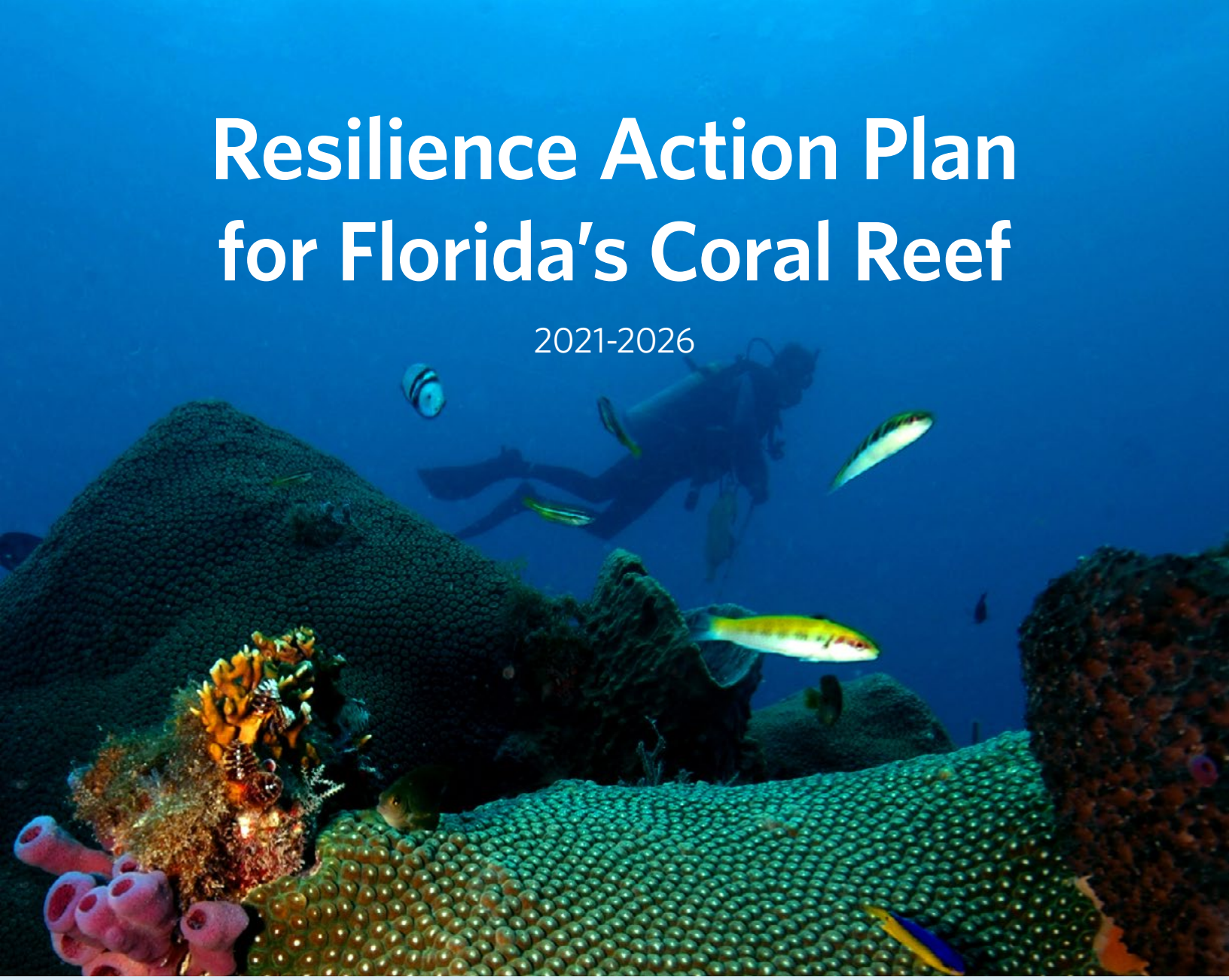
Resilience Action Plan for Florida's Coral Reef

2021-2026



A deep reef off the Dry Tortugas © Jiangang Luo

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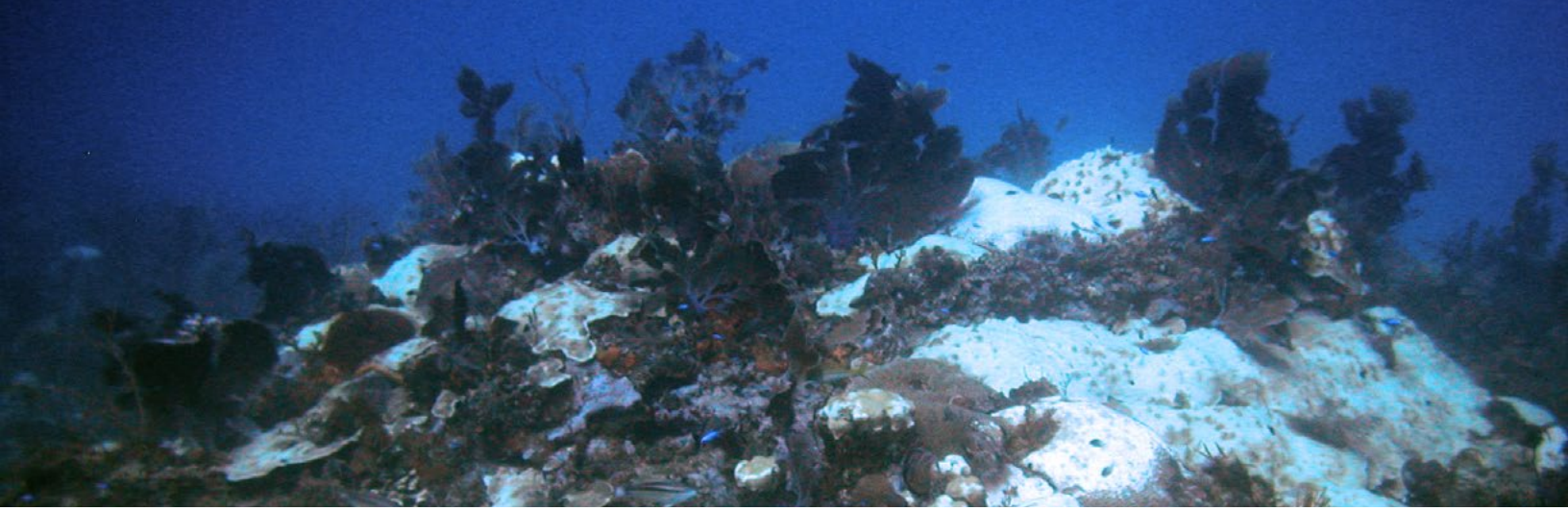

Coral bleaching at Sherwood Forest Reef © Andy Bruckner

A Call to Action for Florida's Coral Reef

Florida's Coral Reef is among the Sunshine State's most remarkable and distinguishing features. It extends 350 miles, from the remote Dry Tortugas, along the Florida Keys to its northern terminus near the St. Lucie Inlet on the mainland. The diversity and abundance of marine life in this region is a national treasure unequalled in the Continental United States. Beyond its biological values, the living reef is an engine of prosperity, creating billions of dollars in tourism and fishing-related economic activity each year. It also serves as a natural shield from hurricanes, reducing flood risk for residents of Monroe, Miami-Dade, Broward, Palm Beach, and Martin counties.

Yet, the vitality of the reef is severely and increasingly compromised by a mixture of global, regional, and local threats. Land-based sources of pollution, direct damage from fishing, diving, boating, and coastal construction, warming ocean temperatures and other consequences of global climate change have each chronically taken their tolls on reef condition for decades. More recently, and much more rapidly, the emergence of Stony Coral Tissue Loss Disease has pushed many reef-building coral populations to the brink of collapse.

Florida's Coral Reef as we knew it in the 20th Century is rapidly declining, even as people continue to enjoy what remains of its beauty and economic productivity. To put this incredibly valuable natural resource on the road to recovery we must address the threats that are degrading it while simultaneously developing and deploying intervention and restoration methods for critical reef species populations and reef conditions. One approach without the other is not enough to save Florida's Coral Reef from the rapid downward spiral that is evident today.

Floridians and visitors alike benefit from healthy and productive coral reefs. It's up to us to help ensure that Florida's Coral Reef maintains its values, now and into the future.

Florida' s Coral Reef Economy

4.4 billion
dollars/year[1]
Florida's coral reef-related expenditures

81,300
jobs[1]
Florida's coral reef-related workforce

675 million
dollars/year[2]
Value of buildings and economic activity protected from flooding by Florida coral reefs

1. Johns, G.M., et al. 2001. Socioeconomic Study of Reefs in Southeast Florida. National Oceanic and Atmospheric Administration, National Ocean Service, Special Projects.
2. Storlazzi, C.D., et al. 2019, Rigorously valuing the role of U.S. coral reefs in coastal hazard risk reduction: U.S. Geological Survey Open-File Report 2019–1027, 42 p., https://doi.org/10.3133/ofr20191027

Executive Summary

The *Resilience Action Plan for Florida's Coral Reef 2021-2026* was developed by the Florida Reef Resilience Program to define the critical, near-term steps that the reef management community, policy makers, and reef users must take now and maintain for the foreseeable future in order to tackle threats to reefs and rapidly increase restoration efforts. It is complementary to existing and emerging plans focused specifically on coral disease response, coral reef restoration, and place-based management of the national and state parks, national marine sanctuary, and state conservation area that encompass essentially all of Florida's Coral Reef.

The plan is organized under three broad goals. Each goal has a specific set of action-takers in mind, reef managers, policymakers, and private stakeholders, respectively. Each goal is supported by specific objectives and each objective by even more specific actions. The full plan is in the body of this document and the following is a high-level summary of goals and objectives.

Goal 1

Enable resilience-based management of Florida's Coral Reef

This goal covers water quality improvements, reduction of direct impacts (e.g. boat anchor damage) and coping with the impacts of climate change and ocean acidification. These efforts are paired with recommendations for enhancing reef condition via coral disease interventions and active propagation and restoration of corals and other reef species. The scientific research and monitoring programs that inform, or should inform, reef conservation, management, and sustainable use decision-making are covered in this goal.

Goal 2

Support public policy that creates the enabling conditions for reef recovery

The policy goal focuses on linking the enormous economic impact of Florida's Coral Reef to policy decision making and resource allocation. Reefs' values to Florida's economy are increasingly well defined, but they are yet to be fully integrated into policy priorities at all levels of government. This goal calls for informing policy decision makers about these values and collaborating with them on development of better policy and more sustainable funding streams to meet the needs of reefs and the people and communities who depend on them.

Goal 3

Enable stakeholders to support the future of the reef and those who depend on it

The coordinated actions of government agency reef managers and policy makers are critical, but they can only do so much. Reef stakeholders—those whose economic success or quality of life are dependent on viable coral reefs—are the front line of coral reef conservation. This goal defines ways in which individuals (e.g., recreational fishermen, divers, and boaters), businesses (e.g., commercial fishermen and dive tour operators), and institutions like universities and non-governmental organizations are essential to successful conservation and restoration efforts.

Taken together, this is the body of work required to protect and restore Florida's Coral Reef while supporting private and commercial uses that benefit individuals, communities, the State of Florida, and the nation.

The Florida Reef Resilience Program

The Resilience Action Plan for Florida's Coral Reef 2021-2026 was developed by the Florida Reef Resilience Program (FRRP). Established in 2005, the FRRP brings reef managers, scientists, and the people whose livelihoods and recreational pursuits depend upon healthy coral reefs together to achieve a common goal. That goal is to improve our collective understanding of coral reef resilience by exploring the biological and environmental aspects of reef health and by asking fundamental questions of society: "What is it that people want and need from coral reefs," and "How can they contribute to ensuring that those wants and needs are met?"

The FRRP uses a collaborative, consensus-based approach to advance strategies to improve the health of Florida's reefs and enhance the sustainability of reef-dependent commercial enterprises and recreational activities. The program is coordinated by The Nature Conservancy on behalf of a steering committee of reef managers representing all of Florida's coral reef management authorities; Florida Department of Environmental Protection (DEP), Coral Reef Conservation Program, DEP Coral Protection and Restoration Program, Florida Fish and Wildlife Conservation Commission (FWC), National Oceanic and Atmospheric Administration's (NOAA) National Marine Sanctuary Program, NOAA Coral Reef Conservation Program, and National Park Service (NPS). The FRRP respects each reef managers' jurisdiction while keeping a shared vision for the entire, interconnected Florida reef ecosystem at the forefront.

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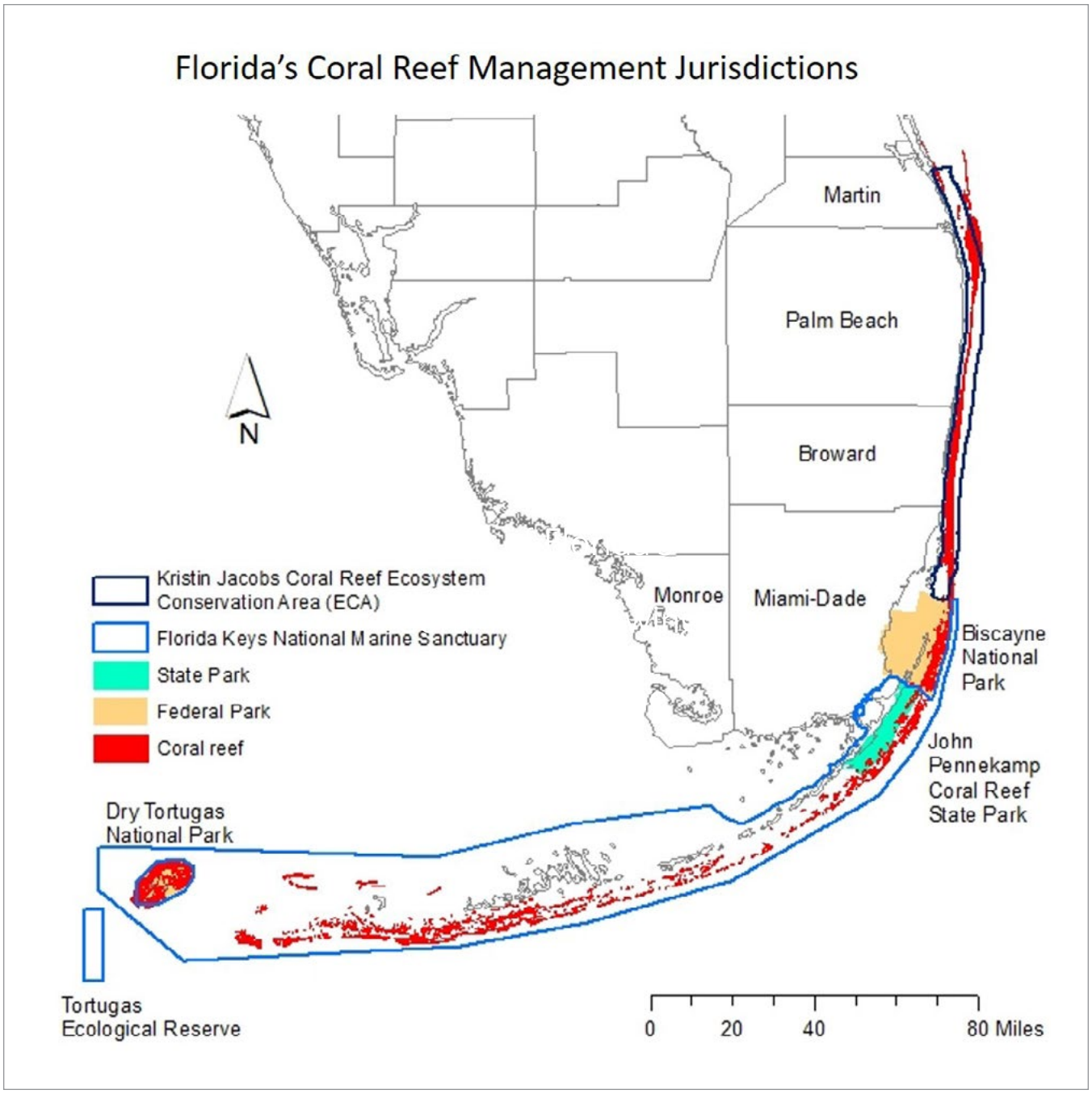
Key products of the FRRP to date include:

- Coordination of annual Disturbance Response Monitoring focused on coral bleaching and coral disease since 2005 and adapted to document impacts of the 2010 cold snap, Hurricane Irma in 2017, and Stony Coral Tissue Loss Disease in 2018 and beyond,
- Trainings for reef managers in "Coral Bleaching Response," "Responding to Climate Change," and "Planning for Resilience" in concert with Australia's Great Barrier Reef Marine Park Authority,
- Stakeholder workshops, conferences, and symposia,
- Outreach to reef users via the #RespectOurReef campaign, and
- Development of the "Climate Change Action Plan for the Florida Reef System: 2010-2015."

Relationships between this and other Plans

The "Resilience Action Plan for Florida's Coral Reef" is the successor to the "Climate Change Action Plan for the Florida Reef System: 2010 to 2015." The FRRP steering committee designed the resilience plan to build on the climate plan's strengths and shore up the weaknesses identified in a formal assessment of the climate plan's progress. The new plan expands the focus on climate change to also encompass other threats and solutions rooted closer to home. The Resilience Action Plan also accounts for new scientific knowledge and updated information about environmental conditions, such as the impacts from Hurricane Irma in 2017 and the ongoing Stony Coral Tissue Loss Disease (SCTLD) outbreak that began in 2014.


Florida's Coral Reef Management Jurisdictions
Martin
Palm Beach
Broward
Monroe
Miami-Dade
N
Kristin Jacobs Coral Reef Ecosystem Conservation Area (ECA)
Florida Keys National Marine Sanctuary
State Park
Federal Park
Coral reef
Biscayne National Park
John Pennekamp Coral Reef State Park
Dry Tortugas National Park
Tortugas Ecological Reserve
0
20
40
80 Miles

© Jenny Adler

Novel conservation approaches are better accounted for in this new plan. Coral disease interventions are covered at a relatively high level herein and interested parties may anticipate a much more detailed treatment of the subject, and all things coral disease-related, in a plan currently in preparation by Florida's multi-faceted SCTLD Response Team, a group of coral reef managers, scientists, and conservation practitioners who are working on a collaborative response to SCTLD. Coral reef restoration received relatively little attention in the climate plan, but the variety of restoration technologies and their success rates are growing while the need for them has increased dramatically over the previous decade. A new generation of restoration efforts is now underway, with "Mission: Iconic Reefs" in the Florida Keys National Marine Sanctuary (FKNMS) and active restoration ramping up in both Dry Tortugas National Park and Biscayne National Park as well as the Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA). In addition to these jurisdiction-specific planning efforts, the reef management community is launching an ecosystem-wide restoration planning effort for Florida's Coral Reef in 2021.

Each of these plans and action areas is predominantly focused on one facet of coral reef conservation: prevention, treatment, or recovery. The Resilience Action Plan for Florida's Coral Reef emphasizes prevention of negative impacts on reefs. The "Florida Stony Coral Tissue Loss Disease Response: 2020-2022 Strategic Action Plan" addresses one of the primary threats to corals by calling for identification of the disease's cause, conducting interventions, and ultimately restoration of the disease-susceptible coral species. Collectively, restoration plans are focused on helping reefs recover from impacts of disease and other threats.

Existing and emerging management plans for each of the coral reef jurisdictions are also in effect or under development. State and national parks and the FKNMS each have management plans in various stages of completion or revision. The Sanctuary, with substantial leadership from its stakeholder Advisory Council and input from other stakeholders, is in the middle of a comprehensive overhaul of its zoning strategy, regulations, and management plan. The Coral ECA, established in 2018, is preparing for development of its first management plan with extensive input from the Southeast Florida Coral Reef Initiative, Our Florida Reefs, and current fisheries stakeholder community engagement processes.

NPS and the FWC are collaborating on new approaches for reef fish management and lobster trapping in Biscayne National Park with goals of protecting corals, enhancing targeted species abundance and biomass, and improving the park visitor experience. This increasingly ecosystem-based approach to management is working its way into revisions to state and federal fishery management plans as well. Clearly, scientific research has demonstrated that an abundant and diverse reef fish assemblage is a critical component of a thriving coral reef ecosystem, and healthy reefs provide the conditions for fish populations to thrive, in terms of both abundance and diversity, which makes fishing in Florida world-class.

To maximize success, each agency's plans and the bodies of work that they support must be robust on their own and coordinated with the other agencies' plans.

Goals, Objectives, and Actions

The Resilience Action Plan for Florida's Coral Reef 2021-2026 is organized under three broad goals:

1. **Enable resilience-based management of Florida's Coral Reef,**
2. **Support public policy that creates the enabling conditions for reef recovery, and**
3. **Enable stakeholders to support the future of the reef and those who depend on it.**

Each goal has a specific set of action-takers in mind, reef managers, policymakers, and private stakeholders, respectively. Each goal is supported by specific objectives and each objective by even more specific actions. While it is impractical to precisely define what each individual action-taker must do within their marine managed area, policy arena, or sphere of influence to contribute to reef recovery, it is the consensus of Florida's reef management community that these are the actions required for success.

GOAL 1

Enable Resilience-based Management of Florida's Coral Reef

This goal supports coral reef managers' ability to identify, stop, or reduce the most significant direct and indirect threats to Florida's coral reef ecosystem. Major threats include global climate change impacts, land-based sources of water pollution, and direct damage from fishing, diving, boating, and coastal construction. It is important to recognize that the current, poor and declining condition of Florida's reefs reflects decades of the combined influences of these threats. Turning this around requires direct management interventions that abate threats and actively foster recovery of degraded habitat. And, while much has been learned about threats and management approaches in recent years, there is a continual need for applied scientific research that helps to refine management actions in the water and onshore.

Objective 1

Abate threats to coral reefs

Some actions are specifically targeted at individual threats while others address multiple threats.

Reduce Water Quality Impacts:

Coral reefs typically thrive in clean, clear, nutrient-poor waters. As such, the reef ecosystem responds rapidly and significantly to nutrient loads that would be considered small in many other ecosystems. Water quality is impacted not only by local factors, but also by perturbations that originate from outside of waters surrounding Florida's Coral Reef. The coral reef ecosystem in Florida is influenced by the Florida Current, the Gulf of Mexico Loop Current, inshore currents of the Southwest Florida Shelf, discharge from the Everglades, and by tidal exchange with both Florida Bay and Biscayne Bay. Water quality is a key element that connects all reef resources and is essential in maintaining the richness and diversity of the Florida's Coral Reef ecosystem. The health and quality of these diverse habitats influences the productivity of numerous marine resources, including our fishery resources.

The following actions are intended to improve water quality and increase the reef system's capacity to recover from impacts such as coral bleaching and disease outbreaks on their own or with the assistance of restoration.

Apply a Watershed Approach: Coordinating actions to reduce land-based sources of pollution using a watershed approach should lead to more rapid improvements in local water quality. South Florida's watersheds are complicated, consisting of the nine "inlet contributing areas" of the southeast Florida mainland (see https://www.coris.noaa.gov/activities/projects/watershed/se_florida_lbsp/welcome.html), plus southeastern Miami-Dade County and the

Florida Keys in closest proximity to the reefs, but also the more inland portions of the Greater Everglades Ecosystem and southwest Florida. Using a watershed approach provides a framework for coral reef-related issues to be included and addressed in water management decisions that have not previously considered their effects on Florida's coral reef ecosystem. Measures for reduction of land-based sources of pollution are much more effective and less expensive when implemented landward/upstream of a receiving waterbody. The watershed approach, with sub-watershed units, also allows for evaluation of pollution reduction measures on more relevant, local spatial scales. Although they are described separately below, the success of these efforts will be enhanced by comprehensive evaluation and coordination of potable water supply, wastewater, stormwater, and natural areas' water requirements. The South Florida Water Management District, DEP, counties, and municipalities, as well as the Army Corps of Engineers with respect to Everglades Restoration, are the key players in these efforts.

Modernize wastewater infrastructure: Septic tanks, leaking centralized wastewater collection systems, and some wastewater disposal systems allow pollutants—nutrients, toxins, pathogens, pharmaceuticals, and more—to enter groundwater that eventually reaches estuarine and marine waters. Critical failures of wastewater collection systems allow these pollutants to directly enter water bodies. Ocean outfalls off the mainland shunt treated, but still pollutant-laden and nutrient-rich, wastewater directly to the reef region. Pollutants and excessive nutrients contribute to harmful blue-green algal blooms, red tides, coral disease, and diminished water clarity. Connecting homes and businesses that are currently using septic tanks to updated or new centralized wastewater treatment facilities that reuse or dispose of effluent via deep injection wells is currently the best available technology.

Modernization of this critical infrastructure won't be fully accomplished in the timeframe of this plan, but key steps forward must be taken, including completion of ongoing facility upgrades, septic to sewer conversions, and closure of mainland ocean outfalls except for emergency situations.

Modernize stormwater infrastructure: Unmanaged stormwater transports pollutants, such as nutrients, contaminants, and toxins, from developed areas to the sea and alters estuarine salinity regimes, creating problems for nearshore waters and the connected reef ecosystem. Everyone has a role to play in preventing pollutants from entering the stormwater, but enhanced stormwater infrastructure is necessary to collect, store and clean polluted water before it reaches groundwater, estuaries, and the reef. This infrastructure may include collection systems, storage reservoirs, stormwater treatment areas, and a variety of "green infrastructure" or "low impact development" techniques. These efforts may also include modifying the timing and process of delivery of storm and flood control releases from regional water management systems.

Everglades restoration: Improvement of water quality for Florida's Coral Reef is among the many critical outcomes of fully implementing the ongoing Comprehensive Everglades Restoration Plan. Each component of the plan is essential, but from the perspective of the reef the stormwater treatment areas, reservoirs, and other features that will provide alternatives to harmful Lake Okeechobee regulatory releases to the Caloosahatchee and St. Lucie estuaries are key elements of the plan, as is returning clean, freshwater flows to Florida Bay and Biscayne Bay. Florida Bay and Biscayne Bay serve as a critical nursery for many species (e.g., grazers and predators) that enhance the health of the coral reef ecosystem and evidence suggests that direct and indirect effects of water quality in these areas can impact other regions of Florida. The combination of Lake Okeechobee releases and local basin runoff through the

Caloosahatchee mingle with water over the Southwest Florida Shelf, some of which makes its way south to the Keys and eventually mainland coral reefs. On the east coast, lake water reaching the St. Lucie Inlet can have dramatic impacts on the northernmost coral reefs and even affect reefs further south via transport by currents that run counter to the Florida Current.

Establish Coral-Specific Water Quality Standards: Corals' basic physiological and reproductive processes require specific water quality conditions. Coral-specific water quality standards should be considered for targeted pollutants including nutrients and turbidity. These factors should be tracked via a comprehensive monitoring program with an appropriate baseline.

Reduce Direct Impacts to Reef Habitat and Species:

Direct impacts to Florida's Coral Reef include outright destruction via dredging, permanent or temporary burial by beach renourishment and dredging-related sediments, and physical injury from fishing, diving, boating, and anchoring, including large commercial vessel anchoring. Inshore, replacement of mangroves and other coastal habitat with hardened shorelines degrades the nursery grounds for many reef species. Some of these impacts further degrade reefs via increased sedimentation and turbidity which makes corals more susceptible to other threats, such as bleaching and disease. Impacts of individuals' fishing, diving, and boating practices are addressed in Goal 3 because they are predominantly the responsibility of individual stakeholders. However, reef managers have a role to play in avoiding, or at least moderating, these and other direct impacts.

Reduce impacts of coastal construction: As recommended by the US Coral Reef Task Force in its mitigation guidelines handbook (https://data.nodc.noaa.gov/coris/library/NOAA/CRCP/other/USCRTF/mitigation_handbook_final_122216.pdf), "due to the complex nature of the coral reef ecosystem, and the even more complex nature of identifying and providing appropriate compensatory mitigation for lost ecosystem services, the emphasis on maximizing avoidance and minimization of planned impacts is imperative." Beach nourishment, coastal armoring, port expansion, and other coastal construction projects on or in proximity to coral reefs, worm reefs, and nearshore hardbottom habitat shall be designed to minimize affects on the resource to the maximum extent possible. When there is no alternative to construction, project impacts may be reduced by containing sedimentation and turbidity, avoiding incidental physical injury to corals and other benthic organisms (e.g., work vessel groundings and anchor damage), and avoiding work during predictable periods of biological importance or stress (i.e., coral spawning, warm-water periods, etc.).

Localized coastal construction impacts take place against the backdrop of unprecedented environmental stress, coral bleaching, and disease outbreaks that affect all or most of the reef ecosystem. Outside of the box thinking for compensatory mitigation requirements and authorities for coastal construction projects could result in more diverse mitigation actions that achieve successful mitigation of construction impacts. Specifically:

- Support efforts to refine intra and inter-agency coordination and consistency on planned coastal construction projects,
- Support update of statutory language to be more supportive of coral reef ecosystem protection and restoration projects,
- Require avoidance, minimization, and compensatory mitigation strategies for coastal construction projects that may impact coral reef functional groups that create habitat (e.g., stony corals, gorgonians, large sponges),
- Work with regulatory entities to re-evaluate Florida's Uniform Mitigation Assessment Method (UMAM) with respect to coral reef ecosystems.

Manage towards a healthy reef fish assemblage: Reef fish, as predators or grazers, play an important role in the community dynamics of coral reef ecosystems. There are strong mutual dependencies between reef-building corals and reef-inhabiting fishes, with many fish species depending on corals for food and habitat, while corals depend on the grazing by certain fishes for reproductive success. Managers should continue to collaborate to ensure that coral reefs have healthy fish populations and stable linkages between populations. Given the interdependence between coral reef health and fish abundance, fishery managers should also continue to work towards the incorporation of habitat characteristics into stock assessments and other ecosystem approaches to fisheries management.

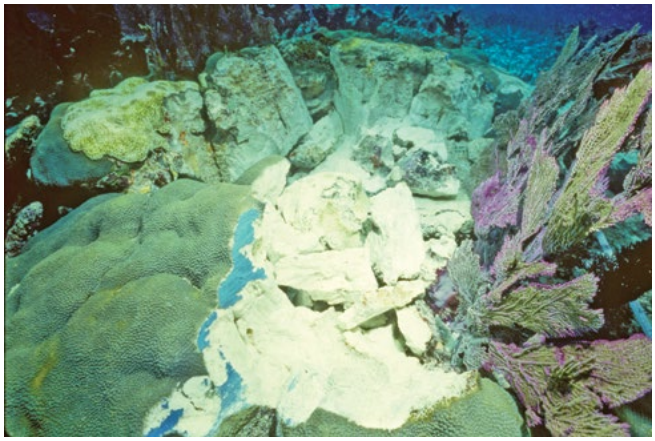
Reduce impacts of trap fishing gear on coral reef and hard bottom habitats: Lobster traps and crab traps can have detrimental impacts to coral reef ecosystems and other marine life when they move or are lost due to storms, currents, interactions with boats, or when they are unintentionally deployed directly onto sensitive habitat. In addition to fully implementing the state's trap reduction programs, fishery and reef managers should continue to encourage fishermen, particularly those who are new to the fishery, to voluntarily avoid trapping on or immediately adjacent to sensitive habitat. Managers should work to improve charting of the existing no-trap zones. Where necessary to protect the most vulnerable habitats or species populations, and with broad stakeholder input, additional marine zoning is a management tool that may be considered. Zoning considerations could include the presence of critically imperiled species (e.g., those listed under the U.S. Endangered Species Act, Florida's Endangered and Threatened Species Rule, Florida's Species of Greatest Conservation Need), and species that are particularly vulnerable to Stony Coral Tissue Loss Disease. Additionally, existing FWC authority to permit removal of lost and damaged traps should be paired with enhanced, agency-sanctioned volunteer efforts by divers and others. Development of lower impact trap gear and harvest methods should continue to be prioritized.

Reduce impacts of hook and line fishing on coral reefs and associated species: Hook and line tackle can become entangled in stony corals and other bottom dwelling organisms causing measurable impacts in heavily fished areas. Fishers should strive to know where they are allowed to fish, the bottom they are fishing on or over, as well as the appropriate tackle for the fish species they are targeting in order to minimize gear entanglement, gear loss, and associated impacts. They should release fish that they are not allowed or inclined to harvest, using descending devices, venting devices, and other proper fish handling techniques when appropriate (see; https://myfwc.com/fishing/saltwater/recreational/fish-handling/). And they should properly dispose of waste fishing line, chum boxes, and other byproducts of their activities. Additional or revised marine zoning, subject to the same considerations outlined in the trap fishing gear action item, above, is a management tool that may be considered to minimize hook and line fishing impacts, particularly for the protection of the most vulnerable species and locations.

Reduce diving impacts on coral reefs: Diving has impacts on corals and reefs, such as breakage, abrasion, and disease transmission. Inadequate training, carelessness, and accidents can result in snorkelers and divers grabbing, kicking, standing upon, and otherwise contacting sensitive corals. At high-use dive locations, these contacts are a threat to coral condition. There is also a growing body of evidence that ingredients of some chemical sunscreens used by divers and others are detrimental, if not lethal, to corals, particularly in their juvenile life stages. Improved diver training and additional education and supervision during dive excursions can help reduce destructive diver

behaviors. Additional or revised marine zoning, subject to the same considerations outlined in the trap fishing action item above, is a management tool that may be considered to minimize diver impacts, particularly for the protection of the most vulnerable species and locations.

Reduce boating and anchoring impacts on coral reefs: No boater wants to run aground on a reef or seagrass meadow, but it happens with regularity despite modern charts and navigational equipment. Generally, the same may be said for anchoring directly on corals, but the temptation to get as close to the reef as possible, typically for fishing or diving activities, is great. However, accidents happen, and improper anchor type, technique, and variable sea conditions frequently lead to anchors, chain, or anchor line contacting corals. Larger vessels (e.g., cruise ships and container ships) anchoring outside designated anchorages may result in damage to corals and reef framework. Direct impacts from boats and anchors are some of the most damaging direct impacts to Florida's Coral Reef and associated habitats. Improved reef marking may be warranted in some locations. Mooring buoys, installed and maintained by reef managers or their designees, are proven to help reduce anchor damage, but they are not suited to every location (e.g., locations with strong currents) and may concentrate reef users leading to other forms of impact. Additional or revised marine zoning, subject to the same considerations outlined in the trap fishing action item, above, is a management tool that may be considered to minimize boating and anchoring impacts, particularly for the protection of the most vulnerable species and locations. Educational efforts, such as the FKNMS' voluntary boater education program, can help.



Coral damaged by boat grounding © Florida Keys National Marine Sanctuary

Reduce impacts from marine debris on coral reefs: NOAA's "2020 Florida Marine Debris Reduction Plan" (https://marinedebris.noaa.gov/sites/default/files/publications-files/2020_Florida_Marine_Debris_Reduction_Plan.pdf) defines marine debris as "any persistent solid material that is manufactured or processed, directly or indirectly, intentionally or unintentionally, disposed of or abandoned into the marine environment or the Great Lakes." Florida's Coral Reef is significantly impacted by marine debris, some of which does substantial harm to corals and other sea life and detracts from the reef's natural beauty. All the reef-dependent activities listed above can be sources of marine debris and reef users should properly dispose of their own waste products before it becomes "marine debris" and pick up after others regardless of the source of the pollution.

Florida's Coral Reef Protection Act Enforcement: Support increased DEP enforcement of the CRPA in the Florida Keys for impacts not pursued under the FKNMS' authority, particularly for recreational vessel impacts to reef framework.

Increase law enforcement capacity and coordination: Increase the funding available for FWC, NOAA, and other enforcement officers focused on Florida's Coral Reef region. Implement "Conservation Regulation Training" for county and municipal marine officers to improve their ability to enforce conservation regulations, increase overall law enforcement presence on the water, and provide additional enforcement for peak periods of reef use. Continue to coordinate with the U.S. Coast Guard permitting process for marine events (e.g., beach festivals and

air shows) to minimize natural resource impacts and ensure enforcement. Support periodic targeted enforcement actions by U.S. Coast Guard, FWC, and local law enforcement agencies.

Enhance coordination with legal professionals: State's Attorneys' prosecutorial authority and judges' sentencing powers related to violations of conservation laws can have a profound influence on coral reef conservation. They can seek full compensation for damage to valuable public resources leading to recovery of lost values. Their actions can serve as a strong deterrent for repeat offenders. When publicized, their efforts contribute to reduced occurrence of first-time offenses. Reef managers should proactively engage these professionals in dialogue about the value of reefs, the importance of conservation laws, and opportunities to use the law to achieve the greatest possible conservation outcomes.

Reduce Climate Change and Ocean Acidification Impacts:

Warming ocean temperatures, sea level rise, more powerful hurricanes, and altered ocean chemistry are all directly linked to global climate change. Greenhouse gas emissions are the primary manageable driver of global climate change. The dominant greenhouse gas, carbon dioxide, drives both ocean warming and ocean acidification, which inhibits coral growth, weakens coral skeletons, interferes with coral reproduction, and negatively affects countless other marine organisms with skeletons or shells by depriving them of their vital building block; calcium carbonate. Runoff of acidic fresh water from the land can also contribute to localized acidification. The combined effects of climate change and ocean acidification contribute significantly to coral bleaching, increased coral disease virulence, increased erosion of the reef framework, turbidity stress, and physical breakage of living organisms and reef structure.

Reduce greenhouse gas emissions: Reef management agencies and others should demonstrate their commitment to reducing greenhouse gas emissions by conserving energy and supporting the transition from fossil fuels to cleaner, alternative energy sources throughout their operations.

Build reef managers' capacity to address climate change impacts: Work with NOAA Coastal Services Center, the Department of Interior Regional Climate Science Center, and Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, and The Nature Conservancy Reef Resilience Network climate change and resiliency teams/programs to provide climate training and climate change tools for Florida's reef managers. For example, refreshing training on coral bleaching response and communications, and testing the efficacy of traditional management strategies against a range of climate change scenarios.

Objective 2

Enhance reef ecosystem condition with disease interventions and restoration

Coupled with threat abatement actions, proactive measures to enhance reef ecosystem condition are necessary to promote the recovery of Florida's Coral Reef and its capacity for self-renewal. The two major types of activities necessary to enhance reef ecosystem condition are active coral disease intervention and reef restoration. The following background and recommendations are a relatively high-level precursor and companion to the Disease Advisory Committee's (DAC) "Florida Stony Coral Tissue Loss Disease Response: 2020-2022 Strategic Action Plan" and the new generation of restoration plans in place in the FKNMS and getting underway elsewhere in Florida.

Coral Disease Intervention: While disease has long been recognized as a major cause of the decline in reef-building corals and coral reef ecosystems in

Florida, the ecosystem is currently experiencing the most widespread and lethal disease outbreak on record. Known as Stony Coral Tissue Loss Disease (SCTLD), this outbreak was first reported in 2014 near Miami and has continued spreading unabated. As of the middle of 2021, SCTLD has affected the entirety of the Florida's Coral Reef except the Dry Tortugas region. SCTLD impacts roughly half of Florida's 45 stony coral species, including key reef building species and five of the seven species listed pursuant to the Endangered Species Act. SCTLD affects most individuals of some coral species. Further, entire coral colonies typically perish when affected, leading to significant declines of these susceptible species' populations. SCTLD has now been confirmed throughout the Caribbean region.

Although active investigations into the potential cause of SCTLD are ongoing, identifying coral disease's agents and their origins is tremendously complicated. Multiple factors, including non-biological factors such as environmental stressors as well as a pathogens or suite of pathogens, contribute to coral disease, so the definitive causes of any outbreak may take years to identify or may never be uncovered. As such, reef managers focus on active disease intervention efforts to save priority coral colonies and maintain reproductively viable wild populations of the key reef building species and federally listed species affected by SCTLD. Current efforts are focused on topical applications of disease treatments to individual disease lesions and the rescue of susceptible coral species to preserve the genetic structure of their populations and begin propagating the corals for future restoration. Probiotic treatments are being tested as a means of scaling disease intervention up.

Coral Disease Intervention Actions:

Gene banking and restoration stock: Conduct collections of SCTLD-susceptible species and other priority coral colonies that have survived despite the disease to preserve genetic diversity. Advance sexual and asexual propagation techniques and produce enough source stock for future restoration activities.

Identify disease resistance factors: Examine SCTLD-susceptible coral colonies that survive the outbreak in search of disease resistance factors at the organismal and environmental scales.

Test and implement interventions: Support experimental implementation, monitoring, and evaluation of intervention measures designed to reduce mortality associated with SCTLD, including topical antibiotic treatment and boosting colony-scale resistance via dosing with probiotics.

Consider establishing and maintaining strike teams: Coral disease "strike teams" may be needed to locate diseased corals, apply best-available disease treatments to stabilize priority coral colonies and/or reef sites, and determine where remaining healthy colonies remain. This action is under review by the DAC.

Scale successful interventions up: Increase capacity to scale up whole-colony intervention strategies to site, reef, and regional levels as the tools and techniques become available.

Coral Propagation & Restoration: Even prior to SCTLD the continual degradation of coral reef resources in Florida had established the critical need for direct action to save or replace lost reef structure and ecosystem function through strategic restoration action. As SCTLD has become established and remains present across almost the entirety of Florida's Coral Reef, restoration activities must now be conducted within the context of disease; repairing damage at unprecedented scale while avoiding further spread. To this end, state agencies developed, "State of Florida Restoration Priorities for Florida's Coral Reef 2021-2026" in January of 2021 State-of-FL-Coral-Reef-Restoration-Priorities_January-2021.pdf (frrp.org). This living document and the prioritization of actions contained therein will be updated annually. The following is a summary of the document, which contains six sections: Data Management, Gene

Banking, Coral Propagation and Rearing of Recruits, Restoration Planning, Direct Restoration Activities, and Restoration of Coral Reef Ecosystem Functions.

Coral Propagation and Restoration Actions:

Data Management: The unprecedented challenges facing Florida's Coral Reef have given rise to increased need for the efficient collection, storage, and wide dissemination of data across the coral restoration community. The state's plan makes specific recommendations for data management capacity, data management needs in support of restoration site selection, and data management needs in support of direct restoration activities. The primary entity for coral-related data management is the FWC's Fish and Wildlife Research Institute (FWRI), Information Science and Management Section, and this Section is already operating at capacity. Proactive planning for coral reef restoration data management needs, as well as attracting and retaining skilled database programmers and data managers within this Section, is a priority.

Gene Banking: As Florida's Coral Reef continues to suffer from SCTLD, reef managers were faced with the stark reality that gene banking of corals was absolutely necessary to ensure that coral reef restoration would be possible post-outbreak. The following priorities support ongoing gene banking projects that are essential to meet Florida's long-term coral reef restoration goals; coral rescue, coral nurseries, research and development in support of coral husbandry (i.e., coral care) for gene banking in both land-based and in-water coral care systems.

Coral Propagation and Rearing of Recruits: Historically, coral populations could recover after disturbances through natural sexual reproduction, resulting in new coral recruits that would replenish depleted reefs. Unfortunately, extremely low coral cover and low coral density significantly reduce the chances that eggs and sperm from different coral colonies will meet, preventing most natural reproduction and recovery. Reef recovery can be supplemented and accelerated through assisted sexual and asexual reproduction in land-based and in-water propagation facilities, also known as coral nurseries. Asexually reproducing corals through fragmentation has the advantage of quickly increasing coral biomass to provide habitat for reef-associated species and prevent reef substrate erosion, but it does not contribute to increasing genetic diversity because these new corals are genetic clones of their parent stock. Assisted sexual reproduction of corals in land-based facilities can also increase coral biomass over a longer time frame, but it has the added advantage of increasing numbers of genetically unique corals. Additionally, coral larval and juvenile mortality is extremely high in the wild and sexual propagation in land-based controlled environments increases the amount of stock available for restoration efforts.

Coral restoration must incorporate a balanced approach that includes both asexually and sexually propagated corals to increase coral biomass, preserve genetic diversity and decrease juvenile mortality. The following priorities support ongoing coral propagation and rearing efforts; prioritizing species and genetic individuals to propagate and restore, identification of resilient genetic traits, research and development to improve propagation and rearing infrastructure and techniques, and cryopreservation of genetic material.

Restoration Planning: Planning for restoration of Florida's Coral Reef requires the development of a strategy, data management, and information and data tools to support appropriate site selection. The following priorities address these needs: restoration strategy development, restoration site selection, data management (see above), larval connectivity and disease risk modelling, and compilation of the state of knowledge and information gaps on this subject. A statewide, multi-agency/multi-stakeholder restoration planning effort is underway in 2021.

Direct Restoration Activities: The decline of coral reefs worldwide over the past several decades has been particularly devastating in the Wider Caribbean, including south Florida, where reefs have sustained massive losses of important reef-building genera such as Acropora and Orbicella. The loss of reef-building species has contributed to decreases in reef structure and function, reef growth, fisheries species habitat, coastal buffering, and biodiversity. Direct biological restoration activities, including coral propagation, outplanting, and spawning hub creation, are now considered essential to recovery of these ecosystem services. Direct restoration focuses on propagating target corals for species recovery. Nursery-reared corals are outplanted to bridge spatial gaps between existing populations, enhance coral cover and abundance, supplement genetic diversity, and promote natural recovery through the creation of sexually reproductive populations.

The following priorities support direct restoration activities: data management (see above), scaling up direct restoration of disease susceptible coral species, enhancing direct restoration success via outplanting design and predator control, developing acclimation procedures, establishing maintenance regimes, optimization of restoration sites to promote natural larval settlement, spawning hubs (i.e., specific locations where corals are centralized through relocation and/or outplanting), and monitoring of direct restoration activities.

Restoration of Coral Reef Ecosystem Functions: While direct coral restoration is the most pressing need for coral reef restoration, restoration of coral reef ecosystem function is also essential. At present, the knowledge and techniques required to restore ecosystem functions are in their infancy. Resources should be directed to development and implementation of the following activities; propagation of reef associated species (e.g., herbivores, animals that feed on coral predators, sponges and soft corals that provide significant three dimensional structure on reefs), seafloor stabilization, and novel approaches such as mitigation of ocean acidification impacts at restoration sites.

Objective 3

Conduct Research to Support Threat Abatement and Reef Restoration

Despite more than 100 years of coral reef science in Florida and elsewhere, we still have a great deal to learn. Dramatic changes in that time frame include Florida's population growth and increased reef use, urbanization and other regional watershed alterations, and global climate change. Actionable scientific knowledge is essential to the development and successful application of reef conservation strategies during these dynamic times.

Priority Research Actions:

Gene Banking

Research and development in support of coral husbandry for gene banking (i.e., holding in captivity): Gene banking of Florida corals has been occurring in both land-based and in-water nurseries due to severe losses of wild colonies due to SCTLD. To support the level of care needed for corals being held in nurseries, the FRRP recommends:

1. development of species-specific treatments for health support of corals in holding systems;
2. analyses of bacterial communities and other essential coral symbionts during coral care in both the holding system environment and in the corals themselves;
3. analyses focusing on the effects and durability of antibiotic and other pharmaceutical treatments for corals in holding systems;
4. standardized and affordable diagnostic techniques (e.g., water quality and toxicology analyses) for diseased corals in holding systems; and
5. development of efficient techniques, including harnessing symbiotic relationships, to clean corals

being held in in-water nurseries and the nursery systems/structures holding them, control coral competitors (e.g., crabs, snails, urchins, surgeonfish), and control predators (e.g., amphipods, corallivorous snails, fireworms, butterflyfishes, damselfishes, corallivorous parrotfishes).

Propagation and Rearing

Genetic priorities: Genetic information is essential to managing and improving the efficacy of existing restoration efforts, maximizing the benefits of novel genetic interventions such as genetic rescue or assisted gene flow in restoration efforts, and to determine resilient traits of different genotypes. Genetics-related priorities for propagation and restoration activities include:

1. develop genetic markers for all priority species for restoration that are not included in coral rescue efforts;
2. genotyping all corals in all nurseries not involved with holding coral rescue corals;
3. estimate effective genetic population sizes and levels of relatedness within populations of all priority species for restoration;
4. evaluate genetic connectivity and population structure of coral populations for all priority species; and
5, identify resilient traits and evaluate the role of the environment and genetic variation in determining coral resilience for all priority species.

Coral propagation and rearing: As coral propagation and subsequent outplanting activities continue to increase along Florida's Coral Reef, additional research is needed to maximize the survival, growth, and reproduction of outplanted corals. These research efforts must include:

1. identification of optimal size, number, genotype, and placement of corals produced sexually and through fragmentation to move coral recruits from land-based nurseries to in-water nurseries or directly to restoration sites and to maximize survival and minimize in-water maintenance;
2. evaluation of the benefits of species-specific probiotic treatments to enhance their survival and reduce susceptibility to disease and/or bleaching;
3. identification of appropriate propagation substrate types and sizes for newly settled coral recruits, microfragments, and propagated fragments;
4. further evaluation of fragmenting methodologies to minimize tissue loss, attachment failure, and disease susceptibility to improve survival and growth;
5. identify ways to efficiently clean in-water nursery structures and control coral competitors and predators at those structures through attraction and retention of beneficial species;
6. evaluate differences in survival between asexually and sexually propagated colonies reared in both in-water and land-based nurseries;
7. optimize propagation techniques for land-based, mass-scale production; and
8. evaluate whether broodstock corals could be sourced for propagation from particular environments that select for climate or disease resilience.

Restoration Planning and Site Selection

Larval connectivity modeling: This modeling is needed to identify reefs that, when directly restored, provide larval spillover effects to help naturally restore other areas of the reef tract without direct restoration. This modeling is essential to the decision-making process for selecting restoration sites to effectively maximize the spatial impact of coral reef restoration actions while minimizing restoration costs and effort.

Identify and address mapping gaps: High-resolution maps of marine habitat types and species ranges are essential for targeting coral restoration locations and measuring the success of these efforts. Florida's existing mapping is excellent, but it is not comprehensive due to mapping technology limitations. As new mapping technology emerges,

filling gaps and continually improving mapping resolution are high priorities.

Understand SCTLD coral disease pathogen and drivers of the disease: Understanding coral disease dynamics is central to disease prevention and management responses. Several fundamental research topics that should be addressed include:

1. identification of the SCTLD pathogen or suite of pathogens;
2. a determination of the sources of those pathogens (i.e., are they associated with wastewater or are they already present on the coral);
3. analysis to better understanding the vectors for transmission and factors that may promote virulence;
4. an evaluation of how environmental variables (e.g., water temperature, water quality, etc.) influence disease dynamics; and
5. how knowledge gained can improve the success of intervention strategies across coral colony, reef, and ecosystem scales.

Direct Restoration Activities

Examine risks and factors influencing survival of outplanted SCTLD-susceptible corals for restoration: Restoration of Florida's Coral Reef is not limited to disease-susceptible corals, but half of the coral species are susceptible to SCTLD and have been significantly impacted by the disease. To appropriately assess the potential risks associated with conducting large-scale restoration of this group of disease-susceptible corals, a proposal was developed to examine the potential disease risks related to outplanting these species. This study will be the largest multi-species outplanting study to date, and it is designed to outplant three species of SCTLD-susceptible coral species across the reef ecosystem and monitor them and the nearby natural communities for an extended time. Outplant monitoring will be sufficiently robust to detect tissue loss and mortality caused by disease relative to other causal factors such as coral predation and bleaching. Reef monitoring has been designed to detect changes in the incidence of active SCTLD. To execute this study, coordinated actions among all the regional coral reef restoration practitioners and science partners will be necessary.

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Determine optimal outplanting design, including genetic mix, for corals produced sexually and asexually to enhance restoration outcomes: While much effort has been dedicated to outplanting as a means to restore Florida's Coral Reef, little is known regarding how colony size, numbers of fragments per genotype planted in each cluster, or spacing of those fragments affects survival, fusion, and growth into a reproductively mature colony. To maximize the rates of these factors, the FRRP recommends that analyses be conducted of existing outplants for all species

involved in restoration efforts. Study methodologies should account for spatial and temporal variation in environmental conditions across the reef tract as well as the long-term health of outplanted coral colonies.

Enhance benthic habitat conditions to optimize conditions for natural larval settlement for coral and other reef obligate species: A complex suite of factors affect settlement of corals and other reef-obligate species. The loss of coral cover, plus the general shift from coral to non-coral species on reefs, including increased abundance of foliose algae, turf algae, cyanobacteria, *Palythoa*, hydrozoan corals, and certain gorgonians, has fundamentally altered the physical and chemical nature of Florida's reefs. Research suggests that coral and fish larvae can detect and utilize physical and chemical cues that emanate from reefs, and typically respond positively to chemical cues from reefs that exhibit higher coral and lower algal abundances. Managing and preparing reefs to facilitate the production of cues that attract recruiting corals and other reef-associated species is an important component of a comprehensive restoration strategy. The following topics are priorities for investigating ways to promote natural larval settlement on coral reefs: appropriate site selection to facilitate natural larval settlement (see Restoration Site Selection section); identification of chemical cues for larval settlement; identification of crustose coralline algae species and other drivers that promote successful recruitment; improving substrate condition through addition of herbivores; and evaluation of how artificial soundscapes can be used to promote coral larval settlement and invertebrate/fish community development.

Examine artificial materials and structures' roles in conservation approaches: Restoration practitioners need to know if the right combination of materials, design, and placement enhance the survival or recovery of key species or deliver services (e.g., flood risk reduction, fisheries) lost from existing reefs. If so, what are the tradeoffs and unintended consequences that must be grappled with prior to recommending these actions? There is evidence of some artificial reef structures contributing to enhanced reef fish growth rates, shelter, and spawning opportunities. Goliath grouper and permit are examples of fish species that utilize some high-profile artificial reef habitat for spawning aggregations. The same concepts could be tested and implemented for other reef fish (e.g., black grouper, red grouper, mutton snapper). Different combinations of materials and locations could be explored to see how they influence fish assemblages either positively or negatively. Artificial reefs may be designed and deployed to strategically influence visitor pressure by dispersing or diverting fishing and diving visitation away from natural coral reefs. Combining artificial structures with intentionally established living organisms (e.g., limestone or ceramic bases with attached coral plugs) is an increasingly common practice and should be further explored to maximize success.

Restoration of Coral Reef Ecosystem Functions

Examine relationships between stony coral populations/reef condition and key reef-associated species' populations: Successful restoration of Florida's Coral Reef requires directed efforts to better understand how reef conditions impact reef-associated fishes and vice versa. Knowledge of fish populations changes (e.g., diversity, abundance, productivity) as a function of reef condition will aid in efforts to restore coral reef ecosystem function. Due to the interconnectivity of the health of coral reef ecosystems and reef fish, the FRRP recommends that scientists and managers evaluate and consider the role of reef fish, from herbivores to upper level predators, in coral reef restoration efforts.

Evaluate the role of reef-associated habit (e.g., seagrass, mangroves, etc.) for key non-coral species and how the health of this habitat ultimately influences productivity and coral reef structure and function: A healthy population of key non-coral invertebrates and reef fish species is an important

component of restoring ecosystem structure and function within coral reef ecosystems. However, the population dynamics of many of these non-coral species are poorly understood and further insight would aid coral reef managers. The roles of environmental factors, their spatial and temporal variability, and understanding of how they influence these species' productivity, from early life history through reproductive maturity, are all important considerations.

Monitoring and Forecasting

Maintain and improve long-term, question-driven monitoring programs that identify climate impacts, key species population changes, and environmental conditions: Coral Reef Watch uses satellite data and sophisticated modelling to document water temperatures and forecast coral bleaching events. The FRRP Disturbance Response Monitoring, which utilizes professional scientific divers, and Mote Marine Laboratory's, FKNMS's, and FDEP's BleachWatch and SEAFAN programs, which utilize first-hand observations by volunteer divers and others, document the occurrence of coral bleaching and disease. FKNMS's long-term monitoring programs (i.e., Seagrass Monitoring Program and Water Quality Monitoring Program) assess these critical features of the coral reef ecosystem. The statewide National Coral Reef Monitoring Program (NCRMP), the Coral Reef Evaluation and Monitoring Project (CREMP) conducted throughout the Florida Keys and Dry Tortugas National Park, NPS's South Florida/Caribbean Inventory and Monitoring Network's coral, seagrass, fish and lobster monitoring in Dry Tortugas and Biscayne National Parks, and similar programs focused on mainland reefs (i.e., Southeast Florida CREMP and Water Quality Monitoring Program) all contribute vital information. Fisheries-independent monitoring of reef fish populations covers the entirety of Florida's Coral Reef. All the foregoing monitoring data should be integrated into coastal observing networks (e.g., Marine Biodiversity Monitoring Network, Gulf of Mexico Coastal Ocean Observing System, and Southeastern Coastal Ocean Observing System) and Florida's Integrated Mapping and Monitoring Programs for seagrass and coastal wetlands. Together, these programs provide reef managers with timely information about conditions on the coral reef. Over time, analysis of their annual datasets helps identify areas that are better able to resist or recover from climate related threats including disease. This information is critical to informing protection and restoration efforts.

Assess the efficacy of existing and new management measures at preventing additional losses and enhancing recovery: Fishery-independent monitoring and benthic monitoring programs have provided detailed information on key resources through reexamination of permanent stations and through random stratified sampling approaches within different regions, habitats, and depths. These have not, however, been designed to ask specific questions regarding the benefits of management measures (e.g. inside and outside a Sanctuary Preservation Area) at reducing damage and loss that can be attributed to diving, snorkeling, fishing, anchoring and other reef-associated activities, or help determine the carrying capacity of individual sites. New monitoring approaches must be developed to answer these questions.

Evaluate the potential social and economic effects of reef loss and degradation on reef- dependent industries and communities: Florida's Coral Reef is an important component of the state's economy and culture. Future conditions of the reef tract will ultimately have large social and economic effects; however, those impacts require comprehensive socioeconomic analyses to better understand their magnitude. Increasing reef-dependent industries and communities' resilience to changing conditions requires evaluation of the following topics: resiliency in Florida's reef fishing and reef tourism industries to

declining reef conditions; the relationship between reef condition and flood risk; impacts of targeted restoration efforts on flood risk mitigation; and socioeconomic costs and benefits of intervention and restoration measures.

GOAL 2

Support Public Policy that Creates the Enabling Conditions for Reef Recovery

Local, state, and federal policy and resource allocation decisions play an incredibly important role in ensuring that Florida's Coral Reef is protected from further degradation and successfully restored. However, due to the reef being "out of sight and out of mind," many are under-informed about the vital role the reef plays, the threats it faces, solutions to reef decline, and what they can do to ensure that solutions are implemented.

Objective 1

Incorporate the Economic Values of Florida's Coral Reef into Decision Making

Economic factors (e.g., business profits, jobs, tax base) of proposed projects, programs, and other activities often weigh heavily in decision making. Ecosystem service valuation, the study of the economic contributions that natural ecosystems make to society, allows these values to be factored into the decision-making process.

Refine and communicate ecosystem service information: Data about the value of contributions of coral reefs for shoreline protection, fisheries, biomedical exploration, and tourism is available and constantly improving. Policy makers and other decision makers should be provided with the most up to date information via a range of communications pathways.

Incorporate spatially explicit economic data into regulatory decisions: Every reef has a measurable economic impact based on the types of services it provides to people and the number of people served. Data from the U.S. Geological Survey's new report, *"Rigorously Valuing the Role of US Coral Reefs in Coastal Hazard Risk Reduction,"* as well as existing tourism and fishery-relevant data should be factored into local, state, and federal regulatory decisions.

Federal Emergency Management Agency (FEMA) should classify coral reefs as "natural infrastructure": FEMA should be authorized to provide emergency access to funds for post-disaster assessment, immediate stabilization, and long-term restoration of coral reefs following damage by extreme events (e.g., hurricanes and disease outbreaks) and to utilize pre-disaster risk mitigation funding to improve reef condition where that improvement reduces flood risk to onshore properties.

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

U.S. Army Corps of Engineers should use updated reef ecosystem service values: The Corps conducts benefit/cost analyses and compensatory mitigation reviews for projects that may impact coral reef and hardbottom habitats in SE Florida. Having the best data available (e.g., updated reef ecosystem service values) is required to determine the appropriate amount of mitigation to offset impacts.

Objective 2

Educate Florida's leaders on coral reef-related issues

Briefing local, state, and federal elected officials and other prominent decision makers about important issues affecting their constituents and communities is essential for ensuring that those issues are factored into their complex deliberations. Since 2014 the South Florida Regional Planning Council and Treasure Coast Regional Planning Council, quasi-governmental organizations established by Florida law (Ch. 186, Florida Statutes) to address problems and plan solutions that are of greater-than-local concern or scope, have collaborated with reef management agencies and other interested parties to conduct these briefings and set the action agenda for Florida's Coral Reef. The councils, which are led by county and municipal elected officials with support from professional staff, focus on local, state, and federal issues, integration among the levels of government, and integration of public and private efforts toward coral reef conservation and restoration.

Policy Priorities:

Annual water quality infrastructure expenditures: The following actions are recommended;

1. target wastewater and stormwater projects that equally address community resilience and ecosystem protection,
2. support transitioning to tertiary wastewater treatment facilities and wastewater reuse from lesser levels of treatment and injection of treated wastewater via disposal wells, and
3. ensure that mainland ocean wastewater outfalls stop releasing effluent except in emergencies.

Water quality regulations: The FRRP recommends that local, state, and federal water quality regulations reduce land-based sources of pollution into coastal waters from all sources including basin runoff, wastewater, and stormwater. This should also include the promotion of Best Management Practices found in, *"Low-Impact Development & Green Infrastructure: Pollution Reduction Guidelines for Water Quality in Southeast Florida,"* (see https://floridadep.gov/sites/default/files/LID-GI_Manual-Publish_Public_508Compliant.pdf).

Reduce waste and litter on the land and in local waters: Support for sustainability initiatives aimed at promoting the "reduce, reuse, recycle" concept for single use plastic, Styrofoam, and other products, is encouraged.

Support use of mineral-based sunscreens and sun protective clothing: Some chemical sunscreens contain ingredients that damage or kill corals in laboratory settings and may have impacts on reefs. Mineral-based sunscreens and sun protective clothing are viable alternatives.

Replicate reef conservation ordinances and resolutions: City of Hallandale Beach (19-085 - Exhibit 1 - Resolution (frrp.org) and 19-194 - Exhibit 1- Ordinance (frrp.org)) and City of Miami Beach (City-of-Miami-Beach-Reef-Resolution.pdf (frrp.org)) established strong, reef-focused ordinances that other municipalities should use as models. These examples should be disseminated to other municipalities and their adoption should be publicly celebrated to encourage widespread uptake.

Kristin Jacobs Coral Reef Ecosystem Conservation Area (Coral ECA): Following more than a decade of public engagement the Florida Legislature established the location of the Coral ECA in 2018. The Coral ECA encompasses all the shallow coral reefs north of Biscayne National Park and the FKNMS, as well as associated habitats. For the Coral ECA to make a difference in the future of Florida's Coral Reef and the people who depend upon it, the state must develop a specific management plan and authority to implement the plan.

Strengthen Penalties for Reef-Related Violations: The Coral ECA, FKNMS, and other reef jurisdictions would benefit from stronger penalties and fines for non-compliance of reef-related regulations. Stronger disincentives would discourage illegal activities and make it clear that violations will not be tolerated.

Water quality improvement projects: The FRRP recommends the support of programs to assist local communities with water quality improvement initiatives, including septic to sewer conversion and expansion or construction of centralized wastewater treatment projects.

Regulation of biosolid application: The FRRP recommends support for increased regulation of all biosolid application to uplands, inclusive of biosolids rated A, B, and AA, to reduce nutrient enrichment of waters of the state, including estuaries and coastal waters.

Florida Keys National Marine Sanctuary regulations: Complete and implement the marine zoning, regulatory actions, and management plan update (AKA the "Restoration Blueprint" process) for the FKNMS. Due to the state and federal co-trustee partnership that manages the FKNMS this is both a state and a federal priority.

Reauthorize the Coral Reef Conservation Act of 2000 or a similar new authority: Promote local, state, and federal support for reauthorization or a new law that supports the following goals:

- Overall increased funding to address the significant increase in local and global-scale threats to coral reefs since 2000.
- Increased funding transferred directly to state coral reef management agencies to enhance local threat abatement for Florida's and other jurisdictions' coral reefs.
- Establishment of a funding mechanism to provide relief from emergencies, scaled to the risk and urgency of the issues and needs of the U.S.A. and Freely Associated States' coral reef jurisdictions. Examples of such emergencies include large-scale coral disease outbreaks, coral bleaching events, large vessel groundings, and hurricane impacts.
- Congressional authorization for the U.S. Coral Reef Task Force, which gives full representation to state and territorial governments.
- Congressional authorization for the U.S. Department of the Interior to conserve coral reefs in our national parks, national wildlife refuges, and marine national monuments.
- Establishment of a dedicated national coral disease response coordinator through NOAA's Coral Disease Health Consortium.
- Enhanced capacity for the U.S. Environmental Protection Agency and U.S. Coast Guard to provide dedicated leadership and research capacity to explore the potential of ballast water or vessel biofilms as coral disease vectors.

Objective 3

Enhance sustainable funding for coral reef management

Public-Private Partnerships: The FRRP recommends actively pursuing and supporting public-private partnerships that advance coral reef conservation and restoration. FKNMS Blue Star diving and fishing operations are a potential starting place for such support.

Stony Coral Tissue Loss Disease: Inter-agency collaboration on funding requests, scaled to the scope and urgency of the collective response effort for SCTLD, is encouraged.

Coral Gene Banking and Propagation Needs: The FRRP recommends support for research and development of coral husbandry, aquarist personnel training, and coral propagation. The FRRP also recommends supporting gene banking activities, coral rearing and propagation facility buildout or expansion, as well as operation and maintenance costs of new and expanded facilities that will supply corals to large-scale ecosystem restoration efforts.

Water quality infrastructure: Collaboration on regional funding requests and mechanisms for improvement of Southeast Florida's coastal water quality is encouraged. Priorities include urban wastewater infrastructure upgrades; accelerated septic to sewer conversions; improved stormwater treatment; and expedited closure of ocean wastewater outfalls.

GOAL 3

Enable Private Stakeholders to Support the Future of the Reef and Those who Depend on it

Many people, corporations, and industry associations already feel strongly about the need to protect and restore Florida's Coral Reef for its biological, aesthetic, or economic values, but comparatively few are actively engaged in creating positive change. With increased knowledge, tools, and coordination, we can improve on-reef and off-reef behaviors that affect reefs and help businesses and organizations participate in reef conservation efforts, effectively increasing the constituency for coral reefs.

Objective 1

Support individual reef users in becoming champions for reefs

Establish or maintain reef education communications campaigns: Focus should be placed on public opportunities for constructive participation in conservation efforts—protection, resilience-building, and restoration. Further, value of services provided by the reef and threats to reef health should be prioritized by these campaigns. Multiple communications approaches could be utilized, including traditional and social media, brochures, community forums, and peer-to-peer networking to communicate facts and catalyze engagement.

Develop and communicate biological and social science-based forecasts of coral reef degradation's impacts on recreational and commercial activities: Reef users know what they value, but they are often less clear about what they may have to lose. Science-based forecasts of the consequences of reef degradation will provide context for understanding of the benefits of reef conservation, restoration, and the importance of individual or corporate responsibility for reef stewardship. These forecasts should also improve decision making for businesses as they adapt to changing conditions.

Promote participation in reef management, restoration, and citizen science programs: Reef-users and the general public should be involved in management and restoration efforts (e.g., reef and shoreline clean-ups, FWC's lionfish challenge and lionfish eradication derbies, etc.) and citizen science programs such as the BleachWatch, C-OCEAN, and SeaFan marine event reporting programs, FDEP's Marine Debris Reporting and Removal Program, and water quality monitoring efforts. Community involvement will be essential for coral reef restoration efforts to achieve their goals at ecologically and socially meaningful scales.

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

Showcase reef champions: FRRP recommends identifying, supporting, and showcasing individual reef champions who set the tone for their peers and for tourists visiting Florida's Coral Reef. "Friends of" organizations (e.g., Friends of Our Florida Reefs for the mainland, National Marine Sanctuary Foundation for the Florida Keys, and Fish and Wildlife Foundation of Florida for all reef regions) should be engaged in these efforts.

Objective 2

Promote businesses' and institutions' efforts to protect, restore, and sustainably use Florida's reefs

Engage business leaders: Business owners and employees who understand that their economic success depends upon healthy reefs can be among the most effective change-makers by taking action within their own corporate structure, promoting positive action among their peers and clients, and amplifying the importance of action to other stakeholders as well as policymakers.

Promote participation in industry accreditation programs: A program like FKNMS's Blue Star Program for snorkel and dive operators and charter fishing businesses should be explored for the remainder of Florida's Coral Reef.

Engage reef-dependent industries in "giving back": Reef-dependent industries should be encouraged to participate in citizen science programs, "adopt-a-reef" style resilience and restoration efforts, and outreach efforts.

Showcase "reef friendly" businesses: Fishing charters, dive operators, ports, hotels, and other coastal businesses that go above and beyond to protect and restore Florida's Coral Reef deserve recognition and contribute to a "race to the top" dynamic in their respective industries. "Friends of" organizations (e.g., Friends of Our Florida Reefs for the mainland, National Marine Sanctuary Foundation for the Florida Keys, Fish and Wildlife Foundation of Florida for all reef regions) should be engaged in these efforts.

Develop/update existing school lesson plans: Coral reef curricula are not required by Florida's educational standards, but lesson plans and materials provided by reef managers (e.g., FDEP's "travelling trunks" of reef-related materials developed as part of SEFCRI and FKNMS's reef restoration-oriented version of same) may be provided to local teachers upon request. These lesson plans should be updated with fresh facts about reef values, threats to reefs, and reef conservation measures, and emphasis on individuals' contributions to impacts to coral reefs via on-reef and off-reef behaviors.

Identify and highlight organizations that focus on reef health: Tourism bureaus, business associations, NGO's, educational institutions, and local governments that promote sustainability of reef-related activities play an important role in spreading the word and encouraging reef-friendly behavior. They should be publicly appreciated along with the individuals and businesses referenced above. "Friends of" organizations (e.g., Friends of Our Florida Reefs for the mainland, National Marine Sanctuary Foundation for the Florida Keys, Fish and Wildlife Foundation of Florida for all reef regions) should be engaged in these efforts.

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Taken together, this is the body of work suggested by reef managers to protect and restore Florida's Coral Reef while supporting private and commercial uses that benefit individuals, communities, the State of Florida, and the nation.

NOAA

FLORIDA'S CORAL REEF

The Nature Conservancy

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

FLORIDA FISH AND WILDLIFE CONSERVATION COMMISSION

NOAA CORAL REEF CONSERVATION PROGRAM

NATIONAL PARK SERVICE

Southeast Florida Coral Reef Initiative