Cyclic and Persistent Florida Bay Algal Blooms

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Introduction

Documented observations of phytoplankton blooms in Florida Bay before the 1990's are scarce; however, algal blooms have been a recurring phenomenon in Florida Bay since an extensive seagrass die-off occurred bay-wide in 1989. A dominant component of the 1991 Florida Bay phytoplankton bloom, and many since then, has been identified as cyanobacteria of the genus *Synechococcus* (Phlips and Badylak 1996). *Synechococcus* is described as non-toxic, but can have detrimental effects on the flora and fauna by decreasing ambient light levels and reducing dissolved oxygen (Phlips et al. 1995). Cyanobacterial blooms are hypothesized as responsible for the decline in the sponge populations in the southern, hard-bottom areas of Florida Bay (Butler et al. 1995). The loss of sponge biomass has functionally reduced the natural filtration and nitrogen cycling of the biological community in Florida Bay, and severely degrades the long-term water quality in the Florida Keys.

Since the 1990's, Florida Bay has experienced several smaller scale algal blooms in specific areas of the bay with varying degrees of impact. A bloom that began in the Northeast portion of the bay in 2005 was correlated with nutrient release from road construction activities and hurricane impacts (Glibert et al. 2009). Another bloom initiated in central Florida Bay in 2007, and a bloom in southern basins starting in September 2013 is associated with a sponge die-off in Mystery basin resulting in a 99% loss of sponge biomass (Hoer, unpublished).

In 2015, Florida Bay experienced a large scale seagrass die-off in the north central portion of the bay. One year later, starting in September 2016, an cyanobacterial bloom was observed in the basins coincident with the seagrass die-off. Chlorophyll levels (a proxy for phytoplankton biomass) in Florida Bay in the aftermath of hurricane Irma in September 2017 were elevated in central and western Florida with recurrent blooms of phytoplankton stretching from the Everglades to the Atlantic.

Methods

Bloom Mapping Methods

- 77 sites were sampled at varying frequencies in Florida Bay basins of eastern, central, and western areas within Everglades National Park.
- Samples were analyzed for chlorophyll *a* and fluorescent dissolved organic matter (FDOM) with a benchtop fluorometer.
- Results were interpolated with ArcGIS by Empirical Bayesian kriging.

Hydrostation Methods

- Buoy Key, Garfield Bight, Peterson Key, Terrapin Bay, and Whipray Basin hydrostations were equipped with YSI EXO2 sondes.
- Chlorophyll *a* was monitored at 30 minute intervals.
- Sondes were replaced with clean calibrated sondes every four weeks.
- Water samples were collected at every sonde deployment to determine chlorophyll *a* concentrations with benchtop fluorometry.
- Chlorophyll data from the YSI were adjusted to laboratory results.

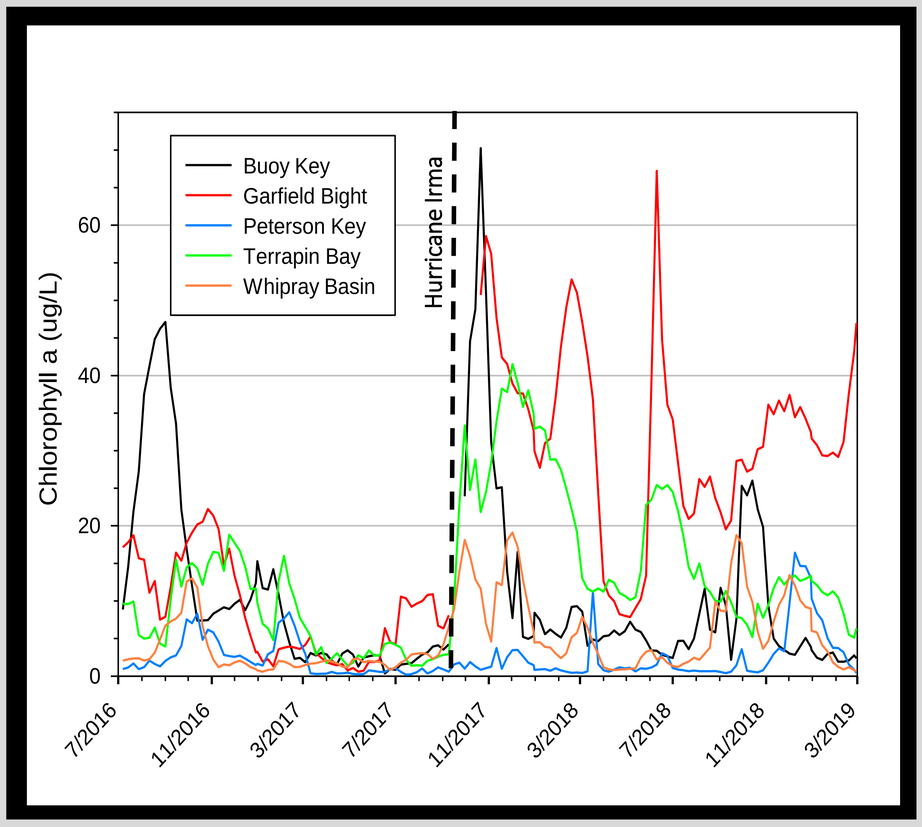
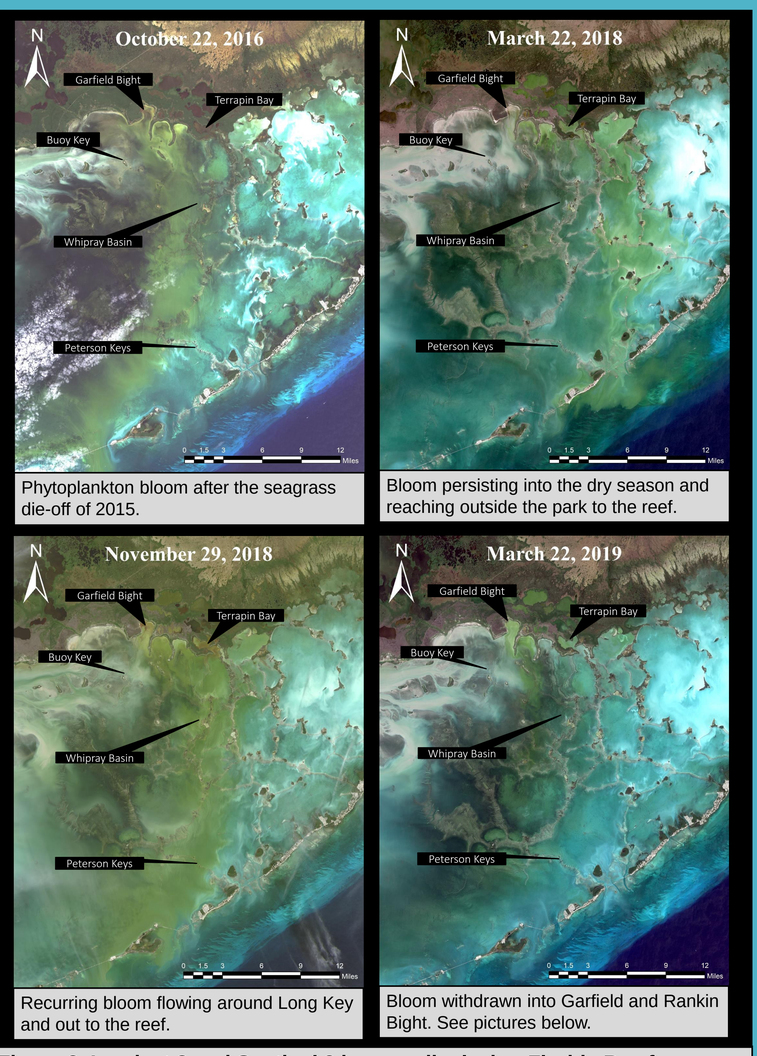


Figure 2. Weekly average chlorophyll *a* concentrations (ug/L) at five monitoring stations in Florida Bay from July 1, 2016 to February 28, 2019.



Phytoplankton bloom after the seagrass die-off of 2015.

Bloom persisting into the dry season and reaching outside the park to the reef.

Recurring bloom flowing around Long Key and out to the reef.

Bloom withdrawn into Garfield and Rankin Bight. See pictures below.

Figure 3. Landsat 8 and Sentinel 2 images displaying Florida Bay from October 2016 to March 2019.

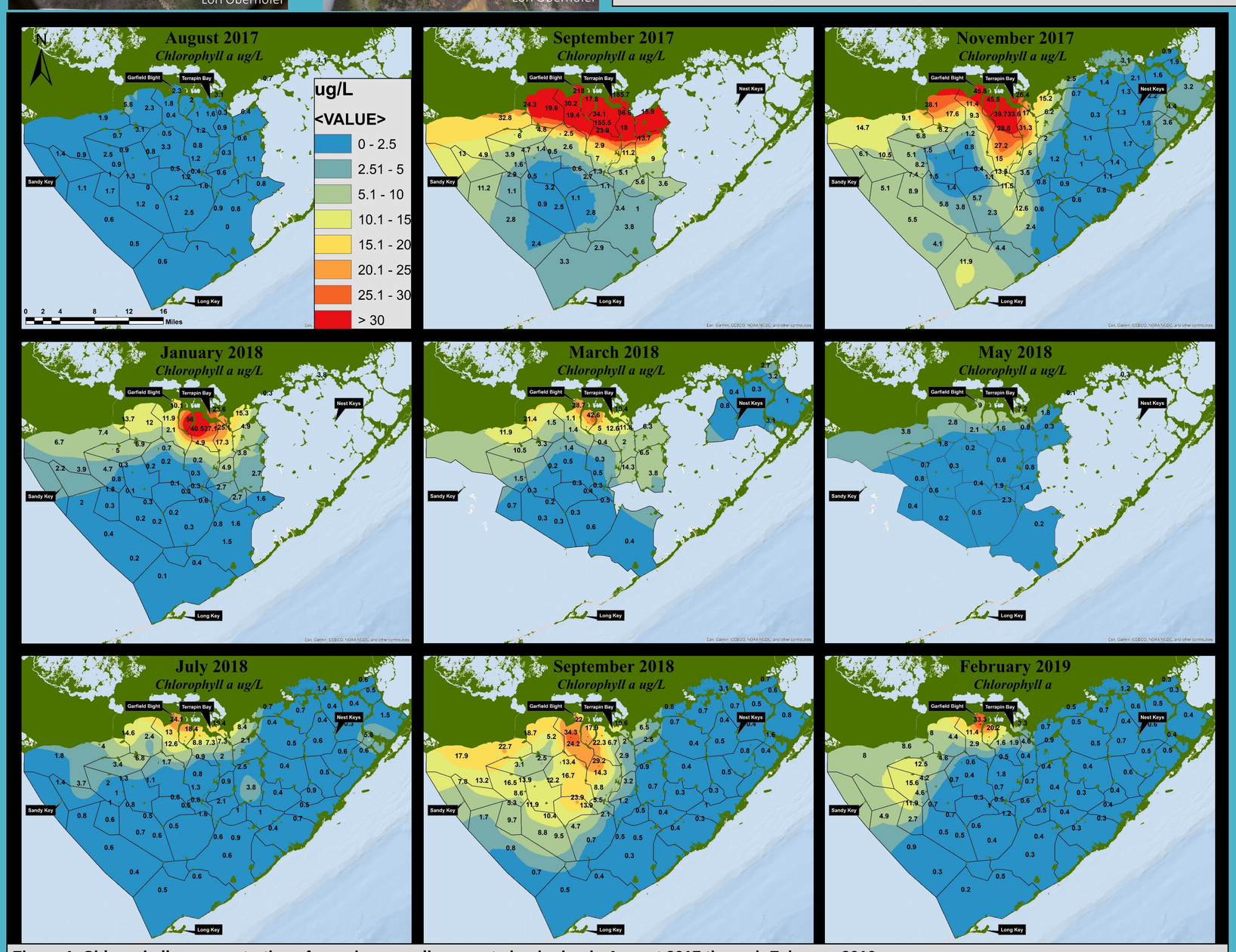


Figure 1. Chlorophyll *a* concentrations from nine sampling events beginning in August 2017 through February 2019.

Discussion

An intense algal bloom appeared in the north central area of Florida Bay in September 2016 and lasted until February 2017. The bloom affected 12 central basins, overlapping the seagrass die-off region, and reached to the Atlantic around Long Key. Chlorophyll *a* concentrations as high as 60 µg/L were measured in Johnson Key Basin.

Hurricane Irma passed through Florida Bay in September of 2017 and triggered another bloom in central portions of the bay with extreme chlorophyll *a* concentrations occurring in Garfield Bight and Terrapin Bay. Bloom intensity was highest along the coast and decreased with distance from the central Everglades shore. The bloom contracted to the north central bights and bays in April 2018, but expanded again in September 2018 reaching the Atlantic in November. The bloom contracted back to the northern bights and bays in March of 2019.

In the most recent series of blooms in Florida Bay, connectivity between the bights of the Everglades and the reef tract of the Middle Keys has been readily apparent. The level of chlorophyll *a* concentration required to maintain a healthy water body for central Florida Bay is 2.2 µg/L, as set by the Florida Department of Environmental Protection (Florida Administrative Code). Phytoplankton chlorophyll *a* have remained above these levels in the north central Bay continually for the past 3 years. Maximum concentrations have exceeded 20 µg/L regularly, a concentration rarely reported in Florida Bay over the last 30 years. Research is still needed to determine triggers, terminators, and community dynamics of phytoplankton blooms in the bay.

Literature Cited

Butler, M., Hunt, J., Herrnkind, W., Childress, M., et al. (1995) Cascading disturbances in Florida Bay, USA: cyanobacteria blooms, sponge mortality, and implications for juvenile spiny lobsters Panulirus argus. Mar Ecol Prog Ser 129: 119−125

Copernicus Sentinel Data 2018, 2019.

Florida Administrative Code 62-302.532 Estuary-Specific Numeric Interpretations of the Narrative Nutrient Criterion.

Glibert, P., Heil, C., Rudnick, D., & Madden, C., Boyer, J., & Kelly, S. (2009). Florida Bay: water quality status and trends, historic and emerging algal bloom problems. Contrib. Mar. Sci.. 38. 5-17.

NASA Landsat Program, Landsat 8 OLI scene LC80150432018333LGN00, USGS Sioux Falls, 10/22/16, 11/29/18

Phlips, E. J., and S. Badylak. 1996. Spatial variability in phytoplankton standing crops and composition in Florida Bay, Florida. Bull. Mar. Sci. 58: 203–216.

Phlips, E. J., Loch, T. C., and S. Badylak. 1995. Chlorophyll a, tripton, color, and light availability in a shallow tropical innershelf lagoon, Florida Bay, USA. Marine Ecology-Progress Series 127:223-234.

Acknowledgments

We would like to thank: V. Absten, M. Patterson, and E. Stabenau for contributions in both the field and lab. T. Frankovich and S. Kelly for technical expertise. D. Rondeau and E. Stabenau for database management. C. Alarcon for GIS Assistance. Critical Ecosystems Science Initiative provided funding.