Report on Development and Implementation of an Annual Report Card Program on the Health of Biscayne Bay Pursuant to Resolution No. R-463-18

December 2020

2019 Biscayne Bay Report Card

Biscayne Bay plays a fundamental role in the quality of life for residents and the economy of Miami-Dade County. In addition to its intrinsic natural beauty, the Bay provides water-related recreational opportunities, supports our local economy through boating and commercial fishing activities, and supports our local tourism industry. Therefore, protecting Biscayne Bay and understanding the overall health of the Bay's ecosystems is important to all Miami-Dade County businesses and residents. Changes observed in recent years including a decline of seagrass cover in some portions of the Bay have raised concerns regarding the health of the Bay's ecosystem. In May of 2018, the Miami-Dade Board of County Commissioners adopted Resolution No. R-463-18 directing the County Administration to develop and implement an annual report card program on the health of Biscayne Bay's ecosystem. The goal was to develop an easy to read report card on the status of the Bay's overall ecological health using a simple red, yellow, and green stoplight approach. By increasing public awareness about the status of and threats to Biscayne Bay, we take an important step in promoting greater stewardship and individual responsibility for implementing actions and changing behaviors that are needed to protect the Bay.

It's all about the water. The clear waters of Biscayne Bay support the growth of seagrasses, corals, sponges, and other important habitat on the bay bottom. These habitats further support the growth of fish populations and other important marine life, including threatened and endangered species. Therefore, protecting water quality in Biscayne Bay is key to supporting the overall health of the Bay's ecosystem. There are many factors that affect Bay water quality including the quality of the water flowing into the Bay, bay bottom habitat, water circulation patterns, and tidal exchange with the ocean. The most notable is the impact of water flowing off the landscape and into the Bay from the various drainage canals located throughout the County. This includes water flowing south into Miami-Dade County from the regional canal system, as well as rain that falls directly on our neighborhoods and streets. Stormwater seeps into the ground and it also flows into a network of regional and local drainage canals where it ultimately flows out to the Bay. Managing stormwater is critically important for protecting our community from flooding. The challenge is that stormwater runoff is often exposed to various sources of pollution on its journey to the Bay. Stormwater can include pollution from roadways, construction sites, agriculture, pet wastes, fertilizers, yard clippings, car washing, septic tank systems, aging sanitary sewer systems, and even litter or trash. While the Bay needs freshwater to help support its complex ecology, many of these land-based sources of pollution can contribute nutrients to stormwater, groundwater, canals, and ultimately the Bay. While nutrients are key to the growth and development of marine life, excess nutrients in the water can degrade Bay water quality.

For development of the **Biscayne Bay Report Card**, County scientists identified three main categories for characterizing the overall ecological health of the Bay: Water Quality, Habitat, and Fisheries. Specific indicators for water quality and habitat were selected and thresholds with ideal comparative baselines were established for each indicator based on review of criteria in scientific literature, as well as analysis of the County's historical monitoring data. Florida Fish and Wildlife Conservation Commission data were used in the selection of indicators, establishment of a baseline, and analysis of fisheries for 2018. Water quality and habitat monitoring data for 2018 were grouped according to the State of Florida numeric nutrient criteria regions established for the Bay in 2012 with some modifications to reflect better detail in the northernmost basins of the Bay, and using nutrient concentrations more protective of Bay health as established in scientific literature. The Report Card provides a visual representation of the overall ecological health of the Bay as expressed using a "stoplight" score of red (poor), yellow (fair), and green (good), when compared with water quality conditions that were observed in the Bay between the years 1996 and 2004. To make the Report Card effective, the upper tier representing the best water quality data observations from this time period were used to form the baseline. Water quality indicators include levels of nutrients such as phosphorus and nitrogen, chlorophyll-a, water clarity and bacteria. Habitat indicators for the Bay include submerged aquatic vegetation (i.e., seagrass and macroalgae) as well as hardbottom habitat which is represented by the frequency of marine sponges observed.

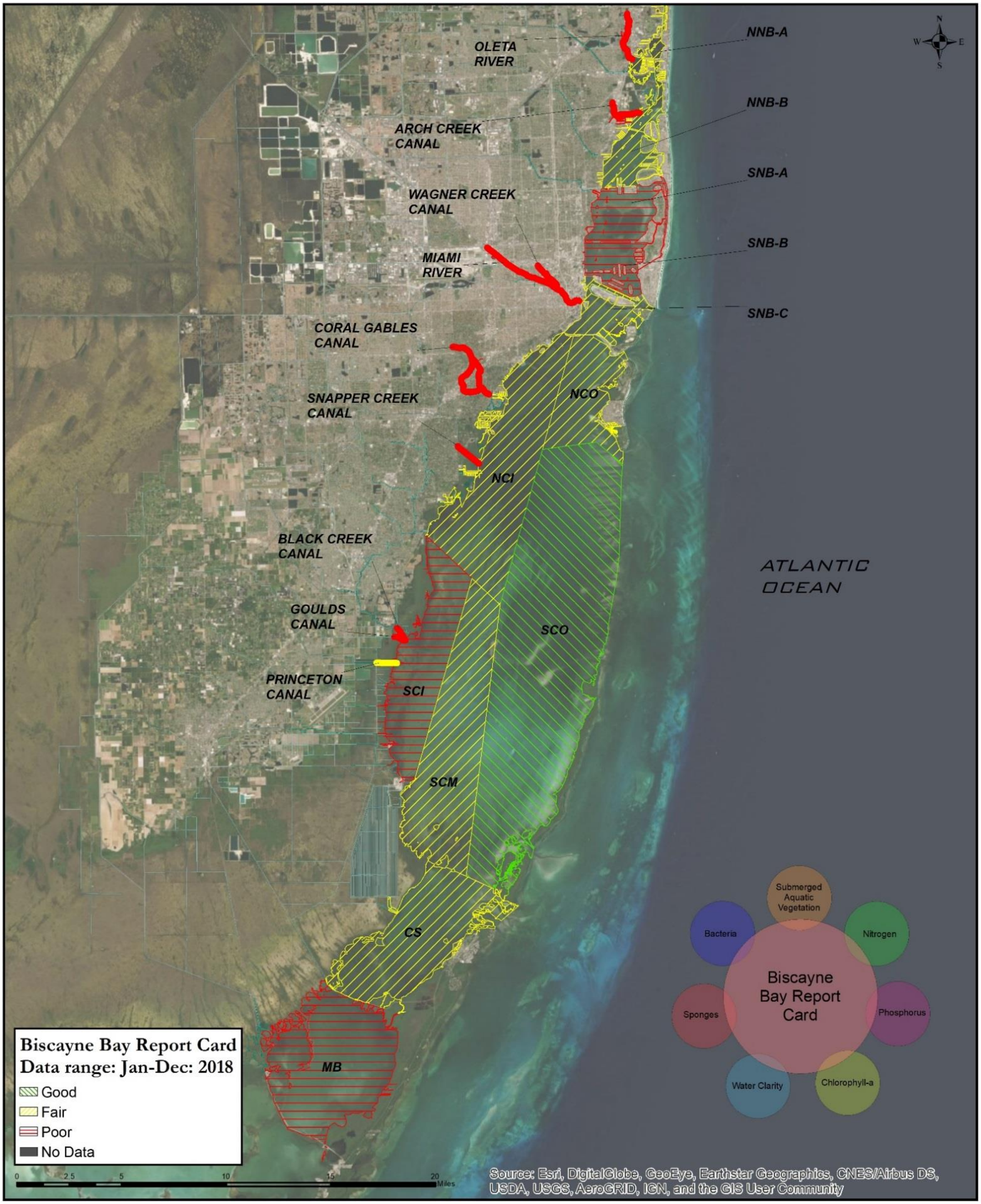
Our History Living with Biscayne Bay. Most would agree that Biscayne Bay's amazing beauty and abundant resources likely attracted many of the people that came to Miami-Dade County over the years, and that this influx of people also brought changes. Biscayne Bay has had its share of challenges over the past 100 years. They include: the rampant dredging and filling activities that occurred in the early part of the last century that impacted the bay bottom and created land masses where they hadn't previously existed; the elimination of the Bay's natural mangrove shoreline in much of the northern Bay; significant alterations to the Bay's historic hydrology through the creation of drainage canals and the conversion of large areas of historic Everglades wetlands that previously served to store and filter water before it would flow off the land into the Bay; and even the deliberate discharge of untreated sewage that occurred prior to the construction of the County's centralized wastewater collection and treatment system decades ago. As we witnessed and learned more about how these activities impacted the Bay over time, new polices and approaches were adopted to help better protect and preserve it. Regulations were developed and implemented to control and minimize dredging and filling activities, regulations protecting mangroves were enacted, laws governing the discharge of sewage were developed and implemented, and restoration of the Everglades ecosystem was elevated to national attention and now benefits from a federal and state partnership. In the 1970's the state of Florida established aquatic preserves covering much of Biscayne Bay, and the County also declared Biscayne Bay to be an aquatic park and conservation area. The County also implemented a Biscayne Bay Habitat Restoration and Enhancement Program conducting numerous projects over the past forty years such as recreating native coastal wetland habitats, replanting mangroves along the shoreline, stabilizing eroding shorelines with riprap, enhancing spoil islands and constructing artificial reef sites in the Bay. It is clear Biscayne Bay has faced challenges over the past century experiencing periods of decline as well as periods of recovery. As with generations before us, we too will observe and evaluate the health of the Bay in today's environment, and use that knowledge to identify new approaches, policies, or actions that are necessary to continue to protect and preserve the Bay into the future.

2019 Report Card Results. The Report Card stoplight results are depicted on the attached 2019 Biscayne Bay Report Card map. In addition, Table A below, provides a brief narrative description of the factors driving ecological trends in each Report Card basin. The findings of this initial Biscayne Bay Report Card support analyses indicating that nutrients and bacteria from within the watershed are documented in canals and tributaries at concentrations that can ultimately impact bay resources. The western region of the Bay along the shoreline and the highly compartmentalized basins of northern Biscayne Bay fall in the "poor" to "fair" range when compared to upper tier baseline conditions observed in the Bay approximately 20 years ago, while the eastern half of the large open bay region of central and southern Biscayne Bay falls in the "good" range. Findings indicate that canal water quality is impacted and that seagrass habitat directly receiving drainage from certain canals has experienced notable losses. As a community, we must strive to reduce our impact on the environment and work to reduce nutrient and bacteria loading to groundwater and our drainage canals as a principal approach to improving the health of Biscayne Bay. We hope this annual Report Card will serve as a useful tool to inform the public on the status of the Bay and its habitat, and will promote the community engagement and commitment that are needed to continue to protect, restore, and preserve the health and resilience of Biscayne Bay.

Table A. 2019 Report Card Basin Ecological Trend Factors

Report Card Region	2019 Score	Ecological Trend Factors
NNB-A	Fair	Highly reduced seagrass coverage with little recovery, nutrient inputs from canals, and elevated chlorophyll concentrations relative to baseline conditions.
NNB-B	Fair	Reduced seagrass coverage following a die-off event decades ago with little recovery, nutrient inputs from canals (both phosphorus and nitrogen), and elevated chlorophyll concentrations relative to baseline conditions.
SNB-A	Poor	This basin (Julia Tuttle) is in decline relative to baseline conditions following a combination of the relatively recent seagrass die off with little indication of recovery, and elevated chlorophyll concentrations and nutrient inputs from canals (phosphorus and nitrogen).
SNB-B	Poor	From the Julia Tuttle Causeway to MacArthur Causeway, highly reduced seagrass coverage, nutrient inputs from canals, and elevated chlorophyll concentrations relative to baseline conditions.
SNB-C	Fair	Reduced seagrass coverage, nutrient inputs from the Miami River which contributes a significant volume of water to Biscayne Bay, and elevated chlorophyll concentrations relative to baseline conditions.
NCI	Fair	Algal blooms that impacted seagrass coverage, nutrient inputs from canals, and elevated chlorophyll concentrations relative to baseline conditions.
NCO	Fair	Reduced seagrass coverage, elevated chlorophyll concentrations, and some elevated nutrient inputs relative to baseline conditions.
SCI	Poor	Reduced seagrass coverage with little recovery, reduced sponge frequency, nutrient inputs from several canals and elevated chlorophyll concentrations relative to baseline conditions.
SCM	Fair	Although seagrass coverage is consistent with historic baseline conditions this basin exhibits some elevated nutrient inputs.
SCO	Good	Seagrass coverage and most nutrient indicators in this basin are consistent with baseline.
CS	Fair	Reduced seagrass coverage, some nutrient inputs and elevated chlorophyll concentrations relative to baseline conditions.
MB	Poor	Reduced seagrass coverage, reduced sponge frequency, some nutrient inputs and elevated chlorophyll concentrations relative to baseline conditions.

2019 Biscayne Bay Report Card



TECHNICAL REPORT RELATED TO THE DEVELOPMENT OF AN ANNUAL "REPORT CARD" PROGRAM ON THE ECOLOGICAL HEALTH OF THE BISCAYNE BAY

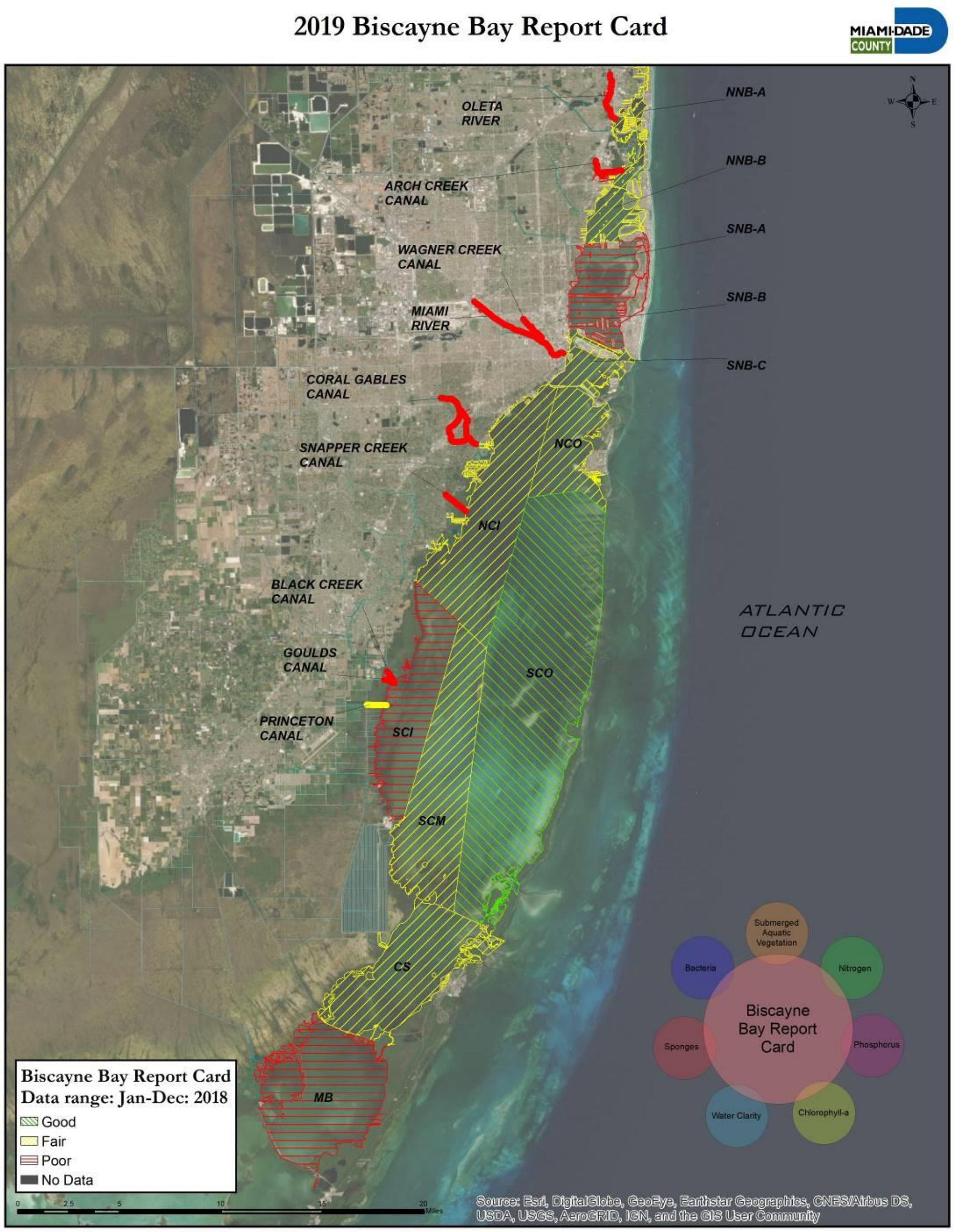
Introduction

Biscayne Bay was designated an aquatic park and conservation area by the Miami-Dade County (County) Board of County Commissioners (Board) in 1981 and is home to two state-designated aquatic preserves, a national park, and a national marine sanctuary. Biscayne Bay has historically been regarded as an oligotrophic estuary (i.e., low in nutrients), where availability of nutrients like phosphorus and nitrogen drive the health and growth of marine plants and wildlife. Impacted over time by hydrological changes, upland development, and increased use, Biscayne Bay has experienced degraded water quality, seagrass die-offs and algal blooms as determined in part through data collected via the County's surface water quality and benthic habitat monitoring programs. Excess nutrients in the water column can degrade water quality, creating conditions that impact seagrass habitat essential for fish, birds, marine mammals, and other marine species. Chronic, low-level nutrient loading and/or acute, pulsed stormwater discharges from canals carrying nutrients can lead to a shift from a seagrass-dominated habitat with clear water, low turbidity, and low levels of algae in the water column to an algae-based ecosystem that may be turbid and ultimately lead to a reduction in fisheries habitat. Sources of nutrients can include land use activities associated with development, agriculture, fertilizers, pet waste, and yard clippings and can be conveyed by stormwater outfalls. Other sources may include leaky sewer infrastructure and septic tank effluent. Unique challenges presented by storms and sea level rise can further compound and complicate inputs from these existing sources.

In May 2018, the Board adopted resolution R-463-18 directing staff to develop and implement an annual report card to evaluate the ecological health of Biscayne Bay using an easy-to-understand "stop-light" approach that was to be data-driven, employ sound scientific principles, include easy-to-read graphics and be publicly accessible. The Board noted the importance of providing the public with important information about the improvement or decline in the health of the bay. Three major categories of Biscayne Bay ecology were identified that together provide the most representative evaluation of the ecological health of the bay: Water Quality, Habitat, and Fisheries. Indicators for water quality, habitat, and fisheries were selected and a baseline and thresholds were established for each indicator based on criteria in scientific literature and through analysis of the County's historical record of data. In developing the water quality baseline, a greater emphasis was placed on better water quality data results observed in the record therefore the Report Card scores represent a comparison to an ideal or even aspirational condition for the Bay in some areas. The Biscayne Bay Report Card is a graphic representation of the overall ecological health of Biscayne Bay, considering both water quality and habitat quality indicators. Nutrient regions established by the state of Florida and modified to further subdivide the northernmost basins, are identified on the maps for each indicator and a "stoplight" score of red, yellow, or green is attributed to each region based on results of the County's analysis of 2018 water quality and habitat data. Water quality indicators include phosphorus, nitrogen, chlorophyll-a, water clarity and bacteria, and habitat indicators include submerged aquatic vegetation (i.e., seagrass and macroalgae) as well as hardbottom habitat (represented by frequency of observations of marine sponges).

Results of the 2018 data analysis as depicted in the Biscayne Bay Report Card (Figure 1), a graphical representation of the regions evaluated for both water quality and habitat quality indicators, indicate "poor" conditions in a number of regions including several canals, the Julia Tuttle Basin and the basin to its south, as well as nearshore areas along the mid-bay and further south in Manatee Bay. Overall, the northernmost basins indicate conditions are "fair", although the canals leading into these basins indicate "poor" conditions. The central and eastern regions of Biscayne Bay that are more readily flushed by the Atlantic Ocean indicate "good" conditions for 2018. Generally, scores for phosphorus, nitrogen, and chlorophyll-a tend to be fair to poor along the shoreline regions of the Bay.

Figure 1. 2019 Biscayne Bay Report Card, indicating “poor” conditions in a number of regions including several canals, the Julia Tuttle Basin and the basin to its south, as well as nearshore areas mid-bay and further south in Manatee Bay. Overall, the northernmost basins indicate conditions are “fair”, although the canals leading into these basins indicate “poor” conditions. The central and eastern regions of Biscayne Bay, more readily flushed by the Atlantic Ocean, indicate “good” conditions for 2018. Generally, scores for phosphorus, nitrogen, and chlorophyll-a tend to be fair to poor along the coastline. Analysis used to derive the stoplight score is found in Table 7.



Background and Findings

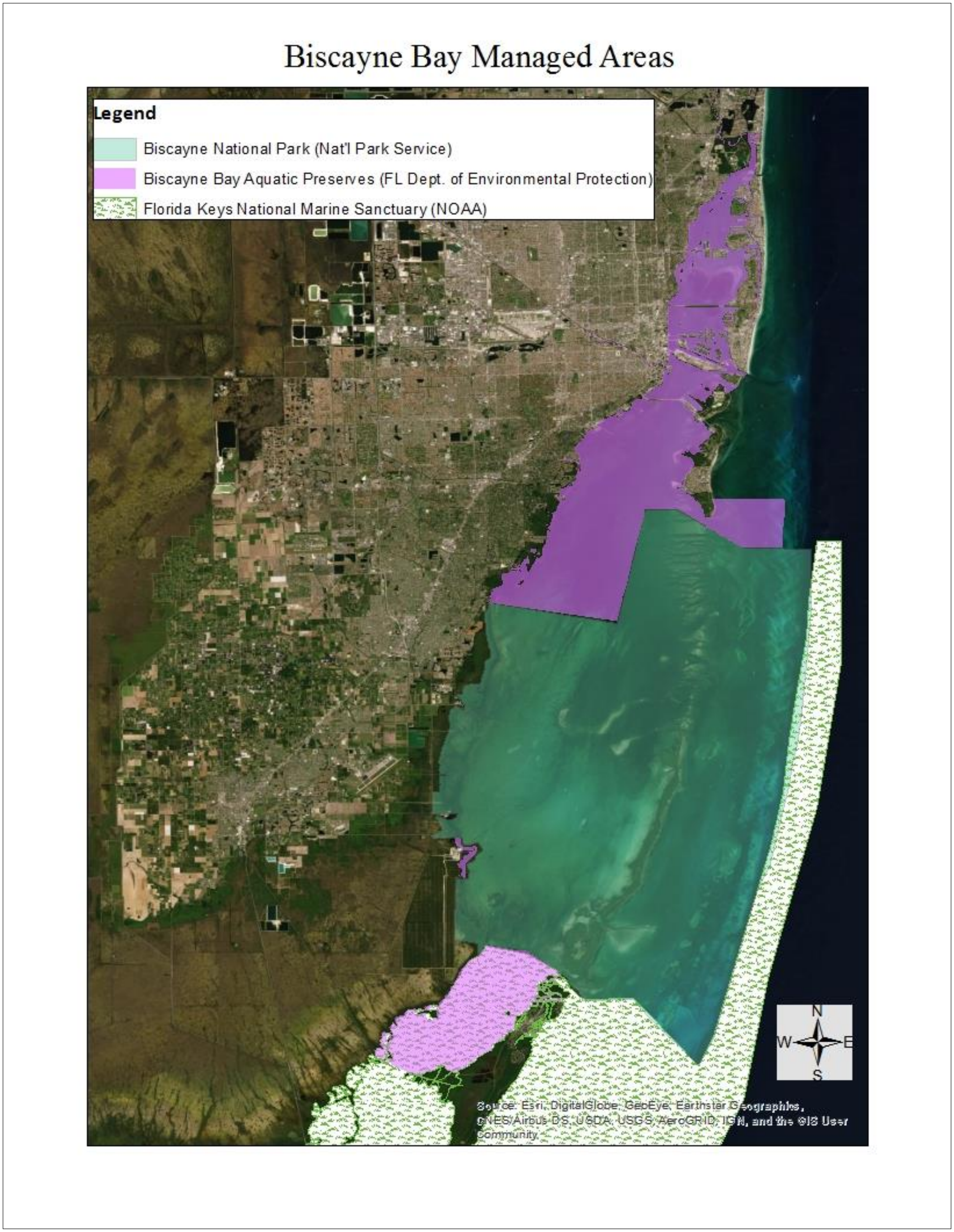
Biscayne Bay is a sub-tropical shallow estuary that is home to two state aquatic preserves, a national park, and a national marine sanctuary. Both the Biscayne Bay Aquatic Preserves and the Florida Keys National Marine Sanctuary are designated by the state of Florida as Outstanding Florida Waters, and Biscayne National Park is designated as Outstanding National Resources Waters, per 62-302.700 Florida Administrative Code (Figure 2). Bounded by the mainland to the west and barrier islands to the east, the bay is a source of sustenance, economic vitality, and provides for countless recreational opportunities enjoyed by residents and visitors alike. Its spectacular natural beauty is widely recognized and enjoyed, with nearly 2.8 million residents and millions of visitors every year.

In 1974, the Board recognized the ecological and recreational value of Biscayne Bay, stating that "…in the interest of the public welfare to protect and preserve unique, natural, aesthetic, and recreational values, Biscayne Bay and its environs are hereby declared to be an 'aquatic park and conservation area' for the use and benefit of the citizens of Miami-Dade County" (Chapter 24-48.22 of the Code of Miami-Dade County).

Local, state, and federal entities have invested in and worked in partnership on behalf of Biscayne Bay for decades. In 1981, having declared Biscayne Bay an "Aquatic Park and Conservation Area" and convening a committee to evaluate the health and needs of Biscayne Bay, the Board formally adopted the Biscayne Bay Management Plan. The plan identified issues facing the health of the Bay, such as the impact of rampant dredging and filling for decades, alteration of natural freshwater flow into the bay, land use changes as urbanization occurred, and the introduction of significant pollutant loading from non-point sources such as canals.

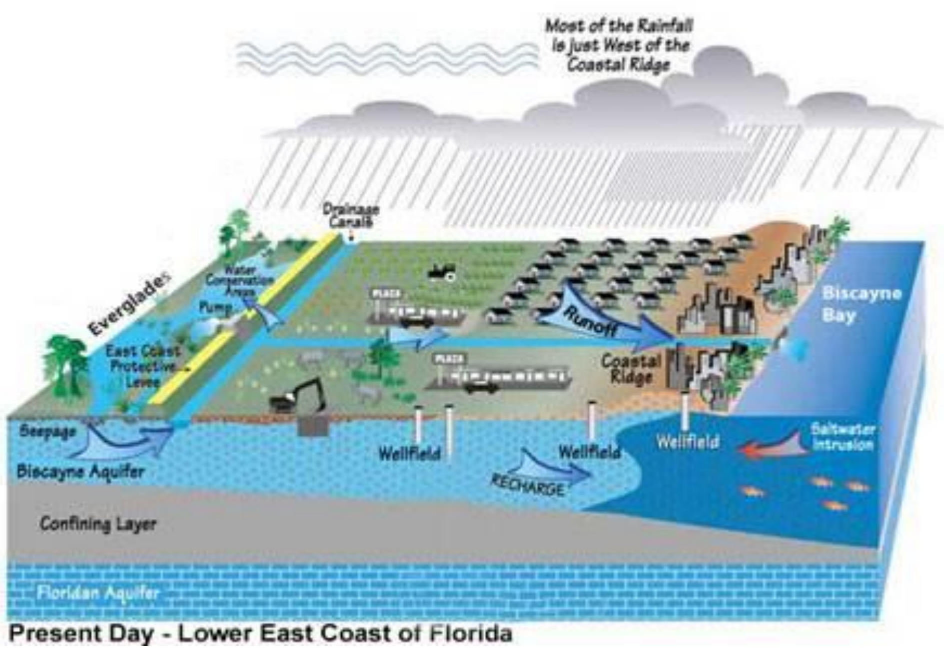
Among the programs created by way of the management plan being adopted are County regulatory programs and habitat restoration and monitoring programs that help protect water quality and habitat in and along Biscayne Bay. The County's Restoration and Enhancement Program was created and staffed to be a major implementation tool of the Biscayne Bay Management Plan. Through this effort, the program has constructed over 600 acres of shoreline stabilization and habitat restoration projects throughout Biscayne Bay. In addition, the County established various programs to regulate work conducted in, on, over, or upon tidal waters, freshwater wetlands, and coastal wetlands as well as other programs to regulate stormwater drainage systems. Nearly twenty years after the adoption of the County's Biscayne Bay Management Plan, the County was integrally involved in the Biscayne Bay Partnership Initiative. The Initiative was established by the Florida Legislature in 1999 and culminated in the publishing of a 2001 report that, in part, characterized pre- and post-urbanization conditions in Biscayne Bay and impacts on water quality.

Figure 2. Managed areas in Biscayne Bay.



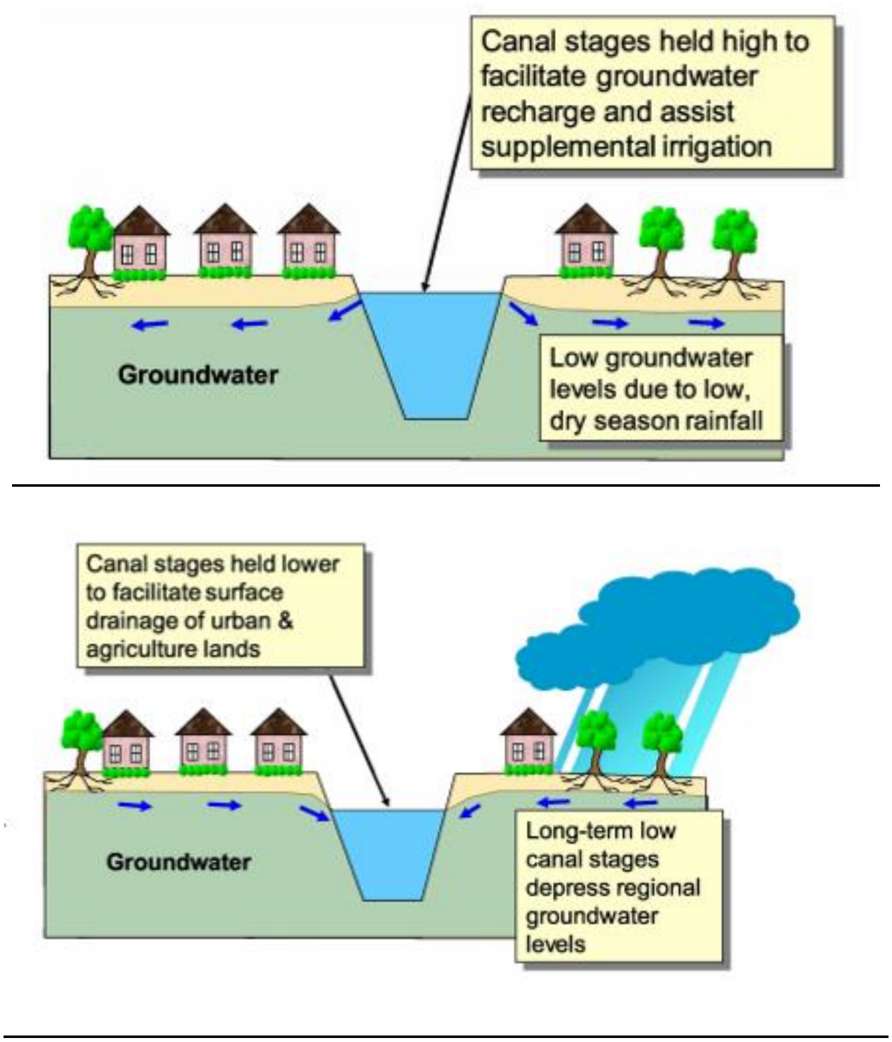
Prior to significant development in southern Florida, surface water flow off the land reached the Bay as stream flow and overland flow. Pre-development streams, rivers, and sloughs were shallow and did not extend very far inland or penetrate very deep into the permeable Biscayne aquifer. The Biscayne aquifer lies below the land surface and is generally regarded as the sole source of drinking water for the County. Rapid urbanization and the growth of agriculture over the past one-hundred years led to a loss of wetlands and natural areas, and with it came a corresponding need to manage water levels to prevent flooding. This resulted in the channelization of natural tributaries and creeks as well as the creation of large regional stormwater drainage canals. This alteration changed the timing, distribution, and quality of surface water flowing to Biscayne Bay. Instead of slowly filtering through wetlands and other natural areas as it had in the past, water from storms and seasonal rains now generally flows across impervious areas in our neighborhoods and streets and is more rapidly conveyed to the Bay through drainage canals. This stormwater runoff is often exposed to various sources of pollution on its journey to the Bay. Stormwater can include pollution from roadways, construction sites, agriculture, pet wastes, fertilizers, yard clippings, car washing, faulty septic tank systems, aging sanitary sewer systems, and even litter or trash. While the Bay needs freshwater to help support its complex ecology, many of these land-based sources of pollution can contribute nutrients to stormwater and the canals. Excess nutrients in water can degrade Bay water quality. Fertilizers and leaky septic tanks and wastewater infrastructure are thought to be some of the major sources of additional nutrients that make their way into the bay via groundwater and surface water inputs (Figure 3).

Figure 3. Miami-Dade County landscape including urban areas, agricultural areas, stormwater management features, and natural resources. (Illustration adapted from SFWMD/USGS)



During the wet season, stormwater accumulates in our system of canals and is drained out to the bay when coastal water control structures are opened to provide flood protection to our neighborhoods and streets. Due to the porous geology here in South Florida, groundwater and surface water resources in the County are inextricably linked. Surface water from the canals interacts with groundwater as water moves back and forth in and out of the canal system. During the dry season, water is held back behind the coastal water control structures which helps prevent saltwater intrusion from the east. When water levels in the canals are lower than the surrounding water table in the aquifer, groundwater will seep into canals via the groundwater pathway. When canal water levels are higher than surrounding groundwater elevations, surface water from the canals can seep back into the ground (Figure 4).

Figure 4. The dynamic movement of water into and out of canals. (Credit: Southeast Florida Climate Compact)



Water Quality

Miami-Dade County's Surface Water Quality Monitoring Program was established in 1979 and collects data that include various physical, chemical, and biological water quality parameters within all major canals across the County and throughout Biscayne Bay on a monthly basis (Figure 5). The program is implemented by the County's Division of Environmental Resources Management (DERM) within the Department of Regulatory and Economic Resources. Indicators that are most representative of the ecological health of water quality in Biscayne Bay include nutrients such as phosphorus and nitrogen, chlorophyll-a, bacteria and water clarity. These water quality parameters can serve as good indicators of the overall ecological health of Biscayne Bay and its tributaries and can help identify the potential impact of the urbanized watershed on water resources throughout the County. These parameters were combined to evaluate the overall water quality health for the Biscayne Bay Report Card.

Biscayne Bay has historically been regarded as an oligotrophic estuary (i.e., low in nutrients), where the availability of nutrients like phosphorus and nitrogen drive the health and growth of marine plants and wildlife, including seagrass and macroalgal communities. Impacted over time by hydrological changes, upland development, and increased use, Biscayne Bay has experienced degraded water quality, seagrass die-offs and algal blooms as determined in part through data collected via the County's surface water quality and benthic habitat monitoring programs. Research conducted by other governmental and academic institutions also indicate that eutrophication, or nutrient over-enrichment, especially of phosphorus and nitrogen, is a major contributing factor to seagrass die-offs worldwide. Chronic, low-level nutrient loading and/or acute, pulsed discharges leading to nutrient loading can lead to an ecological shift from a seagrass-dominated bay habitat with clear water, low turbidity, and low levels of algae in the water column to an algae-based ecosystem that may be more turbid and which can ultimately lead to a reduction in fisheries habitat. Sources of nutrients can include land use activities associated with development, agriculture, fertilizers, pet waste, and yard clippings and can be conveyed by stormwater outfalls. Other sources may include leaky sewer infrastructure and septic tank effluent. Unique challenges presented by storm events and sea level rise can further compound and complicate inputs from these existing sources.

Habitat

Biscayne Bay is home to all seven species of seagrasses found in Florida. Seagrasses are flowering plants that provide the public with a range of ecosystem services, which are the direct and indirect contributions of ecosystems to human well-being. Macroalgae are plant-like organisms that are integral to the health of marine ecosystems, so long as they are in relatively low abundance relative to seagrass coverage. Macroalgae "blooms" can result from an overabundance of available nutrients in the water column and can shade out and compete with seagrass for light and substrate. Together, seagrasses and macroalgae are known as "submerged aquatic vegetation."

Miami-Dade County's Benthic Habitat Monitoring Program was established in 1985 and collects data on the health and presence of benthic resources such as seagrass, macroalgae, sponges, hard corals and soft corals at various locations throughout Biscayne Bay on an annual basis. Additional sites have been added over the years, particularly in areas where seagrass die-offs or algal blooms have occurred. This includes the addition of 40 sampling locations in the Julia Tuttle Causeway basin where one of the most significant die-off events recently occurred between 2012 and 2017 (Figure 6).

Figure 5. Miami-Dade DERM Biscayne Bay Surface Water Quality Monitoring Stations

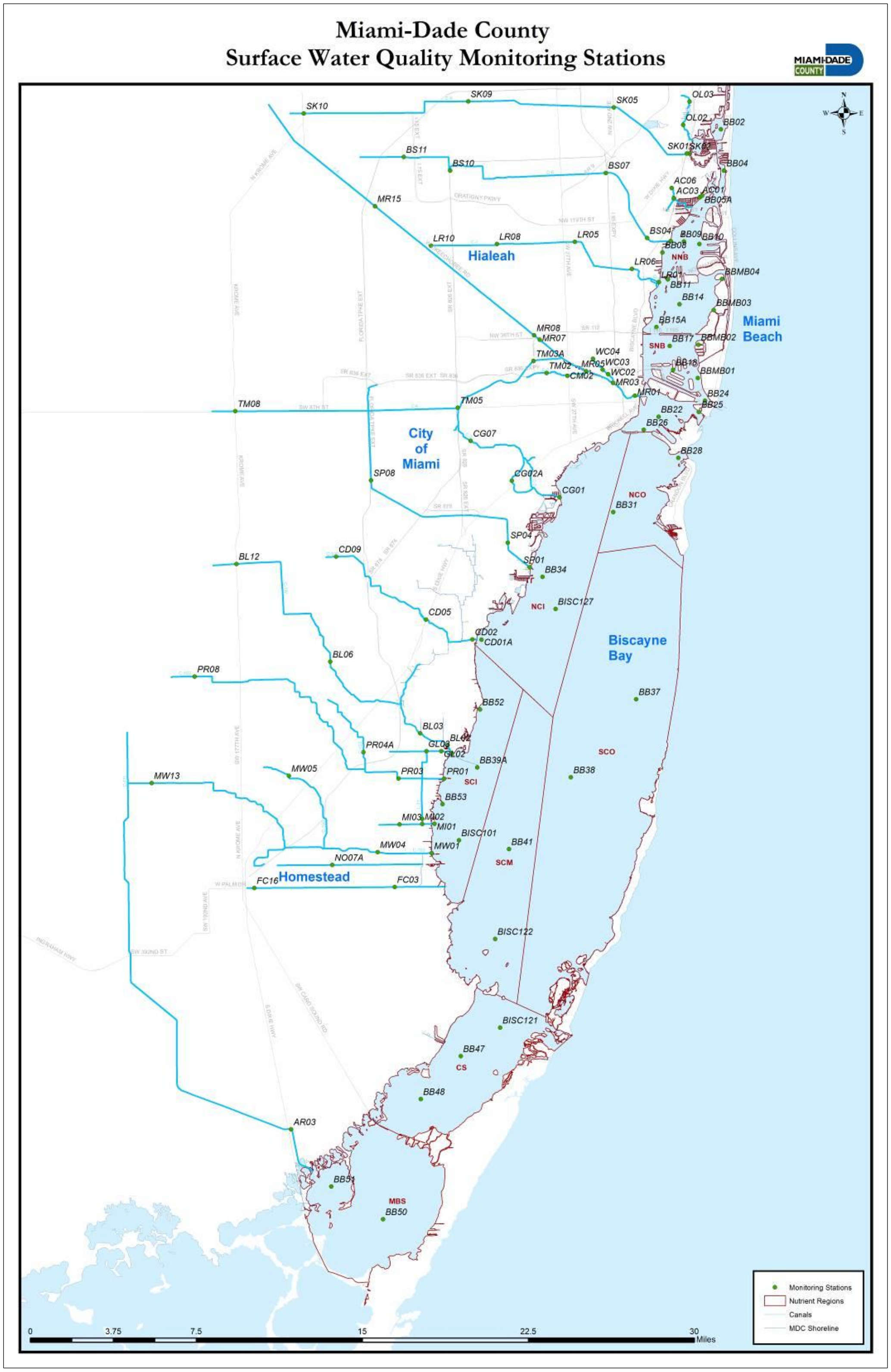
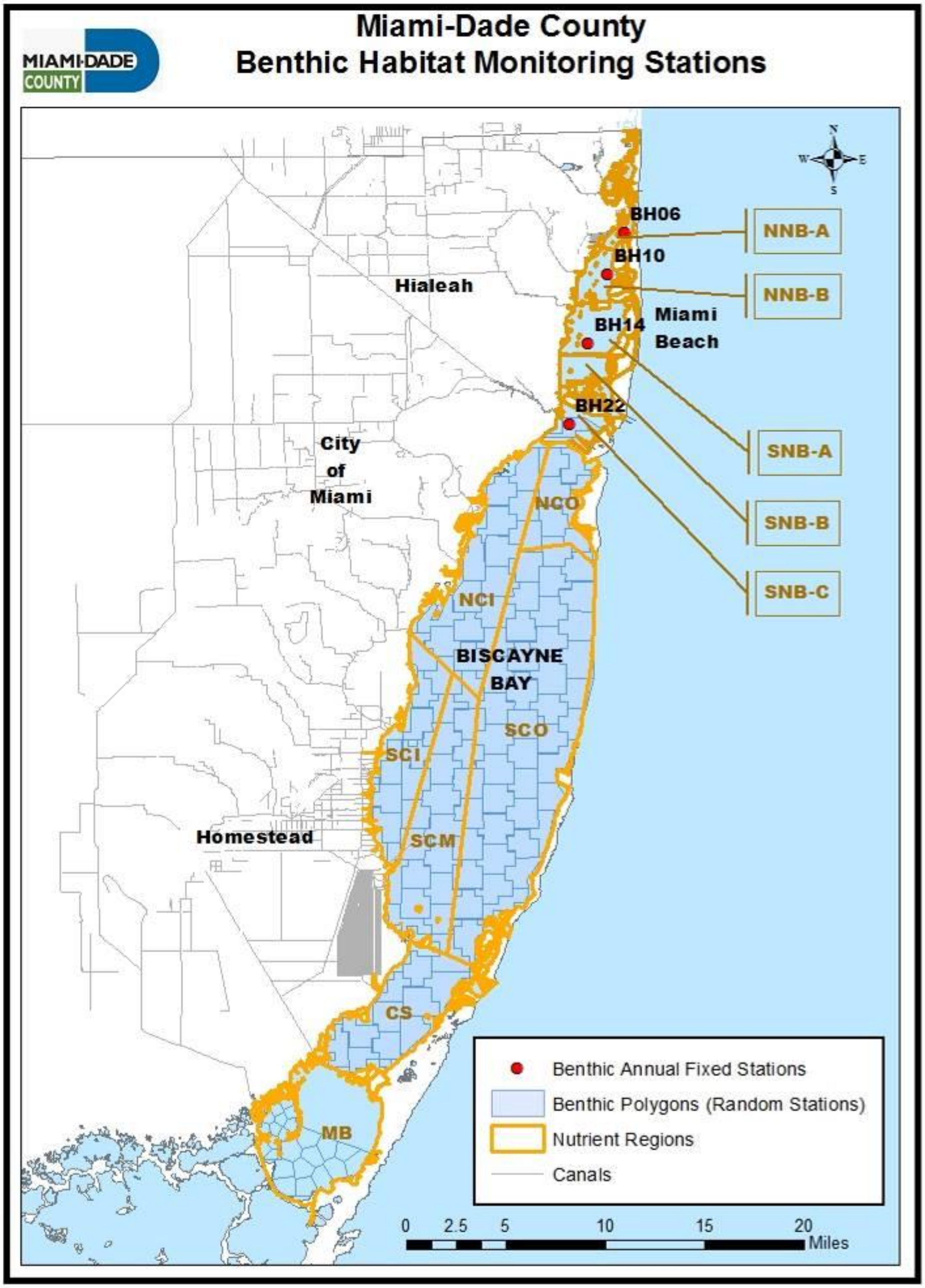


Figure 6. Benthic Habitat Monitoring Stations in Biscayne Bay, Card Sound, and Manatee Bay.



Fisheries

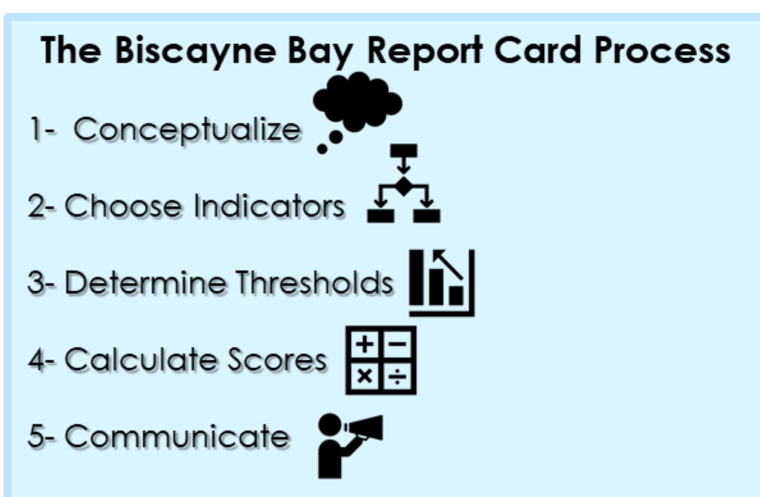
Biscayne Bay habitats such as seagrasses and macroalgae, hard bottom, sandy bottom, mangroves, and others provide habitat critical to the survival of endangered and threatened species, as well as commercial and recreationally important species. Blue crab, spiny lobster, and pink shrimp conduct all or part of their life cycles in Biscayne Bay, and are important components of the local fisheries industry in South Florida.

The Florida Fish and Wildlife Conservation Commission (FWC) collects data from commercial harvesters and dealers to generate statistics on the types of species and quantities landed, as well as the size, weight and age distribution of harvested species as part of the state's mandatory trip ticket program. This information, combined with the number of trips made that year, can provide valuable information regarding the volume of catch that year for that particular species. In addition, FWC also estimates total value per pound of species harvested.

Report Card Development

In May 2018, the Board adopted a resolution directing the County to develop and implement an annual report card to evaluate the health of Biscayne Bay (Figure 7). The process for creating the report card included five major steps, with the first being to conceptualize both the kinds of information most relevant to the health of Biscayne Bay and how that information should be conveyed by way of graphics, maps, tables, and narrative descriptions. Three major categories of Biscayne Bay health were identified by the County that together provide a representative evaluation of the bay's ecosystem health: Water Quality, Habitat, and Fisheries. Second, indicators for water quality, habitat, and fisheries were selected. Third, thresholds were established for each indicator based on criteria in scientific literature and through analysis of the County's historical record of data. This process included developing a baseline level of health for the bay that will be used for comparison, year to year. Threshold ranges were established for each parameter and a red, yellow, or green "stop-light" score was ascribed to the parameter. Fourth, the "stop-light" scores were calculated and assigned based on 2018 values for each parameter as measured against the baseline. Fifth, and lastly, the annual Biscayne Bay Report Card will be provided to the Board, disseminated at County events and will be made available online.

Figure 7. Biscayne Bay Report Card development strategy.



The Biscayne Bay Report Card evaluates water quality, habitat and fisheries in Biscayne Bay as the three representative aspects of the Bay's overall ecological health. There are several indicators of water quality and habitat quality that are collected on a regular basis by DERM. Water quality parameters include total phosphorus, total nitrogen, water clarity, bacteriological indicators and chlorophyll-a. Habitat quality indicators include submerged aquatic vegetation (i.e. seagrass and macroalgae) as well as sponges. Data collected via County programs during calendar year 2018 were used to develop the Biscayne Bay Report Card.

The goal of the annual Biscayne Bay Report Card is to provide the public with a greater understanding of Biscayne Bay ecological health and its challenges using a "stoplight" approach, wherein the colors red ("Poor"), yellow ("Fair"), and green ("Good") signify the relative status of the various indicators. The report card is to address the overall state of the bay's water quality, habitat quality, and trends in fisheries and is to report on any improvements or declines in bay health for the year. County staff scientists will continue to work with academic partners in preparation of the report card and will use data collected by and work in concert with County departments as well as federal, state, municipal, and community partners. The annual report card will serve to promote greater awareness of the status of the Bay ecosystem (Figure 8).

Figure 8. Description of Report Card stop-light scores.

Poor	Fair	Good
These regions or indicators are experiencing considerable water quality and/or ecological degradation. Essential ecological functions and species diversity are impacted and not able to perform beneficial functions at optimum levels.	These regions or indicators are experiencing water quality and/or ecological degradation. Essential ecological functions and species diversity are limited in performing beneficial functions at optimum levels.	These regions or indicators are maintaining ecosystem function. Essential ecological functions and species diversity are largely performing beneficial functions at optimum levels.

Establishing a Baseline

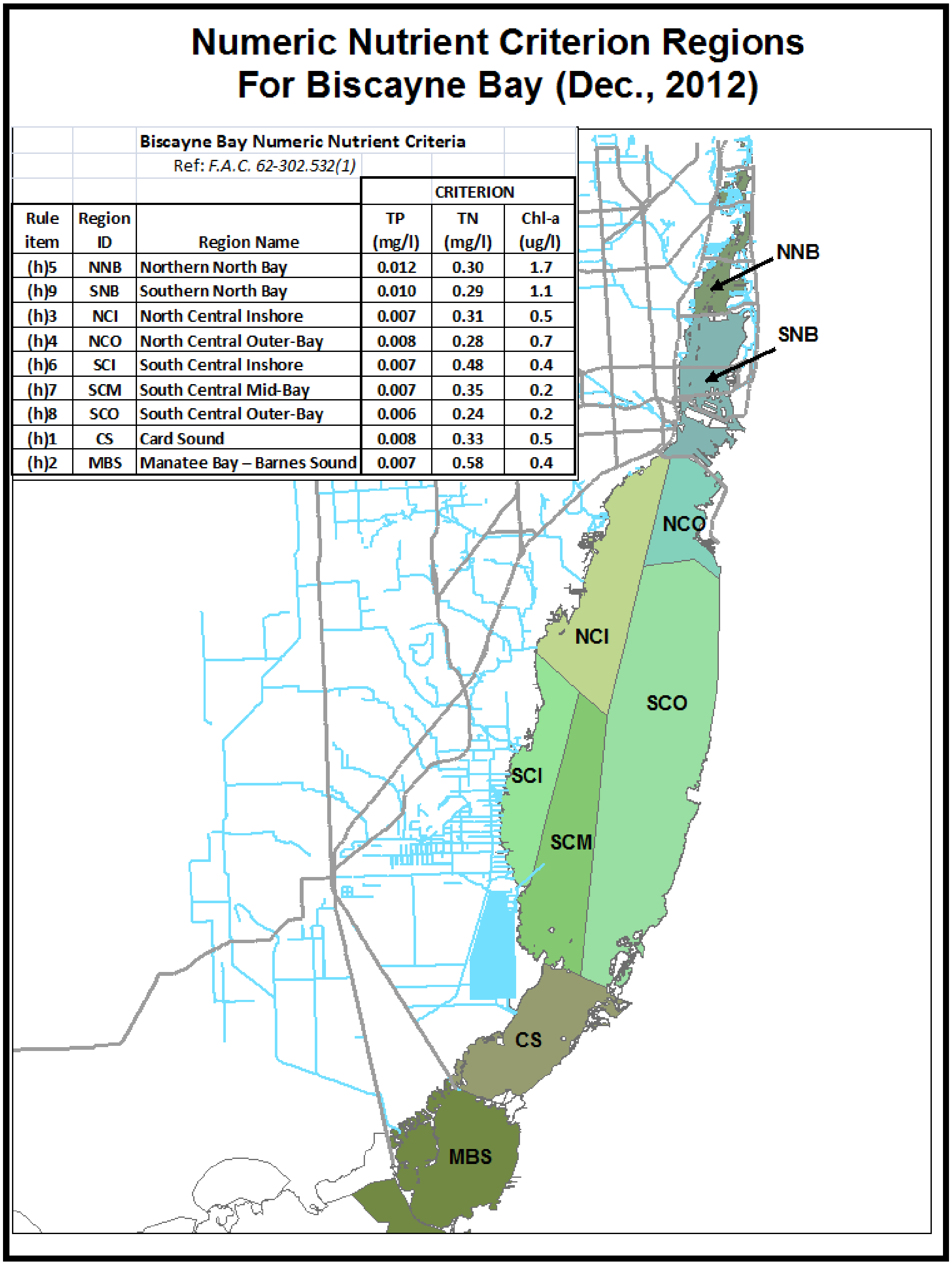
A baseline for the water quality and submerged aquatic indicators selected were used to evaluate the status of the health of Biscayne Bay year to year in the annual report card. Historical data for these indicators are based on the years 1996-2004, which are noted in scientific literature by Briceño et al* as representative of fairly good ecological conditions for Biscayne Bay, and where the data were independent of disturbed conditions such as storms, hurricanes or other major events. From this period, Z-Cusum plots of chlorophyll-a versus total nitrogen and total phosphorus identified inflexion points for chlorophyll-a, with chlorophyll-a serving as an indicator of ecological change in response to increased nutrients. The respective total nitrogen and total phosphorus concentrations that corresponded to these inflexion points (i.e., those concentrations where an increase in chlorophyll-a was noted) were used to derive "long-term limits". Briceño et al also developed an "upper limit" using the 80th confidence interval for the mean of a normal distribution of data. Staff calculated an annual geometric mean for each nutrient parameter (nitrogen, phosphorus, and chlorophyll-a) using 2018 data from the County's Surface Water Quality Monitoring Program and compared the mean to the "long-term limit" and "upper limit". Briceño et al evaluated Biscayne Bay data obtained by Florida International University's monitoring program, and only data from "undisturbed segments" of Biscayne Bay were included in the development of both the "upper limit" and "long-term limit" thresholds. Therefore these thresholds represent near ideal conditions for Biscayne Bay where, if obtained, are likely to represent water quality most conducive to a healthy, productive bay. The County is setting a high bar against which current water quality conditions are being compared in an effort to achieve the collective goal of a healthy bay as well as produce an effective tool through which to progress toward this goal can be evaluated annually. Calculated values based on 2018 observations for habitat parameters were compared to baselines established using County data for the same period of time.

This timeframe of 1996-2004 also represents the historical record used to establish the baseline for the state of Florida's Numeric Nutrient Criteria for nine nutrient regions in Biscayne Bay, as per Ch. 62-302, Florida Administrative Code. Numeric Nutrient Criteria were implemented in 2012 for total nitrogen, total phosphorus, and chlorophyll-a and some of the analyses conducted by Briceño et al were considered by the state of Florida and the Environmental Protection Agency in developing the state's numeric nutrient standards (Figure 9). However, while the state-established criteria for each of nine regions, for the purposes of the Biscayne Bay Report Card, the "upper limit" and "long-term limits" established by Briceño et al were employed These thresholds are considered more protective than those established in state rule as the thresholds set for each parameter are lower (i.e., the state's numeric nutrient criteria for phosphorus in Northern North Bay is 12 parts per billion (ppb) whereas the "upper limit" and "long-term limit" for this region are identified as 9 ppb and 4 ppb, respectively). The nine regions in Biscayne Bay for which Numeric Nutrient Criteria were established are included as polygons on all maps in the report card as a way of dividing the bay into regions in a manner that has been vetted and established by experts. It is noted that the state's Numeric Nutrient Criteria are applied to waters in Biscayne Bay proper and do not extend upstream of the mouth of canals, tributaries, or tidal creeks; however, for purposes of the report card, the "long-term limits" and "upper limits" set by Briceño et al were applied to tidally-connected canals and tributaries (Table 5) as no numeric nutrient criteria exists for canals or tributaries in the Biscayne Bay watershed at this time. In this context, tidally-connected canals and tributaries are those portions of waterways downstream or east of a water control structure. For canals that have salinity structures well inland with two or more sampling points between the bay and the salinity structure, water quality in that portion of the canal or tributary was assessed and provided a score as a canal or tributary. Included in that subset are Oleta River, Arch Creek, Miami River and Wagner Creek, Coral Gables Canal, Snapper Creek, Goulds Canal, and Princeton Canal. Sampling locations for tributaries and canals that currently only have one sampling location between the water control structure and the mouth of the bay are typically located at the mouth of the canal or tributary. Those sampling locations located at the mouth of the waterbody were incorporated into the data associated with the bay and evaluated separately from those sampling locations wholly within the body of the tributary or canal.

Lastly, the County is currently working with the state of Florida to officially subdivide the "Northern North Bay" into two categories (noted in the maps herein as NNB A-B) and subdivide the "Southern North Bay" into three categories (noted in the maps herein as SNB A-C) for the purposes of analyzing annual geometric means against the state's Numeric Nutrient Criteria.

* Briceño, H.O., J. Boyer, and P. Harlem. 2010 Proposed Methodology for the Assessment of Protective Numeric Nutrient Criteria for South Florida Estuaries and Coastal Waters. White paper submitted to Environmental Protection Agency Science Advisory Board. Dec. 6 2010. FIU/SERC Contribution #T-501.

Figure 9. Biscayne Bay Numeric Nutrient Criteria Regions as implemented in 2012 for Florida Department of Environmental Protection (62-302 Florida Administrative Code).



Biscayne Bay Numeric Nutrient Criteria

Ref: *F.A.C. 62-302.532(1)*

Rule item	Region ID	Region Name	CRITERION TP (mg/l)	TN (mg/l)	Chl-a (ug/l)
(h)5	NNB	Northern North Bay	0.012	0.30	1.7
(h)9	SNB	Southern North Bay	0.010	0.29	1.1
(h)3	NCI	North Central Inshore	0.007	0.31	0.5
(h)4	NCO	North Central Outer-Bay	0.008	0.28	0.7
(h)6	SCI	South Central Inshore	0.007	0.48	0.4
(h)7	SCM	South Central Mid-Bay	0.007	0.35	0.2
(h)8	SCO	South Central Outer-Bay	0.006	0.24	0.2
(h)1	CS	Card Sound	0.008	0.33	0.5
(h)2	MBS	Manatee Bay – Barnes Sound	0.007	0.58	0.4

Water Quality Indicators

The following water quality indicators are evaluated in the Biscayne Bay Report Card:

- **Nutrients**
    - **Phosphorus** is considered the limiting nutrient, or less available, as it binds to the calcium carbonate sediments that are characteristic of Biscayne Bay. Availability of phosphorus is largely considered the determining factor in plant growth in the marine environment. Overabundance of this and other nutrients, or eutrophication, is attributed to the cause of seagrass decline on a global and local scale.
    - **Nitrogen** is an important nutrient for the growth and health of marine organisms and can be found in various forms in urban watersheds. Some forms of nitrogen indicate inputs from fertilizer; others can indicate inputs from sewage.
    - **Chlorophyll-a** is a pigment found in plants and algae and is used to convert sunlight into energy. It is used as a measure of the amount of phytoplankton, or microscopic algae, growing in a waterbody. Algae can "bloom" from an overabundance of nutrients leading to eutrophication, clouding the water column and impacting seagrasses. These nutrients exist in various forms of nitrogen and phosphorus. While nutrients are vital to plant and animal life cycles, too heavy a load of nutrients coming into the bay can lead to the ecosystem not being able over time to assimilate those nutrients, which can cause microscopic algae to bloom, causing turbidity and shading seagrasses, preventing them from being able to photosynthesize. This in turn negatively impacts seagrass habitat long-term.

- **Water clarity** is a measure of how much light can penetrate through the water column. Clarity of water can be affected by various factors like suspended particles in the water column, such as turbidity or plankton (microscopic algae) that have grown in number as a result of excess nutrients being present in the water column.

- **Bacteria** levels can fluctuate in canal and bay waters and are naturally occurring to some degree. For example, the breakdown of vegetative matter increases the load of bacteria present in the water column and reduces the amount of oxygen available for plants and animals because oxygen is necessary for decomposition. However, bacteria can also make its way into waterways via septic effluent, faulty wastewater infrastructure that mixes with stormwater, and pet waste. Two types of bacteria found in the human digestive track are collected on a monthly basis by the County- *Escherichia coli* (known as *E. coli*) and *Enterococcus.* Typically, *E. coli* is regarded as an indicator of bacteria in fresh water (i.e., canals) and *Enterococcus* is used as an indicator in estuarine or marine waters.

Nutrients

The annual geometric mean for each indicator within each geographic nutrient region was calculated and compared to its corresponding value as identified in Table 1 to determine its Likert score. The Likert scores for the indicators were translated into three categories representing good conditions (green), bad conditions (red), and fair conditions (yellow) as follows (Table 1; Figures 10-12). Likert scale values were determined by comparing the annual geometric mean, calculated for each of the nutrient indicators (nitrogen, phosphorus, and chlorophyll-a), to the "long-term limit" and "upper limit" established by Briceño et al. "Good" conditions were determined on the Likert scale when the mean either exceeded the 25th percentile of the County's 1996-2004 data (i.e., the lowest nutrient values observed during the "ecologically ideal" range of time per Briceño et al) or fell between the "long-term limit" and 25th percentile. "Fair" conditions were determined to be those parameters with an annual geometric mean that fell between the “long-term limit” to 80% of the “upper limit” threshold. “Poor” conditions were determined to be those parameters with annual geometric means that fell between 80% of the “upper limit” to the “upper limit” threshold as well as any means that exceeded the “upper limit”.

It is noted that Chlorophyll-a is collected at the mouth of the canals, where the canal meets Biscayne Bay. Chlorophyll-a values from the mouths of canals were calculated as part of parameters collected in Biscayne Bay proper and included in the Biscayne Bay Report Card score and not included in the canal nutrient parameter score. Chlorophyll-a is not collected historically in Oleta River, Wagner Creek, or Goulds Canal, and therefore is not depicted on the Chlorophyll-a map. Also, total nitrogen is not collected by the County at Black Creek and Princeton Canal and was therefore not included in the analysis. Total nitrogen is collected at these locations by the South Florida Water Management District; analysis of methodology, minimum detection levels, and other factors will conducted to determine if and how to incorporate this data in future iterations of the report card.

Table 1. Nutrient Score Criteria used to derive the stoplight score. Likert scale values were derived into quarter percentiles based on Long-Term and Upper-Limit values established by Briceño et al.

Range Criteria for the Nutrient Annual Geometric Mean (AGM)	**Score**	**Stoplight Score**
< 25th percentile of County data representative of ecologically healthy conditions between 1996-2004	**5**	**Green**
25th percentile to Long-Term Limit	**4**	**Green**
Long-Term Limit to (0.8 * Upper Limit)	**3**	**Yellow**
(0.8 * Upper Limit) to Upper Limit	**2**	**Red**
> Upper Limit	**1**	**Red**

Figure 10. Total Phosphorus Score, indicating poor conditions in several canals and northernmost basins.

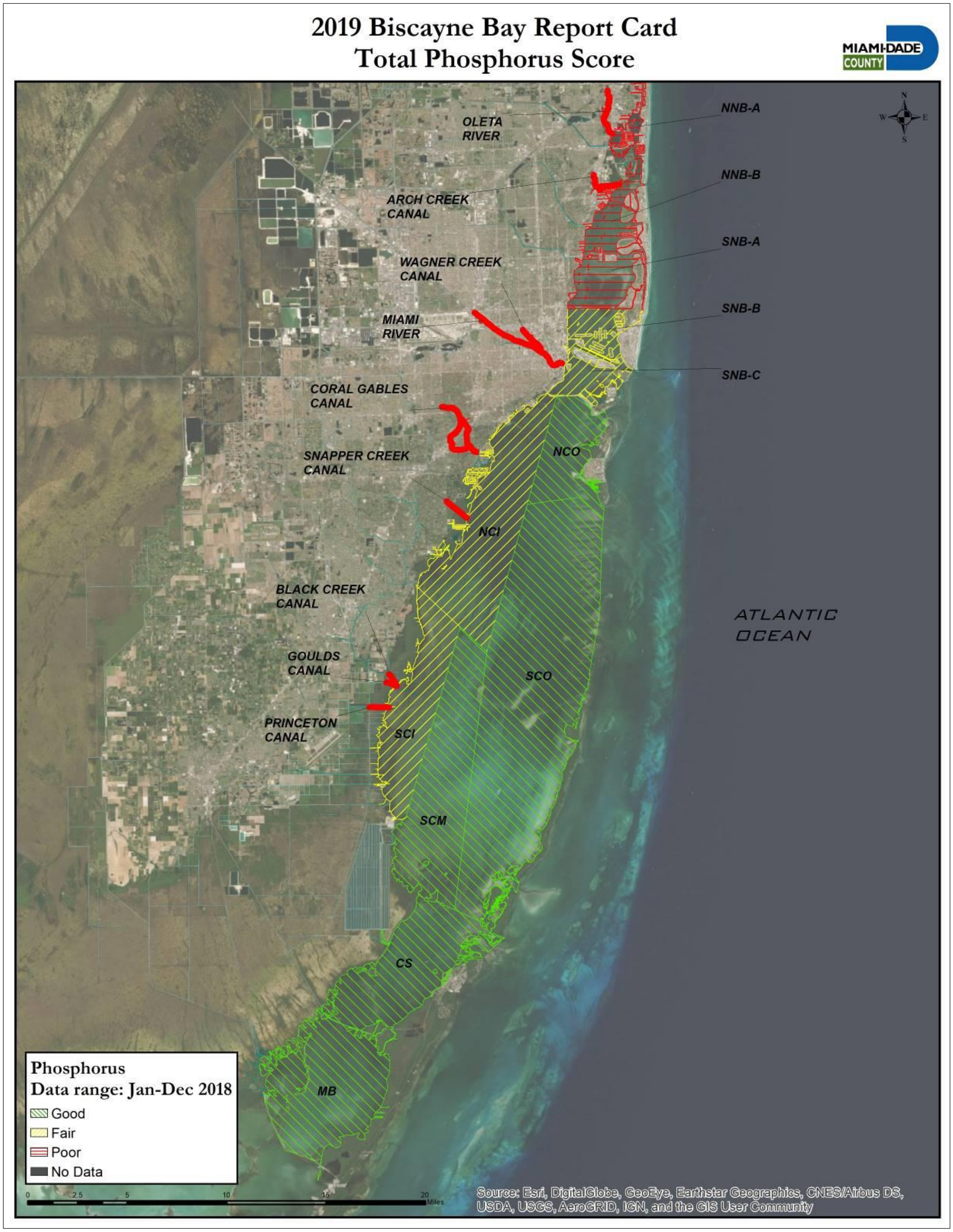


Figure 11. Total Nitrogen Score, indicating poor scores in most nearshore regions and tributaries and fair conditions in northern Biscayne Bay and to the east in central Biscayne Bay.

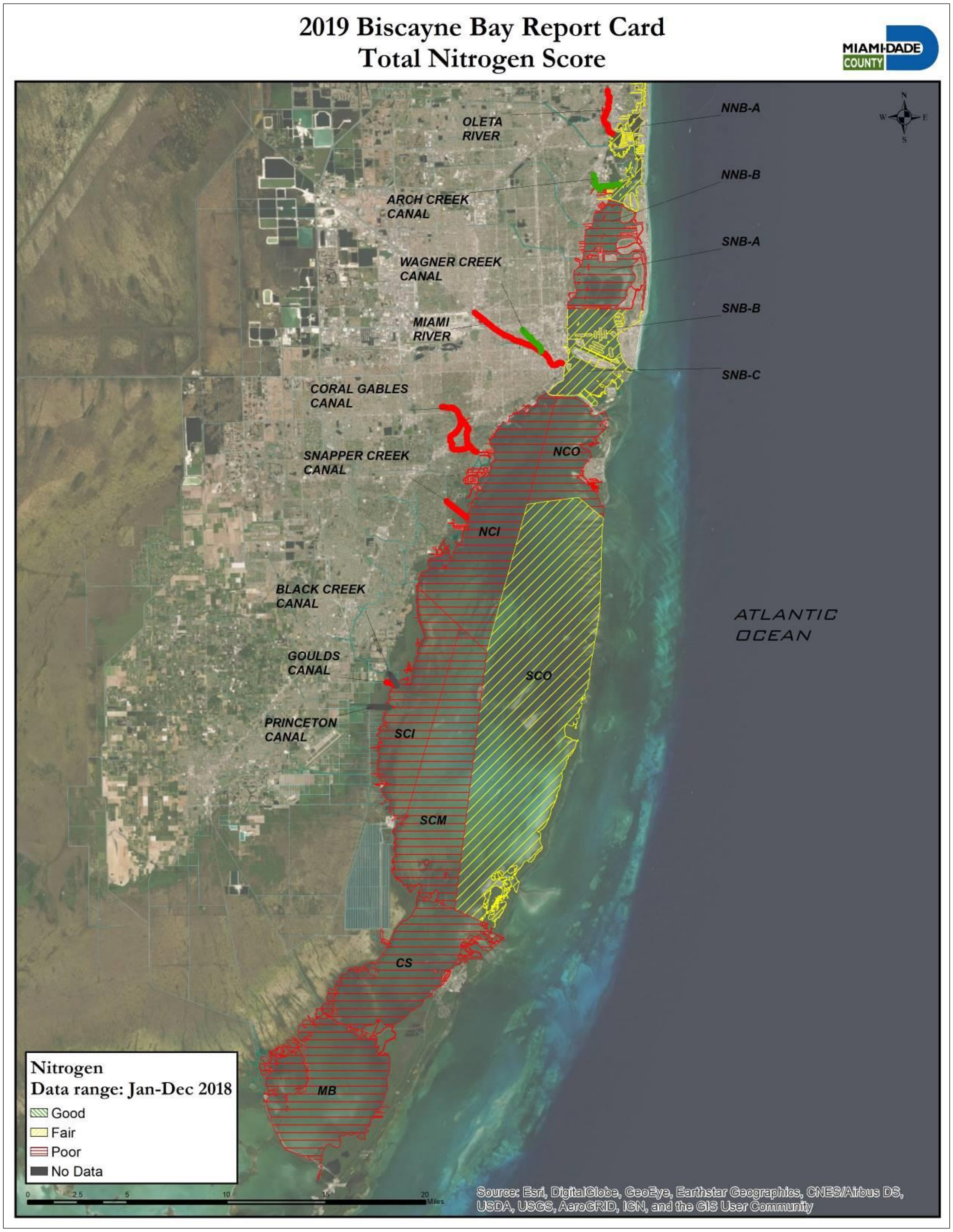
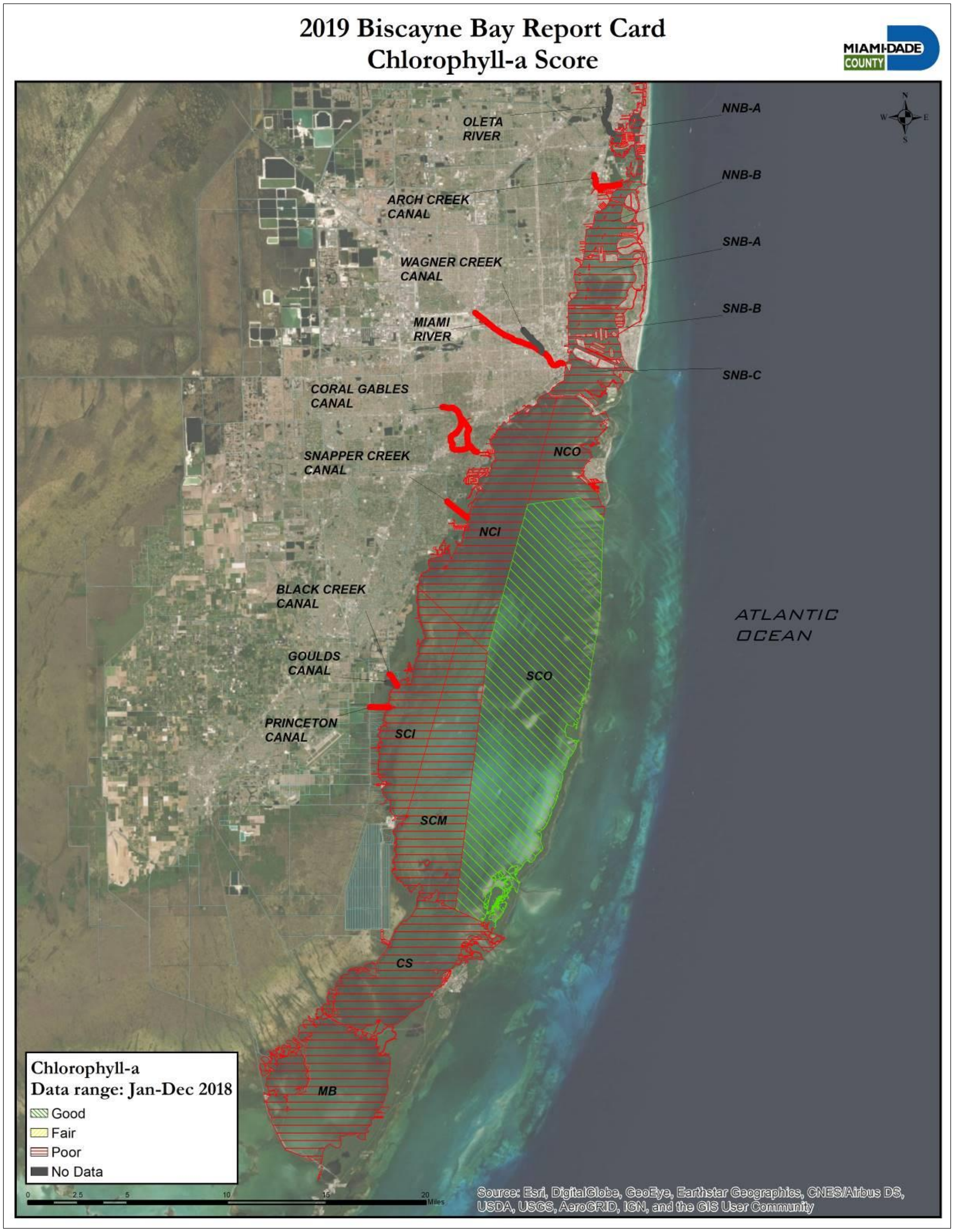


Figure 12. Chlorophyll-a Score, indicating poor conditions in all northern and nearshore regions in Biscayne Bay, with fair conditions in Manatee Bay and good conditions to the east in central Biscayne Bay.



Water Clarity

Water clarity, a measure of how cloudy the water column is, affects light penetration which can negatively impact submerged aquatic vegetation by reducing the amount of light available for photosynthesis and could result in sedimentation of natural resources. The measure of water clarity is subject to several factors in the water column including suspended particles, photosynthetic organisms (i.e., plankton), and other components which can block light. Turbidity was used in the Biscayne Bay Report Card as a measure of water clarity because Total Suspended Solids (TSS) is only collected quarterly and not at all monitoring stations within Biscayne Bay, whereas Turbidity is collected monthly at all monitoring locations. The state's criterion for Turbidity requires that values not exceed background conditions for a particular water body. To establish background for water clarity, the annual geometric mean was calculated using the County's data for the "ecologically healthy" 1996-2004 period consistent with other the methodology established by Briceño et al. Deviations from the baseline in 10, 20, or 30 percent increments, respectively were used to calculate report card scores (Tables 2-3; Figure 13).

Table 2. Water Clarity Score Criteria

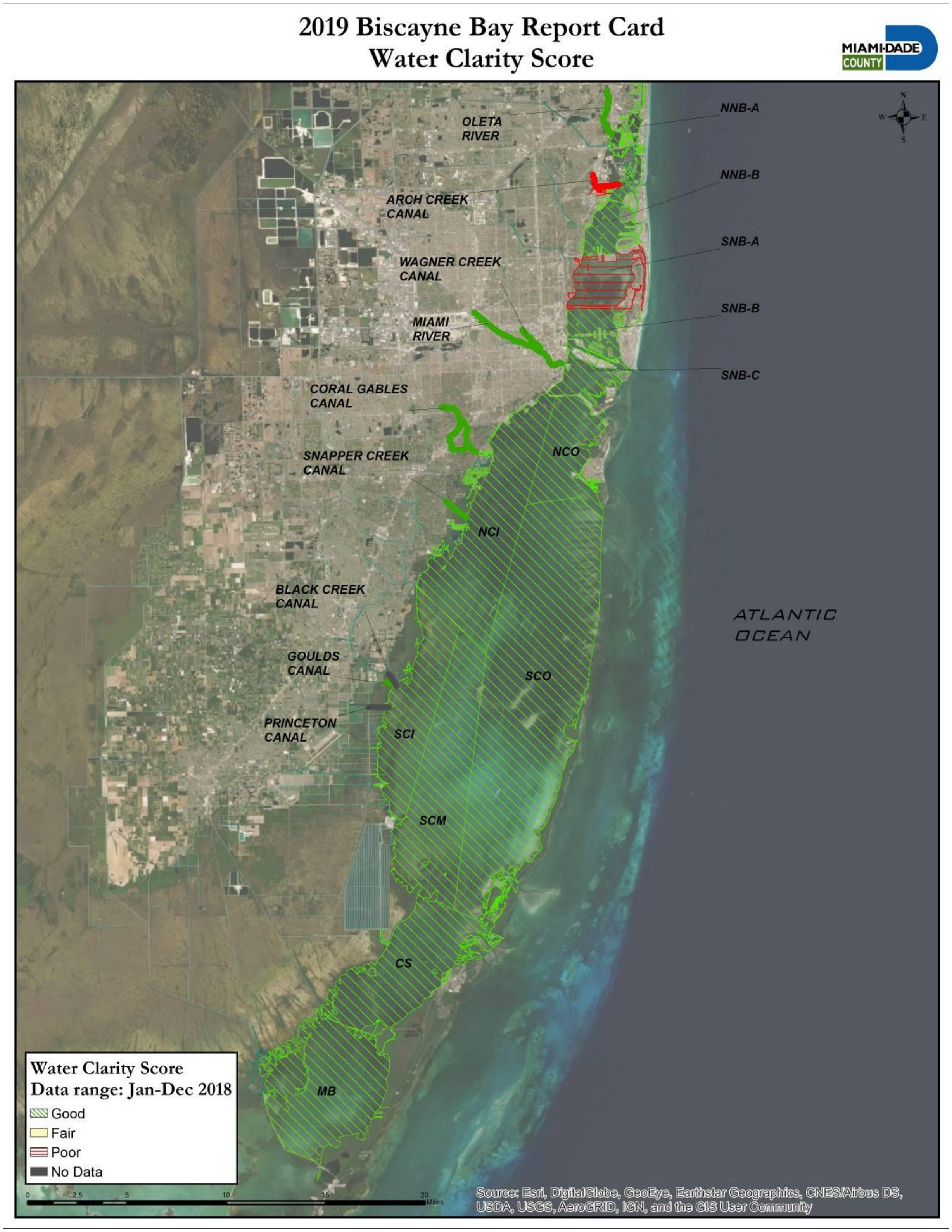
Range Criteria for the Turbidity Annual Geometric Mean (AGM)	**Score**	**Stoplight Score**
< Baseline	**5**	**Green**
Baseline to 10% above Baseline	**4**	**Green***
10% above Baseline to 20% above Baseline	**3**	**Yellow**
20% above Baseline to 30% above Baseline	**2**	**Red**
> 30% above Baseline	**1**	**Red**

Table 3. Water Clarity analysis used to derive stoplight score

Scorecard Region	**Baseline Value (96-04 Geometric Mean)**	**Annual Sample number**	**Annual Geometric Mean**	**Difference**	**Percent Difference**	**Stoplight Score**
Arch Creek - AC	1.3	35	2.1	0.8	65.2	1
Black Creek - BL	1.4	-	-	-	-	-
Coral Gables Waterway - CG	0.7	17	0.5	-0.2	-28.8	5
Card Sound - CS	0.5	34	0.5	-0.1	-12.7	5
Gould's Canal - GL	2.5	12	1.2	-1.3	-51.1	5
Manatee Bay - MB	0.8	24	0.6	-0.2	-21	5

Scorecard Region	Baseline Value (96-04 Geometric Mean)	Annual Sample number	Annual Geometric Mean	Difference	Percent Difference	Stoplight Score
Miami River - MR	1.7	48	0.9	-0.7	-43.9	5
North Central Inshore - NCI	0.6	36	0.5	-0.1	-10.9	5
North Central Offshore - NCO	1.2	12	0.6	-0.5	-47	5
Northern North Bay NNB-A	1.3	24	0.8	-0.5	-39.6	5
NNB-B	1.3	56	1	-0.4	-27.2	5
Oleta River - OL	2.2	12	2.1	-0.1	-5.9	5
Princeton Canal - PR	1.2	-	-	-	-	-
South Central Inshore - SCI	0.8	24	0.6	-0.3	-33.4	5
South Central Mid-Bay - SCM	0.7	24	0.5	-0.1	-18	5
South Central Offshore - SCO	0.8	24	0.5	-0.3	-35.7	5
Southern North Bay - SNB-A	1.4	66	1.8	0.4	29.3	2
SNB-B	1.5	44	1.3	-0.1	-7.3	5
SNB-C	1.2	24	0.9	-0.3	-26.8	5
Snapper Creek - SP	1	12	0.8	-0.2	-19.3	5
Wagner Creek - WC	1.8	34	1.8	0	0	5

Figure 13. Water Clarity Score, indicating poor conditions in Arch Creek and northern Biscayne Bay.



Bacteria

The Annual Geometric Mean (AGM) for *E. coli* and/or *Enterococci* was calculated for each of the regions and compared to the state's bacteriological standard (E. coli: 126 MPN/100 ml; Enterococci: 35 MPN/100 ml). The five categories of Likert scale scores were established by comparing the annual geometric mean derived from the County's data against how much higher or lower the mean is compared to the state standard (35 MPN/100ml for Enterococcus in marine waters or 126 MPN/l00ml for E.coli in freshwater). "Poor" conditions (Red) represent an annual geometric mean that ranges from greater than double the state standard to meeting the state criterion. "Fair" conditions (Yellow) represent an annual geometric mean that ranges from 80% of the state criterion to the criterion. "Good" conditions (Green) generally represent means less than 80% of the state criterion (Tables 4-5; Figures 14 - 15).

Table 4. Bacteria Score Criteria

AGM relative to Criterion	E. Coli (Criterion = 126 cfu/100ml)	Enterococci (criterion = 35 cfu/100ml)	Stoplight score
> 200% of Criterion *(Criterion x 2)*	> 252	>70	1
2 x Criterion to Criterion	126-252	35-70	2
80% of Criterion *(Criterion x 0.8)* to Criterion	100.8-125	28-35	3
60% of Criterion *(Criterion x 0.6)* to 80% of Criterion (Criterion x 0.8	75.6-100.8	21-28	4
< 60% of Criterion *(Criterion x 0.6)*	< 75.6	< 21	5

Table 5. Bacteria (Enterococci) analysis used to derive stoplight score

Parameter	Region	Annual Geometric Mean	Criterion	Stoplight Score
Enterococci	Arch Creek	138.2	35	1
Enterococci	Black Creek	23.1	35	4
Enterococci	Coral Gables Canal	21.8	35	4
Enterococci	Card Sound	10	35	5
Enterococci	Goulds Canal	31.4	35	3
Enterococci	Miami River	73.9	35	1
Enterococci	North Central Inshore	12.7	35	5
Enterococci	North Central Offshore	10	35	5
Enterococci	Northern North Bay (NNB)-A	13.5	35	5
Enterococci	NNB-B	15.4	35	5
Enterococci	Oleta River	150.8	35	1

Enterococci	Princeton Canal	16.9	35	5
Enterococci	South Central Inshore	10.9	35	5
Enterococci	South Central Mid-Bay	10	35	5
Enterococci	South Central Offshore	10	35	5
Enterococci	Southern North Bay-A	26.5	35	4
Enterococci	SNB-B	21.7	35	4
Enterococci	SNB-C	14.2	35	5
Enterococci	Snapper Creek	69.6	35	2
Enterococci	Wagner Creek	753.6	35	**1**

Figure 14. Bacteriological Score for *Escherichia coli* (*E.coli*), indicating poor conditions in some northern and central tributaries. (NOTE: *E.coli* is currently only collected in tributaries, not in the open Bay. Enterococcus is collected in tributaries and the open Bay as the preferred bacteriological indicator in marine waters.

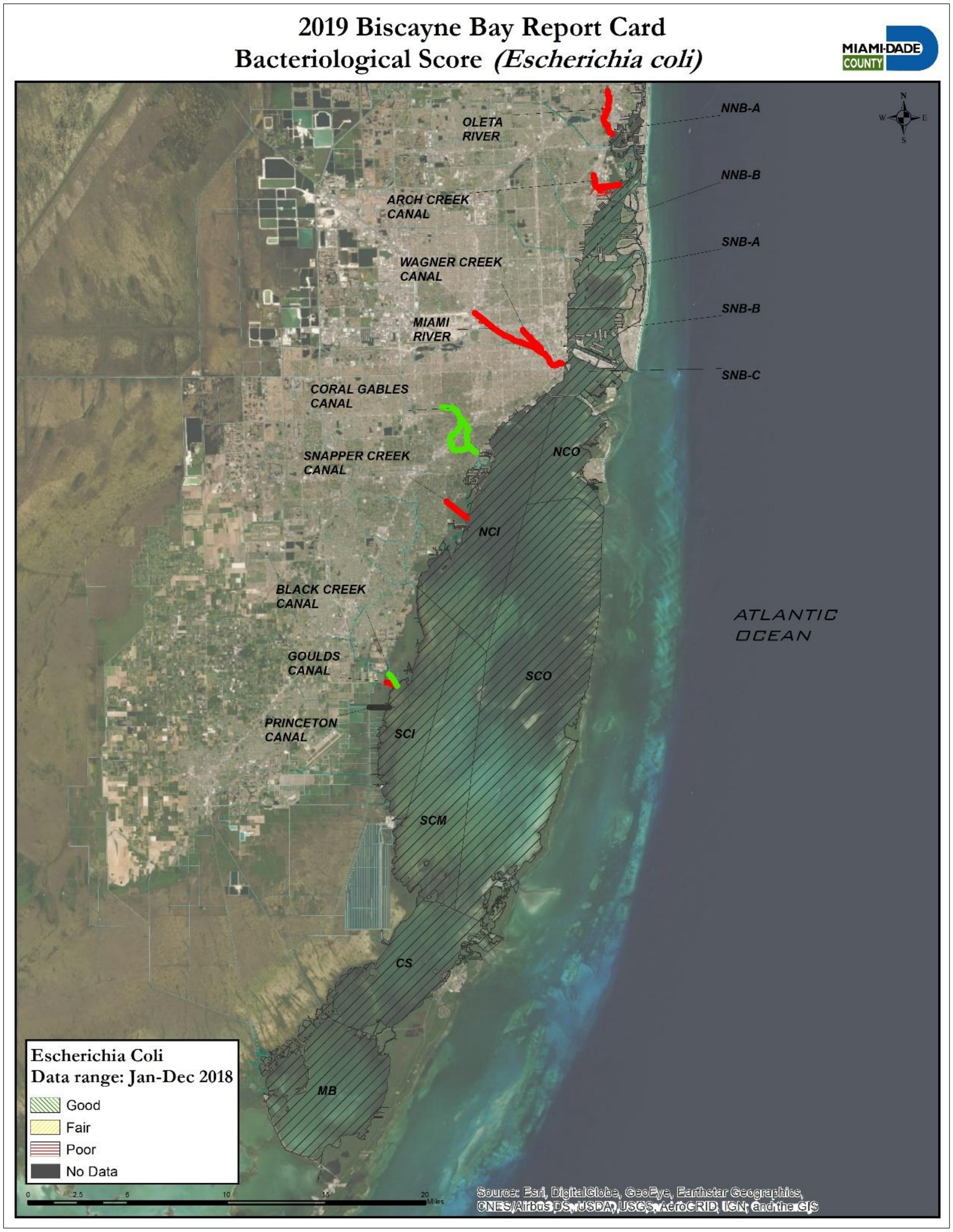
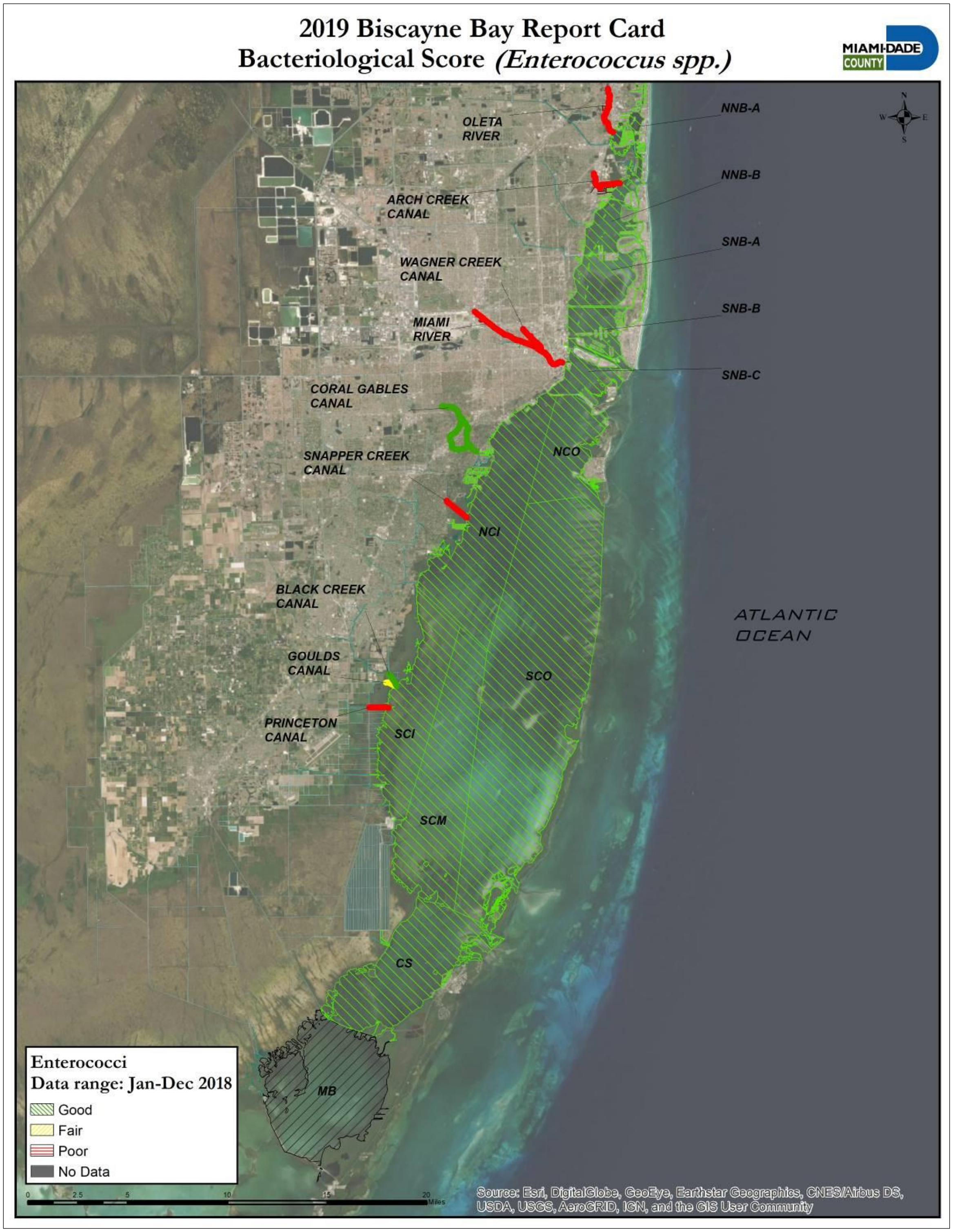


Figure 15. Bacteriological Score for Enterococci (a complex of *Enterococcus* species), indicating poor conditions in some northern and central tributaries, with no data collected in Manatee Bay.



Combined Water Quality

To calculate the Water Quality Combined Score, all water quality parameters (phosphorus, nitrogen, chlorophyll-a, water clarity, and bacteria) were combined into an overall score by averaging the Likert values (Table 6, Figure 16).

Table 6. Water Quality Combined Score and Biscayne Bay Report Card Range Criteria

Range Criteria for Biscayne Bay Report Card and Combined Water Quality Score	Score	Stoplight Score
>4.5	**5**	**Green**
3.51-4.5	**4**	**Green**
2.51-3.5	**3**	**Yellow**
1.51-2.5	**2**	**Red**
<1.5	**1**	**Red**

Figure 16. The Combined Water Quality Score, a graphic representation of only water quality indicators bay-wide, indicates poor water quality conditions in several canals and the Julia Tuttle Basin. Generally, scores for phosphorus, nitrogen, and chlorophyll-a tend to be fair to poor along the coastline.

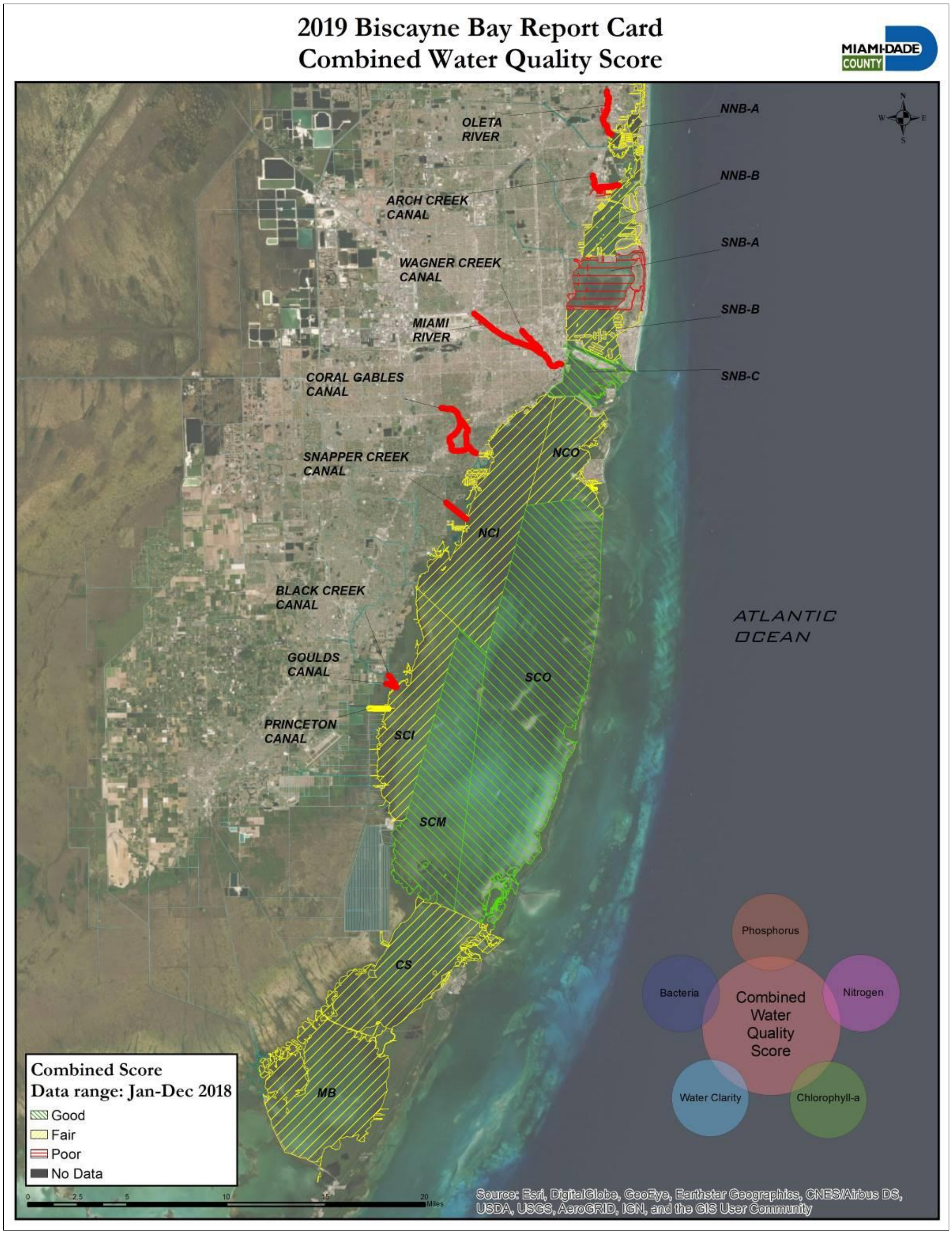


Table 7. Biscayne Bay Report Card analysis used to derive stoplight score

		Criteria established in literature or rule			Values calculated from DERM data				
PARAMETER	**Report Card Region**	**Long Term Limit**	**Upper Limit**	**Bacteria State Criterion**	**25th percentile**	**0.8 x Upper Limit**	**Geometric Mean**	**Water Clarity Baseline (Based on '96-'04 data)**	**Stoplight SCORE**
Chlorophyll-A	Arch Creek (AC)	1.05	1.65		0.68	1.32	2.714	-	1
Enterococci	AC		-	35			138.177	-	1
Total Phosphorus	AC	0.004	0.009		0.007	0.007	0.033	-	1
Total Nitrogen	AC	0.135	0.38		1.74	0.304	0.645	-	5
Water Clarity	AC	-	-				2.07	1.25	1
									1.8
Chlorophyll-A	Black Creek (BL)*	0.26	0.43		0.21	0.344	1.222	-	1
Enterococci	BL		-	35			23.088	-	4
Total Phosphorus	BL	0.004	0.009		0.006	0.007	0.008	-	2
Water Clarity	BL	-	-				-	-	-
* No MDC data for Total Nitrogen or water clarity for period of record; collected by SFWMD									2.3
Chlorophyll-A	Coral Gables (CG)	0.31	0.57		0.21	0.456	1.419	-	1
Enterococci	CG		-	35			21.788	-	4
Total Phosphorus	CG	0.004	0.009		0.005	0.007	0.020	-	1
Total Nitrogen	CG	0.135	0.38		0.203	0.304	0.575	-	1
Water Clarity	CG	-	-				0.53	0.74	5
									2.4
Chlorophyll-A	Card Sound (CS)	0.26	0.29		0.22	0.232	0.526	-	1
Enterococci	CS		-	35			10	-	5
Invertebrates	CS	-	-				-	-	3
Total Phosphorus	CS	0.004	0.009		0.001	0.007	0.003	-	4
SAV	CS	-	-				-	-	3
Total Nitrogen	CS	0.135	0.38		0.204	0.304	0.307	-	2
Water Clarity	CS						0.46	0.52	5
									3.3
Enterococci	Goulds Canal (GL)**			35			31.380		3
Total Phosphorus	GL	0.004	0.009		0.01	0.007	0.015		1
Total Nitrogen	GL	0.135	0.38		0.318	0.304	1.173		1
Water Clarity	GL						1.23	2.53	5
**No MDC data for Chlorophyll-a for period of record									2.5
Chlorophyll-A	Manatee Bay (MB)***	0.53	0.35		0.24	0.28	0.722	-	1
Invertebrates	MB	-	-				-	-	1
Total Phosphorus	MB	0.004	0.009		0.002	0.007	0.004	-	4
SAV	MB							-	3
Total Nitrogen	MB	0.135	0.38		0.366	0.304	0.569		1
Water Clarity	MB						0.61	0.77	5
***No MDC data, Bacteria not collected in this region									2.5
Chlorophyll-A	Miami River (MR)	1.05	1.65		0.42	1.32	1.396		2
Enterococci	MR			35			73.9		1
Total Phosphorus	MR	0.004	0.009		0.009	0.007	0.011		1
Total Nitrogen	MR	0.135	0.38		0.191	0.304	0.694		1
Water Clarity	MR						0.94	1.68	5
									2.0
Chlorophyll-A	North Central Inshore (NCI)	0.31	0.57		0.28	0.456	0.659		1
Enterococci	NCI			35			12.747		5
Invertebrates	NCI								3
Total Phosphorus	NCI	0.004	0.009		0.002	0.007	0.005		3
SAV	NCI								3
Total Nitrogen	NCI	0.135	0.38		0.203	0.304	0.383		1
Water Clarity	NCI						0.54	0.6	5
									3.0

Table 7. Biscayne Bay Report Card analysis used to derive stoplight score, Con't

		Criteria established in literature or rule			Values calculated from DERM data				
PARAMETER	**Report Card Region**	**Long Term Limit**	**Upper Limit**	**Bacteria State Criterion**	**25th percentile**	**0.8 x Upper Limit**	**Geometric Mean**	**Water Clarity Baseline (Based on '96-'04 data)**	**Stoplight SCORE**
Chlorophyll-A	North Central Offshore (NCO)	0.31	0.57		0.28	0.456	0.712		1
Enterococci	NCO			35			10		5
Invertebrates	NCO								2
Total Phosphorus	NCO	0.004	0.009		0.002	0.007	0.003		4
SAV	NCO								3
Total Nitrogen	NCO	0.135	0.38		0.182	0.304	0.353		2
Water Clarity	NCO						0.62	1.17	5
									3.1
Chlorophyll-A	Northern North Bay (NNB)-A	1.05	1.65		2.15	1.32	2.918		1
Enterococci	NNB-A	35		35			15.412		5
Invertebrates	NNB-A								5
Total Phosphorus	NNB-A	0.004	0.009		0.005	0.007	0.012		1
SAV	NNB-A								2
Total Nitrogen	NNB-A	0.135	0.38		0.187	0.304	0.376		2
Water Clarity	NNB-A						0.76	1.26	5
									3
Chlorophyll-A	NNB-B	1.05	1.65		0.93	1.32	1.578		2
Invertebrates	NNB-B								5
Total Phosphorus	NNB-B	0.004	0.009		0.003	0.007	0.008		2
SAV	NNB-B								3
Total Nitrogen	NNB-B	0.135	0.38		0.187	0.304	0.276		3
Water Clarity	NNB-B						0.96	1.32	5
									3.3
Enterococci	Oleta River (OL)**		-	35			150.8	-	1
Total Phosphorus	OL	0.004	0.009		0.035	0.007	0.0354	-	1
Total Nitrogen	OL	0.135	0.38		0.64	0.304	0.718	-	1
Water Clarity	OL	-	-				2.11	2.24	5
**No MDC data for Chlorophyll-a for period of record									2

Table 7. Biscayne Bay Report Card analysis used to derive stoplight score, Con't

		Criteria established in literature or rule			Values calculated from DERM data				
PARAMETER	Report Card Region	Long Term Limit	Upper Limit	Bacteria State Criterion	25th percentile	0.8 x Upper Limit	Geometric Mean	Water Clarity Baseline (Based on '96-'04 data)	Stoplight SCORE
Chlorophyll-A	Princeton Canal (PR)*	0.26	0.43		0.36	0.344	0.930	-	1
Enterococci	PR		-	35			16.922	-	5
Total Phosphorus	PR	0.004	0.009		0.004	0.007	0.008	-	2
Water Clarity	PR	-	-				-	-	-
* No MDC data for Total Nitrogen or water clarity for period of record; collected by SFWMD									2.7
Chlorophyll-A	South Central Inshore (SCI)	0.26	0.43		0.25	0.344	0.491	-	1
Enterococci	SCI		-	35			10.916	-	5
Invertebrates	SCI		-						1
Total Phosphorus	SCI	0.004	0.009		0.003	0.007	0.005		3
SAV	SCI								3
Total Nitrogen	SCI	0.135	0.38		0.318	0.304	0.476		1
Water Clarity	SCI						0.55	0.83	5
									2.7
Chlorophyll-A	South Central Mid-Bay (SCM)	0.26	0.43		0.19	0.344	0.426		2
Enterococci	SCM	35		35			10		5
Invertebrates	SCM								4
Total Phosphorus	SCM	0.004	0.009		0.001	0.007	0.003		4
SAV	SCM								4
Total Nitrogen	SCM	0.135	0.38		0.232	0.304	0.335		2
Water Clarity	SCM						0.54	0.66	5
									3.7
Chlorophyll-A	South Central Offshore (SCO)	0.26	0.43		0.16	0.344	0.245		4
Enterococci	SCO	35		35			10		5
Invertebrates	SCO								4
Total Phosphorus	SCO	0.004	0.009		0.001	0.007	0.003		4
SAV	SCO								5
Total Nitrogen	SCO	0.135	0.38		0.158	0.304	0.197		3
Water Clarity	SCO						0.48	0.75	5
									4.3

Table 7. Biscayne Bay Report Card analysis used to derive stoplight score, Con't.

PARAMETER	Report Card Region	Criteria established in literature or rule: Long Term Limit	Upper Limit	Bacteria State Criterion	Values calculated from DERM data: 25th percentile	0.8 x Upper Limit	Geometric Mean	Water Clarity Baseline (Based on '96-'04 data)	Stoplight SCORE
Chlorophyll-A	Southern North Bay (SNB)-A	1.05	1.65		0.27	1.32	1.973		1
Enterococci	SNB-A	35		35			26.485		4
Invertebrates	SNB-A								1
Total Phosphorus	SNB-A	0.004	0.009		0.004	0.007	0.012		1
SAV	SNB-A								1
Total Nitrogen	SNB-A	0.135	0.38		0.187	0.304	0.394		1
Water Clarity	SNB-A						1.83	1.41	2
									1.6
Chlorophyll-A	SNB-B	1.05	1.65		0.69	1.32	1.629		2
Enterococci	SNB-B	35		35			21.749		4
Invertebrates	SNB-B								1
Total Phosphorus	SNB-B	0.004	0.009		0.003	0.007	0.007	-	3
SAV	SNB-B								1
Total Nitrogen	SNB-B	0.135	0.38		0.191	0.304	0.277	-	3
Water Clarity	SNB-B	-	-				1.34	1.45	5
									2.7
Chlorophyll-A	SNB-C	1.05	1.65		0.42	1.32	1.380		2
Enterococci	SNB-C	35		35			14.216		5
Invertebrates	SNB-C								3
Total Phosphorus	SNB-C	0.004	0.009		0.003	0.007	0.005		3
SAV	SNB-C								1
Total Nitrogen	SNB-C	0.135	0.38		0.191	0.304	0.256		3
Water Clarity (Turb)	SNB-C						0.90	1.23	5
									3.1
Chlorophyll-A	Snapper Creek (SP)	0.31	0.57		0.54	0.456	1.235	-	1
Enterococci	SP	35		35			69.576	-	2
Total Phosphorus	SP	0.004	0.009		0.004	0.007	0.010	-	1
Total Nitrogen	SP	0.135	0.38		0.203	0.304	0.619	-	1
Water Clarity	SP	-	-				0.83	1.03	5
									2.0

PARAMETER	Report Card Region	Criteria established in literature or rule: Long Term Limit	Upper Limit	Bacteria State Criterion	Values calculated from DERM data: 25th percentile	0.8 x Upper Limit	Geometric Mean	Water Clarity Baseline (Based on '96-'04 data)	Stoplight SCORE
Enterococci	Wagner Creek (WC)**	35	-	35			753.610	-	1
Total Phosphorus	WC	0.004	0.009		0.039	0.007	0.056	-	1
Total Nitrogen	WC	0.135	0.38		0.68	0.304	0.617	-	1
Water Clarity	WC	-	-				1.80	1.75	4
**No MDC data for Chlorophyll-a for period of record									1.8

Habitat Quality Indicators

The following habitat quality indicators are evaluated in the Biscayne Bay Report Card:

- **Seagrasses and macroalgae communities** can be found throughout Biscayne Bay. Not only do seagrasses cycle nutrients out of the water column and sediment, they also trap sediment in their root systems, helping to prevent turbidity and erosion. These natural ecosystem services help to stabilize shorelines and reduce wave energy from storms. As plants, seagrasses oxygenate the water column, and they provide habitat, shelter, and food for protected species as well as commercially and recreationally important species of fish and invertebrates, like crabs and lobster. Seagrasses also have the capacity to store carbon dioxide in their tissues and root systems for several decades, making them even more effective at carbon sequestration than terrestrial forests. Macroalgae are also effective at trapping sediments in the water column. The County is currently assessing whether areas of seagrass die-off may experience recovery due in part to an increase in calcareous green macroalgae that are helping to reduce turbidity, and possibly establishing conditions conducive to seagrass growth.

- **Sponges** also provide important ecosystem services, such as providing habitat and a food source. One of the oldest groups of animals on earth, sponges grow attached to substrate and constantly filter water through their pores, making them useful indicators of water quality health. While not all substrate and ecological conditions are suitable for sponges, those areas where they have been documented over time in Biscayne Bay are surveyed as part of the County's habitat monitoring program.

Indicators of habitat quality used in the Biscayne Bay Report Card include seagrass and macroalgae abundance as well as frequency of marine sponges. While seagrass beds, macroalgae communities, and hardbottom habitat that includes sponges vary in location throughout the bay, they each play a unique ecological role. Seagrass and macroalgae habitat scores are combined in the Biscayne Bay Report Card and are together regarded as "submerged aquatic vegetation" or SAV.

Seagrass and Macroalgae (Submerged Aquatic Vegetation)

Annual data collected by the County from each fixed station and stratified random polygon (Figure 6) were used to calculate score metrics on a scale of one to five, then averaged for each bay region. Data collected annually or quarterly as part of the County's Benthic Habitat Monitoring Program primarily includes Braun-Blanquet Cover Abundance collected throughout a network of random and fixed stations in Biscayne Bay. Station distribution and sampling frequency within each Region are notes in Table 8.

Table 8. Station distributions and monitoring frequency within each Nutrient Region.

REGION	NUMBER OF STATIONS	TYPE	SAMPLING FREQUENCY
Northern North Bay	2	2 Fixed	Annual
Southern North Bay	3	2 Fixed and 1 Random	Annual
North Central Inshore	13 to 19	Random	Annual
North Central Offshore	5 to 9	Random	Annual
South Central Inshore	8 to 14	Random	Annual
South Central Middle	16 to 23	Random	Annual
South Central Offshore	42 to 49	Random	Annual
Little Card Sound/Card Sound	10 to 11	Random	Annual
Manatee Bay/Barnes Sound	24	Random	Quarterly

- Stability Metric: Each sampling unit started with a base score of five. This was determined by coverage dominance over time of the main seagrass species (*Thalassia, Halodule* or *Syringodium*) or algae group (Total Green Algae or Total Drift Red Algae). A maximum score (five) was applied when the dominant seagrass or algae group maintained constant coverage/dominance (i.e., less than 25% variation) through the period of record. Between one and four points were subtracted from this maximum score when change in coverage/dominance of the dominant seagrass species was observed. These changes are referred to as *Negative Change Metrics.*

- Negative Change Metric: Between one and four points were subtracted from each fixed station and stratified random polygon based on the following criteria:
    - One point was subtracted from a maximum of five if given the following scenarios:
        - Changes in dominant seagrass species or algae group dominance during consecutive sampling years (i.e. shift from *Thalassia* dominated community to a *Syringodium* dominated community or to a Green Algae dominated community).
        - Less than 25% decrease in coverage of the dominant seagrass group from the historical maximum.
        - Less than 25% coverage of green algae or red algae since last the last sampling event

- Two points were subtracted from a maximum of five given the following scenarios:
  - Greater than 50% decrease in coverage of the dominant seagrass group from the historical maximum.
  - Greater than 25% coverage of green or red algae for two or more consecutive years or for at least four years of a 10 year period if the seagrass coverage had a concurrent reduction of 25% or more.

It is noted that for the Southern North Biscayne subregion SNB-B, the 1999-2017 regional average values from the four fixed and one random stations were used and compared with data collected in 2018 to calculate the SAV score metrics. This is due to the adsence of available quantitative data in this particular subregion prior to 2018. These metrics were evaluated by region and a stoplight score was derlived (Tables 9-10; Figure 17).

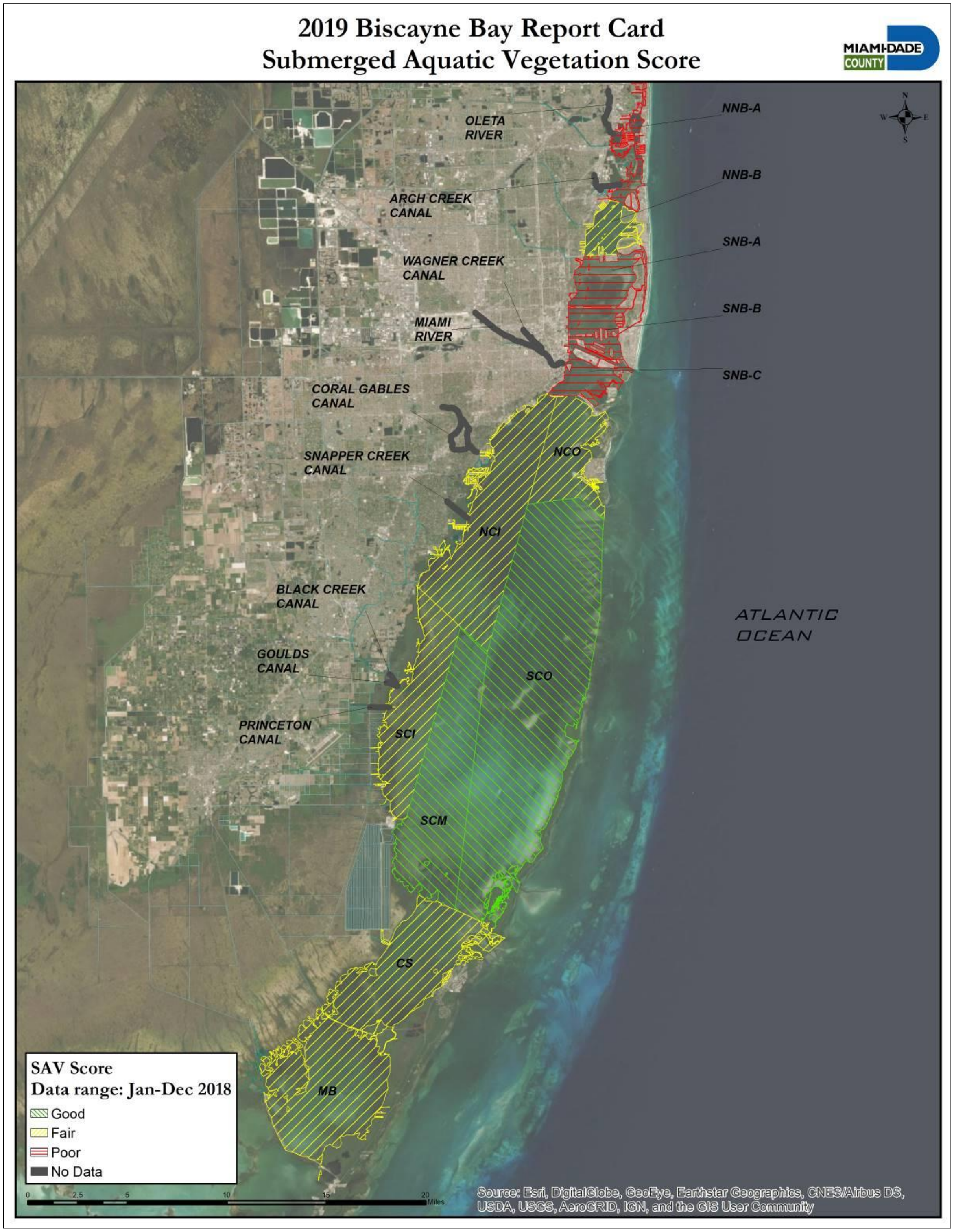
Table 9. SAV analysis used to derive the stoplight score

Nutrient Regions/Subregions	Score Average	Stoplight score
Northern North Bay (NNB-A)	**2**	**2**
Northern North Bay (NNB-B)	**3**	**3**
Southern North Bay (SNB-A)	**1**	**1**
Southern North Bay (SNB-B)	**1**	**1**
Southern North Bay (SNB-C)	**1**	**1**
North Central Inshore	**2.54**	**3**
North Central Off-Bay	**3.13**	**3**
South Central Inshore	**3.18**	**3**
South Central Mid-Bay	**3.71**	**4**
South Central Off-Bay	**4.65**	**5**
Card Sound	**3.18**	**3**
Manatee Bay-Barnes Sound	**2.92**	**3**

Table 10. Submerged Aquatic Vegetation (SAV) Range Criteria

Range Criteria for Submerged Aquatic Vegetation (SAV)	Score	Stoplight Score
>4.5	**5**	**Green**
3.51-4.5	**4**	**Green**
2.51-3.5	**3**	**Yellow**
1.51-2.5	**2**	**Red**
<1.5	**1**	**Red**

Figure 17. Submerged Aquatic Vegetation Score, indicating poor conditions for seagrass (i.e., low coverage) and macroalgae in northern Biscayne Bay with fair conditions in nearshore areas and good conditions in areas in areas to the east in central Biscayne Bay.


2019 Biscayne Bay Report Card
Submerged Aquatic Vegetation Score
MIAMI-DADE COUNTY
OLETA RIVER
NNB-A
NNB-B
ARCH CREEK CANAL
SNB-A
WAGNER CREEK CANAL
SNB-B
MIAMI RIVER
SNB-C
CORAL GABLES CANAL
NCO
SNAPPER CREEK CANAL
NCI
BLACK CREEK CANAL
ATLANTIC OCEAN
GOULDS CANAL
SCO
PRINCETON CANAL
SCI
SCM
CS
MB
SAV Score
Data range: Jan-Dec 2018
Good
Fair
Poor
No Data
0 2.5 5 10 15 20 Miles
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Invertebrates

Average annual frequency of invertebrates (Sponges) between 1999 and 2009 within each Biscayne Bay Nutrient Region was used as reference value to calculate the Invertebrates Indicator. Through this period, the frequency of invertebrates was high and remained relatively stable. The stoplight score per region was calculated using annual frequency and historical frequency of invertebrates (sponges) observed in each region in 2018 (Tables 11-12; Figure 18) using the following formula:

Percent Frequency Score = Current year frequency * 100/ Average frequency (1999-2009)

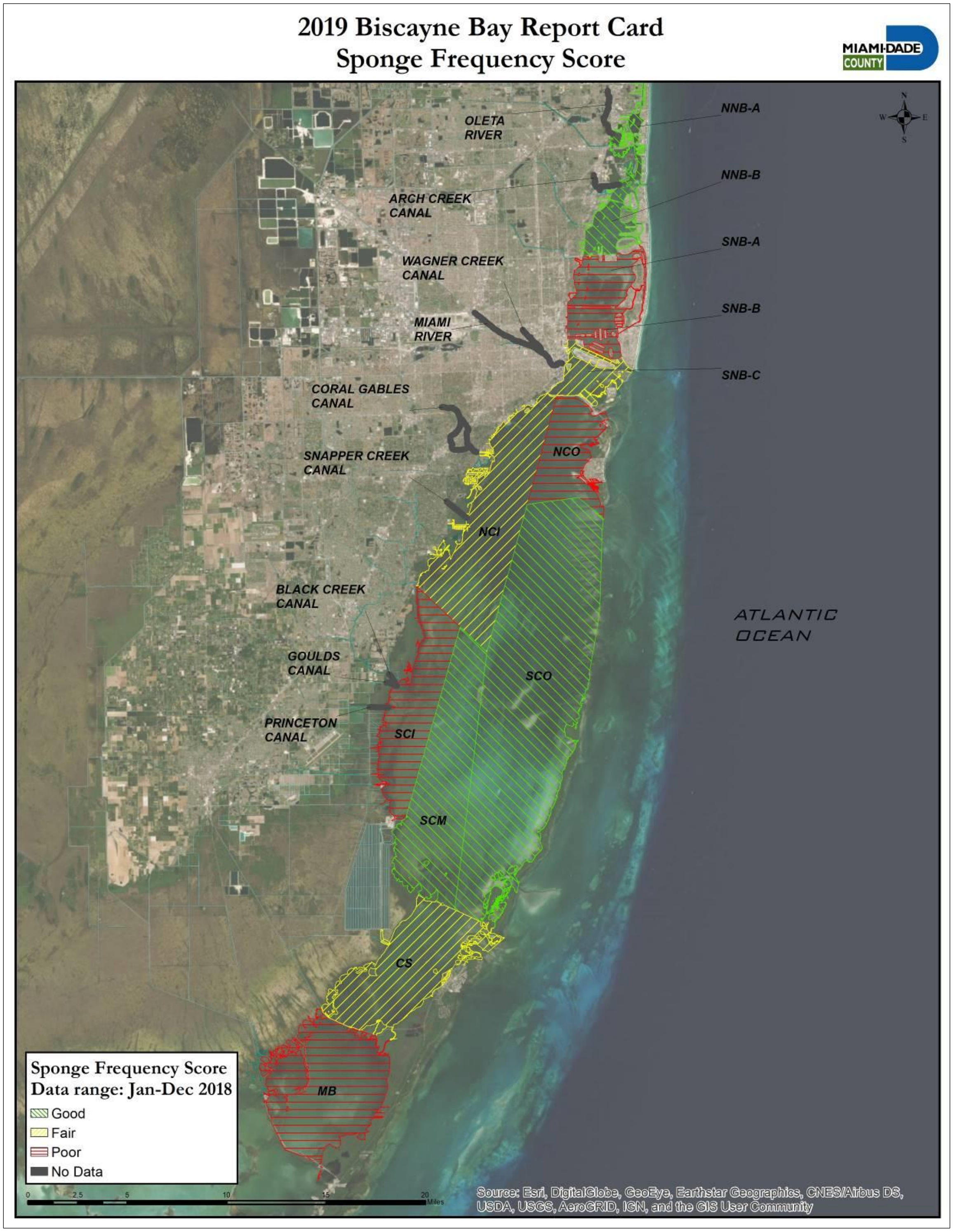
Table 11. Invertebrates (Sponges) Score per Nutrient Region in Biscayne Bay based on the percent frequency score of polygons/fixed stations within each region.

Nutrient Region	Percent Frequency Score	Stoplight Score
Northern North Bay (NNB-A)	100	5
Northern North Bay (NNB-B)	100	5
Southern North Bay (SNB-A)	0	1
Southern North Bay (SNB-B)	18.60	1
Southern North Bay (SNB-C)	49.31	3
North Central Inshore	56.83	3
North Central Off-Bay	34.93	2
South Central Inshore	10.94	1
South Central Mid-Bay	63.43	4
South Central Off-Bay	62.25	4
Card Sound	45.19	3
Manatee Bay-Barnes Sound	10.29	1

Table 12. Invertebrate (sponge) Range Criteria

Range Criteria for Invertebrate Score	Score	Stoplight Score
81% to 100%	**5**	**Green**
61% to 80%	**4**	**Green**
41% to 60%	**3**	**Yellow**
21% to 40%	**2**	**Red**
1% - 20%	**1**	**Red**

Figure 18. Sponge Frequency Score, indicating poor conditions (i.e., low frequency of sponges over time) in some central, nearshore, and southern basins, fair conditions in southern Biscayne Bay, Card Sound, and some nearshore areas and good conditions in areas to the east in central Biscayne Bay.



Fisheries Indicators

The following fisheries were evaluated in the Biscayne Bay Report Card:

- **Blue crab, Spiny lobster**, and **Pink shrimp** can spend all or part of their life cycle in Biscayne Bay. The data reported by the commercial fishers to FWC can provide insight each year into demand for these fisheries and a relative indication of how much was caught that year and value of that catch. In 2018, seagrass communities in Miami-Dade County supported nearly $3 million commercial harvest of spiny lobster, blue crab, and pink shrimp.

Fisheries values are calculated using the annual number of trips and was obtained from FWC in addition to their commercial landings data, so that catch per unit effort could be established. Three commercially and recreationally important species were selected that are known to use submerged aquatic vegetation in Biscayne Bay for all or a part of their life cycle. These species include blue crab (*Callinectes sapidus*), spiny lobster (*Panulirus argus*), and pink shrimp (*Farfantepenaeus duorarum*). The data were standardized by calculating the annual catch per trip (corresponds to catch per unit effort), which was then compared to a measure of central tendency (Geometric mean or Median) as a baseline value derived from the same period of record between 1996 and 2004 that is thought to represent good ecological conditions in Biscayne Bay. The percent change, above or below, from the baseline value determines the Likert score (1-5) presented in Table 6, including a "Critical Threshold Value" that represents 20% below the Baseline. The average Likert score for the three species was translated into three categories representing good conditions, bad conditions, and fair conditions (Table 13).

Table 13. Fisheries Score Criteria

Range Criteria for the Annual Geometric Mean (AGM)	Score	Stoplight Score
>40% above Baseline	5	Green
20% above Baseline to 40% above Baseline	4	Green
Baseline to "Target Value" (i.e. 20% above Baseline)	3	Yellow
Between Baseline and "Critical Threshold Value" (i.e. 20% Below Baseline)	2	Red
>20% below baseline	1	Red

<u>Discussion</u>

The Biscayne Bay Report Card provides an opportunity to share the overall health status of Biscayne Bay water quality, habitat quality, and fisheries values. In general, tributaries and canals in north and central Biscayne Bay are in Fair to Poor condition, while those areas further offshore tend to reflect healthier ecological conditions (Figure 1).

Water Quality

Phosphorus conditions in the northern part of the bay and northern and central tributaries are poor, indicating chronic nutrient loading issues. Nitrogen conditions are largely poor throughout the bay and its tributaries, with the other regions noted as fair.

Chlorophyll-a levels are largely noted as poor throughout most of Biscayne Bay and its tributaries. Chlorophyll-a was elevated throughout the Bay and all the nutrient regions have exceeded the State's Numeric Nutrient Criteria for Impaired Waters since the State established criteria. Values for total nitrogen were also high in several regions within the Bay, but total phosphorus—the primary ecological driver within the greater Everglades ecosystem—was relatively low throughout the Bay, except in the northernmost basins of Biscayne Bay.

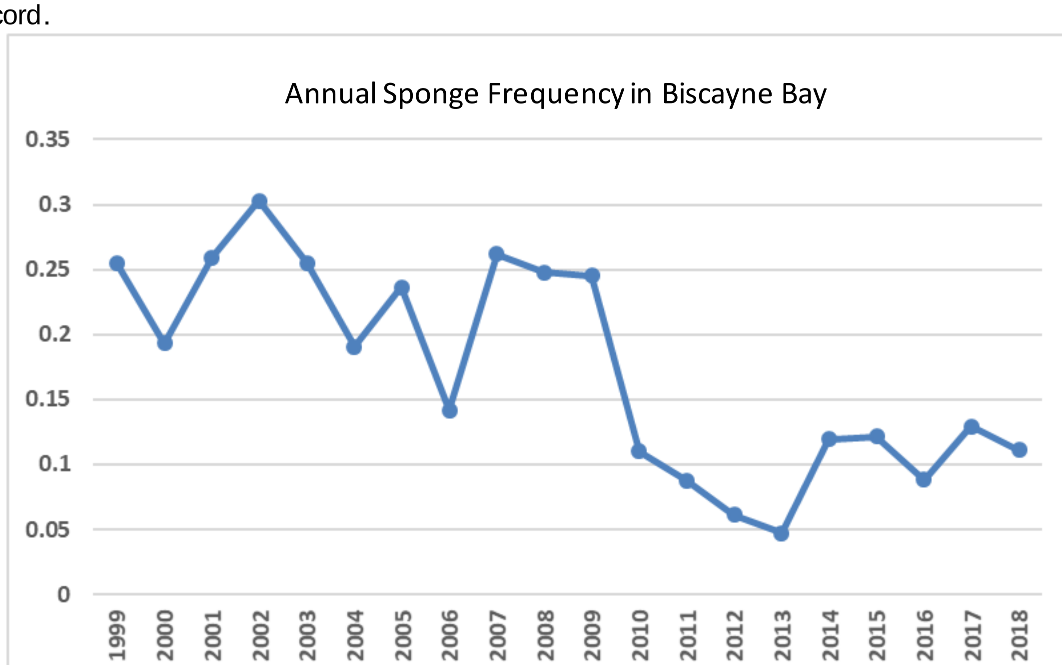
The Combined Water Quality Score, a graphic representation of only water quality indicators bay-wide, indicates poor water quality conditions in several canals and the Julia Tuttle Basin (Figure 16). Generally, scores for phosphorus, nitrogen, and chlorophyll-a tend to be fair to poor along the coastline. (Figures 10-12). Water clarity is generally good throughout the bay, with the northern part of Biscayne Bay and its canals facing considerable issues (Figure 13). Bacteria levels in canals are largely out of compliance with County and state standards (Figures 14-15).

Habitat Quality

The status of submerged aquatic vegetation is generally poor in northern Biscayne Bay as evidenced by steep declines in seagrass cover and recent mortality events. Those regions of Biscayne Bay most proximal to the shoreline are in fair condition, with reduction in seagrass overall and algal blooms occurring over the period of record (Figure 17). Habitats closest to shore in the central portion of the Bay are regarded as Fair- these areas are influenced by impacts from land uses that impact groundwater and surface water. Areas further offshore are noted as Good condition.

Sponges are present throughout Biscayne Bay including in seagrass beds, hardbottom habitat, and sandy bottoms but have been documented through the County's benthic monitoring program in particular areas where substrate to grow on is suitable. Overall, there has been a decrease in the frequency of sponges, a marine invertebrate that serves as a key indicator of water quality health as their primary function and method of taking in nourishment is through filtering water through its cells (Figures 18-19).

Figure 19. Annual sponge frequency in Biscayne Bay, indicating a decrease in frequency of observations over the period of record.



Fisheries

All three species, blue crab, spiny lobster, and pink shrimp, were above the long-term baseline harvest value in 2018, although the harvest decreased from the previous year, and Pink Shrimp harvests have declined in the past two years. Over the past ten years, blue crab catch per unit effort was generally below the established baseline whereas spiny lobster and pink shrimp catch were largely above.

Figure 20. Annual Blue Crab Percent Change from 1996-2004 Baseline. Data indicate a positive change in harvest from 2017-2018 with a decrease

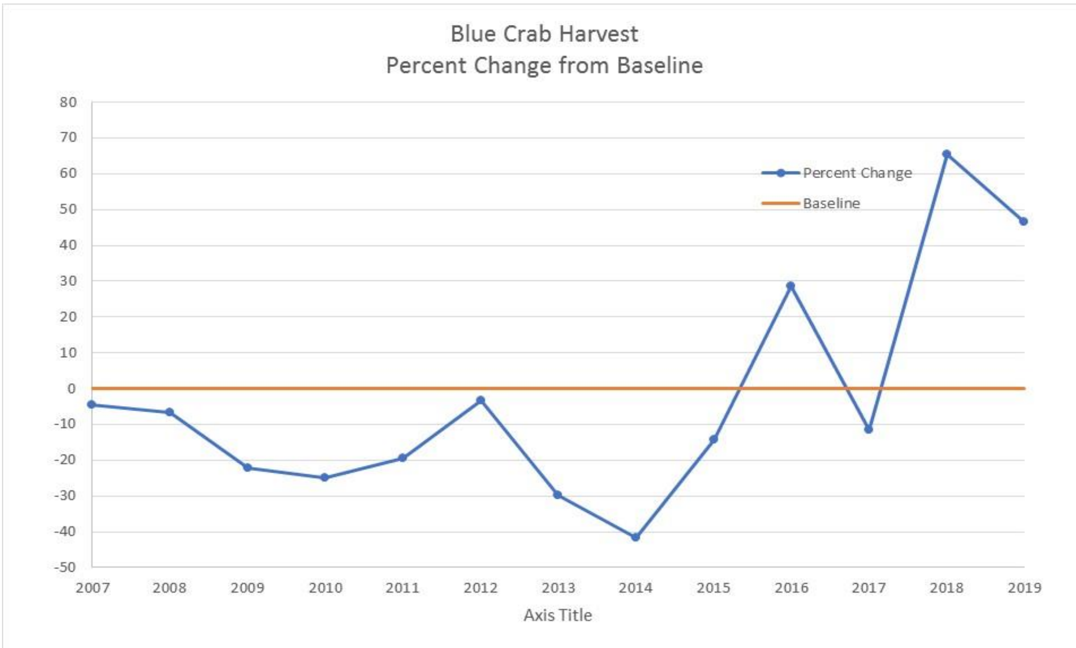


Figure 21. Annual Spiny Lobster Percent Change from 1996-2004 Baseline

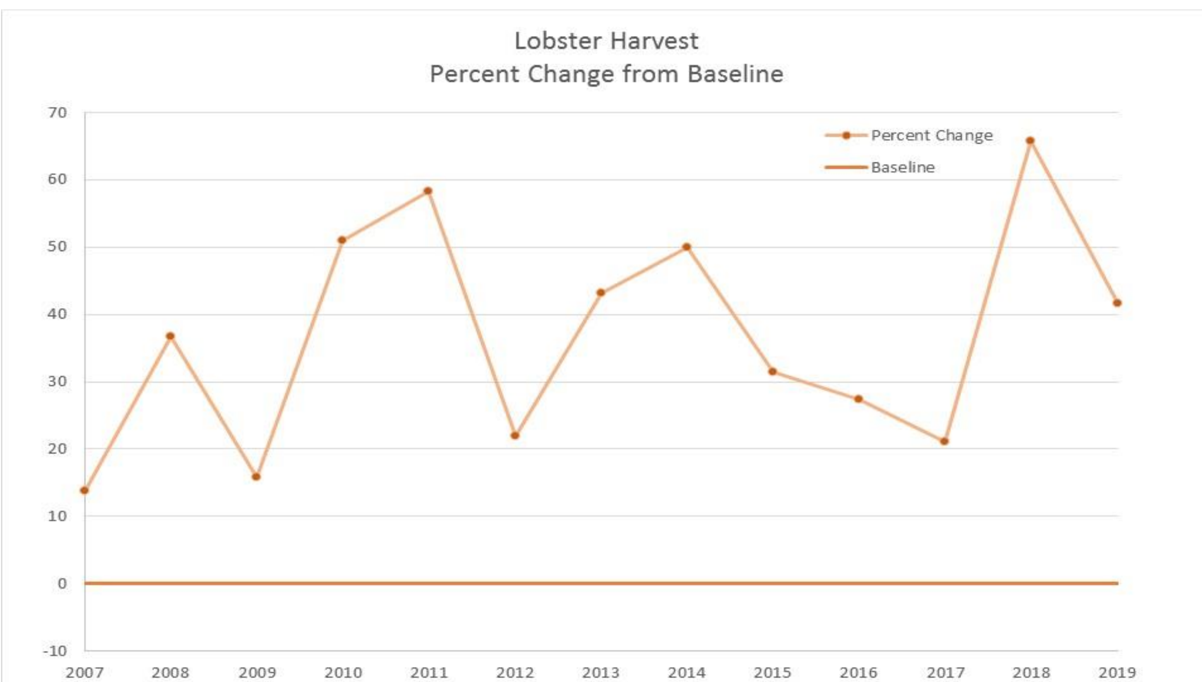


Figure 22. Annual Pink Shrimp Percent Change from 1996-2004 Baseline

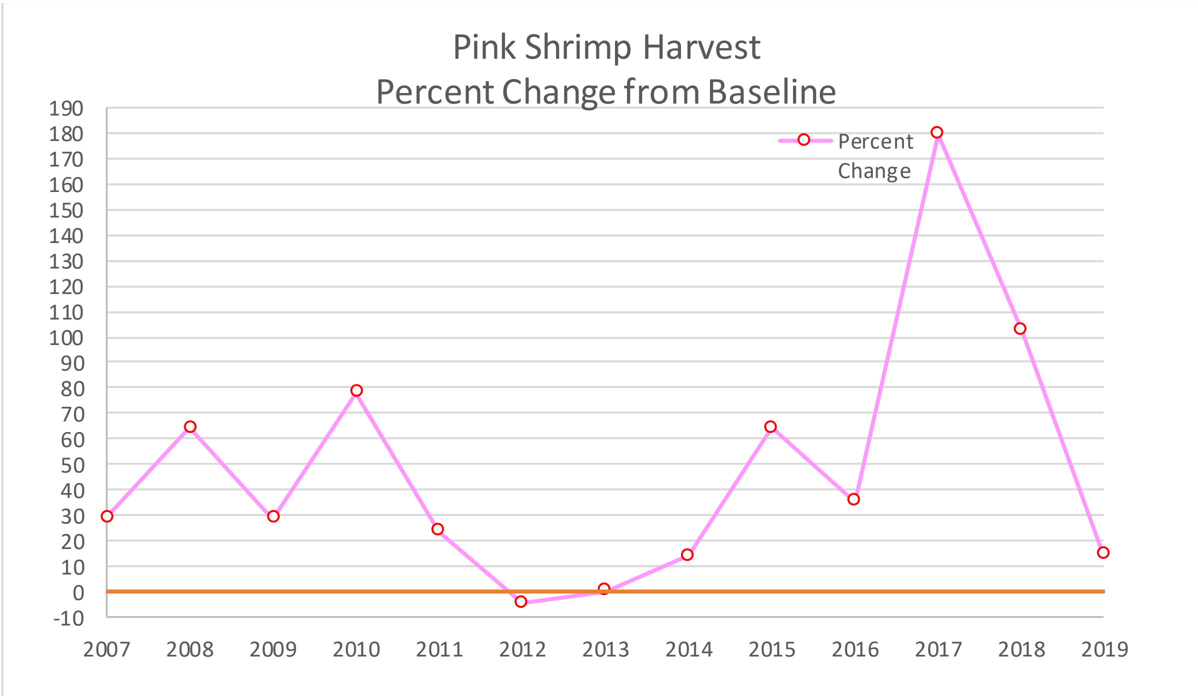
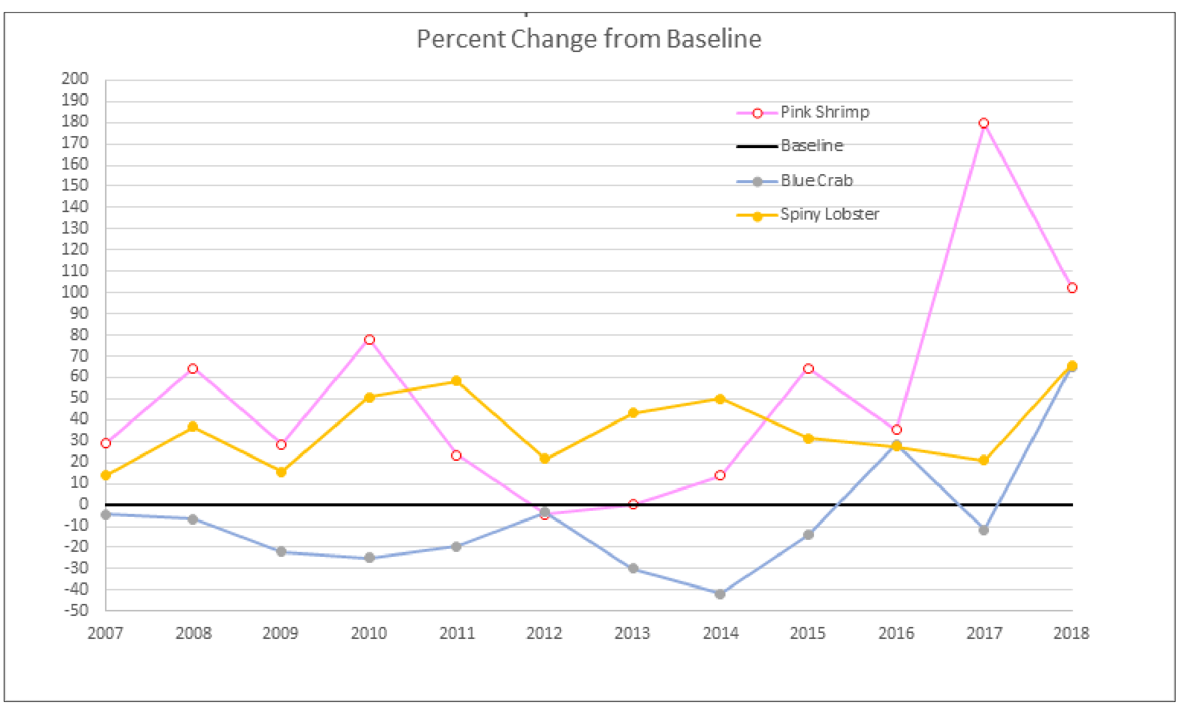


Figure 23. Percent change from baseline in catch per unit effort in pink shrimp, blue crab, and spiny lobster from 2007 through 2018.



Working Today, Looking Ahead

Miami-Dade County will continue to work collaboratively with federal and state agencies as well as municipal governments, community partners, and academic institutions to leverage resources, share knowledge, and take action to prioritize and promote the health of Biscayne Bay.

The County will continue implementing and enhancing programs and initiatives that will serve to protect and restore Biscayne Bay water quality, habitat quality, and fisheries values.

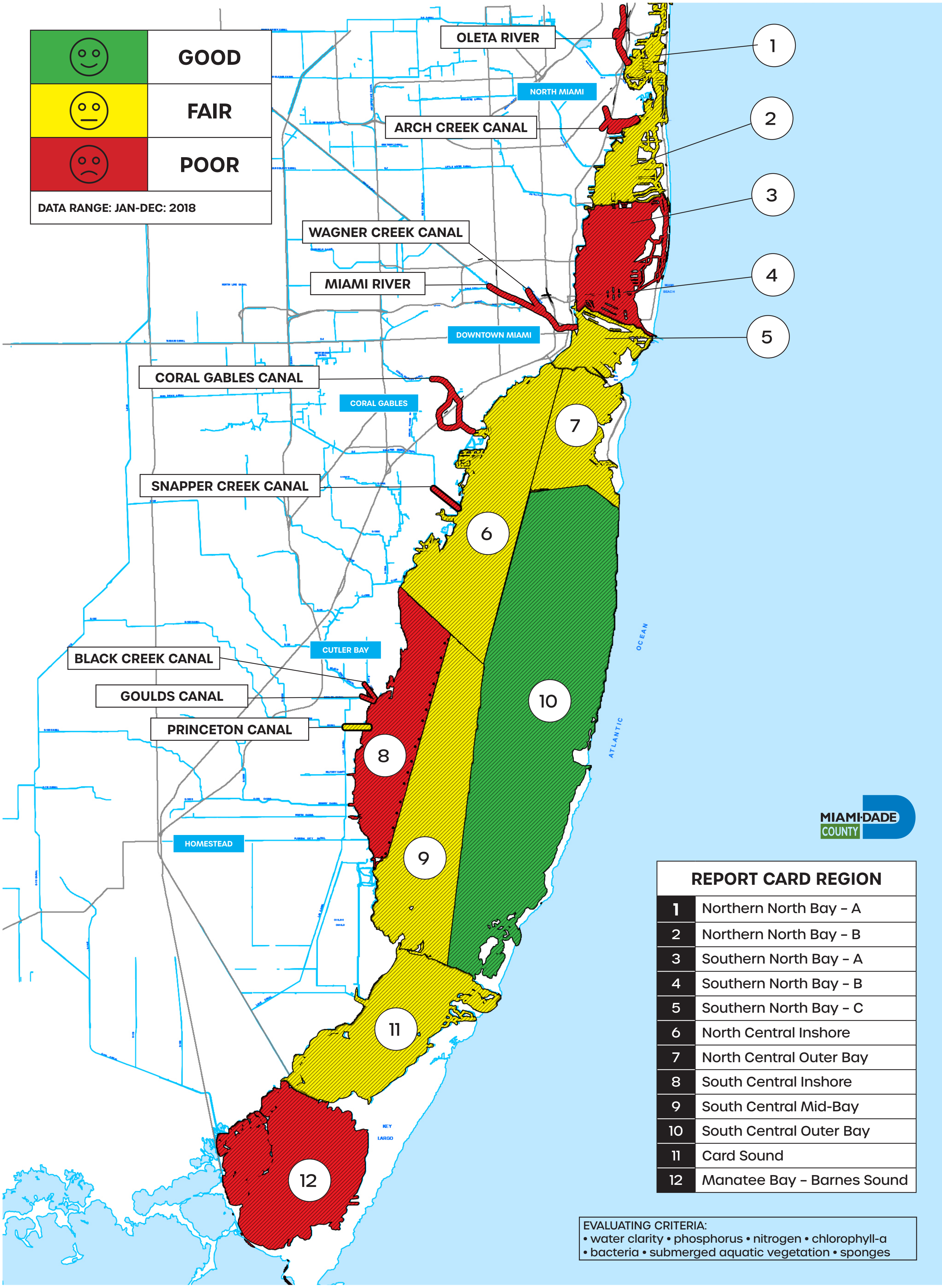
Current and Ongoing Projects:

- Surface Water Quality Monitoring Program
- Benthic Habitat Monitoring Program
- Special studies to determine the source and fate of pollutants including nutrients and bacteria with a focus in the most non-compliant basins
- Employing new technologies, including microbial source tracking and chemical tracers to better understand potential sources of pollutants
- Integrating and enhancing groundwater and surface water monitoring data and data collection
- Additional monitoring and special studies are being conducted to better understand how nutrients move into groundwater and surface water and how these nutrients are received and may impact the health of Biscayne Bay habitats

Future Goals:

- Implementation of recommendations from the Biscayne Bay Task Force
- Enhanced partnership with state, federal, academic and community partners in implementing studies, strategies and other actions to understand the causes of and solutions to impacts on bay health

2019 BISCAYNE BAY REPORT CARD



REPORT CARD REGION	
1	Northern North Bay – A
2	Northern North Bay – B
3	Southern North Bay – A
4	Southern North Bay – B
5	Southern North Bay – C
6	North Central Inshore
7	North Central Outer Bay
8	South Central Inshore
9	South Central Mid-Bay
10	South Central Outer Bay
11	Card Sound
12	Manatee Bay – Barnes Sound