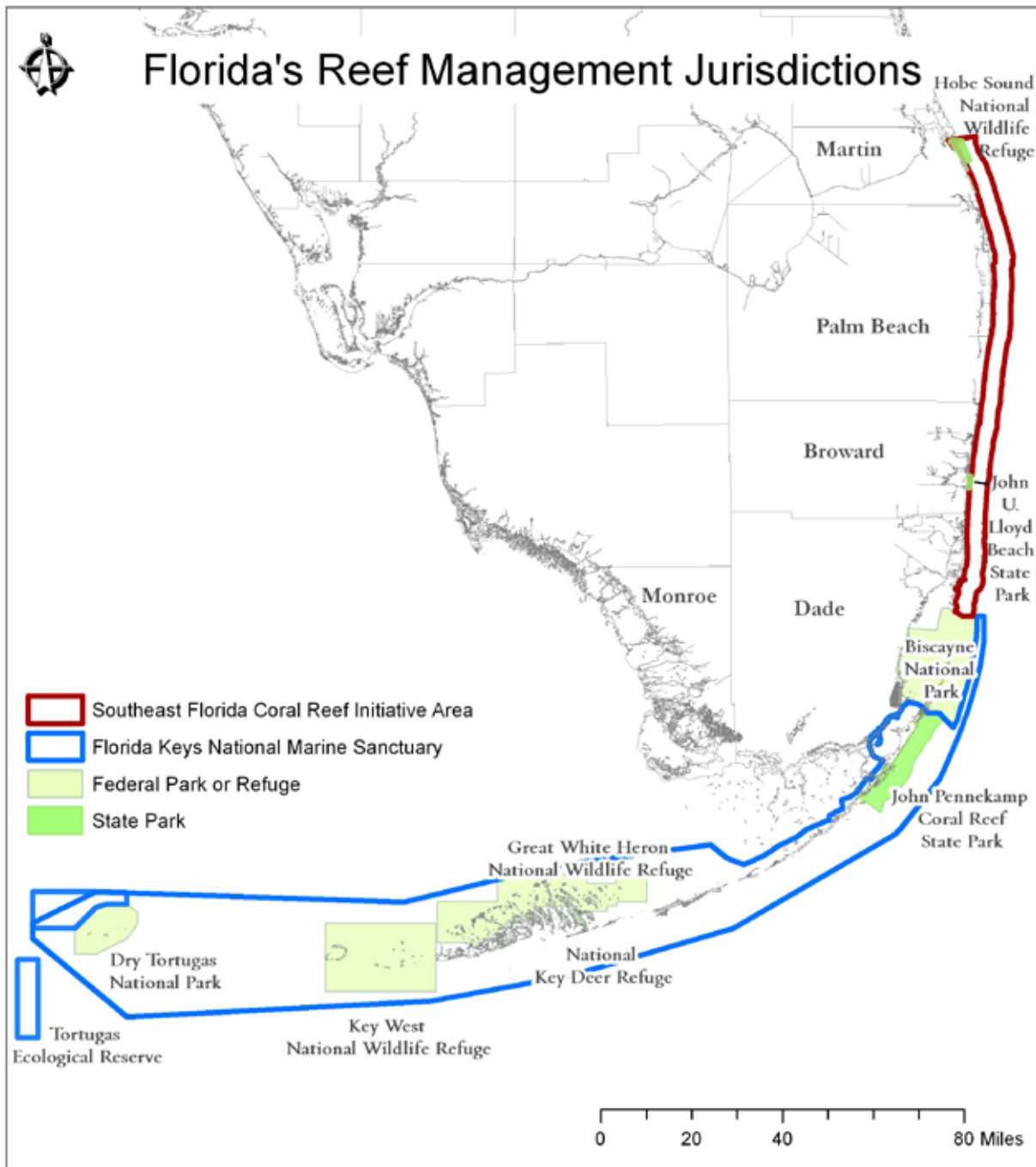
A Climate Change Action Plan for the Florida Reef System—2010-2015

The Action Plan identifies ways to increase reef resilience to climate change and minimize negative impacts on reef-dependent industries such as diving and snorkeling tourism, and commercial and recreational fishing. Built on well-established resilience principles, it outlines a holistic, adaptable five-year program that Florida's reef managers can undertake in collaboration with reef users and other stakeholders to minimize the damage and associated impacts of climate change. It is intended to be adaptable and updated at least every five years.



Coral damaged by boat grounding © Florida Keys National Marine Sanctuary

This Florida-specific Action Plan adds direct habitat degradation (e.g. boat groundings, destructive anchoring, diving and coastal development) to the list of impacts addressed in the NOAA CRCP 2009 framework which focused on climate change, overfishing, and land based sources of pollution. It also includes the Southeast Florida Coral Reef Initiative (SEFCRI) priority actions to increase resilience, as these are specific objectives likely to be adopted across the South Florida region.



Florida is exemplary in terms of marine managed areas and hosts one of the first designated marine protected areas in the world, John Pennekamp Coral Reef State Park established in 1963.

In addition, many of Florida's coral reefs are protected and managed within the Florida Keys National Marine Sanctuary, Dry Tortugas National Park and Biscayne National Park, John U. Lloyd Beach State Park, St. Lucie Inlet Preserve State Park, and four coastal National Wildlife Refuges in the five county region—Great White Heron, Key West, National Key Deer, and Hobe Sound.

Most of the reefs of the northern extension of the Florida Reef System, from the northern border of Biscayne National Park in Miami-Dade County to the St. Lucie Inlet in Martin County, are overseen by the Florida Department of Environmental Protection's Coral Reef Conservation Program which is developing new management strategies for the region through the Southeast Florida Coral Reef Initiative.



Stony corals, soft corals, sponges and reef fish on a healthy Florida reef © Jiangang Luo

Summary of the 10 top priority climate change actions for the Florida Reef system: (for more detailed outcomes and action steps, please see Appendix 1.)

- Work with Florida’s coral reef management jurisdictions to improve regulations and management that facilitate adaptation to climate change and ocean acidification. ⁽¹⁰⁾ Evaluate and revise existing programs and strategies (e.g. Florida Keys National Marine Sanctuary Water Quality Protection Program and the existing marine protected areas in the Florida Reef System) to optimize their effectiveness and make them more robust in the context of creating resilience to climate change. ^(1, 12, 17)
- Develop and implement a marine zoning plan that incorporates resilience-based concepts to provide maximum protection from non-climate stresses for all reef types and associated habitats in the Florida Reef System. This plan must also ensure connectivity between reefs and their associated nursery habitats ^(1, 2, 4, 7, 8).
- Integrate climate change predictions and uncertainties into Florida’s comprehensive planning laws and procedures, particularly in coastal areas. Include sea level rise adaptation and mitigation planning in county and municipal comprehensive plans. ⁽¹⁵⁾
- Continue and expand the FRRP disturbance response monitoring (DRM) and Mote Marine Laboratory’s Bleach Watch activities throughout the entire five-county (Monroe, Miami-Dade, Broward, Palm Beach and Martin) Florida Reef System. ⁽¹⁾
- Decrease the likelihood of negative fishing, diving, and other reef use impacts to key habitats and important functional groups of plants and animals (e.g. herbivores) by increasing law enforcement presence and regulatory compliance. ^(1, 4, 8, 10, 14)

- Develop scientific climate change fact sheets tailored for reef users, community members, visitors, elected officials, businesses and industries to increase understanding of and support for actions to increase resilience. Use multiple outlets (e.g. news media, radio, brochures, community meetings, social networks, blogs and websites) to communicate facts. ^(1,2)
- Forecast the potential social and economic effects of climate change on reef-dependent industries and communities to measure their vulnerability and resilience and determine cost-to-benefit ratios of any proposed climate change mitigation/adaptation measures. ^(2, 12) Support the creation of industry-specific business adaptation plans for diving, fishing and general tourism industries and training opportunities that facilitate any necessary adaptation.
- Increase awareness and appreciation of the Florida Reef System and encourage a sense of urgency for its sound management and protection. ^(1,8)
- Ensure long term, question-driven monitoring of environmental variables linked to coral bleaching and other climate change impacts throughout the Florida Reef System. Integrate monitoring results into a coastal observing network that informs the evolving questions underlying protection and management of marine resources. ^(1, 3, 5) For example, changes in localized acidification linked to water management practices need to be studied and monitored in Florida to see how they relate to global changes in ocean acidity.
- Develop scientific models of the Florida Reef System to help predict its responses to physical, chemical, and socio-economic shifts associated with climate change and ocean acidification, and the interactions of these global processes with local stressors (e.g. pollution, over-fishing, etc). Determine and map areas of high and low resilience to climate change (e.g. identify refugia for thermally tolerant coral species and populations that will provide genetic stock for recovery of the wider Reef System) in order to prioritize management efforts. ^(2, 6,7)



Pillar coral on a patch reef surrounded by seagrass © Ken Nedimyer

Conclusion



Scientist examining coral bleaching © Erich Bartels

Climate change is acknowledged as one of the most serious threats to the long-term health of coral reefs worldwide. Already, in many places around the world such as the Maldives, Seychelles and northeastern Caribbean Sea, coral bleaching has severely degraded more than 50 percent of reefs.

Florida's coral reefs are not immune to climate change. There have already been observable signs of vulnerability in the form of mass coral bleaching events in 1983, 1987, 1990, 1997 and 1998. In each of these years, most Florida Keys coral reefs were affected by bleaching. Fortunately, many corals survived the high temperatures and are exhibiting resilience—the ability to recover—yet many suffered lasting damage, which led to a steady decline in coral cover throughout Florida's well-developed system of reefs.

An analysis of climate projections indicates that coral bleaching events will become more frequent and severe over coming decades, even under optimistic scenarios. Other climate change impacts such as sea level rise and severe weather events can also endanger local reef survival through chronic stress or acute physical damage.

On a broader scale, carbon dioxide-induced ocean acidification is already decreasing the concentration of calcium carbonate in sea water, which limits the rate at which corals build their hard skeletons and will eventually start dissolving available calcium carbonate from the ocean's living and fossil reefs.

The findings and recommendations in the **Climate Change Action Plan for the Florida Reef System 2010-2015** offer great hope for these reefs. Actions reef managers and reef users take today—combined with favorable state, national and international climate and energy policies and other large scale “enabling conditions” (see Appendix 2)—can increase the resilience of Florida's reefs and help protect this vital element of the state's economic base.

But the importance of this work goes far beyond just Florida. By taking action now, responsible federal, state and local government agencies can provide global leadership in the management of coral reef ecosystems facing threats from climate change.

Appendix 1 • Detailed priority outcomes and action steps

Outcome 1: Increased coral reef resilience to climate change and ocean acidification through effective management strategies and actions. ⁽¹⁰⁾

Objective 1.1: Develop and implement a climate-related crisis response plan for Florida's reef system that coordinates across all relevant jurisdictions in order to provide a framework for early warning, communication, monitoring, research, and management response with the goal of minimizing and documenting impacts on reef ecosystems from acute events such as mass coral bleaching, infectious disease outbreaks, tropical storm impacts, cold snaps and pollutant spills. ⁽¹⁰⁾

- **Action 1.1.1:** Continue and expand the FRRP disturbance response monitoring (DRM) and Mote Marine Laboratory's Bleach Watch activities throughout the entire five-county (Monroe, Miami-Dade, Broward, Palm Beach and Martin) Florida Reef System. ⁽¹⁾
- **Action 1.1.2:** Review local and regional management responses to coral bleaching and integrate plans to incorporate the entire Florida Reef System region. ^(1, 8, 14)

Objective 1.2: Encourage and promote management actions that help avoid or minimize impacts, and spread the risks of climate change and ocean acidification. ⁽¹⁰⁾

- **Action 1.2.1:** Integrate climate change-induced crisis response strategies for the entire Florida Reef System into existing and newly created reef management plans. ⁽¹⁾
- **Action 1.2.2:** Develop and implement a regionally inclusive marine zoning plan that incorporates resilience-based concepts to provide maximum protection from non-climate stresses in representative habitats across all reefs in the Florida Reef System.



Shallow nursery habitat with a nurse shark, seagrass meadow and mangrove islands © Bill Keogh

This plan must also ensure connectivity between reefs and their associated nursery habitats. ^(1, 2, 4, 7, 8)

- **Action 1.2.3:** Identify and protect transition or alternative habitats that will provide for range shifts in distribution and abundance of species and habitats affected by climate change. ^(1, 2) Examine areas in the northern coral range and particularly healthy pockets throughout the present range in Florida and Gulf of Mexico as potential refugia. ⁽⁴⁾
- **Action 1.2.4:** Protect species and habitats that are highly vulnerable to climate change (e.g. corals, marine turtles, mangroves, etc.) from non-climate pressures (e.g. direct damage from divers, fishing gear, anchors or boats, beach nourishment, coastal construction impacts, land-based sources of pollution).

- **Action 1.2.5:** Ensure information on the vulnerability of species and habitats to climate change is incorporated into assessments of threatened and endangered species. (1, 4, 14)
- **Action 1.2.6:** Prohibit any new dredging or other direct destruction of coral reefs. (10)

Objective 1.3: Integrate climate change predictions and uncertainties into Florida’s comprehensive planning laws and procedures.

- **Action 1.3.1:** Require south Florida coastal counties and municipalities to address coral reef conservation, climate change mitigation and adaptation in all relevant elements of their comprehensive plans including, but not limited to; future land use, transportation, infrastructure, coastal management, conservation, recreation and open space, intergovernmental coordination, and capital improvements. (15)
- **Action 1.3.2:** Include sea level rise adaptation and mitigation planning into county and municipal comprehensive plans. (15)
- **Action 1.3.3:** Consider limiting certain kinds of development that are at risk from sea level rise. Develop state policy to prohibit rebuilding in places where climate change and its associated impacts (stronger hurricanes and sea level rise) increase the risk that structures may be subject to repeated and severe damage. (15)

Objective 1.4: Work with Florida’s coral reef management jurisdictions to improve regulatory and management frameworks to facilitate adaptation to climate change and ocean acidification. (10)

- **Action 1.4.1:** Evaluate and revise existing programs and strategies (such as the Florida Keys National Marine Sanctuary

Water Quality Protection Program and the existing marine protected areas in the Florida Reef System) to optimize their effectiveness and make them more robust in the context of creating resilience to climate change. (1, 12)

- **Action 1.4.2:** Work with federal and state fisheries management agencies to evaluate risks of climate change for the sustainability of Florida’s reef fish and invertebrate populations and associated fisheries, for incorporation in management plans. (4)
- **Action 1.4.3:** Create a formal Florida Reef System Management Council, including federal, state, local, county managers and user groups to advise, recommend, and oversee a coordinated ecosystem-management approach for the entire Florida Reef System. (11)
- **Action 1.4.4:** Work through the proposed Florida Reef System Management Council (or other appropriate venue) to revise regulations on coastal development and beach nourishment projects to minimize sedimentation, storm water runoff, and other water quality impacts to the Florida reef system.
- **Action 1.4.5:** Through the U.S. Coral Reef Task Force authority, evaluate existing resource protection legislation such as the National Environmental Policy Act, Clean Water Act and the Endangered Species Act for application to climate change related impacts. (1, 2, 3, 4, 5, 8, 13, 14)
- **Action 1.4.6:** Place mainland coral reefs under the authority of a principal management agency. (10)



Herbivores like this *Diadema* sea urchin play vital roles on coral reefs © HalBrindley.com

Objective 1.5: Provide training opportunities for Florida coral reef managers to increase their understanding of the impacts of climate change, the predicted range, and uncertainty of changes that will occur, and management strategies that address the impacts of climate change. (1, 2)

- **Action 1.5.1:** Work with NOAA Climate Service, NOAA Coastal Services Center, the Department of Interior Regional Climate Center, and other organizations working on climate change adaptation to provide climate training and climate change tools for Florida’s reef managers.

Objective 1.6: Decrease the likelihood of negative fishing, diving, and other reef use impacts to key habitats and important functional groups of plants and animals (e.g. herbivores). (1, 4, 8, 14)

- **Action 1.6.1:** Focusing the bulk of efforts on resilient reef areas, increase law enforcement presence, and regulatory compliance to effectively implement management regulations and protect the reef from further damage. (1)
- **Action 1.6.2:** Work with local fishermen to keep lobster and crab traps away from the reef, and fully implement the state’s lobster trap reduction plan. Reduce ghost traps by utilizing existing authority to enable fishermen and reef managers to remove

them and to “deputize” others to do so under controlled circumstances. (1)

- **Action 1.6.3:** Work with local fishing, boating, and diving industries to promote minimum impact reef use activities (e.g. appropriate fishing gear, catch-and-release fishing, trip-rigged anchors and manual anchor placement in sand) and voluntary avoidance of bleached, diseased or otherwise stressed coral reefs. (1)
- **Action 1.6.4:** Create a boating license similar to a driver’s license. (1)

Outcome 2: Identify the risks climate change poses to Florida’s coral reef-dependent people and industries, communicate those risks to affected parties and work with them to develop adaptation strategies that minimize those risks. (10)

Objective 2.1: Identify vulnerable reef-dependent human communities and determine how climate change might affect them. (1, 12)

- **Action 2.1.1:** Forecast the potential social and economic effects of climate change on reef dependent industries and communities to measure their vulnerability and resilience ,and determine cost-to-benefit ratios of any proposed climate change mitigation/adaptation measures. (2, 12)

Objective 2.2: Develop and implement effective local communication programs to increase awareness and appreciation of the Florida Reef System that provide relevant and up-to-date information on climate change and ocean acidification effects to all audiences, including local communities, Florida residents, businesses and industries, and tourists.

- **Action 2.2.1:** Develop scientifically based climate change fact sheets tailored for reef users, community members, visitors, elected officials, business and industry to increase



SCUBA diving, snorkeling and fishing are reef-dependent industries in South Florida © Nancy Sefton

the understanding of and support for actions to increase resilience. Use multiple outlets (news media, radio brochures, community forums, social networks, blogs and websites) to communicate the facts. ⁽¹²⁾

- **Action 2.2.2:** Involve community members, elected officials, visitors and Florida diving, fishing, and other maritime industries in climate change science and monitoring efforts on the Florida Reef System. ⁽¹²⁾
- **Action 2.2.3:** Incorporate general climate change and specific reef impact information into school science curricula. ⁽¹⁰⁾
- **Action 2.2.4:** Develop an education program for emphasizing south Florida’s need to restore the Greater Everglades Ecosystem to improve water quality, quantity, timing, and distribution and increase resilience of coral reefs habitats. ^(1, 3, 5, 8)

- **Action 2.2.5:** Create community feedback mechanisms (e.g. website, suggestion box, annual community meetings, etc.) to allow community members who are aware of the threat of climate change and the Action Plan’s recommendations to identify opportunities to improve the Plan.

Objective 2.3: Work with the reef user community and industry to develop adaptation programs that will assist them in planning for and coping with climate change impacts.

- **Action 2.3.1:** Create business adaptation plans by partnering with key stakeholder groups (such as the dive, fishing, and tourism industries and marine/coastal business industries) to provide training opportunities that increase understanding of the impacts of climate change, predicted range and uncertainty of those impacts, and to develop new business opportunities. ^(1, 8)
- **Action 2.3.2:** Communicate key findings of relevant, existing, and new climate change reports, risk assessments and local, national, and global reef status reports.
- **Action 2.3.3:** Implement regional marine/coastal accreditation programs (such as the Florida Keys National Marine Sanctuary Blue Star Program) in the five counties that touch the Florida Reef system to reduce the impact of divers, snorkelers and fishers on the local coral reef ecosystem. ^(1, 12)
- **Action 2.3.4:** Identify, support, and showcase “climate smart” coastal/marine organizations and businesses (including reef-based industries, ports and harbors, local governments and individuals) that increase sustainability of reef-related activities and reduce greenhouse gas emissions, such as energy and water efficiency, alternative energy and carbon offsets. ^(1, 2, 4, 8, 12)

Outcome 3: Strengthen the scientific foundation supporting strategic management of the Florida Reef System through targeted research, long-term monitoring, and forecasting climate change and ocean acidification impacts.

Objective 3.1: Characterize physical and chemical changes in coral reef environments by enhancing and refining monitoring to fill gaps in our current observations. This both establishes a baseline to assess climate change impacts on coral reef ecosystems and reveals changes through time which are essential to understanding observed and forecasted impacts.

- **Action 3.1.1:** Ensure long term, question-driven monitoring of environmental variables linked to coral bleaching and other climate change impacts throughout the Florida Reef System. Integrate monitoring results into a coastal observing network that informs the evolving questions underlying protection and marine resources management. (1, 3, 5)
- **Action 3.1.2:** Examine relationships between reef fish populations and stony coral populations and condition. (1, 2, 3, 5, 6)
- **Action 3.1.3:** Examine calcium carbonate saturation state and calcification rates at scale of FRRP DRM monitoring, etc. (1, 2, 3, 5, 6)
- **Action 3.1.4.:** Translate climate forecasts and projections into products that are relevant and useful for improving Florida Reef System ecosystem management and decision-making. Include explanations of variability, uncertainty and range of impacts.

Objective 3.2: Develop scientific models of the Florida Reef system to help predict its responses to physical, chemical, and socio- economic shifts associated with climate change and ocean acidification, and the interactions of these global processes with local stressors (e.g. pollution, over-fishing, etc).

- **Action 3.2.1:** Determine and map areas of high and low resilience to climate change (e.g. identify refugia for thermally tolerant coral species and populations that will provide genetic stock for recovery of the wider Reef System) in order to inform management efforts. (2, 6, 7)
- **Action 3.2.2:** Coordinate research to identify thresholds beyond which climate change causes irreversible damage to vulnerable species (e.g. sharks, marine turtles, seabirds, corals, fishes and plankton), habitats (e.g. seagrass, mangroves and pelagic) and processes (e.g. primary productivity and connectivity). (3)
- **Action 3.2.3:** Define and model the transitions of one habitat type into another that rapid anthropogenic climate change will bring to Florida (e.g. transition from terrestrial to marine habitat driven by sea level rise or transition from high relief coral reef to lower relief). (1, 5, 8)

Objective 3.3: Examine intervention and restoration measures that increase survivorship of coral reef species and enhance reef resilience to directly reduce climate change and ocean acidification impacts. (10)

- **Action 3.3.1:** Support field research that evaluates the effectiveness and feasibility, as well as the potential unintended consequences of novel intervention measures designed to reduce stress from climate change and ocean acidification on the Florida Reef System (e.g. pumping in cool ocean water, local reduction of acidification from land based sources, etc.). (10) Support implementation, monitoring, and evaluation of promising intervention measures.

Appendix 2 • Enabling Conditions



A deep reef off the Dry Tortugas © Jiangang Luo

The Action Plan is more likely to achieve success in increasing the resilience of the Florida Reef System if key enabling conditions are met. These conditions are outside the scope of this plan to implement, but they are specifically acknowledged as important to the wider issues of climate change and its associated impacts.

1. The nations of the world must establish an international agreement to reduce the rate and extent of climate change by ensuring that greenhouse gas emissions peak no later than 2020, global warming does not exceed 2°C above pre-industrial temperatures and the atmospheric carbon dioxide equivalents level drops to less than 350 parts per million by 2050. Individuals, corporations, local, state and national governments must all contribute to achieving these goals (IPCC 2007, Vernon et al 2009).
2. The federal government, State of Florida and other leaders of the Comprehensive Everglades Restoration Plan must continue to fund and implement the Plan to ensure future delivery of clean fresh water into south Florida's estuaries in the proper quantity and with the proper timing and distribution. In a related effort, the South Florida Ecosystem Restoration Task Force and the U.S. Coral Reef Task Force should increase efforts to collaborate and reaffirm the fact that the Florida Reef System is a vital component of the South Florida Ecosystem.
3. Residents, industries and governments in the Mississippi River Basin must continue to clean-up their watershed to curb nutrient and toxin pollution that makes its way into the Northern Gulf of Mexico and is transported to the Florida Reef System by currents.
4. Supported by the federal government, the Gulf of Mexico and South Atlantic regional ocean governance alliances, the individual states that comprise them and the stakeholders they all serve must complete comprehensive Coastal and Marine Spatial Planning to identify the range of legal ocean and coastal uses and appropriate locations for such uses that will minimize conflicts among users while striking a sustainable balance between economic production and ecosystem protection. (20)
5. Coral reefs and reef-dependent wildlife located in the Gulf of Mexico and Caribbean Sea, up-current from the Florida Reef System, must be effectively managed in order to continue to supply Florida with juvenile fish, spiny lobster and other invertebrates and to maintain the habitats needed by wide-ranging species.
6. Relevant components of this reef-specific Action Plan should be incorporated into the more comprehensive climate change action plans now under development at municipal, county, southeast Florida regional, state, and federal levels of government.



Appendix 3 • Coral Reef and Climate Change Action Recommendations


This section provides a compilation of resources and references used in the development of this Action Plan. Many of the listed sources have climate change strategies that were considered when developing this Florida specific plan.

Florida Specific Initiatives and Resources

1. **Florida Reef Resilience Program** “Coping with Climate Change” Conference 2008, participants compiled and ranked a list of reef resilience strategies for Florida.
<http://frrp.org/RRC2008%20Results/Final%20FRRP%20strategies%20votes.pdf>
2. **Florida Governor’s Action Team on Energy and Climate Change** was created to develop a comprehensive Energy and Climate Change Action Plan. It includes an adaptation chapter in the Phase II report in 2009 with priority recommendations for Florida.
http://www.dep.state.fl.us/climatechange/files/action_plan/chap8_adaptation.pdf
3. **Miami-Dade County CC Advisory Task Force** “Second Report and Initial Recommendations” April, 2008 and “Annual Report and Supplemental Recommendations” April 2010 <http://www.miamidade.gov/derm/climatechange/taskforce.asp>
4. **Florida Coastal and Ocean Coalition** developed a blueprint for Florida “Preparing for a Sea Change in Florida: a Strategy to Cope with the Impacts of Global Warming on the State’s Coastal and Marine Systems” in 2006.
http://www.flcoastalandocean.org/PreparingforaSeaChange/Climate_Change_Guide_for_Florida_Preparing_for_a_Sea_Change.pdf
5. **The Florida Oceans and Coastal Council** *The Effects of Climate Change on Florida’s Ocean & Coastal Resources.* <http://www.floridaoceanscouncil.org/reports/default.htm>.
6. **Environmental Defense Fund** published a report “Corals and Climate Change: Florida’s Natural Treasures at Risk.” November 2008, written by Terry Gibson, Harold Wanless, James Klaus, Patricia Foster-Turley, Karen Florini, and Thomas Olson.
www.edf.org/documents/8767_corals-and-climate-change.pdf
7. **Florida and Climate Change — The Costs of Inaction.** **Tufts University**, by Elizabeth A. Stanton and Frank Ackerman commissioned by the Environmental Defense Fund, November 2007 <http://ase.tufts.edu/gdae/Pubs/rp/FloridaClimate.html>
8. **Florida’s Wildlife on the Frontline of Climate Change—Climate Change Summit Report, 2008** http://myfwc.com/docs/Conservation/ClimateChange_SummitRept.pdf

US and Global Coral Reef Initiatives and Resources

9. **US Coral Reef Task Force: Climate Change Working Group**
<http://coralreef.gov/climate/>
10. **NOAA Coral Reef Conservation Program Goals & Objectives 2010-2015**
http://coralreef.noaa.gov/aboutcrp/strategy/currentgoals/resources/3threats_go.pdf
11. **Draft Priority Coral Reef Management Goals and Objectives for Florida Oct 2009,** NOAA <http://coralreef.noaa.gov/>

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12. **Great Barrier Reef Climate Change Action Plan 2007–2012**
http://www.gbrmpa.gov.au/___data/assets/pdf_file/0012/22620/climate-change-action-plan.pdf
 13. **“A Call to Action for Coral Reefs.”** Dodge et al. *Science* Vol 322 10 October 2008
http://www.nova.edu/ocean/science_call_to_action.pdf
 14. **The Honolulu Declaration on Ocean Acidification and Reef Management** the Nature Conservancy, 12-14 August 2008, in Hawaii.
http://www.nature.org/wherewework/northamerica/states/hawaii/files/final_declaration_no_app.pdf

Florida Coastal Management Policy

15. **Florida’s Resilient Coasts: A State Policy Framework for Adaptation to Climate Change (2008)** http://www.ces.fau.edu/files/projects/climate_change/Fl_ResilientCoast.pdf

International Collaborations

16. **Fourth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC)** Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds. Cambridge University Press, Cambridge, UK, 976 pp.
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