

Summary Report for Florida Bay

Contacts:

Margaret O. Hall and Paul R. Carlson Jr.

Florida Fish and Wildlife Conservation Commission

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

Fish and Wildlife Research Institute

100 Eighth Avenue Southeast

St. Petersburg, Florida 33701 USA

Summary Report for Florida Bay

Contacts: Margaret O. Hall (monitoring) and Paul R. Carlson Jr. (mapping),
Florida Fish and Wildlife Conservation Commission



General assessment: In 2010–2011, approximately 380,680 acres of seagrasses were mapped in Florida Bay. This is a small and likely insignificant increase in acreage since 2004, when 359,036 acres of seagrass were mapped. Large turbid and uninterpretable areas (67,790 acres in 2004 and 42,460 acres in 2010–2011) obscured the bottom in imagery acquired in both 2004 and 2010–2011. Seagrass cover in western Florida Bay suffered significant losses in the late 1980s and early 1990s as the result of a massive, apparently natural die-off. Seagrass appears to have recovered from this event, based on data from the most recent imagery. In 2005, Hurricanes Katrina and Wilma passed directly over Florida Bay with serious impacts on mangroves and other aboveground communities. Seagrasses, however, were much less affected. Thick phytoplankton blooms occurred in the eastern basins in 2007 and

2009, but they abated after 2009. Unusually hot and dry conditions in summer 2015 resulted in high-salinity, anoxic bottom water and build-up of high concentrations of sulfide in sediment porewaters in seagrass beds in Rankin Lake and Johnson Key Basin. This in turn led to die-off of large areas of seagrass in these basins in the fall. The die-off appeared to be expanding to seagrass beds in Rabbit Key Basin and Whipray basin as well. The extent of die-off and assessment of the potential for further losses are under investigation.

Turtlegrass (*Thalassia testudinum*) is the most common seagrass found in Florida Bay. Shoalgrass (*Halodule wrightii*) is also common in north central and western regions of Florida Bay, and manateegrass (*Syringodium filiforme*) is common in the western Bay as well. Stargrass (*Halophila engelmannii*) is found sporadically in northern regions of the Bay.

General Status of Seagrasses in Florida Bay			
Status and stressors	Status	Trend	Assessment, causes
Seagrass cover and species	Green	Fairly stable	
Water clarity	Yellow	Locally poor	Phytoplankton blooms (eastern Bay)
Natural events	Green	Occasional	Tropical cyclones
Propeller scarring	Yellow	Localized	Within Everglades Park

Geographic extent: Florida Bay lies at the southern end of the Florida peninsula. Most of the bay is in Everglades National Park

and is bounded on the north by the Florida Everglades, by the U.S. Highway 1 causeway on the northeastern side, the

Florida Keys to Long Key to the south and east, and the park boundary that extends north from Long Key to Cape Sable in the west. The total area of Florida Bay within the boundaries of Everglades National Park is approximately 395,000 acres or 615 square miles, most of which is covered by seagrass beds.

Mapping and Monitoring Recommendations

- Continue aerial photography and mapping of the north half of Florida Bay at least every 5 years and the entire bay every 10 years.
- Continue twice-yearly on-ground monitoring.

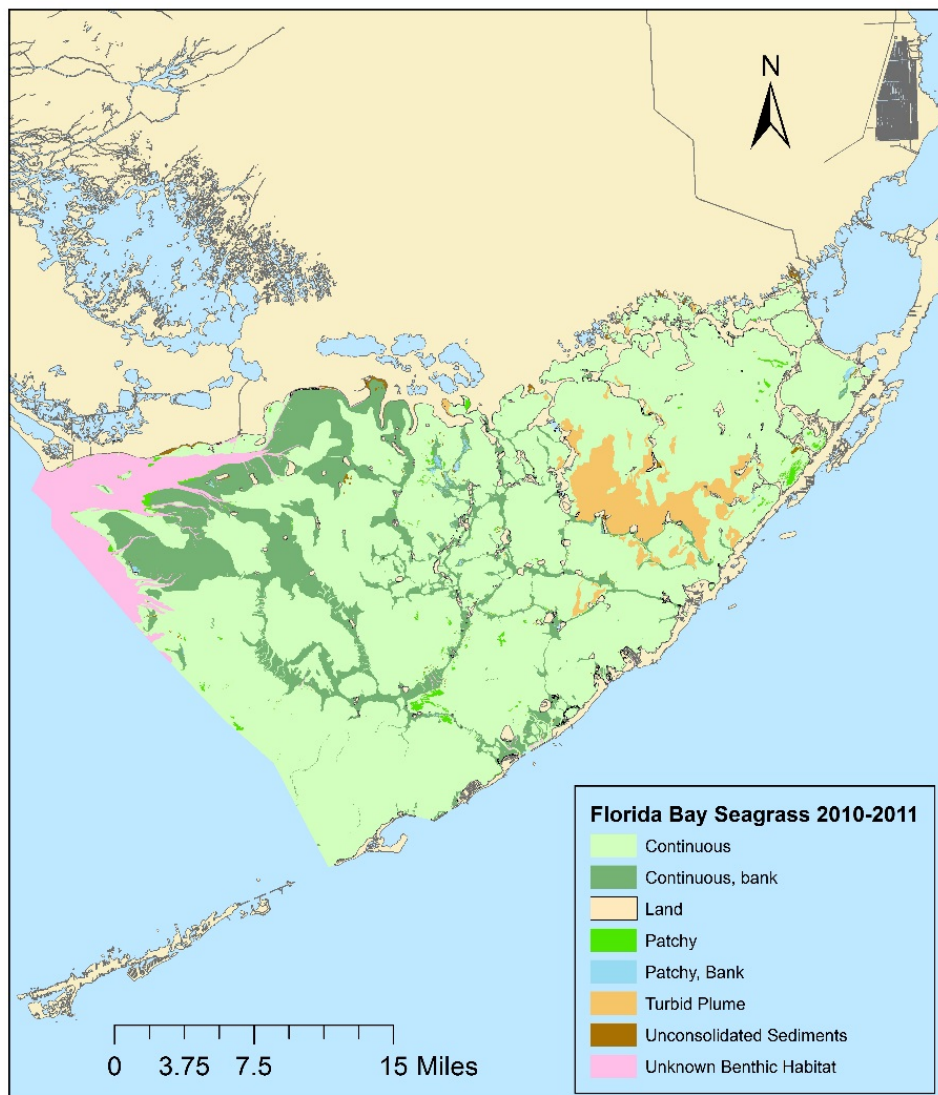


Figure 1 Seagrass cover in Florida Bay, 2010–2011.

Management and Restoration Recommendations

- Estimate the loss in acreage of seagrasses in basins affected by the 2015 die-off by acquiring and interpreting aerial photography and continuing field monitoring of salinity, water temperature, and sediment sulfide concentrations.
- Continue the program initiated by Everglades National Park staff to reduce propeller scarring in the park.
- Continue collecting data to allow prediction of the effects of changing

hydrology due to the planned restoration of the Everglades.

Summary assessment: Until fall of 2015, seagrass beds were generally stable across Florida Bay in terms of both acreage and species composition. Persistent phytoplankton blooms in the northeastern bay may affect seagrasses, particularly turtlegrass. Hurricanes (for example, Wilma, 2005) have had minimal impact on seagrass beds in the bay. Propeller scarring of shallow banks near boat channels in Everglades National Park affects some seagrass beds.

Seagrass Status and Potential Stressors in Florida Bay			
Status indicator	Status	Trend	Assessment, causes
Seagrass cover	Green	Stable	
Seagrass meadow texture	Green	Stable	
Seagrass species composition	Green	Stable	
Overall seagrass trends	Green	Stable	Phytoplankton blooms
Seagrass stressor	Intensity	Impact	Explanation
Water clarity	Yellow	Locally poor	Phytoplankton blooms, northeastern region
Nutrients	Green	Good, stable	
Phytoplankton	Yellow	Variable	High in eastern Bay
Natural events	Green	Sporadic	Occasional tropical cyclones
Propeller scarring	Yellow	Localized	Within Everglades Park

Seagrass mapping assessment: Mapping estimates of total seagrass area have varied by about 5% around a mean of 367,320 acres for imagery collected in 1992, 2004, and 2010–2011 (Table 1). Much of the variation is likely due to the size of uninterpretable areas in Florida Bay, where turbidity or

unknown features prevent complete photo-interpretation. Continuous seagrass beds accounted 98–99% of seagrass acreage in 2004 and in 2010–2011. In the most recent mapping effort, photo-interpreters differentiated between seagrass beds located on banks (shallow shoals that

separate large basins) and beds in basins;
most seagrasses were found in basins; only

16% of seagrass area was mapped on banks.

Table 1 Acreage of seagrasses in Florida Bay, 1992, 2004, and 2010–2011. Data for 2010–2011 are from interpretation of imagery collected during both years.

Bottom type	1992	2004	2010–2011
Seagrass:			
Continuous			314,712
Continuous, bank			62,446
Total continuous		353,033	377,158
Patchy			2,967
Patchy, bank			556
Total patchy		6,003	3,522
All seagrass	362,249	359,036	380,681
Other features:			
Turbid plume		67,790	18,230
Unconsolidated sediments			2,671
Unknown benthic habitat			24,228
Total area		426,826	425,810

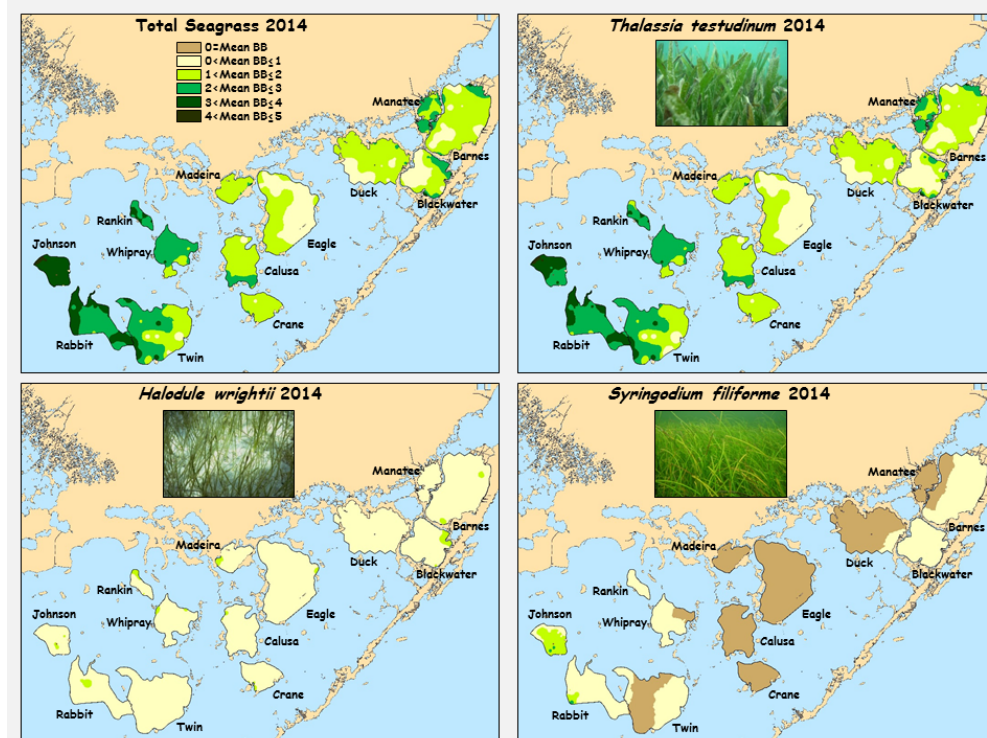


Figure 2 Ranges of mean Braun-Blanquet scores for all seagrasses and for the most common seagrass species in Florida Bay, 2014 (data from FWRI FHAP).

Monitoring assessment: As part of the Florida Bay Fisheries Habitat Assessment Program (FHAP), personnel of the Fish and Wildlife Research Institute (FWRI) of the Florida Fish and Wildlife Conservation Commission (FWC) monitor seagrass ecosystems twice a year, in May and October. This program began in 1995. Monitoring data from 2014 show that

turtlegrass is the dominant seagrass, accounting for most of the seagrass cover throughout the bay (Figure 2). Shoalgrass was observed at low densities at locations throughout the bay, and manateeegrass was very limited in distribution, occurring at moderate densities in the Johnson Key and Rabbit Key basins in the western bay.

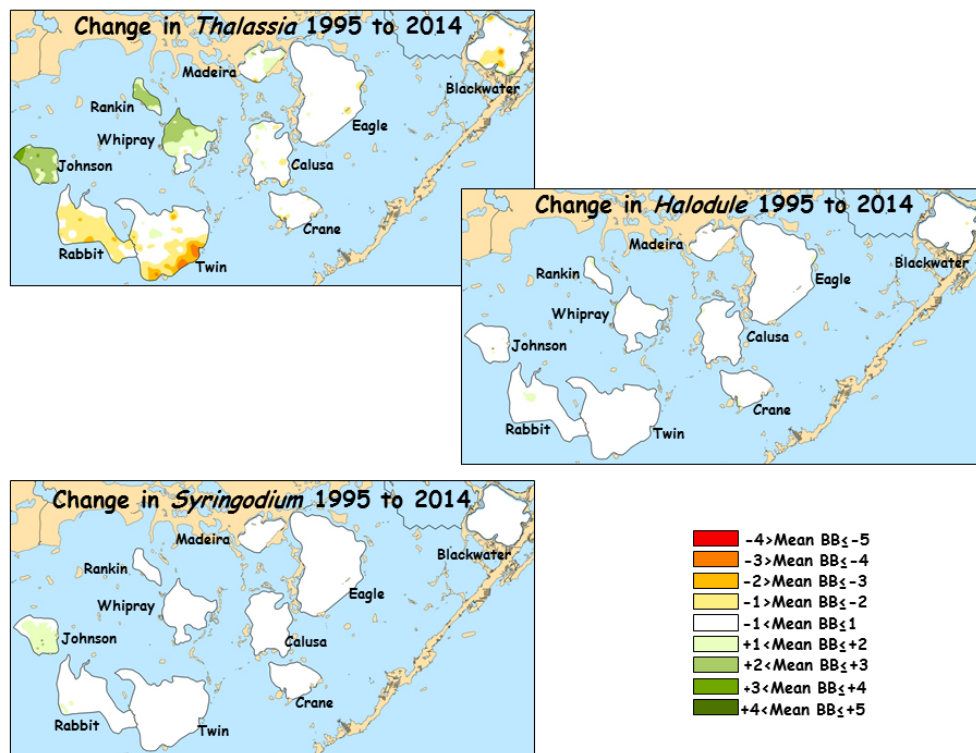


Figure 3 Change in mean Braun-Blanquet scores for seagrass species, 1995–2014 (data from FWRI FHAP).

During 25 years of seagrass monitoring by the FHAP, seagrasses in the bay recovered from a massive die-off that occurred in the late 1980's and a persistent phytoplankton bloom that followed in the 1990's. When monitoring data from 1995 and 2014 are compared (Figure 3), turtlegrass shows the greatest change: in the northwestern bay, mean densities increased by 2–3 Braun-Blanquet scores, while mean densities decreased by 2–3 Braun-Blanquet scores in the southern portions of Rabbit Key and

Twin Key basins and in Blackwater Sound. Over the 25-year period, mean density of manateeegrass increased by 1–2 Braun-Blanquet scores in Johnson Key basin but showed little change elsewhere. Shoalgrass showed little change in mean Braun-Blanquet scores over the same period. Despite recovery from die-off, phytoplankton blooms, and hurricanes (e.g., Wilma, 2005), seagrass cover has remained remarkably stable over the past 25 years.

Manateegrass and shoalgrass showed much greater year-to-year variability in mean Braun-Blanquet scores from 1995 through 2014 than was evident when comparing scores just between 1995 and 2014 (Figure 4). Before 2001, mean scores for shoalgrass exceeded those of turtlegrass in Rankin Lake, in north central Florida Bay, and in Johnson Key Basin, in the western bay. As recovery from phytoplankton blooms proceeded in these basins, mean Braun-Blanquet scores of turtlegrass increased to

levels significantly higher than those of shoalgrass and manateegrass. In Whipray Basin, in the central bay, and in Twin Key and Rabbit Key basins, in the southwestern bay, turtlegrass dominated during the 25-year monitoring period with much greater mean Braun-Blanquet scores than those of manateegrass and shoalgrass. With the exception of Twin Key Basin, mean Braun-Blanquet scores of seagrasses in the other five basins exhibited considerable variability over 25 years.

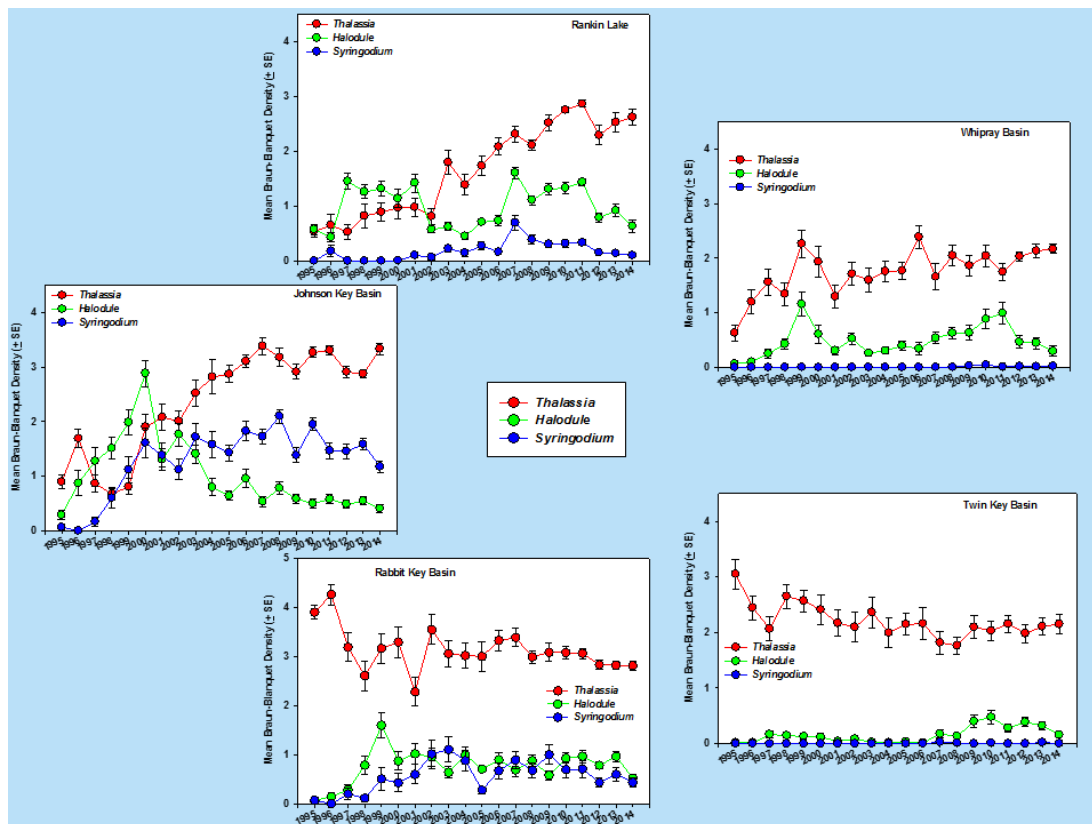


Figure 4 Mean Braun-Blanquet scores for the seagrasses turtlegrass (*Thalassia*), shoalgrass (*Halodule*), and manateegrass (*Syringodium*) in five basins of Florida Bay, 1995–2014 (data from FHAP/FWRI).

Water quality and clarity: The Southeastern Environmental Research Center (SERC) of Florida International University (FIU) monitors water quality in Florida Bay monthly, and data are available

from the DBHYDRO database of the South Florida Water Management District (SFWMD). The database includes measurements of chlorophyll-a concentration and turbidity, two

contributors to light attenuation in the water column. In the tropical waters of Florida Bay, water color is typically very low and rarely measured. We calculated annual mean chlorophyll-a concentration, turbidity, and salinity for 2009–2014 for six subregions of Florida Bay using data from DBHYDRO (Figure 5). The east subregion included sites in Barnes Sound, Blackwater Sound, Butternut Key, Duck Key, Little Blackwater Sound, Long Sound, and Manatee Bay. The middle subregion included sites from Captain Key, Little Madeira Bay, Park Key, Porpoise Lake, Terrapin Bay, and Whipray Basin. Sites in Garfield Bight and Rankin Lake were in the north-central subregion; while sites at Peterson Key and Twin Key basins were in the south-central region. The northwest Florida Bay subregion included sites at East Cape and Murray Key, and the west subregion included sites in Johnson Key Basin, Old Dan Bank, Oxfoot Bank, Rabbit Key Basin, and Sprigger Bank. Annual mean chlorophyll-a concentrations were 2–3 times higher in the northwest subregion than in the other subregions of Florida Bay in 2009–2011 but dropped to levels very close to those observed in middle and north-central regions in 2012–2014. Annual mean chlorophyll-a concentrations remained low (equal to or less than 1 mg/m³) in 2009–2014 in the east, south-central and west subregions, while mean chlorophyll-a in the middle and north-central subregions increased in 2012 and 2013 from very low levels in the previous years. All subregions had lower mean chlorophyll-a concentrations in 2014. Annual mean turbidity was very high in the

northwest subregion from 2009–2011, but dropped in 2012 to moderate levels similar to values calculated for the middle and east subregions. These three subregions are subject to resuspension of bottom sediments during wind and storm events. Turbidity levels were low and fairly uniform during 2009–2014 in the north-central, south-central, and west subregions. Whereas annual mean chlorophyll-a and turbidity values varied among subregions, mean salinity showed similar year-to-year variations in all subregions. Mean salinities were greatest in 2009, 2011, and 2014, and salinities remained above 35 psu in the north-central, south-central, and west subregions from 2009 through 2014. The least annual variation occurred in the northwest subregion where salinities varied from 34.5 to 37.5 psu. The greatest variation from year to year and the lowest levels in mean salinity occurred in the east and middle subregions, which receive more freshwater runoff than the other subregions.

Mapping and Monitoring Recommendations

- Acquire aerial photography or satellite imagery of the northern half of the bay every 5 years and the entire bay every 10 years.
- Continue FHAP and Florida International University field monitoring programs to assess long-term changes and to provide background information before the planned hydrologic restoration of the Everglades.

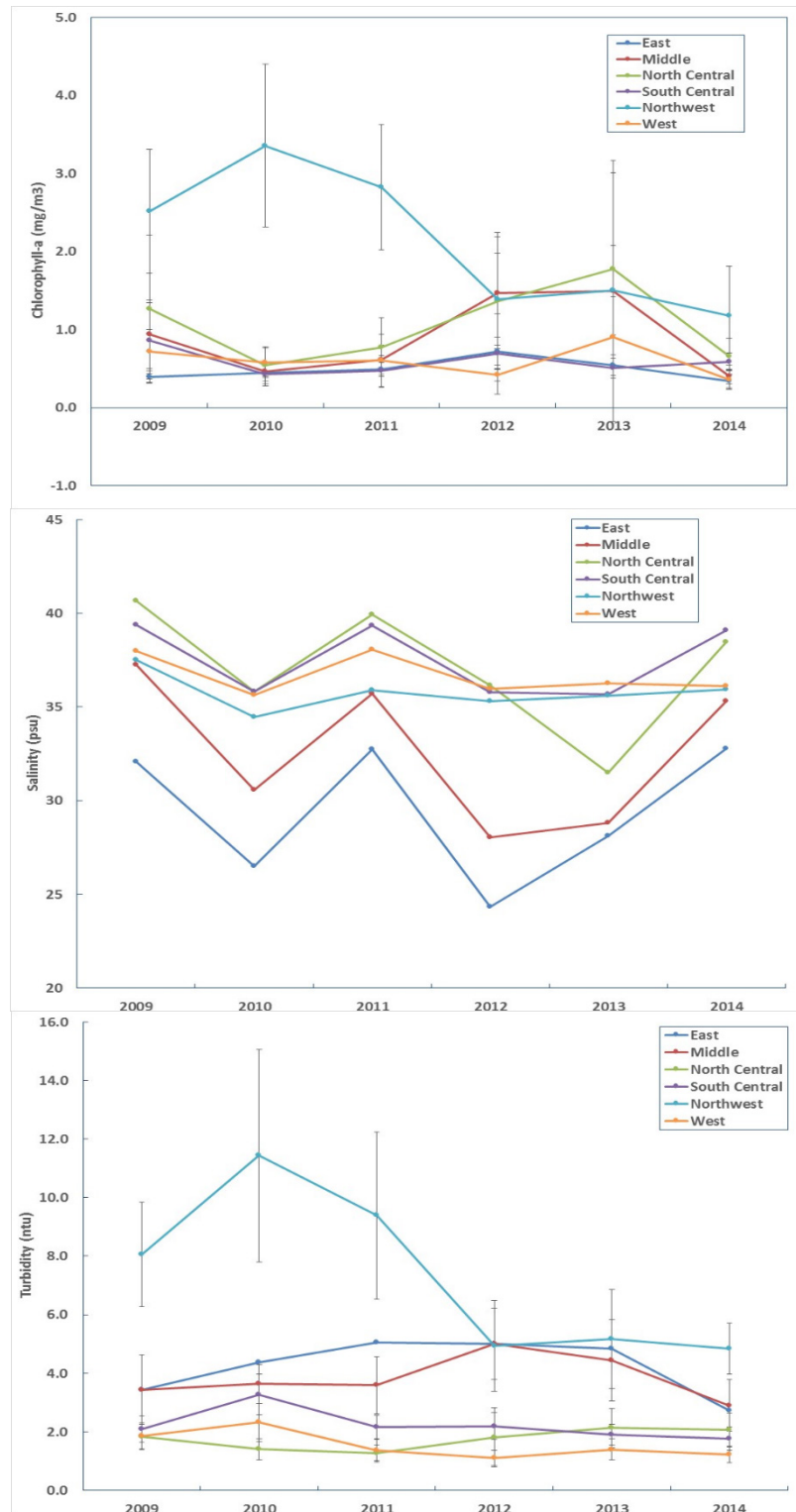


Figure 5 Annual mean A) chlorophyll-a concentrations; B) turbidity; and C) salinity in subregions of Florida Bay, 2009–2014. Error bars in graphs A and B are ± 2 standard error. Data from the DBHYDRO database of the South Florida Water Management District.

Management and Restoration Recommendations

- Estimate the loss in acreage of seagrasses in basins affected by the 2015 die-off by acquiring and interpreting aerial photography and continuing field monitoring of salinity, water temperature, and sediment sulfide concentrations.
- Evaluate potential impacts of changing hydrology due to Everglades restoration.
- Assess nutrient inputs from increasing development in the Florida Keys.
- Mitigate and minimize propeller scarring on banks adjacent to channels in the Everglades National Park.
- Establish a framework for detecting effects of climate change and ocean acidification on coastal marine resources in the region.

Mapping methods, data, and imagery:

Digital aerial imagery was collected in 2010 and 2011 by Everglades National Park. Most of the acquisition occurred in 2010, but additional flights were necessary in 2011 to photograph locations that were very turbid in 2010 and could not be interpreted. Even with additional imagery, water in some locations in central Florida Bay remained cloudy during both years and the bottom was not visible in the photographs. Photo-interpretation was completed by PhotoScience Inc. (St. Petersburg) at a bottom resolution of 0.3 m. Imagery and mapping data are available from Paul Carlson.

The SFWMD acquired aerial photography in the spring of 2004, and images were

interpreted and ground-truthed. Benthic habitats were defined using the Habitat Classification Categories for Florida Bay Benthic Habitat Mapping—2004/2005, Version 3-23-05. Natural color aerial imagery was collected in 1992 at 1:48,000 scale in a multi-agency project including FWRI, the National Oceanic and Atmospheric Administration (NOAA), and Dade County, Florida. Florida Bay imagery was digitized by the NOAA Coastal Services Center in Charleston, S.C., by scanning the photographs and linework overlays, and images were interpreted by FWRI and NOAA scientists. More information is available at http://atoll.floridamarine.org/Data/Metadata/SDE_Current/benthic_south_fl_poly.htm.

Monitoring methods and data: The FWRI FHAP began field monitoring of seagrasses at 10 locations in Florida Bay in 1995. In 2005, the number of monitoring locations was expanded to 22, extending from Lostman's River in the Ten Thousand Islands, northwest of Florida Bay, through Florida Bay to northern Biscayne Bay, northeast of Florida Bay. Five locations in the northeastern region were dropped in 2009. Each location is visited at the end of the dry season (May–June), and a monitoring point at each location is chosen randomly using sampling grids similar to those developed by the U.S. Environmental Protection Agency (EPA) Environmental Monitoring and Assessment Program (EMAP). The community structure of the submersed aquatic vegetation (SAV) is assessed using a modified Braun-Blanquet technique (Fourqurean *et al.*, 2002) within eight 0.25-m² quadrats placed on the bottom. At sites where turtlegrass is present, 10 shoots are collected for

determination of shoot morphometrics and reproductive status. Secchi depth, water depth, water temperature, salinity, and light attenuation are also measured at each location.

More intensive field monitoring of seagrasses began in 2006 at 15 locations in Florida Bay that are also long-term water-quality stations maintained by the Southeast Environmental Research Center of FIU. At each location, a 50-m transect is sampled twice a year, in May–June and in October. Along each transect, personnel evaluate seagrass cover in ten 0.25-m² quadrats using the modified Braun-Blanquet technique and count the number of seagrass shoots within a 0.1-m² area inside each quadrat. At sites where turtlegrass is present, 10 shoots are collected for determination of shoot morphometrics, reproductive status, and biomass of epiphytes on seagrass blades. In addition, three 15-cm cores are collected at each transect location to measure seagrass and macroalgal standing biomass and seagrass belowground biomass. Secchi depth, water depth, water temperature, salinity, pH, dissolved oxygen and light attenuation are also measured at each transect location.

Monitoring data are available from the Florida Bay FHAP (FWRI, Margaret O. Hall), funded by SFWMD, and the Florida Keys National Marine Sanctuary Seagrass Status and Trends Monitoring Data (Florida International University, James Fourqurean).

Pertinent Reports and Scientific Publications

BOYER, J. N., C. R. KELBLE, P. B. ORTNER, and D. T. RUDNICK. 2009. Phytoplankton

bloom status: chlorophyll *a* biomass as an indicator of water quality condition in the southern estuaries of Florida, USA. *Ecological Indicators* 9S: S56–S57.

FOURQUIREAN, J. W., J. N. BOYER, M. J. DURAKO, L. N. HEFTY, and B. J. PETERSON. 2003. Forecasting responses of seagrass distributions to changing water quality using monitoring data. *Ecological Applications* 13: 472–489.

FOURQUIREAN, J. W., M. J. DURAKO, M. O. HALL, and L. N. HEFTY. 2002. Seagrass distribution in south Florida: a multi-agency coordinated monitoring program, pp. 497–522, in J. W. Porter and K. G. Porter, eds. *The Everglades, Florida Bay, and Coral Reefs of the Florida Keys: An Ecosystem Sourcebook*. CRC Press, Boca Raton, FL.

HACKNEY, J. W., and M. J. DURAKO. 2004. Size-frequency patterns of morphometric characteristics of the seagrass *Thalassia testudinum* reflect environmental variability. *Ecological Indicators* 4: 55–71.

HALL, M. O., K. MADLEY, M. J. DURAKO, J. C. ZIEMAN, and M. B. ROBBLEE. 2006. Florida Bay, pp. 242–253 in L. Handley, D. Altsman and R. DeMay, eds. *Seagrass Status and Trends in the Northern Gulf of Mexico, 1940–2002*, Scientific Investigations Report 2006-5287, U.S. EPA 855-R-04-003. 267 p.

KELBLE, C. R., E. M. JOHNS, W. K. NETTLE, T. N. LEE, R. H. SMITH and P. B. ORTNER. 2007. Salinity patterns of Florida Bay. *Estuarine, Coastal and Shelf Science* 71: 318–334.

KELBLE, C. R., P. B. ORTNER, G. L. HITCHCOCK, and J. N. BOYER. 2005. Attenuation of photosynthetically available

radiation (PAR) in Florida Bay: potential for light limitation of primary producers. *Estuaries* 28: 560–571.

MADDEN, C. J., D. T. RUDNICK, A. A. MCDONALD, K. M. CUNNIFF, and J. W. FOURQUREAN. 2009. Ecological indicators for assessing and communicating seagrass status and trends in Florida Bay. *Ecological Indicators* 9(6, Supplement 1): S68–S82.

RUDNICK, D. T., P. B. ORTNER, J. A. BROWDER, and S. M. DAVIS. 2005. A conceptual ecological model of Florida Bay. *Wetlands* 25: 870–883.

STALETOVICH, J. 2015. Dying seagrass and ‘yellow fog’ signal trouble for Florida Bay. *Miami Herald*, October 3, 2015. <http://www.miamiherald.com/news/local/environment/article37583577.html>. Accessed November 2015.

VAN TUSSENBROEK, B. I., J. CORTES, R. COLLIN, A. C. FONSECA, P. M. H. GAYLE, H. M. GUZMAN, G. E. JACOME, R. JUMAN, K. H. KOLTES, H. A. OXENFORD, A. RODRIGUEZ-RAMIREZ, J. SAMPER-VILLARREAL, S. R. SMITH and others. 2014. Caribbean-wide, long-term study of seagrass beds reveals local variations, shifts in community structure and occasional collapse. *PLoS One* 9(5): e98377.

General References and Additional Information

Seagrass Monitoring Project, Florida Keys National Marine Sanctuary: <http://floridakeys.noaa.gov/scisummaries/seagrassmonitor.pdf>. Accessed July 2014.

DBHYDRO, Database of hydrologic and physical data, South Florida Water Management District, West Palm Beach: http://my.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu Accessed May 2015.

Florida Keys National Marine Sanctuary Seagrass Status and Trends Monitoring Data: <http://serc.fiu.edu/seagrass/cdreport/datahome.htm>. Accessed July 2014.

Florida Bay/Florida Keys Feasibility Study, Comprehensive Everglades Restoration Plan (CERP): http://www.evergladesplan.org/pm/studies/fl_bay.aspx. Accessed July 2014.

Contacts

Monitoring: Margaret O. Hall, Florida Fish and Wildlife Research Institute, 727-896-8626; penny.hall@myfwc.com; and James Fourqurean, Florida International University, 305-348-4084, jim.fourqurean@fiu.edu.

Mapping: Paul Carlson, Florida Fish and Wildlife Research Institute, 727-896-8626, paul.carlson@myfwc.com.

Document Citation:

Hall, M. O., and P. R. Carlson Jr. 2016. Summary report for Florida Bay. pp. 222-233, *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.

