2015-2020
BISCAYNE BAY HABITAT FOCUS AREA IMPLEMENTATION PLAN

Updated April 4, 2019

Biscayne Bay with Boca Chita Lighthouse, Biscayne National Park, in foreground and City of Miami skyline in background
Photo credit: Judd Patterson, courtesy National Park Service

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EXECUTIVE SUMMARY

In 2011, the National Oceanic and Atmospheric Administration (NOAA) launched the NOAA Habitat Blueprint, a framework to address the growing challenge of integrating the Agency's coastal and marine habitat conservation activities as part of a long-term effort to rebuild fisheries, recover threatened and endangered species, and support resilient coastal communities nationwide. As part of the Habitat Blueprint, NOAA has selected ten Habitat Focus Areas (HFAs) in priority locations where NOAA and its partner organizations and agencies work together to restore and protect regionally important habitats. These HFAs are identified by regional experts as places where NOAA can increase the effectiveness of its science and coordination efforts to better protect highly valued natural resources and habitats at risk.

In 2015, NOAA designated Biscayne Bay and its adjacent reef tract as the Southeast region's HFA to apply the principles of the Habitat Blueprint. Biscayne Bay is a subtropical estuarine lagoon located adjacent to the Miami metropolitan area on the southeast coast of Florida between latitudes 24.95° N and 25.17° N. The Biscayne Bay HFA (BBHFA) encompasses the entirety of Biscayne Bay, including the shoreline, barrier islands and adjacent areas of the Florida Reef Tract to a depth of 200m (Fig. 1).

Biscayne Bay's importance was recognized by the State of Florida by its designation as an Outstanding Florida Water (OFW) and by establishment of two Biscayne Bay Aquatic Preserves: 1) the Biscayne Bay Aquatic Preserve, which occupies the entire northern bay south into the central bay and in Card Sound and 2) the Biscayne Bay – Cape Florida to Monroe County Line Aquatic Preserve, which begins offshore of Key Biscayne. Biscayne Bay's importance was previously recognized by the federal government by the designation of Biscayne National Park (BNP) in the central and southern bay and adjacent coral reef.

Biscayne Bay and its parallel coral reef area were selected by NOAA as an HFA because of their valuable natural resources, serious threats to these resources, and the likelihood that effective action now could prevent a later need for costly, and possibly impossible, resuscitation. This HFA's rich resources include many protected species, important recreational and commercial fishery species, and extensive mangrove shorelines, seagrass meadows, and coral reefs that serve as nursery grounds for many species and nurture sea life of all types. Since it shares its shoreline with the Miami urban area, the Biscayne Bay HFA provides many nearby recreational opportunities to residents of a huge regional urban center (2.66M in 2014[1]) (5.5M MSA, 2010 census) and serves as a magnet for tourism (38M visitors/year). However, this proximity to a growing number of residents and tourists is also a significant source of pressures on the bay, including immediate and growing threats to water quality, freshwater inflows, and continuity and function of habitat. The BBHFA seeks to ameliorate these threats by increasing the sustainability of human activities that affect Biscayne Bay and, thus, the resilience of a major waterfront metropolitan city. The goals of the Biscayne Bay HFA are to, by 2020:

1. Understand major sources of nutrients that contribute significantly to phytoplankton and algal blooms in Biscayne Bay and work with resource managers to enhance policies and management approaches for improving water quality.
2. Improve freshwater inflows to enhance estuarine habitat in western nearshore Biscayne Bay.
3. Support and enhance recovery of protected species, sustainability of fishery species, and protection and restoration of their habitat.
4. Increase public awareness of the ecological, economic and social benefits of the Biscayne Bay ecosystem and increase citizen involvement in bay-related conservation activities.

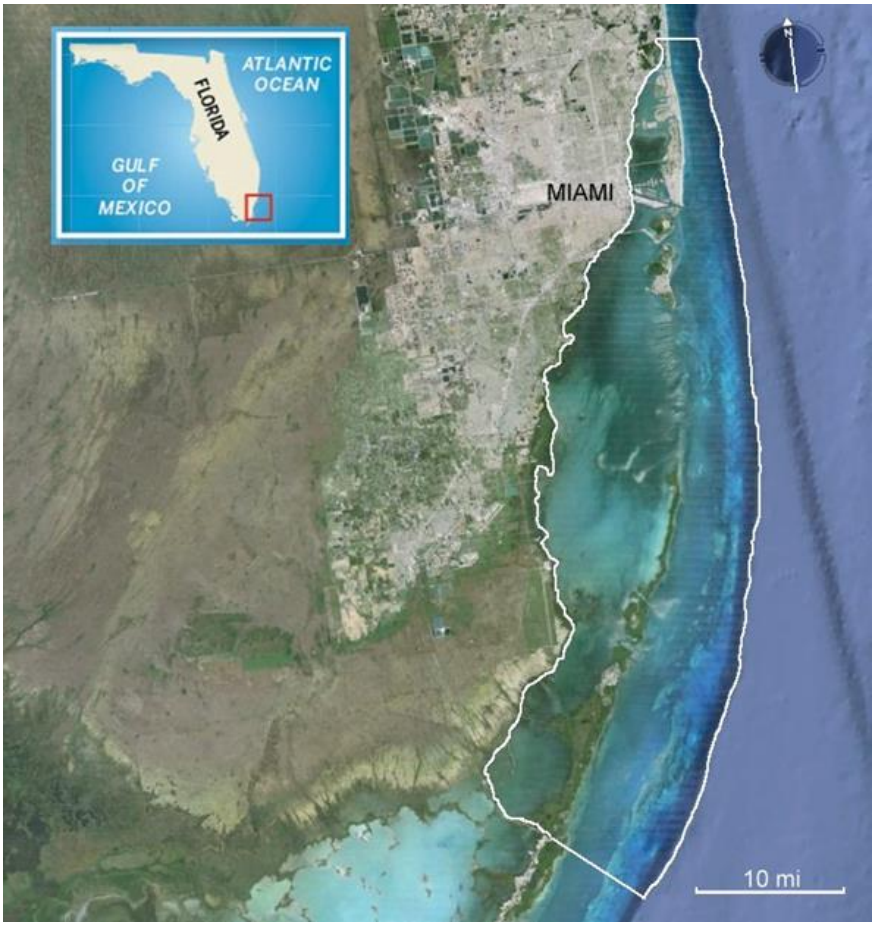

Figure 1. Google image of Biscayne Bay HFA (outlined in white), showing the bay and the reef tract, separated by the barrier islands from Miami Beach south to Upper Key Largo.

LIST OF ACRONYMS

AOML	-	NOAA/OAR Atlantic Oceanographic and Meteorological Laboratory
BB	-	Biscayne Bay
BBAP	-	FDEP Biscayne Bay Aquatic Preserve
BBCW	-	CERP Biscayne Bay Coastal Wetlands
BBHFA	-	Biscayne Bay Habitat Focus Area
BBPCT	-	Biscayne Bay Program Coordination Team
BBWW	-	Biscayne Bay Water Watch
BNP	-	Biscayne National Park
BBRRCT	-	Biscayne Bay Regional Restoration Coordination Team
CERP	-	Comprehensive Everglades Restoration Plan
CRCP	-	NOAA/NOS Coral Reef Conservation Program
CWA	-	Critical Water Area
Deering Estate	-	Deering Estate Environmental, Archaeological and Historic Preserve
ECOMB	-	Environmental Coalition of Miami Beach
EFH	-	Essential Fish Habitat
ESA	-	Endangered Species Act
FIND	-	Florida Inland Navigation District
FDACS	-	Florida Department of Agriculture and Consumer Services
FDEP	-	Florida Department of Environmental Protection
FFO	-	Federal Funding Opportunity
FFWCC	-	Florida Fish and Wildlife Conservation Commission
FKNMS	-	Florida Keys National Marine Sanctuaries
GIDAST	-	Georeferenced Interactive Data Analysis System Tool
GIS	-	Geographic Information System
GPS	-	Geographic Positioning System
HFA	-	Habitat Focus Area
IBBEAM	-	Integrated Biscayne Bay Ecological Assessment and Monitoring Project
IPT	-	BBHFA Implementation Planning Team
JW	-	Junior Waterkeepers
MD-RER	-	Miami-Dade Department of Regulatory and Economic Resources
MD-PROSD	-	Miami-Dade Parks, Recreation, and Open Spaces Department
MD-WASD	-	Miami-Dade Water and Sewer Department
MSA	-	Metropolitan Statistical Area
MWK	-	Miami Waterkeeper
NCCOS	-	National Centers for Coastal Ocean Science
NGO	-	Non-Governmental Organization
NH_4	-	Ammonium
NOAA	-	National Oceanic and Atmospheric Administration
NOS	-	National Ocean Service
NOx	-	Inorganic nitrogen
NMFS	-	National Marine Fisheries Service
NPCA	-	National Parks Conservation Association
NPS	-	National Park Service
OAR	-	NOAA Office of Oceanic and Atmospheric Research
OCED	-	NOAA/AOML Ocean Chemistry and Ecosystems Division

OFW	-	Outstanding Florida Water
RMA	-	Recommended Management Actions
RVC	-	Reeffish Visual Survey
SAV	-	Submerged Aquatic Vegetation
SEFSC	-	NOAA/NMFS Southeast Fisheries Science Center
SERO	-	NOAA/NMFS Southeast Regional Office
SFERTF	-	South Florida Ecosystem Restoration Task Force
SFRPC	-	South Florida Regional Planning Council
SFWMD	-	South Florida Water Management District
SRP	-	Soluble Reactive Phosphorus, or Orthophosphate
SRWG	-	Shoreline Resilience Working Group
STEM	-	Science, Technology, Engineering and Mathematics
TMDL	-	Total Maximum Daily Load
TN	-	Total Nitrogen
TNC	-	The Nature Conservancy
TP	-	Total Phosphorous
UM-RSMAS	-	University of Miami - Rosenstiel School of Marine and Atmospheric Sciences
USACE	-	U.S. Army Corps of Engineers
USF	-	University of South Florida
USFWS	-	U.S. Fish and Wildlife Service
USEPA	-	U.S. Environmental Protection Agency
VKNP	-	Virginia Key North Point
WASD	-	Miami-Dade Water and Sewer Department
WK	-	Miami Waterkeeper
WW	-	Biscayne Bay Water Watch

INTRODUCTION

Background

Biscayne Bay is a shallow, clear water bay located on the lower southeast Florida coast. As defined for NOAA Habitat Blueprint, the BBHFA extends from Dumfoundling Bay in the north, south through Barnes Sound and Manatee Bay. The BBHFA also includes the coral reefs that run parallel to the bay and are a northern extension of the Florida Keys reef tract. On both the southern bay and the reef tract, the boundaries of the BBHFA overlap with the boundaries of the Florida Keys National Marine Sanctuary (FKNMS) and Biscayne National Park (BNP). The BBHFA produces ecosystem services that are essential to the well-being and health of the adjacent human community (Fig. 2). Both bay and reef support many federally protected species, as well as managed fishery species that support coastal and oceanic commercial and recreational fisheries. The BBHFA is an important recreational area, used for diving, snorkeling, kayaking, and swimming. Biscayne Bay is a favorite site for community events and private parties, and much of the life of the surrounding city revolves around its spectacularly picturesque natural setting.

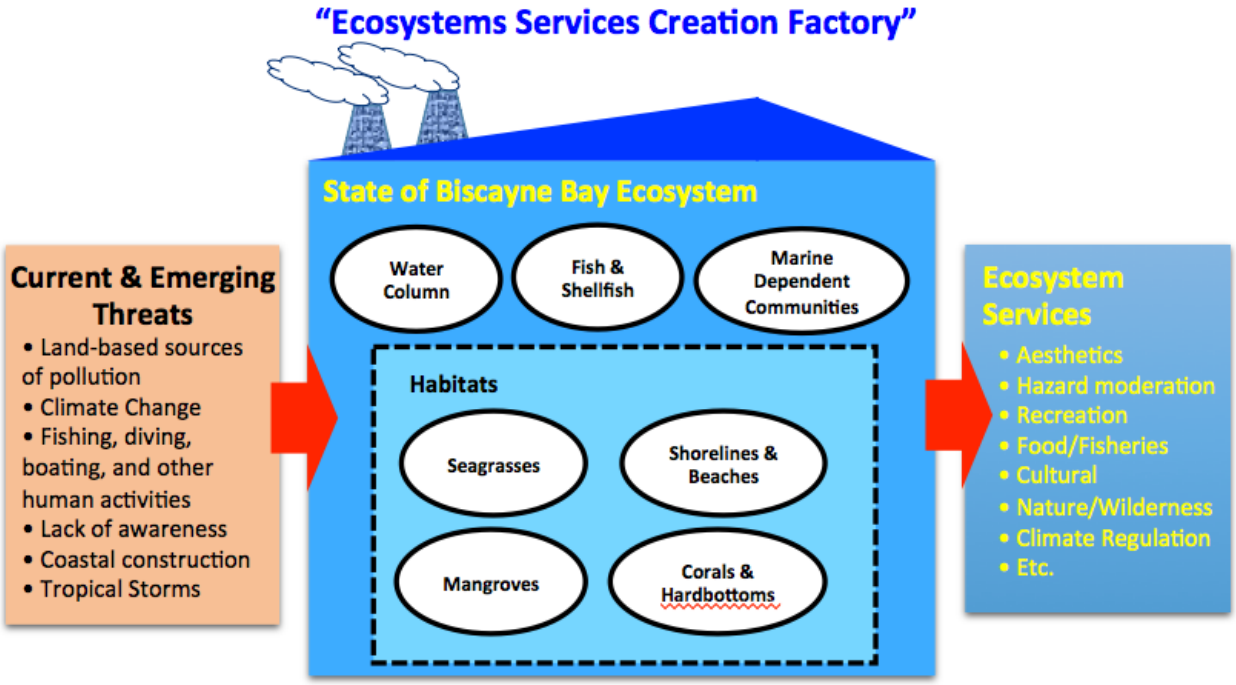

Figure 2. current and emerging threats affecting the ecology of the BBHFA and some ecosystem services currently being produced by the BBHFA.

Biscayne Bay is a subtropical lagoon with freshwater inflow creating an estuarine salinity gradient along parts of its western shore. The estuarine salinity zone provides important nursery habitat for the many estuarine-dependent life history stages common to fish and crustaceans that inhabit this region. The estuarine salinity zone of Biscayne Bay was once much larger and more consistent prior to construction of drainage canals to accommodate urban and agricultural development of southern Miami-Dade

County. The habitats of the BBHFA include its oligotrophic water column, extensive mangrove shorelines, seagrass meadows, beautiful sandy beaches, and coral reefs. This diversity of high quality habitats supports many charismatic and economically-important species, including bottlenose dolphin, sea turtles, Acropora corals, pink shrimp, blue crab, Caribbean spiny lobster, stone crab, bonefish, groupers, and snappers. The Bay and its reef tract make enormous economic, recreational, and aesthetic contributions to the large urban area of Miami-Dade County. The recreational opportunities afforded by the BBHFA's proximity to a major metropolitan area are an exceptional amenity for locals and a magnet for tourists. Industries supporting tourism are among the fastest growing components of the regional economy. The aesthetic contribution of the clear subtropical waters of the Bay and reef represent an important contribution to real estate value not only in the immediate vicinity of the Bay but beyond it as well. The Biscayne Bay area was selected by NOAA as a Habitat Focus Area in 2015 not only for its exceptional natural assets and its value to the surrounding area, but also because of the threats it is facing. Biscayne Bay offered NOAA the unique opportunity to promote conservation and sustainable management of a high-value habitat before it collapsed and needed restoring. Thus, the overarching goal of the BBHFA is to improve management of Biscayne Bay by reducing the risk that it will collapse due to eutrophication. This collapse would significantly degrade the high value habitats found in Biscayne Bay and reduce the Bay's value to the adjacent human population. Moreover, such a collapse would likely prompt the undertaking of ecosystem restoration of the bay, which is far costlier and less effective than sustainable management of a relatively healthy ecosystem. The purpose of this document, the BBHFA Implementation Plan, is to describe the primary goals of the BBHFA and the activities being undertaken by the BBHFA and partners to achieve these goals by mitigating major threats.

The primary goals of the Biscayne Bay HFA Implementation Plan are to, by 2020:

1. Understand major sources of nutrients that contribute significantly to algal blooms in Biscayne Bay and work with resource managers to inform development and application of enhanced policies and management approaches to improve water quality and habitat condition in Biscayne Bay.
2. Improve freshwater inflows to enhance estuarine habitat conditions in western nearshore Biscayne Bay.
3. Support and enhance recovery of protected species, sustainability of fishery species, and protection and restoration of their habitat.
4. Increase public awareness of the ecological, economic, and social benefits of the Biscayne Bay ecosystem and increase citizen involvement in Bay-related conservation activities.

These goals are interrelated and address threats to bay ***water quality***, ***water quantity***, and ***physical/biological habitat***. To better appreciate a healthy bay ecosystem and ensure its future, today's policy makers, resource managers, and the public need to know the value of the ecosystem services the Bay provides.

Key issues threatening the Biscayne Bay HFA

Water quality

The BBHFA ecosystem is highly dependent upon sustaining its natural oligotrophic conditions to support characteristic benthic habitats. While oligotrophic conditions continue to persist in the BBHFA, there are warning signs from increasing chlorophyll *a* to macroalgal blooms that suggest eutrophication is beginning to have deleterious effects on the ecosystem. Chlorophyll *a* is an accepted indicator of eutrophication in Biscayne Bay (Boyer et al. 2009), and the most recent assessment of this indicator found a significant, steady linear increase in chlorophyll *a* in Biscayne Bay over the past 20-years. Since 2005, three unprecedented, large-scale blooms (one of macroalgae and two of phytoplankton) have occurred in the central and southern parts of the bay. One of these blooms was of *Synechococcus*, microscopic algae in the water column, that reduced water clarity, shading out seagrass and causing seagrass loss, clogging and causing loss of sponges and other filter feeders and creating a cascade of negative environmental consequences in the ecosystem (Millette et al. In Review, Gilbert et al. 2009). A bloom of the macroalgae, *Anadyomene*, growing on the bay bottom and crowding out existing seagrass communities, peaked in 2011-2012, killing approximately 12 square miles of seagrass (Miami Dade County Department of Regulatory and Economic Resources, unpublished data; Collado-Vides et al. 2013). A diatom bloom in the water column, dominated by the prickly microscopic genus *Chaetoceros*, covered much of the central and southern bay in 2013.

Water quantity

Biscayne Bay is near the downstream end of a hydrologic system managed primarily for water supply and flood control. Upstream control structures, canals, and operations have substantially changed the quantity, quality, timing, and distribution of freshwater inflow to the Bay. The Comprehensive Everglades Restoration Plan (CERP) seeks to correct damaging influences of this managed system on remaining natural systems. CERP is, however, constrained by commitments to the "built" system for water supply and existing levels of flood control, which affect freshwater inflow to Biscayne Bay from both local and regional sources, and tradeoffs with other components of the natural system, both upstream and downstream, whose freshwater inflows and outflows have been distorted by anthropogenic alterations in the hydrologic system. One CERP project, Biscayne Bay Coastal Wetlands (BBCW) Phase I, is under implementation. BBCW is designed to capture a part of the water that would otherwise enter the bay through canals and distribute it broadly along the coastline in a semblance of natural flow pathways, restoring some of the bay's former coastal wetlands and improving nearshore nursery function for fish and invertebrates. However, upstream CERP projects and accommodations for agriculture and industry in southeastern Miami-Dade County may further reduce annual freshwater flows to Biscayne Bay and change their seasonality. An expected net loss of water to Biscayne Bay in CERP was recognized in the original CERP planning process (USACE 1999), and a wastewater reuse project and search to find other sources of "makeup" water were proposed to replace the deficit. Neither have thus far been pursued, and subsequent events and decisions have further threatened Biscayne Bay's freshwater supply. A State "reservation" of fresh water for Biscayne Bay guaranteed only the amount of freshwater specifically required for Phase I of BBCW, not protecting the total volume of water flowing into the Bay currently despite a significant deficit in the dry season. Planning for Phase II of BBCW, with an associated reservation of additional water for Biscayne Bay, is not scheduled to start until 2020, and the land footprint and fresh water needed for Phase II may not all be available by then.

Habitat for Protected and Fishery Species

The well-being of protected and fishery species in the BBHFA depends upon the spatial extent and quality of habitat. All major ecologically supportive habitat types are under siege by a variety of threats. This includes the threat of direct physical damage or destruction in addition to the already mentioned threats of declining water quality and losses of freshwater inflow. The prime supportive types of habitat in the BBHFA, in addition to the water column itself, are seagrass, coral reef, and mangrove. Various species of fish and invertebrates, including game and commercial species, use the bay as a nursery habitat or they shelter in the mangroves prior to migrating to the reef and other offshore habitats. For most of the HFA, primary productivity is dominated by benthic communities, primarily seagrass and corals, which provide food and structure to support higher trophic levels such as sport fish (reef and flats fish) and bottlenose dolphin. Seagrass meadows occur throughout the BBHFA and may provide a refugia to ocean acidification. Coral reefs are primarily distributed at the edge of the continental shelf offshore of the barrier islands and are especially noted for their high biological diversity. Mangroves provide high quality habitat to many protected and fishery species and serve an important role in cycling nutrients and sequestering carbon.

Seagrass and corals are especially vulnerable to water quality degradation. Seagrass and mangroves are affected by past and future changes in the quantity of fresh water Biscayne Bay receives from the upstream managed hydrologic system. All three types of habitat are vulnerable to physical threats such as shoreline and marine construction and damage from boats and anchors. Physical threats to Biscayne Bay habitat have been accelerating with increased population, shore-side and marine development, and boat-based recreation.

Public awareness of Biscayne Bay and its Benefits

Socio-economic information is needed in conjunction with ecological information to help policy makers, resource managers, and the public better appreciate the benefits of a healthy bay ecosystem and use the bay sustainably. Biscayne Bay underwent a thorough economic valuation in 2004, when an estimated 65.5M person days were spent in Biscayne Bay by residents and tourists (Hazen and Sawyer 2005), and the information developed from that study is still useful. However, additional socioeconomic information about the bay would help to better explain the bay's value to the city and region and the potential loss of ecosystem services that would result from any degradation of water quality or diminishment of support level. Increasing the use of socioeconomic information in Biscayne Bay, educating the public about the bay, and increasing citizen involvement in Biscayne Bay stewardship activities will be significant steps toward putting Biscayne Bay and adjacent human communities on a sustainable path.

The Natural Resource Management Environment

Multiple organizations and agencies work in the BBHFA, and there are multiple jurisdictional mandates across the resource management agencies. Biscayne National Park (BNP) manages both bay and reef areas, in collaboration with state agencies. The Florida Department of Environmental Protection (FDEP) oversees the Biscayne Bay Aquatic Preserves (BBAP) and the Coral Reef Conservation Program (CRCP). CRCP manages the reef track north of the Florida Keys National Marine Sanctuary and Biscayne National

Park from Miami-Dade through Martin counties. FDEP regulates nutrient inputs to the bay through the TMDL program, which establishes numeric nutrient criteria. Other management entities operating in the bay or on the reef track include Miami-Dade County, Florida Fish and Wildlife Conservation Commission (FFWCC), Florida Department of Agriculture and Consumer Services (FDACS), South Florida Regional Planning Council (SFRPC), South Florida Water Management District (SFWMD), the Florida Keys National Marine Sanctuary (FKNMS), U. S. Fish and Wildlife Service (USFWS), U. S. Army Corps of Engineers (USACE), U. S. Environmental Protection Agency (USEPA), the U.S. Coast Guard Station Miami Beach, and state and federal interests associated with the Port of Miami, including the Department of Transportation, Customs, and the Border Patrol, as well as municipalities bordering the Bay including the City of Miami. The USACE and SFWMD are partners in the construction and operation of a system of canals, levees, and other structures that affect the flow of fresh water to Biscayne Bay. In addition to the multiple governmental groups operating in the BBHFA, several non-governmental organizations (NGOs) focus significant attention on the BBHFA area.

Ongoing Activities of NOAA and Key Partners Supporting BBHFA Goals

This Plan is built on a core of ongoing research, monitoring, education and outreach activities of NOAA and resource management partners. Some ongoing activities that support BBHFA goals are listed by goal in Table 1. Many are included as key activities in this Implementation Plan. Ongoing activities of the NOAA laboratories support their mandates of providing sustainable fisheries, protecting marine mammals and endangered and threatened marine species, conserving coral reefs, and understanding, characterizing, and predicting ecosystem health. The listed ongoing activities of BBHFA partners are taking place independently of BBHFA implementation plan development and were not specifically designed to support BBHFA goals and yet, they do, because BBHFA goals are so well aligned with the goals of these resource management entities. Incorporating these activities into our plan and working together with our partners will enable a more effective overall effort to restore and protect Biscayne Bay and its adjacent reef tract.

The main NOAA Labs supporting the BBHFA are the Southeast Fisheries Science Center (SEFSC) of the National Marine Fisheries Service (NMFS) and the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the Office of Oceanic and Atmospheric Research. These NOAA labs have several ongoing projects that support the BBHFA goals, all of which are included in this Plan. The Coral Reef Conservation Program (NOAA/NOS/CRCP) also has activities relevant to this Implementation Plan.

Key partners of NOAA in the BBHFA are Biscayne National Park (BNP), Miami Dade County (especially the Department of Regulatory and Economic Resources (MD-RER), and the Florida Department of Environmental Protection's (FDEP) Biscayne Bay Aquatic Preserves (BBAP). Biscayne Bay management plans of each of these entities are listed in Table 2.

BBHFA Implementation Plan Key Activities, by Goal and Objective

The overarching goal for the BBHFA is to protect and enhance Biscayne Bay's support value for protected and fishery species, as well as the human community and economy dependent upon its clear, clean waters and its richness of fish and other sea life. Water quality and quantity issues and physical

damage or destruction to the BBHFA's biologically-based habitats (mangrove shoreline, seagrass beds, coral reefs) jeopardize the species and their ecosystem and the underpinnings of the regional human community and economy. Water quality issues are addressed by **Goal 1** and water quantity issues, by **Goal 2**. Much of the habitat in the BBHFA is biologically based and exceptionally fragile. **Goal 3** addresses protected and fishery species, their habitat use, and physical damage to, or destruction of, habitat. Helping partners accomplish their habitat-protection goals is critical to making progress toward protecting and restoring habitat. **Goal 4** attempts to moderate human impacts on species and habitat. The activities listed under each objective include not only current and new activities of the BBHFA lead agencies and their funded partners, but also those of partner resource management entities in the Bay that seem particularly pertinent to our objectives and fill critical gaps that would make the plan otherwise seem incomplete.

The four major BBHFA goals and their associated objectives will be addressed by the five major strategies that follow. The effect of these strategies on threats to Biscayne Bay ecological health and function are shown in the logic frame models in Appendix A. Success in carrying out this plan depends upon attracting partners and maintaining stakeholder engagement. The partner and stakeholder engagement strategy to support this plan is described in Appendix B.

Improve the scientific basis for management

As a general approach, this strategy includes data acquisition (i.e., monitoring), analysis, and modeling to address specific issues such as eutrophication, freshwater loss, and characterization and location of key habitat. This strategy is especially directed at finding the major nutrient sources and conditions that instigate algal blooms. It also is directed at determining the habitat needs of protected, and managed fishery, species.

Facilitate stewardship of natural resources by users

This strategy includes providing navigational aids and mooring buoys to boaters and calling their attention to the importance and vulnerability of seagrass and corals.

Improve Resiliency of Coastal Habitat and Communities

This strategy employs infrastructure repair, replacement, or redesign to improve habitat and community resilience. Habitat can refer to either human communities or communities of wetland, estuarine, or marine plants and animals or both at the same time. It could potentially include as diverse actions as repair of malfunctioning sewer system pipes or replacement of seawalls with living shoreline.

Educate, Inform and Engage Communities

This strategy seeks opportunities to reach out to stakeholders, informing them on the importance of Biscayne Bay and its associated reef tract and the need to protect their vital yet vulnerable habitat.

Contribute to Resource Management Planning and Implementation

This strategy supports strengthened communication with resource managers, providing them with information from research on the Bay and reef tract and gaining their experience and insight on how to turn that information into effective protective actions. This strategy also includes promoting enforcement of rules and regulations to protect resources by making the rules easier to follow and/or developing a deeper comprehension of the value of these resources and the need to protect them.

Following are the four goals, their objectives, and the activities either ongoing or planned to support the goals and objectives.

GOAL 1. By 2020, understand major sources of nutrients that contribute significantly to phytoplankton increases and algal blooms in Biscayne Bay and work with resource managers to enhance policies and management approaches for improving water quality.

Warning signs suggest that Biscayne Bay could be approaching a tipping point for eutrophication. The Bay is a naturally clear water system supported predominantly by primary production in benthic communities and shoreline mangrove communities (Brand, 1988). Added nutrients have shifted most of North Biscayne Bay to a system dominated by primary production in the water-column, while southern Biscayne Bay remains primarily a system dominated by benthic primary production. Many estuaries around the world have exceeded the tipping point toward eutrophication, resulting in a significant loss of seagrass and benthic primary production as pelagic phytoplankton shades out benthic plants
The warning signs in Biscayne Bay include:

1) 20+-year increases in water-column chlorophyll *a* (an indicator of phytoplankton concentration) and soluble reactive phosphorus, the limiting nutrient in Biscayne Bay
2) An unprecedented macroalgal bloom of *Anadyomene* sp. that started in 2009, causing seagrass mortality (estimated 12 mi^2 loss, MD-DERM), and has left behind unvegetated bottom, thus reducing habitat quality
3) Unprecedented phytoplankton blooms in the central and southern bay in 2013
4) Recent additional loss or degradation of seagrass area

Change from a benthic to water-column primary production system can cause a cascade of ecological disturbance that affects important commercial fishery species such as spiny lobster, *Panulirus argus* (Butler et al., 1995). The intermittent algal blooms, in themselves, are not so much a concern as the generally widespread and persistent higher concentrations of phytoplankton, as indicated by chlorophyll *a*, and provoking nutrients occurring routinely in the water column, which weaken the system and make it harder to recover from the occasional blooms.

Depending on the nutrient source, mitigation strategies to reduce nutrient inputs can often be expensive. Targeted approaches to determine and reduce the most influential sources of nutrients are the preferred method. To help protect the vital seagrass habitats of Biscayne Bay, the Habitat Focus Area aims to develop scientific understanding necessary to advise managers and regulators on the most effective and efficient methods to reduce nutrient sources to Biscayne Bay.

OBJECTIVE A – Understand the major sources of nutrients that contribute to algal blooms and the long-term increase in soluble reactive phosphorus (SRP) and chlorophyll α in Biscayne Bay.

Strategy: Improve the Scientific Basis for Management

The first step to achieving nutrient controls necessary to protect benthic and pelagic habitat in Biscayne Bay HFA is quantifying nutrient sources contributing to increases in nutrients and chlorophyll *a* over the past 20-years. Analyzing existing water quality monitoring data allows us to begin quantifying the relative importance of different nutrient sources. Because nutrient reduction measures can be expensive, the existing monitoring data should be supplemented with data aimed at determining the land-based sources of pollution that could be targeted with management actions. Funding for water quality monitoring programs has been cut significantly in recent years at all levels of government. In response to this recent dearth of water quality monitoring in Biscayne Bay, Florida Sea Grant has launched a citizen water quality monitoring program called Biscayne Bay Water Watch. The hope is that Biscayne Bay Water Watch (BBWW) will be a model for supplemental, scientifically-sound water quality monitoring. The activities and data listed below have been identified as necessary to understand nutrient distributions in Biscayne Bay and quantify their sources, especially with regards to potential land-based or aquifer sources of pollution. The collection and analysis of these data should be of the highest priority. The BBHFA has begun a detailed investigation of sources of nutrients in the Coral Gables Waterway. Besides its value in partitioning nutrient inputs among sources in a major watershed, this investigation will demonstrate an approach that can be applied to other watersheds contributing nutrients to Biscayne Bay.

Major activities to support this work include:
• Analyze existing water quality data to determine spatial and temporal rates of increase in nutrients and chlorophyll *a* to aid in identifying potential threats to Biscayne Bay water quality. AOML (FY16, FY17 FUNDED BY AOML)
• Sample chlorophyll-*a* and nutrient (TP, TN, NH_4, NO_x, Silica, and SRP) distributions in Biscayne Bay. MD-DERM; WW UF SEA GRANT (HFA FY15, FY16, FY17 FUNDING); NOAA/AOML; BNP (ONGOING)
• Sample canal flow volume/rates and upstream-to-downstream nutrient gradients (TP, TN, NH_4, NO_x, Silica, and SRP to identify possible nutrient input locations and determine and compare nutrient loads to Biscayne Bay. NOAA/AOML (HFA FY15, FY16 FUNDED; FY17 UNFUNDED)
• Use markers to identify potential nutrient sources in Biscayne Bay waters from among wastewater treatment plants, septic tanks, agriculture, and grass fertilizers. NOS/NCCOS & FDEP (UNFUNDED)
• Sample water column for chlorophyll-*a* and water column and seagrass epiphytes for nutrients and microalgae community composition along the mainland shoreline to pinpoint potential nutrient input sources, and use the information to develop models to predict high chlorophyll-*a* concentrations and the main algal taxa involved. NOAA/SEFSC (HFA FY15, FY16, FY17 FUNDED)
• Conduct pilot study in Coral Gables Waterway to determine sources and sinks of nutrients from watershed perspective. NOAA/AOML and SEFSC (HFA FY17 UNFUNDED, but completed on a volunteer basis)
• Introduce satellite remote sensing technology to monitor water quality in Biscayne Bay and the nearby reef system through a "Virtual Buoy System". WK, USF (CONTINGENT ON HFA FY18, FY19 FUNDING)

OBJECTIVE B – Create Scenario Evaluation Tools and Alternative Scenarios to Guide Development of Effective Nutrient Reduction Strategies

Strategy: Improve the Scientific Basis for Management

Results of analysis of the water quality data will be used to develop an ecological forecasting capability for scenario evaluations that predict the effectiveness of different nutrient reduction approaches. Nutrient reduction approaches might include, for example, replacement of septic tanks with connection

to sewers at strategic locations, repair or replacement of malfunctioning sewer mains, or best management practices to reduce fertilizer inputs from agricultural or residential areas. Scenario evaluations would provide the scientific basis for implementing effective nutrient controls for Biscayne Bay. The scenario evaluations would have to be effectively communicated to managers.

Major activities to support this work include:
• Analyze 20-year time series of chlorophyll-α data in relation to potential influencing variables AOML (FY16, FY17 FUNDED BY AOML).
• Develop an ecological forecasting model and alternative nutrient reduction strategies (scenarios) AOML (FY17 FUNDED BY AOML).
• Evaluate scenarios to predict effectiveness of various nutrient reduction approaches.

OBJECTIVE C – Inform Decision-Makers on the Importance of Biscayne Bay, Regarding Nutrients, and Effective Nutrient Controls

Strategy: Contribute to Resource Management Planning and Implementation

The next step will be to communicate this information to decision-makers in such a way that effective nutrient mitigation measures are enacted. The Biscayne Bay HFA will work with partners at Miami Waterkeeper to conduct "on-the-water" education for elected officials that focuses on communicating: 1) Biscayne Bay's ecological and economic importance, 2) the nutrient pollution issues facing Biscayne Bay, and 3) land-based sources of pollutants, and 4) potential mitigation strategies and best management practices for reducing nutrient loading to Biscayne Bay and protecting its vital seagrass and sponge habitats. (See Goal 4 for more details).

Major activities to support this work include:
• Communicate predictions on the effectiveness of alternative nutrient reduction approaches to resource managers directly and through the BBHFA education/outreach programs. WK (FY15, FY16, FY17 FUNDED, FY18, FY19 CONTINGENT ON AVAILABILITY OF HFA FUNDING)
• Provide on-the-water education about Biscayne Bay issues and solutions to public officials and local leaders. WK (FY15, FY16, FY17 FUNDED, FY18, FY19 CONTINGENT ON AVAILABILITY OF HFA FUNDING)

GOAL 2. Improve Freshwater Inflows to Enhance Estuarine Habitat Conditions in Western Nearshore Biscayne Bay.

Biscayne Bay is repeatedly subjected to new threats to its freshwater inflows and lacks a specific guaranteed allotment other than a minimal amount that is a "reservation" associated with the Phase I Biscayne Bay Coastal Wetlands (BBCW) project of CERP. Completion of Phase II planning will provide another increment of reserved flow for Biscayne Bay, but the planning stage of Phase II is years away (scheduled to start in 2020 and take 4 years to complete), and the full reservation still will not be as much as the bay is receiving now. Although monitoring is underway to establish pre-CERP conditions and follow changes associated with CERP implementation, no capability has been identified to address these threats preemptively. Two strategies we will pursue are 1) modeling to relate change in flow to change in habitat area to quantify potential impacts and 2) direct communication with water

management and operations staff to take advantage of ad hoc opportunities to improve the quantity, timing, and distribution of freshwater inflow to Biscayne Bay.

The Deering Estate Environmental, Archaeological and Historic Preserve (Deering Estate), a key partner of BBHFA, is entering the final phase of development of an education wetland as part of the South Florida Water Management District's (SFWMD) Comprehensive Everglades Restoration Plan (CERP) on County property on the shoreline of southern Biscayne Bay. This project is part of a larger project to restore freshwater flows into Biscayne Bay in the Biscayne Bay Coastal Wetlands Project and CERP. Deering Estate is also engaged in the Deering Flow-way/Cutler Slough Rehydration project, a site-specific reconciliation ecology effort to help restore seasonal water flow into an historic slough (a freshwater wetland habitat) that once existed within the Estate boundaries. The Deering Flow-way redistributes water from the SFWMD flood protection canals via a spur canal and pumping station. The slow-moving water is then naturally filtered by vegetation and soil as it travels through the Estate's habitat and out to Biscayne Bay in a more ecologically beneficial sheet flow manner.

Objective A – Show Water Managers and Others the Effects of Water Management Actions on Area of Favorable Bay Habitat for Estuarine-Associated Organisms.

Strategy: Improve the Scientific Basis for Management

A hydrodynamic model of Biscayne Bay could be used to predict the area of favorable salinity for an estuarine fish and invertebrate community (i.e., mesohaline, 5-18 salinity range; polyhaline, 19-30 salinity range) under different freshwater inflow regimes. A hydrodynamic model of southern Biscayne Bay originally developed by Wang et al. (2003) and recently revised by Stabenau et al. (2015) is now available in the public domain and could be used with the actual freshwater inflow record from 1996-2011 to estimate the area of bay habitat within the desired salinity range and the effect on favorable area of scaling flow volume upward or downward. Distribution in time and space could also be varied to determine effects. Habitat suitability models prepared as part of an ongoing monitoring and assessment project for CERP are also available for several Biscayne Bay nearshore species to help translate change in salinity habitat into change in abundance.

Major activities to support this work include:

◊ Use a hydrodynamic model for Biscayne Bay now in the public domain (Stabenau et al. 2015):

• Predict area of favorable nearshore habitat, as defined for an estuarine fish and invertebrate community, with incremental changes (decreases or increases) in freshwater inflow.

NOAA/SEFSC, AOML, NPS (UNFUNDED)

◊ Conduct monitoring and assessment as part of IBBEAM:

• Record salinity and temperature at 15-sec intervals along the western Biscayne Bay shoreline and develop indices.
• Monitor submerged aquatic vegetation (SAV) along the western Biscayne Bay shoreline and develop habitat suitability models.
• Monitor mangrove fish and epifauna, relate abundance to salinity and seagrass, and develop habitat suitability models.
• Determine weighted salinity of occurrence of sampled epifauna species from nearshore Biscayne Bay.

NPS, NOAA/SEFSC, UM-RSMAS (ONGOING, PARTLY FUNDED BY USACE)

◊ Conduct Wetland/groundwater monitoring:

- Monitor SAV downstream from culverts in the L31E canal created to redistribute water to the Bay in BBCW.
- Monitor physicochemical parameters in groundwater wells at the Deering Estate.
- Monitor salinity in Deering Estate in groundwater wells in creeks feeding into Biscayne Bay at the Deering Estate.

MD-RER and MD-PROSD (ONGOING, FUNDED BY SFWMD)

Objective B – Improve Communications with Water Managers and Seek Opportunities to Augment Flows and Improve Timing and Distribution

Strategy: Contribute to Resource Management Planning and Implementation

Major activities to support this work include:

◊ Communicate effectively with resource managers and planners:

- Take part in science planning and science presentation meetings of CERP and the South Florida Ecosystem Restoration Task Force (SFERTF) NPS, MD-RER, SEFSC (ONGOING)
- Attend and help support the BBRRCT, whose priority activity is to advise the SFERTF Working Group on issues affecting freshwater inflow to Biscayne Bay. BNP, MD-DERM, SEFSC, BBAP, NPCA (ONGOING)
- Communicate with NPS and MD-RER scientists and managers about Biscayne Bay water quantity issues. SEFSC, AOML (ONGOING)

◊ Use improved communications with water managers and up-to-date knowledge of flows and weather to propose temporary modifications of operations to improve quantity, timing, and distribution or freshwater flow to Biscayne Bay within management constraints. NPS, MD-RER (ONGOING)

Objective C – Decrease Urban Water Demand

Strategy: Inform and Engage Communities

Miami-Dade County WASD conducts community outreach programs to reduce consumer demand. Two popular programs initiated several years ago are still ongoing.

Major activities to support this work include:

◊ Provide incentives to reduce water consumption:

- Continue Water Conservation Program implemented in 2006 with incentives for switching to high efficiency toilets and fixtures.
- Survey landscaped components of single and multi-residential homes and provide one-time-only $2,800 toward retrofit irrigation systems on owner-acceptance of recommended irrigation improvement.

(ONGOING, MD-WASD)

GOAL 3. Support and Enhance Recovery of Protected Species, Sustainability of Fishery Species, and Protection of Their Habitat.

Objective A – Improve Knowledge of the Habitat Requirements of BBHFA Protected Species.

Strategy: Improve the Scientific Basis for Management

Many protected species occur in the BBHFA. Under NOAA's mandate are the bottlenose dolphin, five sea turtles (green, loggerhead, hawksbill, Kemp Ridley, and leatherback), the critically endangered smalltooth sawfish, and nine Endangered Species Act (ESA)-listed coral species. SEFSC has ongoing projects in the HFA related to improving our knowledge of habitat use and habitat needs of bottlenose dolphin, sea turtles, and the *Acropora* corals. Miami-Dade County has oversight for the West Indian Manatee. New work in the BBHFA on the smalltooth sawfish is being initiated by the Miami Laboratory of the SEFSC.

◊ Smalltooth Sawfish: This endangered fish species requires low-salinity mangrove areas as nursery habitat. NOAA-designated Essential Fish Habitat (EFH) for smalltooth sawfish (STS) includes two southwest Florida areas (1) the Charlotte Harbor-Peace River area and (2) the area from Cape Romano south through the Ten Thousand Islands and Florida Bay to U.S. Highway 1, the generally recognized boundary between Florida Bay and Biscayne Bay. The smalltooth sawfish EFH does not at present include the BBHFA. A new BBHFA effort to consolidate and improve the knowledge base on smalltooth sawfish presence in the BBHFA is part of this plan, is described in the bullets below, and is being led by Tom Jackson, fishery research biologist at the SEFSC Miami Laboratory and BBHFA coordinator.

Major activities to support this work include:
<u>To acquire and synthesize existing data:</u>
• Accumulate and synthesize existing smalltooth sawfish data documenting presence, size, and habitat type where found in Biscayne Bay and coordinate with International Sawfish Encounter Database (ISED) representatives to provide them records they do not already have. Potential sources are historic records and eye-witness-accounts.
<u>To develop new information:</u>
• Collaborate with University of Miami scientists studying sharks in areas adjacent to the urban environment in Biscayne Bay and help them expand their acoustic array in the BBHFA to place units where sawfish are most likely to be found.
• Consult STS management plans (2009/2014), records of discussion, and researchers tracking sawfish to determine characteristics of habitat frequented by sawfish elsewhere and use this information to direct placement of acoustic receivers to best target sawfish in the BBHFA.
• Identify probable nursery areas in the BBHFA based on criteria established in the 2014 STS management plan, determine historic and current STS activity in these areas for evaluation and future surveillance for neonates. Identify parties with jurisdiction, contact and collaborate.
• Provide NOAA boat captain and NOAA small craft to place, service, retrieve, and download acoustic receiver units.
<u>To make information available to resource managers:</u>
• Communicate with CERP-Biscayne Bay Coastal Wetland Project managers about opportunities to increase project benefits by restoring potential juvenile sawfish habitat.
• Explore opportunities to address specific needs of the Sawfish Recovery Plan.

NEW HFA PROJECT, NOAA/SEFSC/Miami Lab (NOAA INKIND), University of Miami (LIMITED INDEPENDENT FUNDING)

Background: Tom Jackson, BBHFA coordinator and SEFSC Miami Laboratory fishery research biologist, is conducting the BBHFA work on smalltooth sawfish summarized in the above bullets. The international monitoring of sawfish is coordinated by the Florida Museum of Natural History Museum's International Sawfish Encounter Database (ISED). The Regional Office of NOAA National Marine Fisheries Service developed and manages the Smalltooth Sawfish Recovery Plan. Dr. John Carlson at the SEFSC Panama City Laboratory conducts sawfish tagging and other aspects of NOAA sawfish research primarily in the designated EFH area in cooperation with the Florida Fish and Wildlife Conservation Commission and several Universities. Their activities have resulted in many smalltooth sawfish being tagged in southwest Florida and the Florida Keys. Dr. Neil Hammerschlag of the University of Miami conducts the Urban Shark Study in Biscayne Bay that collaborates with SEFSC Miami's Tom Jackson. As part of this collaboration, UM upgraded its acoustic receiver equipment by joining the open source Florida Atlantic Coast Telemetry (FACT) acoustic network, which allows all acoustically tagged species, including sawfish, turtles, and others, to be monitored by the receivers. The UM-SEFSC Miami collaboration led to an increase in the number of acoustic receivers in the Biscayne Bay acoustic array from only one at its start to 40 (as of late 2018). FACT support for this array was recently extended to 2024 based on results of the UM-SEFSC-Miami collaborative effort. Sawfish are not tagged with acoustic tags in the BBHFA. Sawfish detected there will have been tagged elsewhere. Dr. Hammerschlagg can readily communicate with all researchers whose tags his equipment reads.

◊ **Bottlenose Dolphin:** SEFSC has been studying the bottlenose dolphins in Biscayne Bay since 1990, starting with a photo-identification effort that has provided the critical foundation for other studies.

Major activities to support this work include:
• Conduct photo-identification mark-recapture studies to estimate abundance and study population structure, movements, and habitat use. Observations regarding dolphin health and group interactions are also recorded during surveys. Potential causes of dolphin mortality in the Bay, including a recent unusual mortality cluster, are sought. NOAA/SEFSC (ONGOING)

◊ **Sea Turtles:** NOAA shares responsibility for sea turtles with the U.S. Fish and Wildlife Service (USFWS). SEFSC participates in the regional stranding network for sea turtles, covering beaches on Virginia Key routinely and responding to citizen alerts on stranded turtle sightings. Stranding results reveal the past presence not only of loggerhead and green turtles, but also Kemp's Ridleys, Hawksbills, and Leatherbacks, in the BBHFA. SEFSC started its first survey and study of living sea turtles in Biscayne Bay in 2015.

Major activities to support this work include:
• Conduct vessel transect surveys to assess distribution and relative abundance of sea turtles in the Bay along with mark-recapture data collection and satellite telemetry to assess habitat use in Biscayne Bay NOAA/SEFSC (ONGOING)
• Participate in sea turtle regional stranding network, covering beaches on Virginia Key routinely and responding to citizen alerts on stranded turtle sightings. NOAA/SEFSC (ONGOING)
• Acoustic tagging sea turtles (loggerheads, greens, If possible hawksbills, Ridleys), within the BB HFA / FACT array (explained in smalltooth sawfish section below in detail) to investigate local (residential, reproductive) or transient (migratory) activities. NOAA/SEFSC Miami Lab (NEW)

◊ **West Indian Manatee:** The manatee is an important marine mammal living in Biscayne Bay that is federally protected under both the ESA and the Marine Mammal Protection Act. Its protection is the mandate of the U.S. Fish and Wildlife Service rather than NOAA. Miami Dade County administers a Manatee Protection Plan coordinated with the regional USFWS Manatee Recovery Plan and the Florida Fish and Wildlife Manatee Management Plan. A previous major cause of manatee deaths in Miami-Dade County was entrapment in SFWMD water control structures, but this problem was resolved with installation by the U.S. Army Corps of Engineers and SFWMD of pressure sensitive devices that caused the gates to reopen for the passage of a manatee. Collision with boats is presently the main cause of manatee deaths in the county.

Major activities to support this work include:
• Administer Miami-Dade County Manatee Protection Plan with regulation, enforcement, education and outreach. MD-RER, FFWCC, USFWS, SFWMD (ONGOING)

◊ **Corals:** ESA-listed coral species include two *Acropora* species (staghorn coral (*Acropora cervicornis*) and elkhorn coral (*A. palmata*)) and five newly listed species found on the Florida reef tract. The two acroporids and their hybrid were the dominant reef building species throughout Florida and the Caribbean, and the wholesale loss of these branching corals is resulting in loss of reef structure. Many stressors affect them. Extremes of light attenuation and temperature are especially damaging. Some researchers think that these corals may have to change genetically to keep up with environmental change and maintain their reef building roll; current research includes looking for signs of adaptive change and trying to help it along. A new coral disease, affecting over half the coral species on the reef tract (but not *Acropora* spp.), was discovered in 2014 and has been spreading.

Major activities to support this work include:
• Refine scientific techniques for coral nursery culture, restocking, and reef restoration approaches and their evaluation. NOAA/SEFSC, /SERO, NOS/CRCP (ONGOING)
• Characterize the trait of disease resistance in elkhorn and staghorn corals using pairwise field transmission assays and targeting genotypes in Tavernier and Middle Keys nursery and wild genets in Key Largo region. NOAA/SEFSC, NOS/CRCP (NEW, FUNDED)
• Stock and maintain coral nursery in Biscayne National Park. UM-RSMAS (ONGOING)

Objective B – Determine Condition and Habitat Use of Fishery Species in the BBHFA.

Strategy: Improve the Scientific Basis for Management

The Reeffish Visual Census (RVC) is a well-established diver-based method of monitoring reef fish species that was developed by SEFSC and UM-RSMAS on the Florida Keys Reef Tract and has been refined over time and extended north beyond the BBHFA northern boundary. In a multispecies assessment based on RVC and other data, Ault et al. (2001) determined that 77% of the 35 exploited reef fish species in Biscayne National Park that could be analyzed were overfished. Continued monitoring is needed to keep resource managers informed on local and regional stock conditions.

Major activities to support this work include:

• Conduct RVC of Biscayne National Park and Miami-Dade County area in conjunction with Florida Keys and SEFCRI in even years (i.e., 2016, 2018, 2020) to track change in fish species densities and size distributions over time. NOAA/SEFSC, with UM-RSMAS, BNP, MD-RER and FFWCC (ONGOING).
• Prepare a user-friendly data portal to improve access to RVC data. NOAA/SEFSC (ONGOING)

Objective C –Improve and Protect Habitat

Seagrass, mangrove, and coral areas provide essential habitat for fishery and protected species and are the basis of the BBHFA's natural productivity and value. These habitats are highly vulnerable to physical damage from boats and anchors, and boats also can be damaged for lack of good information about habitat and bathymetry. Shoreline construction obliterates most shoreline habitat within its footprint and even underwater habitat outside the construction footprint is damaged by the scouring associated with wave action along a vertical shoreline. Marine debris and invasive exotics are other factors that can degrade habitat quality. Habitat protection under this Plan will be addressed with activities that will protect, improve, or restore habitat or mitigate for habitat losses. Examples of actions that could be conducted under the BBHFA Implementation Plan follow, listed by strategy. Only a few are being partially NOAA-funded. Some may be on-going activities of partner resource-management agencies that could be joined within the Plan framework.

Examples of actual and potential activities follow:

Strategy: Facilitate Stewardship of Natural Resources by Users

• Compile recent spatial datasets of benthic cover and bathymetry (e.g., including lidar, aerial imagery, habitat cover) into a set of GIS layers that can be used to create maps useful for nearshore navigation, plan future updates of the official NOAA chart, contribute to commercial navigation applications, help site navigational/resource protection signage, and inform resource managers on a range of issues. NOAA/SEFSC, UM-RSMAS (PARTIALLY NOAA FUNDED)
• Prepare up-to-date habitat and bathymetric maps to supplement outdated parts of NOAA nautical charts (and chart-dependent applications) to help protect habitat from boat-related impacts. NOAA/SEFSC, UM-RSMAS (PARTIALLY NOAA FUNDED)
• Acquire physical markers, mooring buoys, and bathymetric maps, as well as digital) means (GPS or cell phone applications, to help boaters avoid sensitive habitat and boating hazards. (MD-RER, BNP, UNFUNDED BY NOAA, PURSUED OPPORTUNISTICALLY)
• Boaters' Guide to Biscayne Bay https://www.flseagrant.org/wp-content/uploads/SGEB_73_web.pdf FLORIDA SEAGRANT (COMPLETED)

Strategy: Improve Resilience of Coastal Habitat and Communities

• Restore or mitigate for lost or damaged seagrass, mangrove, coastal wetland, or beach habitat to recover productive habitat area. (BNP, BBAP, UNFUNDED BY NOAA, PURSUED OPPORTUNISTICALLY)
• Promote use of living shorelines and maintenance of remaining natural shoreline to increase shoreline stability and natural productivity. (MD-RER, UNFUNDED BY NOAA, PURSUED OPPORTUNISTICALLY)
• Remove marine debris (derelict or abandoned fishing gear, vessels, plastic debris, other) from the BBHFA to improve habitat quality and shore and seascape esthetics and reduce hazards to

wildlife and boaters. MD-RER, BBAP (ONGOING, PAST AND RECENT NOAA FUNDING, PURSUED OPPORTUNISTICALLY)

Strategy: Engage Stakeholders in Implementation

• Create native plant communities on spoil islands and other disturbed lands bordering Biscayne Bay or adjacent waters to provide habitat for animals with both terrestrial and aquatic needs. MD-RER, BBAP (ONGOING, UNFUNDED BY NOAA)
• Remove invasive exotic plant species from SEFSC property on Virginia Key to remove invasive exotic plant species from SEFSC property on Virginia Key. SEFSC, FFWCC, Virginia Key Trust, Treeeemendous (NOAA INKIND)

Strategy: Improve the Scientific Basis for Management

• Compile list of exotic species specific to BBHFA based on existing lists. SEFSC (NOAA INKIND)

GOAL 4. Increase public awareness of the ecological, economic, and social benefits of the Biscayne Bay ecosystem and increase citizen involvement in conservation activities.

The long-term success of the Biscayne Bay Habitat Focus Area hinges on getting scientists, managers, industry, environmental groups, citizens and other stakeholders working together towards the common goal of balancing the needs of resource conservation with the enjoyment of the many ecological, economic and social benefits that the Bay provides. Effective collaboration depends upon getting citizens and communities engaged in conservation activities based on sound science and best practices. Raising people's awareness can lead to changes in attitude that eventually manifest into responsible individual behavior and practices. Collectively, this translates into active citizen engagement in resource management, policy development, research, enforcement, and education/outreach programs that result in better stewardship of their environment and resources.

The implementation strategies to achieve Goal 4 of the Biscayne Bay Habitat Focus Area will focus primarily on: (1) ***Improve the Scientific Basis for Management***, and (2) ***Educate, Inform, and Engage Communities***. The Biscayne Bay Results Chain Model (Figure A-3) shows how these strategies and associated programs will be implemented to achieve Goal 4 of the Biscayne Bay HFA.

Activities described under Goal 4 are aimed at contributing relevant and timely scientific information to help responsible government agencies better manage and protect the resources of Biscayne Bay. Adding to the habitat science (water quality, quantity, and habitat protection) research contributions of Goals 1 through 3, Goal 4 will data mine relevant archival information pertaining to the Bay, update past socio-economic valuation studies, conduct rapid response samplings of reported algal blooms and Bay pollution, and supplement/complement local management agency's long-term water quality monitoring programs in the Bay. In cooperation with Federal, State, and local partners, the Biscayne Bay HFA will make this information available to the public using various media, including a publicly accessible, GIS-enabled, single point-of-contact BBHFA website.

Objective A – Acquire and Synthesize Available Socioeconomic Information Relating to Biscayne Bay.

Much of the Information about Biscayne Bay is dispersed and hard to find. A means is needed to synthesize and disseminate current knowledge about the bay ecosystem in education and outreach efforts and to advance development of new scientific knowledge about living resources and their habitat.

Strategy: Improve the Scientific Basis for Management

Major activities to support this work include:
• Conduct literature search and review of all referenced and grey literature relevant to socio-economic issues related to Biscayne Bay, including web linkages to all relevant information and a catalog of all ongoing and historical projects within Biscayne Bay that we can access NOAA/NMFS/SEFSC (HFA FUNDED FY15)
• Compile stakeholder contact list. NOAA/NMFS/SEFSC (HFA FUNDED FY15)
• Develop Biscayne Bay literature and stakeholder database in Endnote. NOAA/NMFS/SEFSC (HFA FUNDED FY15)
• Conduct local stakeholders/key informant Interviews. SEFSC (UNFUNDED)
• Conduct economic valuation study encapsulating the various values of Biscayne Bay to different user groups, linking Bay health to the viability of various economic sectors. WK (HFA FUNDED FY15, FY16 FUNDING REDUCED)
• Survey marina visitors for boater expenditures, activities, and willingness to pay for better management and protections. WK (FY16 FUNDING REDUCED)
• Develop Biscayne Bay-focused and web-enabled GIS database and encourage other scientists to upload their spatial data to this database. WK (HFA FUNDED FY15, FY16 FUNDING REDUCED)
• Provide single-point-of-entry Biscayne Bay website to facilitate access to, and dissemination of, scientific and management information on Biscayne Bay. NOAA/AOML, WK (HFA FUNDED FY15, FY16 UNFUNDED)
• Migrate socio-economic literature, results of Goals 1 through 3 research, and other relevant information into the Biscayne Bay HFA web-enabled GIS database and the single-port-of-entry website. NOAA/SEFSC, AOML, WK (HFA FUNDED FY15, FY16 UNFUNDED).

Objective B – Integrate Socioeconomic and Ecological Information into Messages That Help Spread Realization of the Bay's Importance and Need for Active Support and Protection.

Strategy: Improve the Scientific Basis for Management

Major activities to support this work include:
• Develop effective Bay-wide science-based communication strategies in support of local conservation activities. WK (HFA FUNDED FY15, FY16, FY17)
• Economic valuation studies to update 2005 Hazen and Sawyer; quantify Bay-dependent uses. WK (HFA FY15, FY16 FUNDED)
• Research and compile a summary of best management practices designed to reduce nutrient loading. WK (HFA FY17 FUNDED)

• Focus on communities and businesses that contribute to nutrient loading, educating them about ways to improve local water quality and reduce land-based sources of pollution to the bay through best management practices. WK (HFA FY17 FUNDED)
• Conduct ecosystem services calculation and risk analysis. NOAA/AOML (ONGOING)

Objective C - Educate Miami-Dade Citizens about Biscayne Bay.

Strategy: Educate, Inform and Engage Communities

Major activities to support this work include:
• Develop bay-related curricula about Biscayne Bay to initiate Junior Waterkeeper training
• Recruit and train student educators, potential Biscayne Bay JW Ambassadors, and teachers, including a core network, to promote the importance of critical Biscayne bay habitats and organisms in the schools and to local communities
• Administer/organize Junior WaterKeepers/Ambassadors outreach presentations and events at various participating schools and communities.
• Incorporate education/outreach activities into partner schools' and communities' Junior Waterkeeper programs (e.g., smalltooth sawfish monitoring, adopt-a-water quality station, etc.)
WK (HFA FY15, FY16, FY17 FUNDED)

On-Going Education and Outreach Programs of Partners in Biscayne Bay:

Education and Outreach Program at Biscayne Bay Aquatic Preserves (BBAP) includes
• Public presentation forums for academic and public groups
• Eco-Experience Tours guided tours by kayak and powered catamaran
• Eco-Experience Bayologist camps and after-school programs for children

Education and Outreach Program at BNP includes
• Environmental Education programs for local schools
• Education/Outreach booths at Community Events
• Junior Rangers Program
• Spoil Island Native Habitat Creation
• Fisheries Awareness Course; designed to help citizens learn more about fishing (species and rules) in Biscayne National Park

Education and Outreach Programs at Miami-Dade County RER
• Baynanza annual county-wide educational activities and shoreline cleanup
• Law Enforcement natural resource training presentations and programs

Education and Outreach Programs at Deering Estate
• Project associated with the Biscayne Bay Coastal Wetlands Project and the Cutler Slough Rehydration Project.
• Citizen science program in habitat monitoring and data collection to encourage greater understanding, support, and advocacy of natural areas and restoration projects (with emphasis on understanding wetland habitats and water conservation in a local/regional context)
• In partnership with Florida International University/Florida Coastal Everglades Long-Term Ecological Research, and SFWMD, all professional field research and citizen science data collected is being

incorporated into a new K-12 STEM curriculum and a special environmental stewardship training program

Objective D – Increase Community Involvement in Conservation Activities.

Strategy: Educate, Inform and Engage Communities
Strategy: Facilitate Stewardship of Natural Resources by Users

NOAA will work directly with Miami Waterkeeper, a nongovernmental organization (NGO) actively involved in local environmental issues, to better implement targeted Biscayne Bay HFA social science research, education and outreach programs. One major feature of the Biscayne Bay HFA Education and Outreach strategy is its focus on identifying target audience/stakeholders to better design, develop and implement effective programs and activities that address their specific needs while at the same time minimizing program delivery costs. Miami Waterkeeper will engage a panel of citizens and partners to develop and implement curricula for Biscayne Bay HFA education/outreach programs. Community programs in the Environmental Stewardship Program include Water Watch and Water School, as well as the previously listed (under Objective C) Junior Waterkeeper.

• Water Watch - water quality monitoring by trained Citizen Scientists to adopt former Miami-Dade RER sampling sites discontinued due to cut-backs in funding; this work will complement the existing MD RER monitoring program.

Major activities to support this work include:
• Recruit, train, and equip citizen scientists to collect scientifically-rigorous water quality data. UFL SEA GRANT WATER WATCH (HFA FY15, FY16 FUNDED)
• Process citizen scientist water quality samples (AOML INKIND)
• Provide water quality data for public use and management decisions UFL SEAGRANT, AOML (HFA FY15, FY16 FUNDED)

• Water School - Bay-orientated half day educational tours specifically tailored to public officials and their aides to alert and educate them about Biscayne Bay's critical water quality, habitat/resource management issues (note: also listed under Goal 1).

Major activities to support this work include:
• Conduct annual educational workshops about Biscayne Bay for 20 elected officials/aides.
• Communicate findings of economic, water quality, and GIS studies directly to elected officials. WK (HFA FY15, FY16, FY17 FUNDED, FY18, FY19 FUNDING CONTINGENT ON AVAILABILITY)

Objective E – Establish a Collaboration with the County and Other Enforcement Agencies to Enhance Enforcement of Regulations and Increase User Compliance.

Strategy: Contribute to Resource Management Planning and Implementation

Major activities to support this work include:
• Biscayne Bay Regional Restoration Coordination Team (BRRCT) Seminar Series. SEFSC, supporting SFERTF (IN KIND)

• Assess stormwater permit compliance within the NPDES program in waterways discharging to Biscayne Bay to determine the scale of unpermitted discharges into the Bay; educate and engage local students to assist in the assessment; inform agencies and elected officials about the state of compliance. WK (FY18, FY19 FUNDED)
• Prepare a curriculum and implement a program for "Bay Patrol Continuing Education" to help improve the capability of conservation officers to recognize, coordinate, and enforce multi-agency natural resource regulations pertaining to Biscayne Bay. MD-RER, BNP, BBAP, SEFSC, AOML, WK (UNFUNDED)
• Southeast Florida Coral Reef Initiative - Our Florida Reefs process: Community Working Groups composed 68 Recommended Management Actions (RMA) to improve coral health, water quality, and education programs. FDEP, CRCP, SEFSC, TNC, WK (ONGOING)
• Miami-Dade County Manatee Plan includes education/outreach and compliance/enforcement component MD-RER (ONGOING)
• Virginia Key North Point (VKNP) volunteer planting to restore 15 acres of wetlands FROST SCIENCE MUVE (ONGOING)
• Fishery Awareness Course offered preferentially to those who have received fishing citations, who can take the course in lieu of fines or other penalties; others can also take the course. BNP (ONGOING)

Objective F – Engage other Federal, State, and Local Government Agencies and Non-Governmental Organization (NGO) Stakeholders in Bay Conservation Programs.

Strategy: Educate, Inform and Engage Communities

Major activities to support this work include:
Re-enforce effectiveness of other stakeholders/partners through:
• Establish a BBHFA Implementation Program Coordination Team (BBPCT) that includes major resource management partners in the region and facilitates coordination with and among them.
• Coordinate with Miami Dade County, local municipalities, Biscayne National Park, and the State of Florida to work toward achieving shared goals and objectives for the BBHFA.
• Continue to support the operations & stakeholder outreach activities of the Biscayne Bay Regional Restoration Coordinating Team (BBRRCT). SEFSC (INKIND)
• Communicate and look for opportunities to productively collaborate with other government agency partners on topics of mutual interest (e.g., South Florida Water Management District, U.S. Army Corps of Engineers, U.S. Fish & Wildlife Service, U.S. Department of Agriculture). SEFSC, AOML (UNFUNDED)
• Engage NGOs to find out how the BBHFA can better support their conservation efforts on behalf of the Bay. SEFSC and AOML (UNFUNDED)

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PLAN FOR MONITORING PROGRESS

The Biscayne Bay HFA Implementation Plan has four major goals, all of which support the overarching goal of conserving and improving HFA habitat for protected and fishery species and the human community that surrounds them. To progress toward these goals, the Implementation Plan employs five strategies, as follows: a) Improve the scientific basis for management, b) facilitate stewardship of natural resources by users, c) improve resiliency of coastal habitat and communities, d) educate, inform and engage communities, and e) contribute to resource management planning and implementation. Evaluation of results of plan implementation will be based on goal-related performance measures and outcomes, which form the foundation and structure of this management plan. Expected outcomes and performance measures are described by goal.

Goal 1. Understand major sources of nutrients that contribute significantly to phytoplankton and algal blooms in Biscayne Bay, and work with resource managers to enhance policies and management approaches for improving water quality.

Addressing this goal requires survey and synthesis of existing information, both documented and anecdotal, relating to water quality and algal blooms, as well as field activities that acquire new data on spatial and temporal aspects of nutrient concentrations, source contributions and influencing factors. New data acquisition focuses on the western shoreline and canals discharging to the bay along this shoreline. Satisfying Goal 1 requires the development of evaluation tools, or models, to test alternative scenarios for nutrient reduction and algal overgrowth control. Addressing Goal 1 requires strong collaboration and communication with local government resource management units, particularly at Miami-Dade County and local municipalities, as well as exchanges with their policy makers and the public. Solutions based on scientific results will be found by interacting with resource managers, who can help communicate potential solutions to policy makers. Water quality improvement depends upon sound science and good communication among scientists, resource managers, policy makers, environmental educators and the public.

Performance Measures:
Number of specific projects addressing algal bloom and nutrient sources/influencing factors issues.
Number of recommendations on reducing nutrients or other factors influencing blooms.
Number of briefings and/or presentations of findings (to resource managers, policy makers, journalists, public forums).
Number of nutrient load reduction policies or plans informed by results of HFA studies.
Number of resource managers/management units interacting with BBHFA scientists on nutrient enrichment/algal bloom issues.
Number of policy makers supporting nutrient reduction plans.
Number of areas with reversing trend in nutrient and/or chlorophyll-lα concentrations.
Number of areas/acres of regenerating or restored seagrass.
Number of valid eye-witness reports pertaining to conditions or incidents of accidental or intentional habitat abuse.
Number of peer-reviewed manuscripts delineating the sources of nutrients to Biscayne Bay.

Outcomes:
A science-based set of recommendations to best reduce nutrient inputs and the occurrence of algal blooms in the central and southern parts of Biscayne Bay.

A model (or models) that accurately reproduce current nutrient distributions and can accurately predict the effect on nutrient loads of potential management actions.
Actions by County and City governments (e.g., rules, regulations, changes in policy and/or operations) based on the recommendations.
Areas of the bay with declining trends in chlorophyll a (eutrophication indicator).
Areas of seagrass regeneration or successful seagrass restoration.

Goal 2. Improve freshwater inflows to enhance estuarine habitat conditions in western nearshore Biscayne Bay.

Addressing Goal 2 requires interaction with Federal and state agencies and interagency groups associated with the Comprehensive Everglades Restoration Plan (CERP). The main area of focus is the western shoreline mangrove and shallow-water area of Biscayne Bay between Shoal Point and Turkey Point, where NOAA Fisheries (SEFSC) monitors shrimp, crabs, small forage fish, and reef-related mangrove fish in conjunction with submerged aquatic vegetation and salinity—the latter monitored by UM-RSMAS and NPS, respectively. The core BBHFA contribution to Goal 2 comes from assessments of monitoring results and participation in an adaptive management process that informs water managers on CERP's effectiveness in reestablishing a more natural volume, timing, and distribution of freshwater flow and a shoreline estuarine community. Other contributions can potentially be made through (1) interactions with water management system operators or managers about special water rerouting opportunities afforded by variation in rainfall, (2) use of a public-source hydrodynamic model to investigate the relationship of nearshore salinity patterns to freshwater flow volume and distribution, and (3) analyses of the effect of CERP Biscayne Bay Coastal Wetlands operations (rerouting canal water and pumping) on salinity in potentially affected nearby parts of Biscayne Bay. Separately, Miami-Dade County Water and Sewer Authority has outreach initiatives that stimulate reduction in public water consumption.

Performance Measures:
Number of presentations about Biscayne Bay hydrologic model results.
Number of times when interactions with water managers or system operators change the amount or distribution of freshwater inflow along the Biscayne Bay shoreline to improve conditions for estuarine species.
Number of CERP design refinements to improve volume, frequency, distribution, and/or timing of freshwater flow to Biscayne Bay.
Number of sampled estuarine species whose seasonal (wet or dry) abundance indicators (density or occurrence) are on a positive trend.

Outcomes:
Increased concern for Biscayne Bay's water needs by the South Florida Ecosystem Restoration Task Force Working Group and its members.
Increased freshwater flow to Biscayne Bay, with emphasis on expanded distribution of water along the shoreline (rather than more flow from canals) and additional water during the dry season.
Increased duration and spatial coverage of mesohaline conditions along the south-central mainland shoreline.
Reduced number of days with no measurable surface flow along the south-central shoreline.

Long-term positive trend in areal coverage of mixed *Halodule* and *Thalassia* in monitored nearshore area.
Increased number of estuarine species in monitoring samples.
Decreased water use in residential, industrial, and agricultural areas.

Goal 3. Support and enhance recovery of protected species, sustainability of fishery species, and protection and restoration of their habitat.

Actions to support Goal 3 are focused directly on species or species groups or on their habitat. Included under this goal are both ongoing projects of the SEFSC or partner entities or projects initiated specifically as part of the BBHFA effort. Species in the BBHFA that receive some level of Federal or state protection or management include those for sea turtles, marine mammals, the West Indian Manatee, the American crocodile, several coral species, reef fish (mangrove snapper and other species), and other sport fish (spotted seatrout, bonefish). An effort to learn more about the occurrence of the smalltooth sawfish in the BBHFA has been initiated to support BBHFA Goal 3. The main emphasis of species-related projects is on improving the information base for species protection and management.

HFA projects to protect or restore habitat in the Biscayne Bay HFA are included in this plan although they thus far have little direct NOAA support because there are opportunities to produce benefits by collaborating with partners. Such collaboration can include providing alerts on grant opportunities from NOAA and others, cooperating in joint grant applications, and offering assistance on projects initiated by partners. Of special interest are actions that 1) assist boaters in avoiding vulnerable areas of seagrass or coral reef, 2) encourage use of living shorelines, 3) remove or control invasive exotics, 4) restore seagrass or coral or 5) remove marine debris.

Performance Measures:
Number of projects initiated or joined and expanded to support Goal 3
Number of items of new information about a protected or fisheries species that can be used to assist in its protection
Amount of new funding acquired to support Goal 3
Number of new products developed to support Goal 3
Number of new signage and/or mooring buoys added to protect sensitive habitat
Change in direction or rate of seagrass or coral area damaged by boats
Change in direction or rate of repeated fishing violations
Change in direction or rate of seagrass or coral area restored
Area cleared of invasive exotic vegetation
Area of bay bottom or coral reef cleared of marine debris
Number of new habitat protection measures in place
Acreage of seagrass habitat restored

Outcomes:
Increased acreage of seagrass habitat
Increased acreage of recovering coral habitat
All sensitive habitat protected with signage and/or mooring buoys
Shorelines protected with natural or living shoreline expanded
Shorelines and cul-de-sacs free of debris

Goal 4. Increase public awareness of the ecological, economic and social benefits of the Biscayne Bay ecosystem, and increase citizen involvement in bay-related conservation activities.

Goal 4 supports the other three goals by promoting, throughout the community, the incentive to advance the stewardship of BBHFA species and habitat. Addressing this goal involves synthesizing existing information and filling knowledge gaps with new information and using it to educate the public, civic leaders, and policy makers about the bay's unique ecology, its substantial contributions to the regional economy, and its vulnerability to lasting damage that could undermine its worth and might be hard, if not impossible, to reverse.

Performance Measures:
Number of reports and publications with new or newly synthesized information that demonstrates bay-reef ecologic and/or economic values.
Number of civic leaders and policy makers introduced to Biscayne Bay's values, economic benefits, and vulnerabilities on "Day on the Bay" boat trips organized by Miami Waterkeeper.
Number of Junior Waterkeepers graduated from Miami WaterKeeper training program.
Number of teachers incorporating BBHFA issues into their courses.
Number of citizen-scientists conducting water quality monitoring in the Bay and coastal canals (organized and managed by Water Watchers.
Number of monitoring sites managed by Water Watchers.
Increase in funding for Biscayne Bay conservation programs.
Number attending monthly Biscayne Bay Regional Restoration Coordination (BBRRCT) Meetings.
Number of presentations relating to BBHFA Goals at BBRRCT meetings.
Improvements in focus, content, and reach of presentations at BBRRCT meetings.
Number of news items about Biscayne Bay issues.

Outcomes:
Increased communication among agencies and NGOs on Biscayne Bay environmental issues, both CERP-related and other.
More recognition of, and attention to, Biscayne Bay's environmental threats/issues at public meetings of managerial agencies and groups.
Expanded stewardship and active citizen involvement in bay and reef focused conservation activities.
Expanded water quality monitoring program.

Overview

By addressing its goal of increased public awareness of the ecological, economic and social benefits of Biscayne Bay and its adjacent coral reef ecosystem and increased citizen involvement in bay-and-reef-related conservation activities, Goal 4 will help meet the other goals of the BBHFA Implementation Plan. Protection of BBHFA resources can only be obtained when an informed public understands their values, their importance to the regional economy and human wellbeing, the threats they face, and the imperative to protect them. Public involvement is critical, not only because policy makers need to know that their constituency expects them to maintain a highly functional bay-reef ecosystem, but also because the individual actions of members of the public must be self-controlled through knowledge and

dedication to prevent collective thoughtless actions of a growing population from overwhelming the natural system. An informed and appreciative public can be the guardian of the BBHFA by speaking up for what it cares about and making relatively simple personal changes.

Outcome:

The ultimate outcome of efforts to improve habitat in the BBHFA is clean, clear waters teeming with fish and protected species between the south Florida mainland coast and the Gulf Stream.

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TABLE 1: Ongoing activities of NOAA and resource management partners that support BBHFA goals, listed by goal.

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
1	BNP	FDEP	Monitor phytoplanktonic algae to determine Karenia brevis presence and high concentrations of any other algae.
1	MD-DERM	FDEP	Study seagrass loss associated with Anadyomene bloom off Coconut Grove and Coral Gables
1	MD-DERM	SFWMD	Monitor surface water quality at 117 sites in Biscayne Bay and contributing canals/rivers; now reduced to 86 sites with loss of SFWMD funding.
1	MD-WASD		Using historic data on location and volume of spills, replace old infrastructure to reduce future sewage spills.
2	NOAA SEFSC, BNP, MD-DERM		Take part in science planning activities of the South Florida Ecosystem Restoration Task Force (SFERTF) and the Comprehensive Everglades Restoration Project (CERP)
2	NOAA SEFSC, BNP, BBAP		Attend and help support the Biscayne Bay Regional Restoration and Coordination Team (BBRRCT), whose priority activity is to advise the SFERTF Working Group on issues affecting freshwater inflow to Biscayne Bay.
2	BNP		Monitor and record salinity and temperature at 15-sec intervals at BNP stations in Biscayne Bay.
2	NOAA SEFSC	BNP, UM-RSMAS	Monitor mangrove fish and epifauna in relation to salinity and seagrass along the western Biscayne Bay shoreline (Shoal Pt to Turkey Pt) to develop potential performance measures and assess ecological effects of changes in freshwater inflow to the Bay in CERP.

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
2	MD-DERM	SFWMD	Monitor vegetation downstream from culverts in L31E Canal created to redistribute water to Biscayne Bay for CERP-BBCW.
2	MD-DERM	SFWMD	Collect physiochemical data monthly at groundwater monitoring wells at the Deering Estate for CERP-BBCW.
2	MD-PROS	SFWMD	Collect physiochemical data from groundwater monitoring wells at Cutler and North Creeks (Deering Estate) to determine whether mesohaline conditions are being restored, as sought in CERP-BBCW.
2	MD-WASD		Well-field Impact Study and Groundwater Study related to freshwater supply
2	MD-WASD		Water Conservation Program implemented in 2006 with large outreach component and incentives for switching to high efficiency toilets and fixtures
2	MD-WASD		Landscape program: survey single and multi-residential homes and recommend irrigation improvements; provide one-time only $2,800 toward a retrofit irrigation system.
2	MD-WASD		2-day per week watering program made permanent in 2009
3	MD-DERM	FFWCC, SFWMD	Administer the MD County Manatee Protection Plan with its regulatory, enforcement, and education and outreach components.
3	NOAA SEFSC		Conduct vessel transect surveys to assess distribution and relative abundance of sea turtles in Biscayne Bay; use mark-recapture data and satellite telemetry to assess sea turtle habitat use in the bay.

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
3	NOAA SEFSC	USFWS, BNP	Participate in sea turtle regional stranding network, covering beaches on Virginia Key routinely and responding to citizen alerts on stranded turtle sightings.
3	NOAA SEFSC		Conduct photo-ID mark-recapture studies of bottlenose dolphin in BBHFA to estimate abundance and habitat use. Investigate any reports of stranded or injured dolphins in Biscayne Bay to monitor causes of morbidity and mortality.
3	UM RSMAS		Stock and maintain coral nursery in Biscayne National Park
3	NOAA SEFSC	NOAA SERO, CRCP	Refine scientific techniques for coral nursery culture, restocking, and reef restoration approaches and their evaluation; study factors affecting recruitment and survival from disease.
3	NOAA SEFSC	CRCP	Characterize trait of disease resistance in elkhorn and staghorn corals using pairwise field transmission assays and targeting genotypes in Tavernier and Middle Keys nursery and wild genets in Key Largo region (new FY16 project).
3	BNP		Establish No-Take Marine Reserve Zone on the Reef Tract of Biscayne National Park, designated as part of the General Management Plan.
3	NOAA SEFSC	BNP, UM-RSMAS	Collect RVC (reeffish visual census) data to determine temporal trends and spatial variation in fish species abundance and size distribution in BB-HFA.

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
3	NOAA SEFSC	UM-RSMAS	Develop user-friendly connection to historic (since 1999) RVC data on fish species presence, abundance, and size distributions with RVC Data Portal.
3	NOAA SEFSC	UM-RSMAS, BNP	Expand knowledge of fish-habitat relationships in BB- HFA and linkage of mangrove, seagrass, and reef habitat through fish ontogeny and trophodynamics.
3	FDEP	NOAA-CRCP, MD DERM	Develop community-based recommendations to protect and restore reefs in Southeast Florida Coral Reef Initiative(SEFCRI) and Our Florida Reefs (OFR).
3	FDEP	NOAA-CRCP, FFWCC, USFWS	Collect and analyze data about vessel use patterns, coral reef impacts of boat anchoring and user activity, and effectiveness of mooring buoys to reduce reef damage.
3	MD DERM	BBAP	Identify seagrass areas damaged by prop scarring or groundings; prioritize areas for restoration and protective navigational signage.
3	BBAP		Review permit applications and participate in conservation, restoration, and monitoring of seagrass habitat.
3	FFWCC	BBAP	Act as steward of Critical Wildlife Area on Virginia Key north of Rickenbacker Causeway
3	TNC	BBAP, MD DERM	Identify living shoreline and resiliency improvement opportunities as member of Shoreline Resiliency Working Group;
3	BNP	MD-DERM, volunteers	Create native plant communities on spoil islands in Biscayne National Park
3	BBAP	Volunteers	Create native plant community on spoil island near 79th St. Causeway

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
3	MD-DERM		Restore wetlands and create living shorelines.
3	MD-DERM		Use permitting authority to protect bay habitat from gear, illegal pumping, shading effects, and derelict vessels
3	MD-DERM	FLSG, BNP, Florida Audubon, NOAA-SEFSC, others	Remove derelict crab pots and other derelict fishing gear from Biscayne Bay.
3	MD-DERM		Remove derelict vessels from Biscayne Bay.
4	BBAP	Friends of Biscayne Bay	Biscayne Bay Cell Phone App shows boaters where they are in the bay in relation to jurisdictional boundaries and rules specific to management area.
4	BBAP		Public presentation forums
4	BBAP		Train-the-Trainer Program shows educators how to bring Biscayne Bay to their classrooms
4	BBAP		"Environmental Immersion Day" Program provides hands on science training, with introduction to water quality or weather instruments and biological sampling.
4	BBAP		Conduct Eco-Experience Tours by kayak and Eco-Experience Bayologist camps and after school programs for children.

Goal	Lead Implementing Partner	Supporting Partner(s)	Activity
4	MD DERM	BBAP	Baynanza Community Bayshore Clean-up Day
4	BNP	US Department of Justice	Fishery Awareness Course offered to those who have received fishing citations, in lieu of fines or other penalties, to explain the regulations and generate understanding of the importance of these regulations to fish and to humans.
4	NOAA-AOML	NOAA/COP/ COCA, Hart Institute	Estimate ecosystem services of Biscayne Bay and conduct risk assessment.
4	BBAP		Participate in educational outreach programs informing the public and law enforcement personnel about habitat and living marine resources of the Bay

TABLE 2: Biscayne Bay management plans

Entity	URL	Status
Miami-Dade County	http://www.miamidade.gov/environment/library/reports/biscayne-bay-mgt-plan.pdf	Adopted in 1981, reviewed in 2001
Biscayne Bay Partnership Initiative	http://www.discoverbiscaynebay.org/documents/website/BBPI-Final_Report.pdf	Presented to Governor in 2001
Biscayne Bay Aquatic Preserves	http://publicfiles.dep.state.fl.us/cama/plans/aquatic/Biscayne_Bay_Aquatic_Preserves_Management_Plan_2012.pdf	In final approval stage at Florida DEP
Biscayne National Park	http://parkplanning.nps.gov/document.cfm?parkID=353&projectID=11168&documentID=65801	Approved by Regional Director Aug. 31, 2015

APPENDIX A
Logical Framework and Results Chain Models for BBHFA Implementation Planning

The Logical Framework Model (for the Seagrass Habitat component) shown in Figure A-1 provides a graphic representation of the complex interactions among the different elements of the Biscayne Bay Habitat Focus Area. As a planning guide, the Log Frame model provides a systematic approach to problem solving by enabling the BBHFA team to identify: (1) the major current and emerging threats to the ecosystem, (2) the factors contributing to these threats, and (3) their specific impacts on both the biotic and abiotic components of the system, which in turn (4) determine the overall health of the Biscayne Bay and the well-being of the people that benefit from the Bay's ecosystem services. Disaggregating the major, long-term threats into more specific, "bite sized" contributing factors enables the BBHFA team to identify short- as well as medium-term strategies to effectively address Biscayne Bay issues at the local community, Bay-wide, and regional levels.

Following from the Logic Frame Model, the Results Chain Model (for example, the seagrass habitat component of the Biscayne Bay Ecosystem) shown in Figure A-2 provides a framework for translating Biscayne Bay HFA goals into implementation strategies and action programs that specifically address the key contributing factors impacting the overall health and long-term sustainability of the Bay. The Results Chain model also functions as a communication tool for resource managers and education/outreach professionals as it shows stakeholders and local communities the linkages between policies, programs and management actions such as regulations with expected improvements in ecosystem services and outcomes. It also shows how and where their individual as well as collective actions, no matter how small, can make a difference in bringing about a healthy Biscayne Bay HFA.

The Results Chain Model in Figure A-3 shows how information development, education, and outreach are used to help address Goals 1, 2, and 3.

Figure A-1. Logical Framework for Biscayne Bay (Seagrass Habitat component)

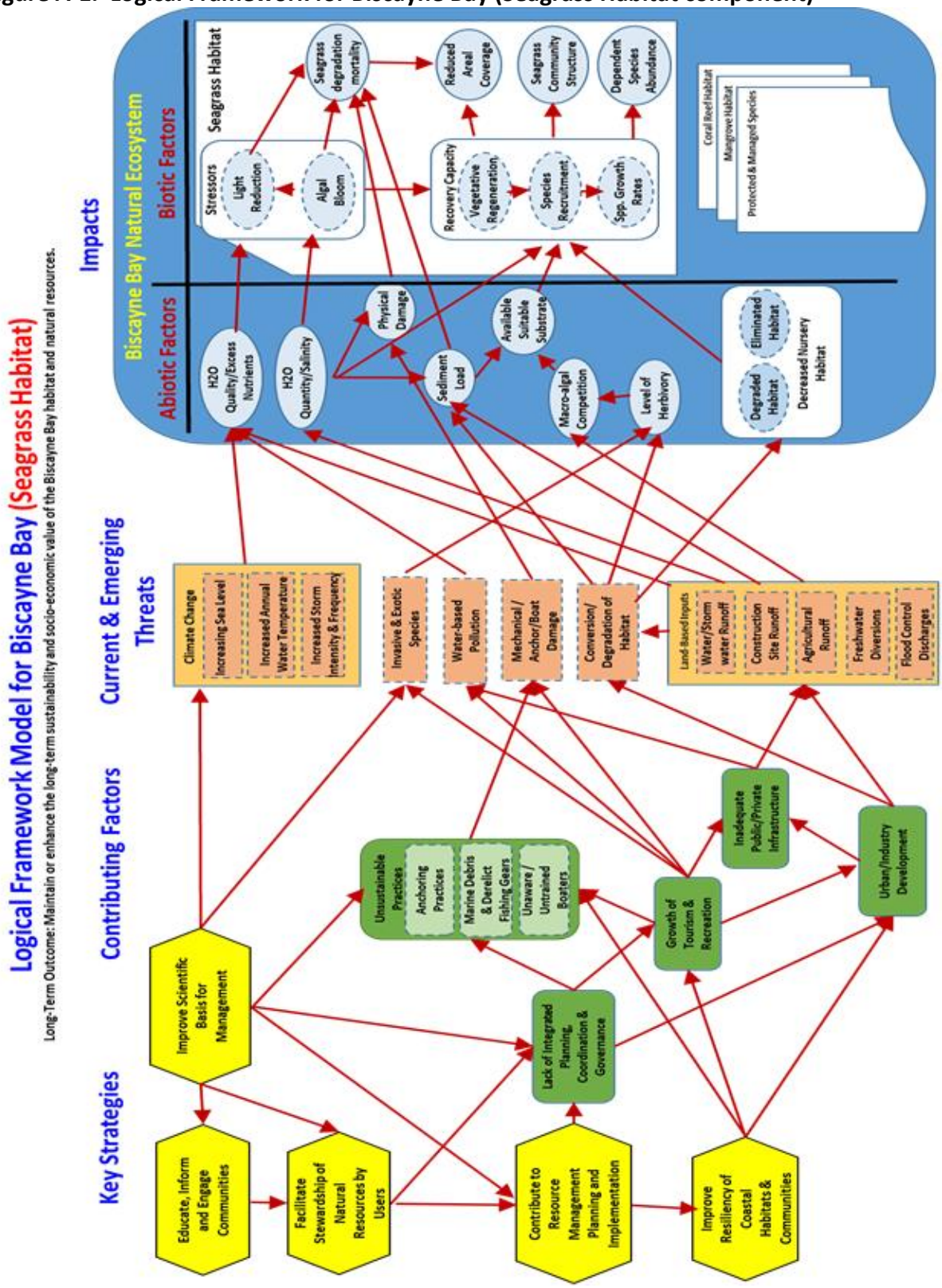


Figure A-2. Results Chain Model for Biscayne Bay (Seagrass Habitat component)

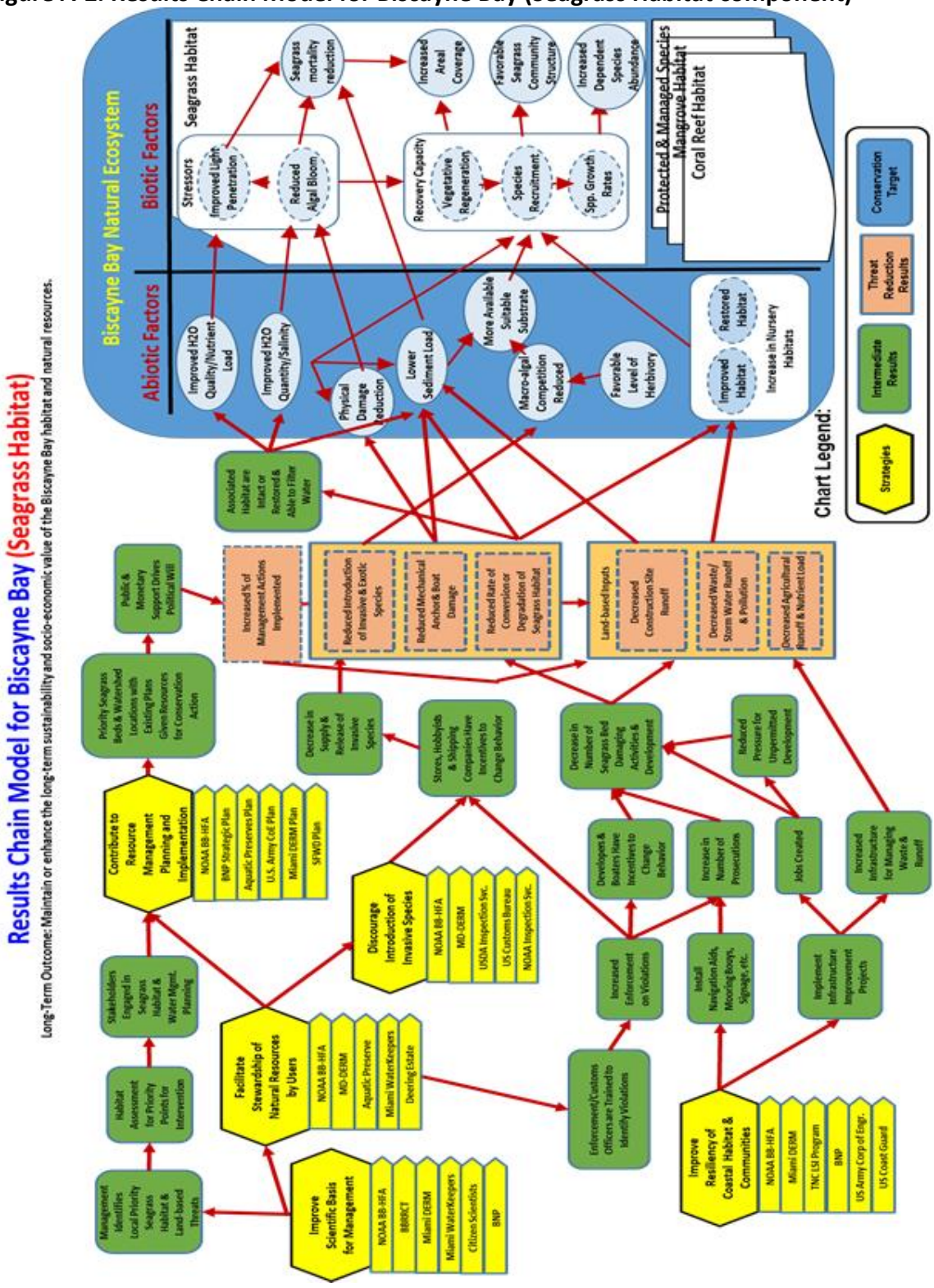
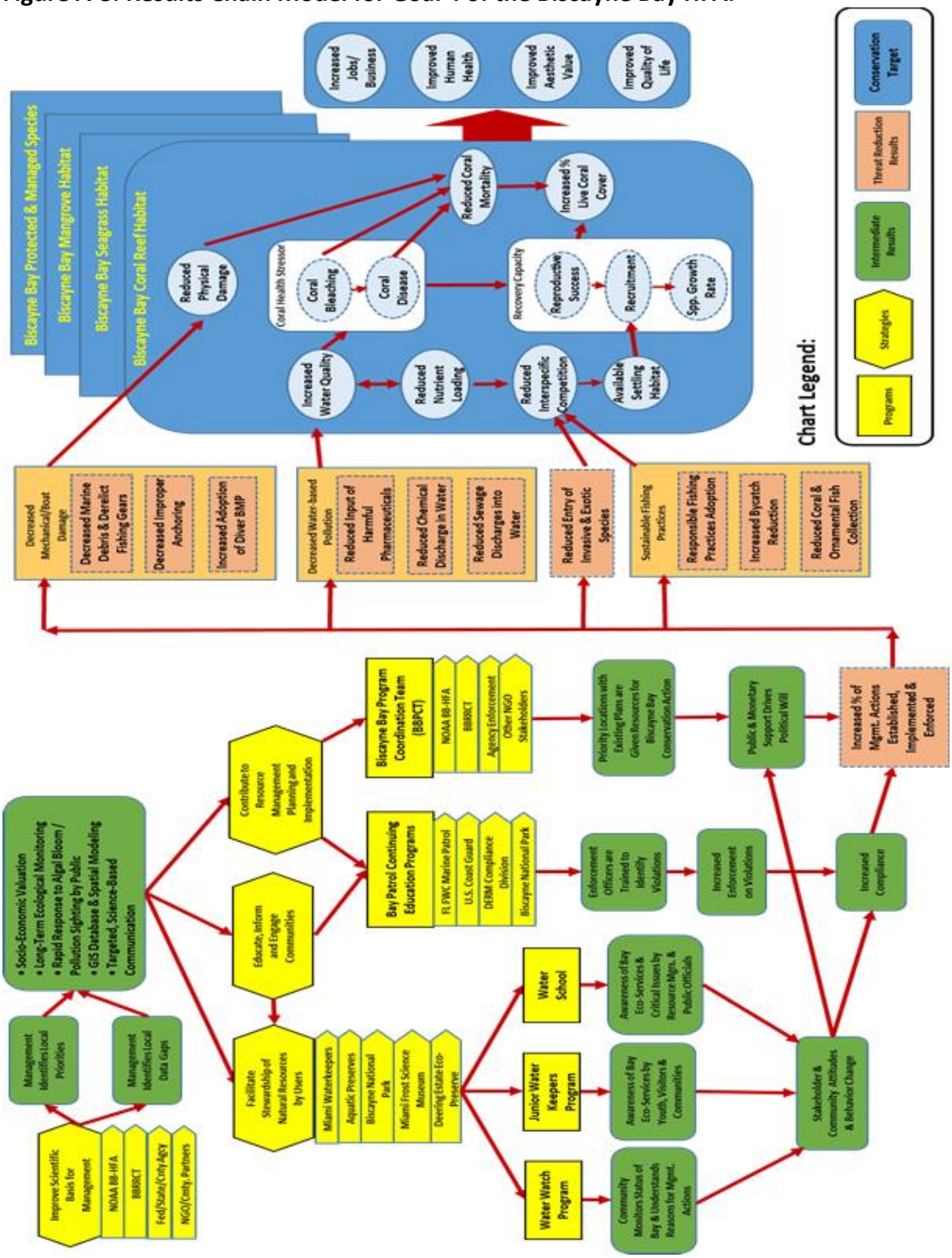


Figure A-3. Results Chain Model for Goal 4 of the Biscayne Bay HFA.



APPENDIX B
Partner and Stakeholder Engagement

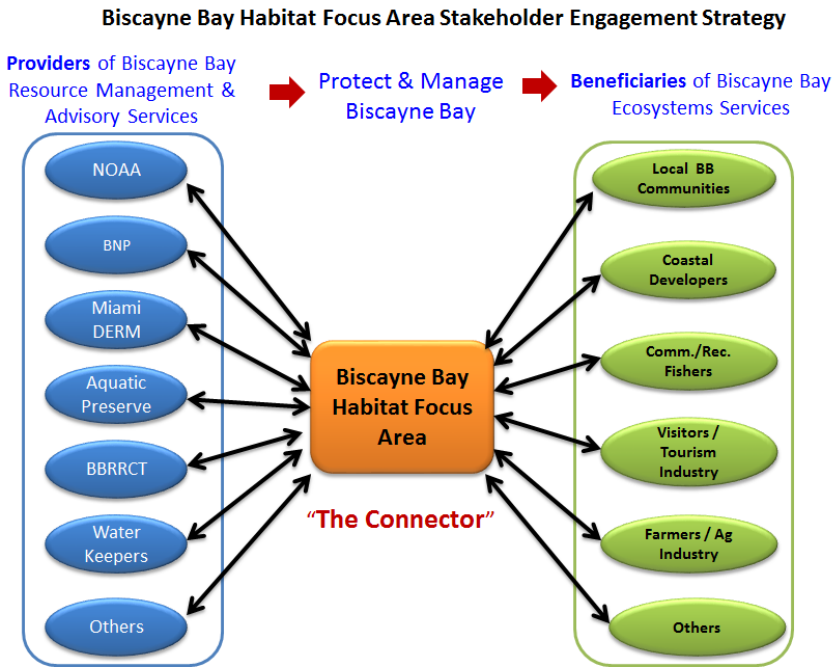
a. The BBHFA Partner and Stakeholder Engagement Strategy

The diversity of the Biscayne Bay environment makes it impossible for any single organization, no matter how big or well-funded, to tackle the enormous and complex issues required for its long-term sustainability. Fortunately, there are several agencies at various levels of government as well as non-governmental organizations, industry stakeholders, user groups, schools, individual citizens, and communities dedicated to addressing one or more aspects of Biscayne Bay's major habitat conservation and resource management needs. However, the fragmented nature of these organizations poses at least two major challenges for BBHFA:

(1) How to link and enable these diverse conservation and user groups to more effectively work together, and
(2) How to keep the major BBHFA partners and stakeholders continuously engaged and focused on achieving their common goal of maintaining a healthy, productive, and sustainable Biscayne Bay ecosystem?

The first challenge points to the need for building and maintaining a strong partnership and stakeholder network dedicated to the conservation and wise management of Biscayne Bay. Working closely with the Biscayne Bay Regional Restoration Coordination Team (BBRRCT), the BBHFA team will adopt the "switchboard strategy" and connect conservation/management service "providers" with major Biscayne Bay stakeholders and resource "users/beneficiaries" (Figure B-1). In this capacity, BBHFA's primary role will be to help orchestrate and streamline inter-agency communications and implementation of ongoing and planned activities, programs, and strategies of key alliance partners and stakeholders.

Figure B-1. Biscayne Bay-HFA partner and stakeholder strategy.



For BBHFA, the value and effectiveness of the switchboard strategy rests on its ability to recruit and retain major partners and stakeholders into the alliance (a phenomenon known as the *network effect*), which goes at the heart of the second challenge. Keeping partners and stakeholders (the "customers") engaged requires maintaining focus on their needs by developing specific products or services that will satisfy their needs. One effective way to achieve this is to involve them in the planning, development, and/or implementation of complementary or supplementary programs, collaborative projects, or activities designed to achieve commonly held goals.

Major activities to support this work include:
• Continued support and involvement in the BBRRCT.
• Continued involvement in CERP, with increased participation in workshops and project planning activities most directly related to Biscayne Bay.
• Inclusion of representatives of Miami-Dade DERM, Florida Aquatic Preserves/Florida Department of Environmental Protection Southeast Region Coastal Office, and Biscayne National Park on our BBHFA Plan Implementation Coordination Team.
• Expanded communication and collaboration with major NGOs directly involved in Biscayne Bay.
• Expanded effort to involve other federal (e.g., U.S. Department of Agriculture, U.S. Army Corps of Engineers, U.S. Coast Guard, Small Business Administration) and state (e.g., Florida Fish & Wildlife Commission and Florida Department of Agriculture and Community Services) agencies in various BBHFA initiatives.
• Seek opportunities to engage municipalities, cities and local industries (e.g., Economic Development Authorities, Business Improvement Districts, Marina/Maritime Associations, Miami Propeller Club, Sailing Clubs).

b. BBHFA Organizational Framework

Once the BBHFA Implementation Plan is finalized, getting the multitude of programs, projects and initiatives underway and running smoothly requires proper organization and staffing. Initially, the BBHFA will be loosely organized as a *de facto* informal alliance of government agencies and environmental NGOs comprising the current BBHFA Implementation Planning Team, internal FFO project staff, and various BBHFA program partners, as shown in Figure B-2. Under this organizational structure, members of the BBHFA IPT will form the incipient BBHFA Advisory Body who will be responsible for providing policy direction and guidance to the BBHFA and the Executive Leadership Group. NOAA HFA Services and Operations Support will continue to serve as Habitat Blueprint Liaisons between NOAA Office of Habitat Conservation, other HFAs, and the BBHFA team. Coordination and management of BBHFA activities and projects (both internal and FFO-funded) will be the responsibility of the BBHFA Executive Leadership Group.

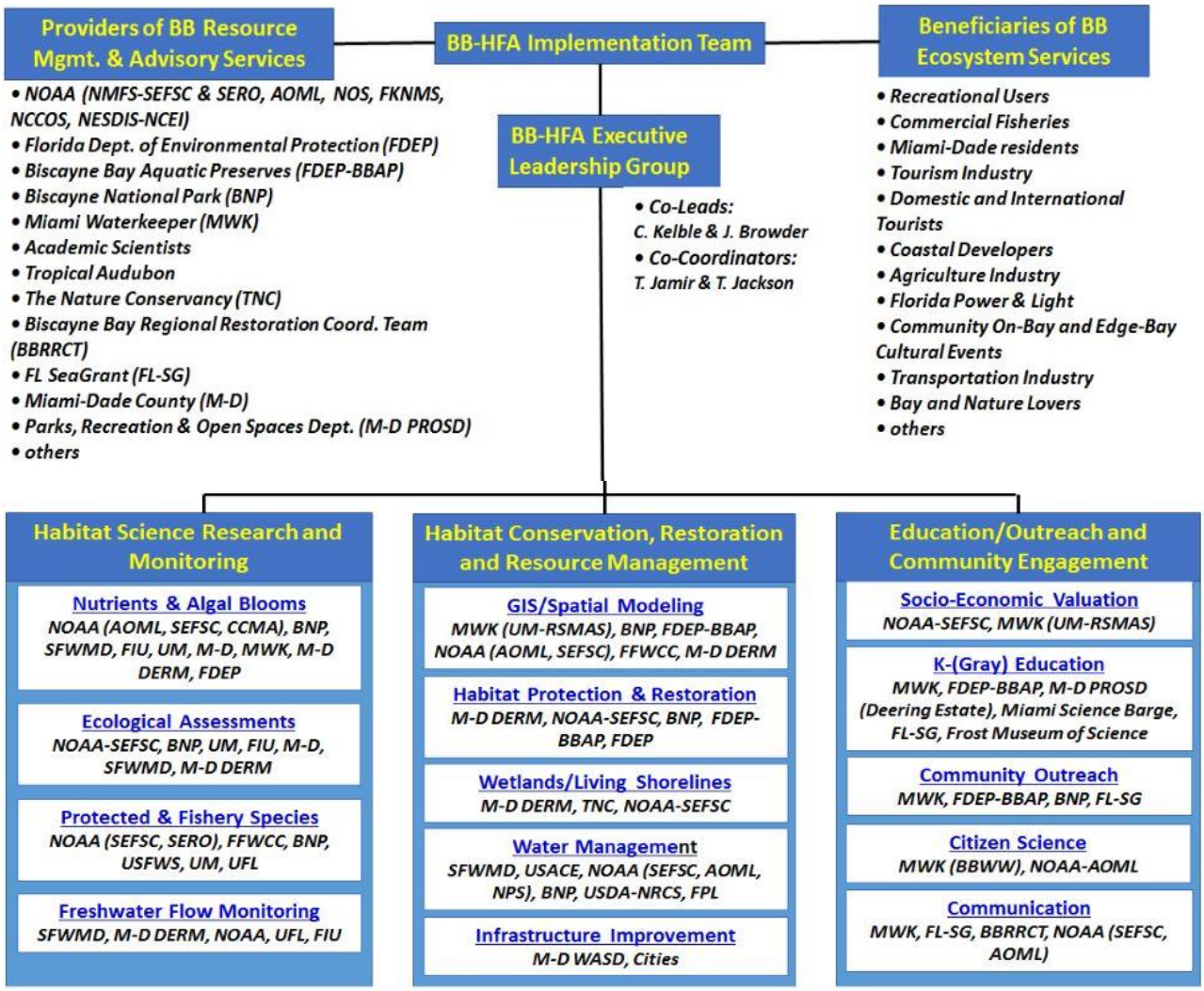
At the operational level, major BBHFA collaborative programs and projects will be assigned to respective agency staff leads. The BBHFA programs/projects will be grouped into three thematic clusters to facilitate coordination and monitoring:

(1) Habitat Science Research and Monitoring,
(2) Habitat Conservation, Restoration and Resource Management; and
(3) Education/Outreach and Community Engagement.

The BBHFA Executive Leadership Group will oversee the overall coordination, monitoring, and evaluation of collaborative programs, projects and initiatives included in the BBHFA portfolio to

streamline operations, prevent duplication of effort, effectively leverage resources, achieve synergy, and realize the benefits of specialization and economies of scale.

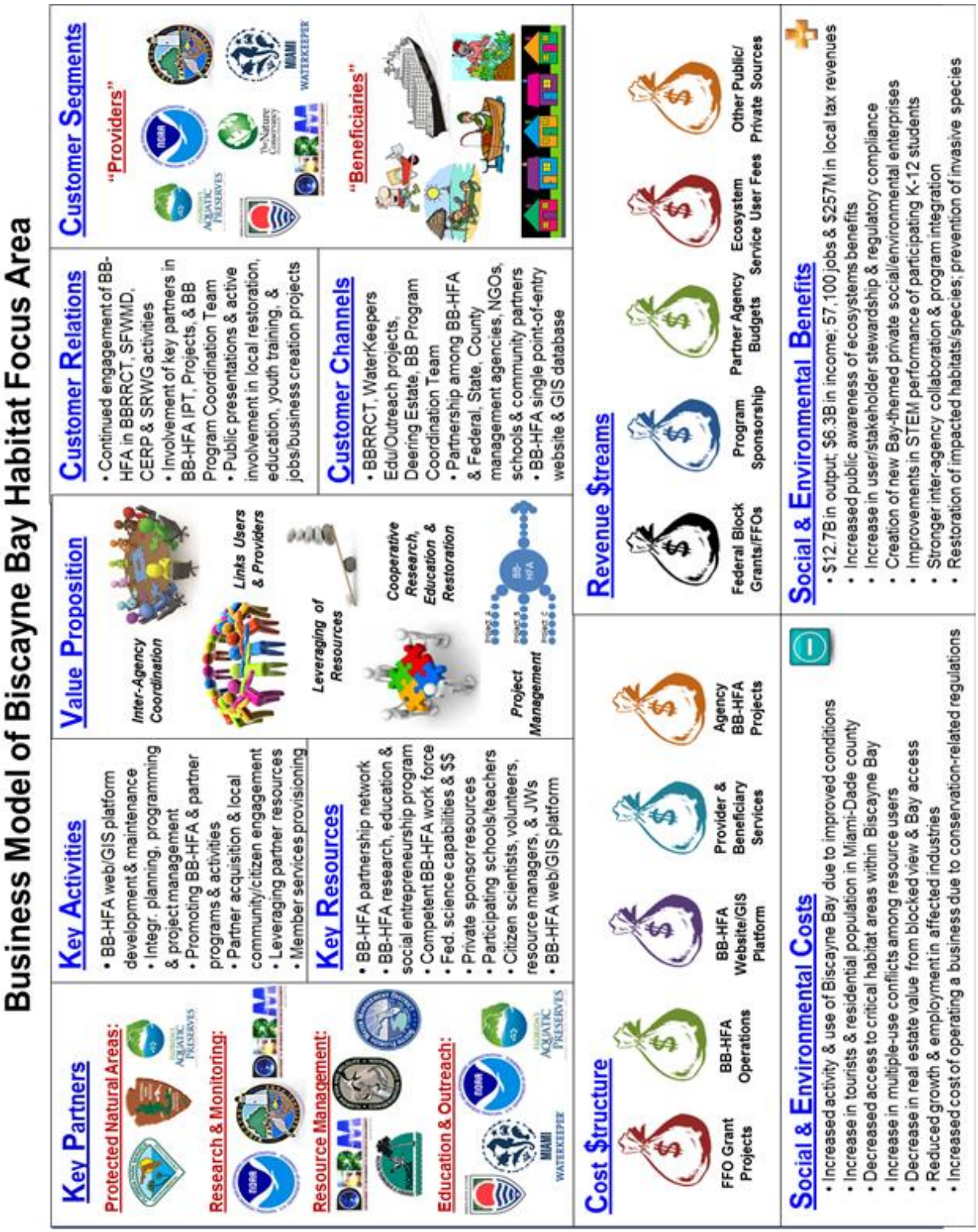
Figure B-2. Organizational chart of Biscayne Bay Habitat Focus Area.



Biscayne Bay – Habitat Focus Area's Business Model:

Following from the switchboard strategy, the BBHFA will adopt the "multi-sided platform" business model at the implementation level as the main mechanism for leveraging partner resources, creating value, and delivering them to intended customer groups. Multi-sided platforms create value by bringing together two or more distinct but interdependent groups of customers and facilitating mutually beneficial interactions between them. The detailed components of BBHFA's multi-sided platform business model is summarized in Figure B-3.

Figure B-3. Business Model Canvas for the Biscayne Bay Habitat Focus Area.



a. Customer Segments – The customer segments building block defines the different groups of people or organizations that the BBHFA initiative aims to reach and serve. In this case, the two interdependent customer segments comprising the multi-sided platforms (or multi-sided markets) are the "providers" of conservation and management products or services (e.g., Federal, State, County, City government agencies and environmental NGOs) and the "beneficiaries" of a healthy and productive Biscayne Bay ecosystems and ecosystem services (e.g., fishing and other recreational users, coastal communities, tourism industries, etc.). Segmentation into these two categories enables BBHFA partners to target their key customers, zero in on their problems and needs (e.g., by applying the logical framework model), and use the results chain model to develop effective solutions to address them.

b. Value Proposition – The value proposition building block describes the bundle of products and services that create value for a specific customer segment through a distinct mix of elements catering to that segment's needs. Among the unique and valuable products and/or services that the BBHFA provide to its target customer segments include: facilitating inter-agency communication and coordination; linking of users with providers; leveraging of alliance partners' resources; conducting cooperative research, education, and restoration projects; and streamlining of BBHFA programs and activities through the provision of integrated strategic planning and project management services.

c. Customer Channels – The channels building block describes how BBHFA communicates with and reaches its customer segments to deliver its value proposition. The main channels employed by BBHFA include: established BBRRCT mechanisms; education and public outreach projects of the Miami WaterKeepers, Deering Estate, Miami-Dade Aquatic Preserves, Biscayne National Park, and the Florida Sea Grant Extension; and the NOAA Habitat Blueprint website and the BBHFA single point-of-entry website/publicly accessible GIS database.

d. Customer Relations – The customer relations building block describes the types of relationships (ranging from personal to automated) that BBHFA establishes with specific customer segments to acquire, retain, and engage them. This is initiated at different levels for the BBHFA team, such as: active engagement of BBHFA Co-leads and Co-coordinators in BBRRCT, SFWMD, CERP, and SRWG activities; involvement of key partners in BBHFA IPT deliberations, projects, and BB Program Coordination Team activities; and through public presentations and involvement in local habitat restoration activities, cooperative research, education/outreach, youth training, and jobs creation/social and environmental entrepreneurship projects.

e. Key Activities – The key activities building block presents the most important things that BBHFA must do to make its business model work. This involves: development and maintenance of the BBHFA website and GIS platform; participation in integrated Biscayne Bay planning, programming, and project management initiatives; promoting BBHFA and alliance partners' programs and activities; partner acquisition including local community/citizen engagement; leveraging of alliance partners' resources; and member services provisioning.

f. Key Resources – The key resources building block describes the most important assets required to make the BBHFA model work. This includes: the BBHFA partnership network; BBHFA research, education, and social entrepreneurship programs; competent BBHFA work force; federal and state agency science and resource management capabilities (scientists, laboratory facilities, management and enforcement mandates, etc.), and financial resources (regular budgets and special/grant allocations); private sponsor/partner resources; participating schools, teachers, and administrators in BBHFA and

partner programs; citizen scientists, volunteers, resource managers/legislative allies, and Junior Waterkeepers; and the BBHFA website/GIS platform.

g. Key Partnerships – The key partnerships building block describes the network of suppliers and partners that make the BBHFA business model work. They include the following: Protected Natural Areas (Biscayne National Park, Aquatic Preserves, Florida Park Service); Research and Monitoring (NOAA AOML and SEFSC, Biscayne National Park, Miami – DERM, University of Miami, Florida International University); Resource Management (Miami – DERM, Florida Fish and Wildlife Conservation Commission, South Florida Water Management District, Florida Department of Environmental Protection, Biscayne National Park); Education and Outreach (Deering Estate, Miami Waterkeeper, NOAA/Florida Sea Grant College Program, Aquatic Preserves, Florida Audubon).

h. Cost Structure – The cost structure identifies and describes all costs incurred to operate the BBHFA model such as FFO Grant Projects, BBHFA Operations, BBHFA website/GIS platform development, acquisition and engagement of alliance partners and stakeholder (i.e., major providers and beneficiaries), and costs to implement various in-house and partners' collaborative agency research projects.

i. Revenue Streams – The revenue streams building block represents the cash that BBHFA generates from or allocates for each customer segment. These come from various sources, including: Federal Block Grants/FFOs, Program Sponsorships, Agency Budget Allocations, Ecosystem Service User Fees (e.g., park entry fees, marina/docking fees, ecotour registration fees, etc.), Other Public or Private Sources (e.g., local taxes, municipal bonds, etc.).

j. Socio-Economic Costs – The socio-economic costs looks at the negative impacts that the BBHFA success may incur such as: increased activity and use of Biscayne Bay due to improved conditions, increase in tourists and residential population in the Miami-Dade county, decreased public access to critical habitat areas within Biscayne Bay (e.g., with expansion of Marine Protected Areas and stricter boating/fishing regulations), increase in multiple-use conflicts among resource users, decrease in real estate value from blocked views and bay access (e.g., with increased adoption of living shorelines), reduced growth and employment in affected industries (e.g., gentrification of working waterfronts), and increased cost of operating a business due to conservation-related regulations.

k. Socio-Economic Benefits – The socio-economic benefits describe the positive impacts that may accrue from successful implementation of BBHFA, including all Partner initiatives. This includes: $12.7 Billion in output, $6.3 Billion in income, 57,100 jobs created, and $257 Million in local tax revenues from Biscayne Bay ecosystem services (Hazen and Sawyer, 2005); increased public awareness of Biscayne Bay's ecosystems benefits resulting in increased user/stakeholder stewardship and regulatory compliance; creation of new Biscayne Bay-themed private social/environmental enterprises; improvements in STEM performance of participating K-12 students; stronger inter-agency collaboration and program integration; restoration of impacted habitats/species; and prevention of further introductions of invasive species.