# Summary Report for Biscayne Bay

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In

## Seagrass Integrated Mapping and Monitoring Program

## Mapping and Monitoring Report No. 2.0

## FWRI Technical Report TR-17 version 2

## 2016

Edited by Laura A. Yarbro and Paul R. Carlson Jr.

Florida Fish and Wildlife Conservation Commission

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**General assessment:** Seagrasses cover extensive areas (159,363 acres, from aerial photography acquired in 2004 and 2005) in the Biscayne Bay region. Mapping data from 1992 indicate that seagrass beds in the adjacent nearshore Atlantic Ocean accounted for an additional 104,910 acres. Most of the seagrass acreage in the Biscayne Bay region (120,756 acres) occurs in Biscayne Bay proper as continuous beds. Turtlegrass (*Thalassia testudinum*) is the dominant species in Card Sound and southern Biscayne Bay, while northern Biscayne Bay has more diverse seagrass beds, the most common species being manateegrass (*Syringodium filiforme*). Macroalgae are also important components of the bay's seagrass habitats and can even exceed the cover of seagrasses. Macroalgal communities include drift taxa such as *Laurencia* spp., *Anadyomene* spp., and *Digenia simplex* and other mixed masses of red algae including *Polysiphonia* spp. and *Acanthophora spicifera*. Attached rhizophytic taxa, such as *Halimeda* spp., *Penicillus* spp., *Batophora oerstedii*, *Chara hornemanii*, and *Caulerpa* spp., are common as well (Biber and Irlandi, 2006; Collado-Vides *et al.*, 2011).

| General Status of Seagrasses in the Biscayne Bay region | | | |
|---|---|---|---|
| **Status and stressors** | **Status** | **Trend** | **Assessment, causes** |
| Seagrass cover and species | Yellow | Regional declines | Losses in North Bay and Barnes Sound; *Anadyomene* bloom in north central bay |
| Water clarity | Yellow | Regional declines | Phytoplankton blooms |
| Natural events | Green | Sporadic | Tropical cyclones |
| Macroalgal blooms | Yellow | Subsiding | Central bay; caused seagrass loss in recent years |
| Propeller scarring | Yellow | Localized | Near high-use areas |

**Geographic extent:** The Biscayne Bay region is located along the Atlantic coast of southeastern Florida and includes North Biscayne Bay, Biscayne Bay proper, Card Sound, and Barnes Sound. The region extends from the Oleta River north of Miami Beach through Biscayne Bay National Park, Card Sound, and Barnes Sound to the U.S. Highway 1 bridge to the Florida Keys.

**Mapping and Monitoring Recommendations**

- Obtain imagery; photo-interpret and map seagrasses in the region every 6–10 years.
- Continue and expand seagrass monitoring programs. Monitoring has been conducted by staff of several agencies. Miami-Dade County samples 101 probabilistic randomly chosen sites and 12 non-random fixed sites each June. Since 2008, scientists from the Rosenstiel School of Marine and Atmospheric Science (RSMAS) at the University of Miami have monitored inshore (<500 m from shore) seagrass beds on the western side of the bay twice a year as part of the Comprehensive Everglades Restoration Plan (CERP). Scientists from Florida International University (Collado-Vides) and Miami-Dade County (Avila) have monitored the abundance and distribution of green macroalgal blooms in central Biscayne Bay since 2010. The U. S. Geological Survey monitors fish and invertebrates in the bay as part of its Fish and Invertebrate Assessment Network (FIAN). The Fisheries Habitat Assessment Program (FHAP) of the Fish and Wildlife Conservation Commission (FWC) Fish and Wildlife Research Institute (FWRI) conducted field monitoring twice a year from 2005 through 2009 at randomly selected sampling points.
- Assess nutrient content of seagrass and algal tissue on a twice a year.

**Management and Restoration Recommendations**

- Continue research to determine the response of seagrass beds to anticipated changes in salinity and nutrients associated with restoration of the Everglades.
- Reduce and manage nutrient loading from land runoff.
- Monitor ongoing blooms of the green macroalgae *Anadyomene* spp. in Biscayne Bay and phytoplankton in the southern bay; investigate causes and, if needed, remediation.
- Monitor selected sites that have lost or are losing seagrasses due to macroalgal overgrowth and track changes in seagrass species composition.
- Begin investigation of seagrass losses in North Biscayne Bay; investigate causes and, if needed, remediation.
- Continue monitoring seagrass declines in Barnes Sound; determine causes and best techniques of remediation.

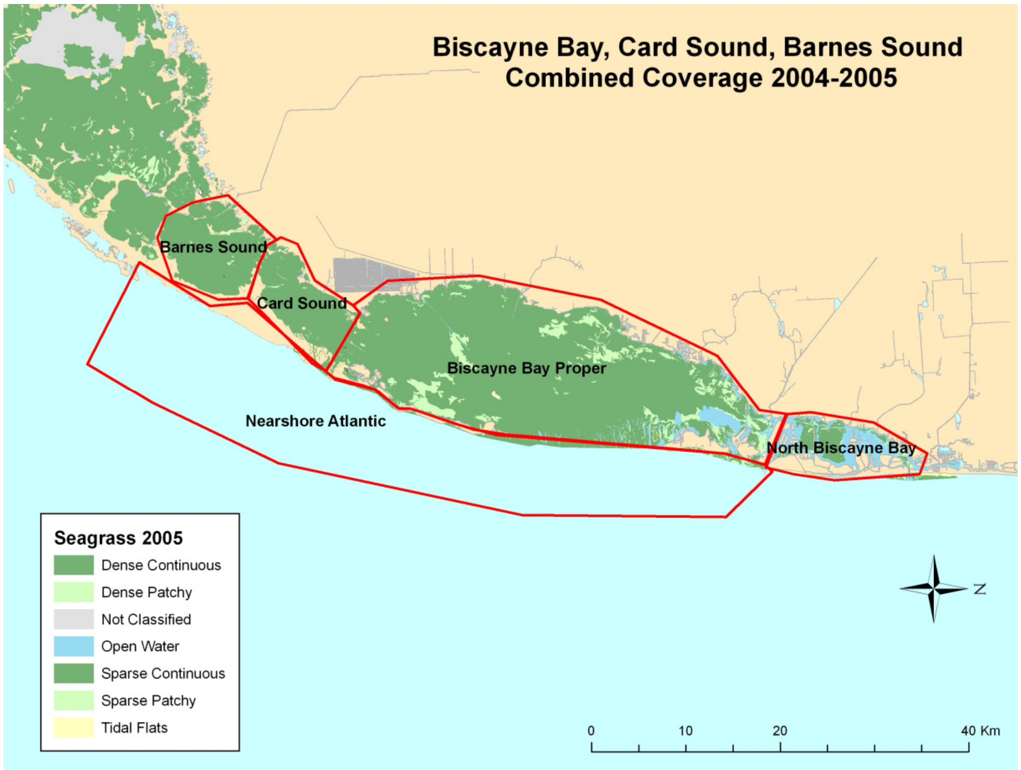


*Figure 1* *Seagrass cover in the Biscayne Bay region, from photography collected in 2004 and 2005.*

**Summary assessment:** Seagrass cover is extensive (159,363 acres; Table 1) in the Biscayne Bay region and from 1992 to 2005 increased in all sub-regions of the bay except North Biscayne Bay, which lost 660 acres, or 11%. There are substantial differences in seagrass species composition among the regions of Biscayne Bay. Turtlegrass dominates beds in Card Sound and southern Biscayne Bay, while in northern Biscayne Bay seagrass beds are more diverse, with manateegrass occurring most frequently. The proportion of bay bottom that is bare also increases from south to north. A persistent bloom (2005–2016) of the green macroalgae *Anadyomene* spp. in the central inshore part of the Bay has impacted seagrass, covering as much as 14,800 acres of seagrass beds (Collado-Vides *et al*., 2013). While the extent of *Anadyomene* distribution may have decreased since 2013, areas previously occupied by the algae have not been revegetated by seagrass and in some cases have been covered by other drifting macroalgae such as *Digenia* spp. (Collado-Vides *et al*., 2016). Furthermore, a species of the genus *Ulva,* which is known to create blooms, has recently appeared near the shore of the Deering Estate area of the western bay (Melton *et al*., 2016). A phytoplankton bloom also developed in summer 2013 in southern portions of the bay region. Studies by Lirman *et al*. (2008, 2014) indicate that the location of freshwater inputs and nutrient loading from the watershed determine the distribution of seagrass species in nearshore regions of the western bay. Changing hydrologic regimes, nutrient loading from agricultural and urban land use, and boating are likely stressors to seagrass beds.

| Seagrass Status and Potential Stressors in Biscayne Bay | | | |
|---|---|---|---|
| **Status indicators** | **Status** | **Trend** | **Assessment, causes** |
| Seagrass cover | Yellow | Regional declines | Losses in North Bay and Barnes Sound; *Anadyomene* spp. bloom in north central bay |
| Seagrass meadow texture | Green | Stable | |
| Seagrass species composition | Green | Stable | Varies across region |
| Overall seagrass trends | Yellow | Regional declines | Continuing bloom impacts |
| **Seagrass stressors** | **Intensity** | **Impact** | **Explanation** |
| Water clarity | Yellow | Regional declines | Phytoplankton blooms |
| Salinity changes and variation | Yellow | Increasing | Watershed, canal inputs of freshwater and nutrients |
| Nutrients | Yellow | Some impacts due to blooms | |
| Phytoplankton | Yellow | | |
| Macroalgal blooms | Yellow | Subsiding | Central bay; caused seagrass loss in recent years |
| Natural events | Green | Sporadic | Tropical cyclones |
| Propeller scarring | Yellow | Localized | Near high-use areas |

**Seagrass mapping assessment:** Mapping of aerial photography acquired in 2004 and 2005 showed that seagrasses covered 159,363 acres in the Biscayne Bay region and that most of the acreage (120,756 acres, or 76%) was found in Biscayne Bay proper (Table 1). The classification system used for seagrass cover in the 1992 imagery set differed from that used for the 2004–2005 imagery set. Change analysis between 1992 and 2004–2005, therefore, is useful only for total seagrass area. FWRI staff conducted change analysis in ArcMap, using identical polygons or spatial extents for 1992 and 2004–2005 for the Biscayne Bay region.

Cover was lowest in North Biscayne Bay in 2004–2005 (5,208 acres) and had decreased from the 5,868 acres mapped there in 1992. Barnes and Card sounds showed small increases in seagrass acreage in 2004, with seagrass covering 18,793 and 14,606 acres that year, respectively. Overall, seagrasses increased by 5, 536 acres, or 3.6%, between 1992 and 2004–2005. In 2004–2005, 92% of seagrass beds were classified as continuous seagrass. In addition, in 1992, 104,910 acres of seagrass were mapped along the margin of the nearshore Atlantic Ocean outside the boundaries of Biscayne Bay.

*Table 1 Seagrass acreage in the Biscayne Bay region, 1992 and 2004–2005.*

| Habitat type | Barnes Sound | Card Sound | Biscayne Bay proper | Northern Biscayne Bay | Total Biscayne Bay | Nearshore Atlantic |
|---|---|---|---|---|---|---|
| Acreage in 1992 | | | | | | |
| Continuous seagrass | 14,733 | 11,672 | 56,464 | 3,846 | 86,715 | 79,296 |
| Hardbottom/seagrass | 3,107 | 1,634 | 42,842 | 0 | 47,583 | 7,605 |
| Patchy seagrass | 795 | 1,106 | 15,606 | 2,022 | 19,529 | 18,009 |
| **All Seagrass** | **18,635** | **14,412** | **114,912** | **5,868** | **153,827** | **104,910** |
| Acreage in 2004–2005 | | | | | | |
| Year Imagery Acquired: | 2004 | 2004 | 2005 | 2005 | 2004–2005 | |
| Continuous seagrass | 18,479 | 14,388 | 109,440 | 4,277 | 146,584 | |
| Patchy seagrass | 314 | 218 | 11,316 | 931 | 12,779 | |
| **All Seagrass** | **18,793** | **14,606** | **120,756** | **5,208** | **159,363** | |
| Change in acreage for all seagrass | | | | | | |
| Acres | 158 | 194 | 5,844 | –660 | 5,536 | |
| % Change | 0.85% | 1.35% | 5.09% | –11.2% | 3.60% | |

**Monitoring assessment:** Miami-Dade County has conducted seagrass monitoring at 12 fixed and 101 random transect locations throughout Biscayne Bay during the summer wet season annually since 1995. Recent findings indicate a persistent *Anadyomene* spp. algae bloom in the North Central Inshore (NCI) area of Biscayne Bay, which originated between 2004 and 2005. Between 2009 and 2015, the *Thalassia*-dominated community (1999–2008) changed to a community dominated by green macroalgae, composed mainly of *Anadyomene* spp. (Figure 2). Two species of *Anadyomene* were identified: *Anadyomene stellata* and a diminutive *Anadyomene* sp., likely a new species. The estimate of seagrass loss, based on change in percent cover in the bloom area, indicates that approximately 7,660 acres of seagrass cover disappeared in the NCI area (a 63% decline) during 2010–2014. Since 2014, some seagrass recovery has been observed where the bloom has receded, but based on monitoring data, the *Anadyomene* spp. coverage remains greater (37.1%) than the total seagrass coverage (15.8%).

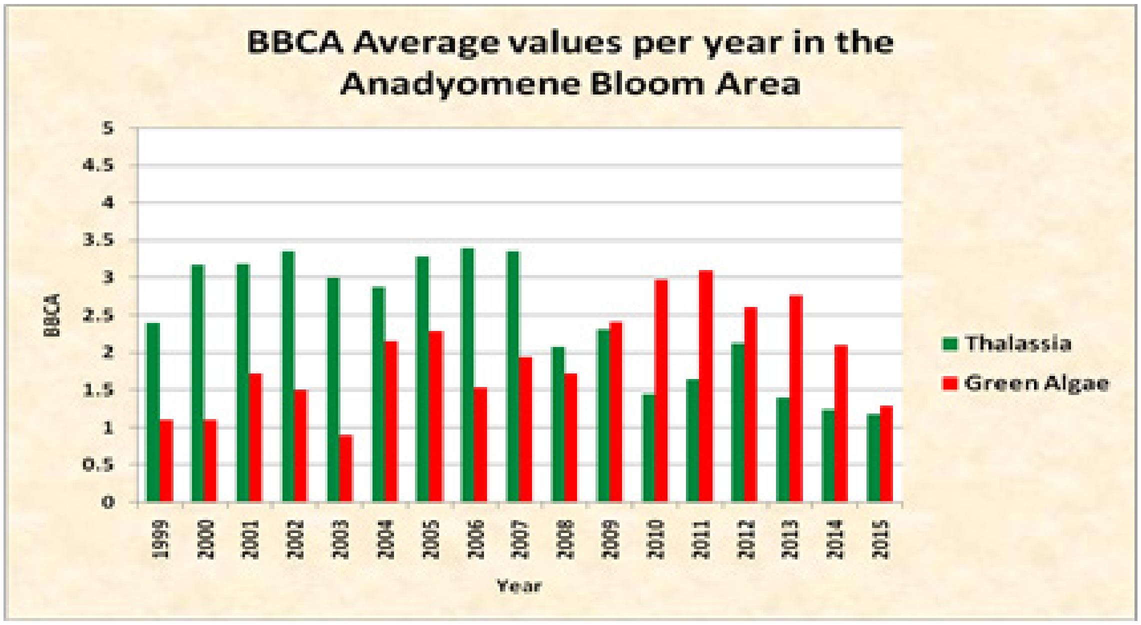


*Figure 2* *Average Braun-Blanquet cover abundance (BBCA) for turtlegrass and green algae in the* Anadyomene *spp. bloom area, 1999–2015. Data are from 80 sites at which* Anadyomene *spp. presence has been recorded.*

The RSMAS monitors nearshore (<500 m from shore) seagrass beds in western Biscayne Bay from Matheson Hammock to Turkey Point. Shoalgrass (*Halodule wrightii*) and turtlegrass are the main components of the seagrass communities in western Biscayne Bay, with only minor contributions from manateegrass (Figure 3). Shoalgrass was the dominant species in terms of occurrence (found at > 86 % of samples in all surveys) and mean cover, whereas turtlegrass was found in 68% of samples at inshore sites (<100 m from shore). The cover of all seagrasses has oscillated between 24 and 31% since 2008. The cover of turtlegrass has remained between 15 and 22% since 2008, and the cover of shoalgrass, which remained just above 5% until 2011, has increased to more than 10% between 2012 and 2015. The cover of manateegrass in the nearshore habitats has remained <4% for the period of record.

The distribution and nutrient status of macroalgal taxa were also examined by Collado-Vides *et al.* (2011, 2013). Nutrient content of seagrasses and macroalgae is influenced by season and proximity to freshwater canals. In general, macroalgal tissues have high nitrogen content and high nitrogen:phosphorus ratios, indicating high nitrogen availability.

The Fisheries Habitat Assessment Program (FHAP), supervised by Margaret O. Hall, monitored seagrasses in Biscayne Bay twice a year from 2005 through 2009. Monitoring assessments were conducted each May and October using fixed sampling points and Braun-Blanquet evaluation of 0.25-m² quadrats. In 2005 and 2007, turtlegrass occurred most frequently in Card Sound and southern Biscayne Bay (>80% frequency of occurrence; Figure 4). Shoalgrass occurred in all segments of Biscayne Bay but generally at <30% frequency of occurrence. The number of bare quadrats increased from south to north and had >20% frequency of occurrence in northern Biscayne Bay in 2007, where seagrass acreage decreased from 1992 to 2005. Significant changes in species distribution or occurrence were not observed between the two years of monitoring.

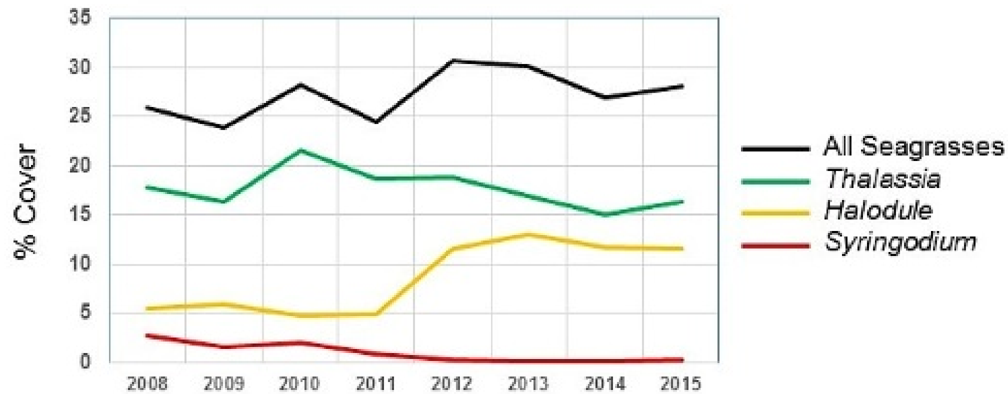


*Figure 3* *Percent cover of seagrasses in nearshore (<500 m from shore) habitats of western Biscayne Bay from Matheson Hammock to Turkey Point, 2008–2015.*

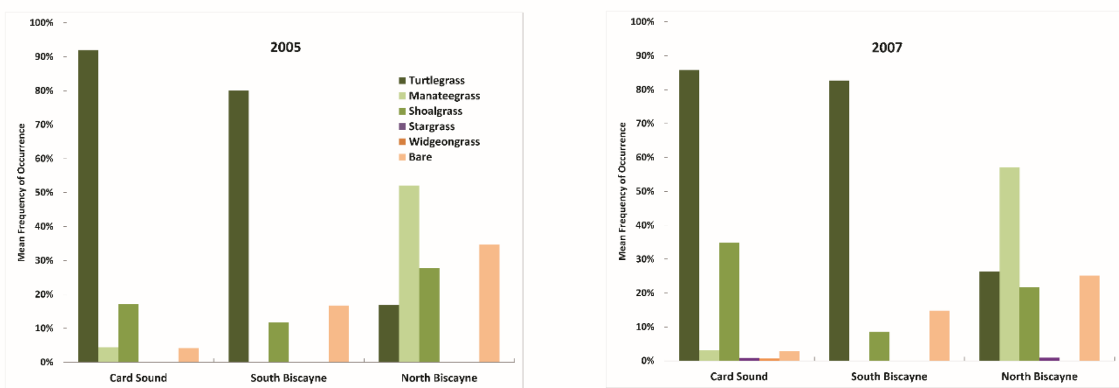


*Figure 4* *Mean frequency of occurrence of seagrasses in Biscayne Bay, 2005 and 2007. Stargrass is* Halophila engelmannii, *and widgeongrass is* Ruppia maritima. *Data from FHAP/FWRI.*

**Water quality and clarity:** Miami-Dade County has monitored surface water quality at 86 fixed stations throughout Biscayne Bay and its tributaries monthly since 1979. Evaluation of numeric nutrient criteria in 2014–2015 for the nutrient regions in Biscayne Bay, as required by Florida law (620-302.532 F.A.C), showed that chlorophyll-a levels failed to meet the legal criterion (*i.e.*, that it must not exceed the designated value of the annual geometric mean more than once in any three-year period) in all nine regions of Biscayne Bay. But the annual geometric means for chlorophyll-a in the Biscayne Bay regions were low (1.92–0.14 µg/l) during that period and exceeded the criterion by only very small amounts (generally <0.25 µg/l). Total nitrogen (TN) and total phosphorus (TP) concentrations, as well as other indicators of nutrient enrichment (*e.g.*, ammonia concentration, biological oxygen demand, fecal coliform levels), met their respective criteria. Nevertheless, the annual geometric means for TN and TP have increased significantly (TN has doubled) in most estuarine regions in 2015. Also algal blooms can take up nutrients rapidly, which might make detection of the causal nutrients difficult. Biscayne Bay has had two significant phytoplankton algal blooms in the recent past, as well as an ongoing benthic algal bloom.

**Mapping and Monitoring Recommendations**

- Obtain imagery, photo-interpret and map seagrasses in the region.
- Acquire imagery every 6 to 10 years.
- Continue and expand seagrass monitoring programs.
- Assess nutrient status of macrophytes.
- Collect high-resolution water quality data to capture climate variability and the input of freshwater into the Bay.

**Management and Restoration Recommendations**

- Reestablish consistent mesohaline conditions in central and southern Biscayne Bay, through hydrologic restoration initiatives such as the CERP Biscayne Coastal Wetlands program.
- Evaluate the response of seagrass beds to anticipated hydrological changes associated with restoration of the Everglades.
- Evaluate nutrient loading from land runoff, a significant threat to seagrass health in Biscayne Bay.
- Continue to monitor phytoplankton populations in Card Sound where they have been elevated.
- Continue to monitor the ongoing phytoplankton bloom in Biscayne Bay; investigate causes and, if needed, remediation.
- Continue to monitor blooms of the green macroalgae *Anadyomene* spp. and possibly that of *Ulva* spp. in Biscayne Bay; investigate causes and, if needed, remediation.
- Monitor species succession in areas affected by the blooms of *Anadyomene* spp. in the central bay to determine whether seagrasses can recover.
- Use boating and angling guides for the region to improve boater education and awareness of seagrass beds.
- Establish a framework for detecting effects of climate change and ocean acidification on coastal marine resources in the region.

**Mapping methods, data, and imagery:** Aerial imagery acquired in 1992 is part of the GIS data set of benthic habitats of south Florida archived at FWRI. The presence of seagrass beds, classified as continuous seagrass, mixed hard bottom and seagrass, or patchy seagrass, was interpreted from1:48,000-scale natural-color aerial photography. The photographs were digitized by Greenhorne and O'Mara (West Palm Beach, FL) using stereo analytical plotters. Imagery acquired in 2004 and 2005 was interpreted by PhotoScience Inc. (St. Petersburg, FL) using a modified Florida

Land Use Cover and Forms Classification System (Florida Department of Transportation, 1999) in which seagrass beds were classified as continuous or patchy. ArcMap shapefiles of benthic habitats are distributed on the FWRI Marine Resources Geographic Information System (MRGIS) website (http://ocean.floridamarine.org/mrgis/).

**Monitoring methods and data:** Miami-Dade County began seagrass monitoring in 1985 by sampling fixed locations along transects (see http://www.dep.state.fl.us/coastal/sites/biscayne/science/seagrass.htm). Since 1999, a stratified random design has been used, and 101 sites have been visited annually. Frequency, abundance, and density of submerged vegetation are assessed at each location. Additionally, water is sampled monthly at 86 locations and analyzed for nutrient levels, clarity, sewage pollution, trace metals, and physical characteristics, to identify geographical patterns and temporal trends. These data help managers design habitat restoration projects and cleanup of stormwater runoff, evaluate the effectiveness of ongoing management and regulation, and support development of models for regional water management programs, including stormwater master plans, CERP, the Lower East Coast Water Supply, and state obligations under federal consent orders to establish lists of impaired waters and total maximum daily loads for such waters.

The RSMAS has monitored the abundance and distribution of seagrasses and macroalgae during dry and wet seasons from 2009 through 2016 in nearshore environments (<500 m from shore) of western Biscayne Bay. This monitoring program has three goals: 1) to evaluate spatial and temporal relationships of the occurrence of seagrasses and macrophytes with water quality parameters such as salinity, light, temperature, and dissolved oxygen concentration; 2) to identify indicators of the status of the submerged aquatic vegetation (SAV) community; and 3) to formulate performance measures for gauging success of CERP (Lirman *et al*., 2014). Sampling includes visiting 47 permanent sites along the shoreline as well as 125 randomly located stations. Seagrass cover is assessed visually or from underwater photographs on a scale of 0 to 100%. Light (photosynthetically active radiation or PAR) attenuation, water temperature, dissolved oxygen concentration, and salinity are also measured at each site.
In 2008 and 2011, seagrass blades were collected at 99 sites in nearshore habitats for determination of their nutrient content. Tissue nitrogen content was measured using a carbon-hydrogen-nitrogen analyzer. Tissue phosphorus content was determined by a dry-oxidation, acid-hydrolysis extraction followed by a colorimetric determination of phosphate concentration. Elemental content was calculated based on tissue dry weight, and elemental ratios were calculated on a mole to mole basis.

The FHAP, supervised by Margaret O. Hall, monitored seagrasses in Biscayne Bay twice a year from 2005 through 2009. Monitoring assessments were conducted each May and October using fixed sampling points and Braun-Blanquet evaluation of 0.25-$m^2$ quadrats.

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Document Citation:

Lirman, D., J. Monty, C. Avila, E. Buck, M. O. Hall, S. Bellmund, P. R. Carlson, and L. Collado-Vides. 2016. Summary report for Biscayne Bay. pp. 234-245, *in* L. A. Yarbro and P. R. Carlson Jr., eds. Seagrass Integrated Mapping and Monitoring Report No. 2. Fish and Wildlife Research Institute Technical Report TR-17, version 2. Florida Fish and Wildlife Conservation Commission, St. Petersburg. 281 p. DOI: 10.13140/RG.2.2.12366.05445.