HARMFUL ALGAL BLOOMS AND IMPLICATIONS FOR THE FLORIDA KEYS

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Florida has >50 HAB species FWRI HAB Monitoring $\leftarrow \rightarrow$ Research







Florida Department of Agriculture and Consumer Services (FDACS) is the management Authority and monitors SHA Zones



FWC-FWRI provides technical support through statewide harmful algal bloom (HAB) monitoring and biotoxin testing -- and method validation











+ county agencies, citizen volunteers, + many other partners

Florida has >50 HAB species

Florida Keys National Marine Sanctuary/Monroe County

- Marine cyanobacteria blooms in FL Bay
- Red tide aka *Karenia brevis -* in Monroe Co. with an overview of the 2017-2018 bloom
 - Throughout: Ongoing research

From land to sea: regional inflow and outflow

 Flow patterns are complex and vary from year to year, depending on precipitation and water management strategies

Potential bloom impacts

- Freshwater taxa and nutrients can be transported into Florida's estuaries and lagoons → cyanobacteria blooms dominated by fresh/brackish taxa including toxic species may occur (e.g., St. Lucie and Caloosahatchee Rivers and estuaries); red tide (*Karenia brevis*) can use nutrients if bloom is present
- During reduced freshwater flow, high salinities (>40 psu) can occur and are sometimes associated with marine cyanobacteria blooms (e.g., *Synechococcus* blooms in Florida Bay)



Figure 2-1. WY2015 and historical average inflow and outflow (in acre-feet, or ac-ft) into major hydrologic units of the regional water management system. [Note: The three arrows depicted from Lake Okeechobee represent lake outflows in inset].

2016 South Florida Environmental Report: http://www.sfwmd.gov/portal/page/portal/pg_grp_sfwmd_sfer/portlet_prevre port/2016_sfer_final/v1/chapters/v1_ch2.pdf

Central Florida Bay Late 1980's- extensive seagrass mortality event

Early 1990's-Cyanobacteria blooms, dominated by *Synechococcus*, associated with sponge mortality



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25

20

15

10

5



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Barnes & Blackwater Sounds *Synechococcus* blooms occurred from 2005-2008 and were associated with mortality events



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S. Central Florida Bay *Synechococcus* bloom in 2013 associated with sponge mortality event



Cyanobacteria blooms in FL Bay

2013 FL Bay Images





Can reach >10 million cells per mL







Photo: Niels Lindquist, UNC

Flow Cytometry benefits and principles

- Good sensitivity for small particles (<1µm)
- High sample throughput compared to traditional methods (analyze up to 10k cells/second)
- Well established analysis approaches for autotrophic picoplankton

Evaluates **particles** based on **optical characteristics**

Measures 14 parameters:

- i. Light scatter particle size & internal complexity
- ii. Red, Green, and Orange Fluorescence - cell pigmentation



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2013 – 2014 FL Bay Bloom

MODIS chlorophyll a 7-day mean composite imagery Hu lab: http://optics.marine.usf.edu



Flow cytometry also used for monitoring and event response in 2016 – 2017

Conclusions

Picocyanobacteria blooms continue to episodically disrupt Florida Bay, and are sometimes associated with negative ecosystem effects including sponge mortality, seagrass mortality

- Flow cytometry can be used in concert with satellite observations to monitor ecosystem disruptive picocyanobacteria blooms in Florida Bay
- New project looking at sponge feeding (cultivated vs. wild at different ages)









What is Red Tide?

Harmful Algal Blooms (HABs) form when algae proliferate and produce toxins and/or cause low dissolved oxygen

Toxins kill fish, birds, sea turtles, manatees, dolphins



Since November 2017: >10,000 water samples processed via microscopy



Longest documented red tide blooms*

12

X months (1946–1947, 2017-2018**) **bloom still occurring 12 months (1959–1960)

17 months (2004–2006)

18 months (1953–1955)

21 months (2002-2004)

30 months (1994-1997)

Statewide Karenia brevis concentrations 10/04/2018 - 10/11/2018

(arenia brevis (cells/liter)) not present/background (0-1,000)) very low (>1,000-10,000)) low (>10,000-100,000)) medium (>100,000-1,000,000)) high (>1,000,000) Only 8 prior east coast blooms

Florid Conse

Florida Fish and Wildlife Conservation Commission

"based on observations of >100,000 Korenio brevis cells/L and periods of suspected continuance of redition

http://myfwc.com/redtidestatus

Google earth

Blooms initiate 10-40 miles offshore, at depth One initiation zone, south of Big Bend to South of Tampa Bay



Karenia brevis is ecologically flexible



Currents transport red tide south



Monroe County Karenia brevis (cells/L*)

*From FWC's HAB Monitoring Database: http://myfwc.com/research/redtide/monitoring/database/

• January or February 1980, 1984, 1995, 2007: cells exceeded 1 million cells/L

• December – April: red tide commonly observed since monitoring has increased

Currents transport red tide south

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Red tide fish kill reports November 2017 - September 2018



Currents transport red tide south

Monthly summaries on Flickr: http://myfwc.com/research/redtide/media/



http://myfwc.com/research/saltwater/health/fish-kills-hotline/

FL Bay - 1/28-2/20: Numerous reports of fish kills including: snapper, mullet, grouper, puffer, trout, catfish, cowfish, pinfish, grunt, hogfish, remora, mackarel, filefish, and others

Aerial surveys and satellite imagery to assess bloom extent



https://optics.marine.usf.edu/

Patchy red tide observed ~7-10 miles from shore

http://myfwc.com/research/redtide/statewide/

NEW: Daily Sample Map @ This map contains the last eight days of sampling and is updated daily at 5 p.m.

This map contains the last eight days of sampling and is updated daily at 5 p.m. Please be sure to click on individual dots for sampling details.

Direct link: http://myfwc.maps.arcgis.com/apps/View/index.html?appid=87162eec3eb846218cec711d16462a72



Respiratory irritation forecasts: https://tidesandcurrents.noaa.gov/hab/gomx.html



Gulf of Mexico Harmful Algal Bloom Bulletin

Monday, October 15, 2018 NOAA National Ocean Service NOAA Satellite and Information Service NOAA National Weather Service

Instructions for viewing this geospetial pdf are available at: https://go.usa.gov/kn9g2.



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The image above is the top layer in a series of maps for 10-15-18 to 10-19-18 displaying the highest level of potential respiratory initiation forecasts in each region.

The image above is the top layer in a series of maps for 10-12-18 to 10-18-18 displaying the highest level of potential respiratory initiation forecasts in each region.

Current conditions

10/13/18 ModisA 19:05 GMT, GCOOS product



Prediction of red tides and their impacts 3.5 day bloom transport forecasts: winds and currents Surface Near-bottom



USF Ocean Circulation Group/FWC Collaboration for the Prediction of Red Tides http://ocgweb.marine.usf.edu/hab_tracking/

New progress w/ seasonal forecasts

Mapping Marine Biodiversity in National Marine Sanctuaries

As part of the Marine Biodiversity Observation Network, eDNA methods utilize universal primer sets to target prokaryotes, phytoplankton, invertebrates, and vertebrates including bony fish and mammals in a single seawater samples (FWRI focus on eukaryotic phytoplankton in FL)



Sanctuaries MBON eDNA Standard Protocol





Several eukaryotic HAB genera identified:

Karlodinium, Alexandrium, Takayama, Prorocentrum, Gonyaulax, Cochlodinium, Dinophysis, Akashiwo, Azadinium, Ostreopsis, Pseudo-nitzschia

Dominant alga:

100% match to *Theleodinium* (freshwater dinoflagellate; sister genus to *Scrippsiella*)



NOAA cruise out right now!

Questions???

It takes a huge network to monitor, track, research, and predict Florida's diverse HABs http://myfwc.com/research/redtide/