Progress & Priorities for CyanoHABs in Florida: Insights from the State of the Science Symposium II

Water Institute Symposium 2024

Image: David Berthold, UF

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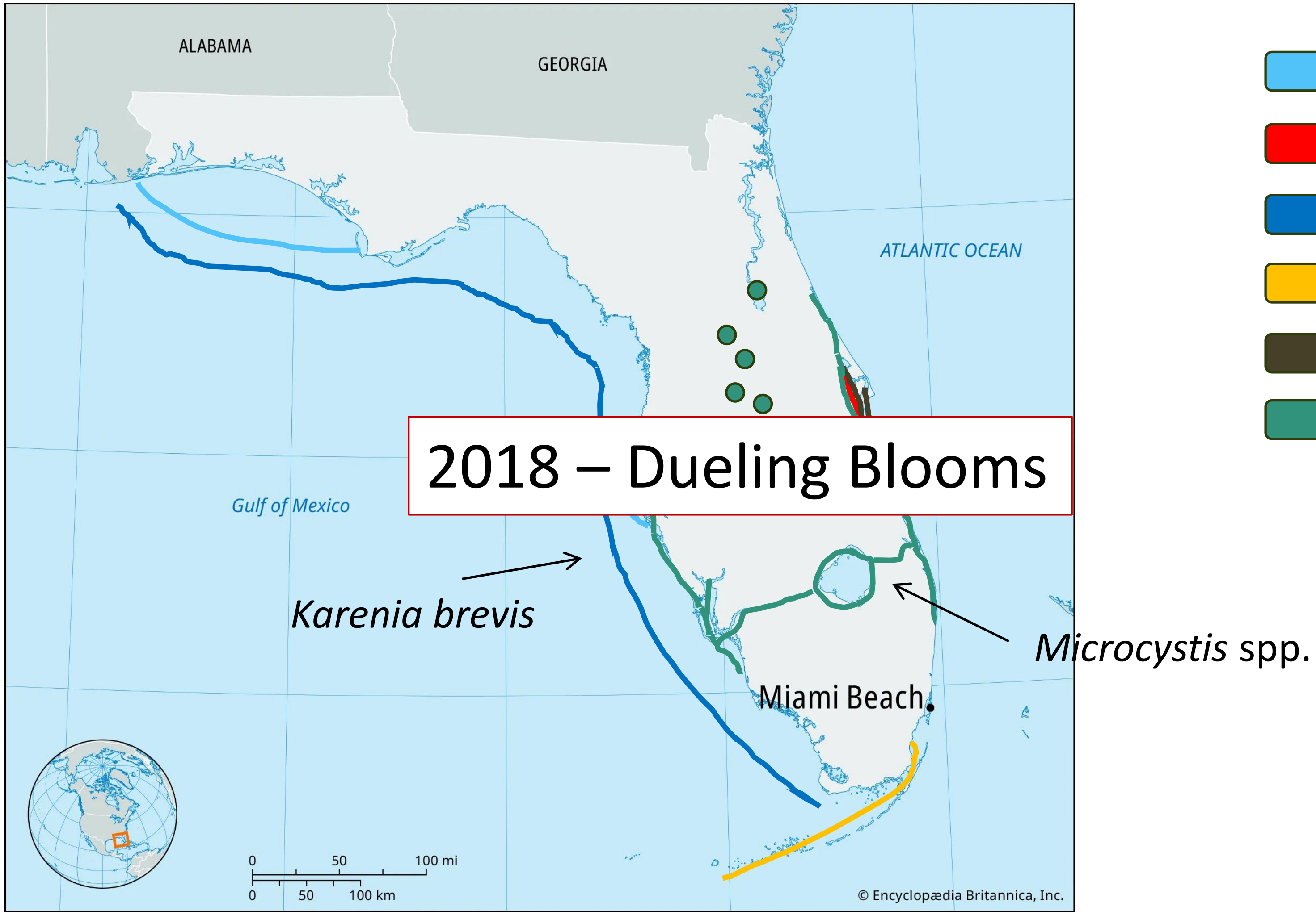
Florida Harmful Algal Blooms



- ASP
- PSP
- NSP
- CP
- Brown Tide
- CyanoHABs

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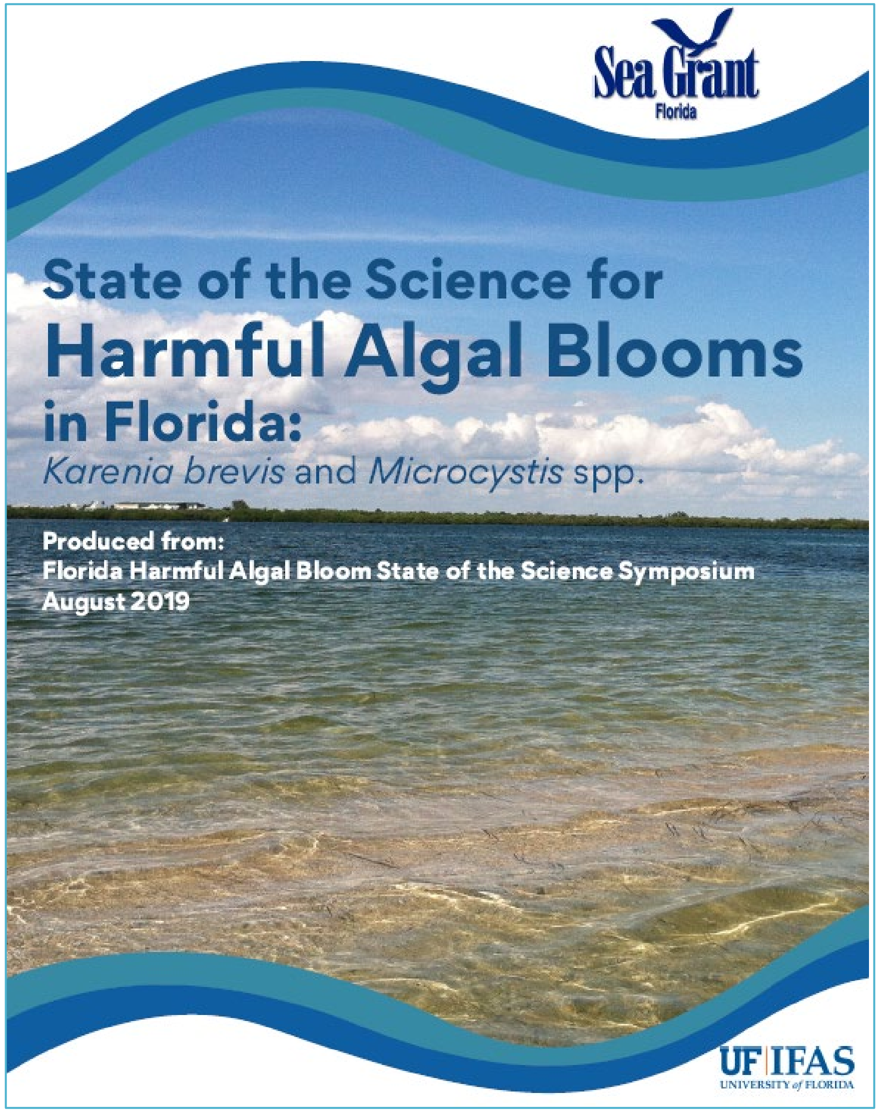
Florida HABSOS

AUGUST 20 & 21, 2019, USGS ST. PETERSBURG



Objectives

1. Facilitate information exchange and networking opportunities among Florida's harmful algal bloom scientists
2. Assess current state of knowledge for Florida's HABs with a focus on *Karenia brevis* and *Microcystis aeruginosa*
3. Identify data gaps and research needs and prioritize high level research priorities for moving the state of the science forward

I. Initiation, Development & Termination
II. Prediction & Modeling
III. Detection & Monitoring
IV. Mitigation & Control
V. Public Health

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BGASOS II – 4 YEARS LATER

May 15 & 16, 2023, Maitland, FL

Goals

1. Identify what progress has been made since the inaugural symposium in 2019, determine what knowledge gaps still exist, and prioritize new research needs to inform and improve cyanoHAB management in Florida;
2. Efficiently share updates on new findings and ongoing efforts to ensure that the most current best practices are being employed statewide and that ongoing efforts are not being duplicated.

PROCESS

Image: David Berthold, UF

BGASOS II
4 YEARS LATER

Statewide phytoplankton cyanoHABs

I. Drivers of bloom initiation & termination
II. Prediction & Modeling
III. Detection & Monitoring
IV. Management & Mitigation
V. Public health

Other blooms of concern

VI. Pico & nanocyanobacteria in the IRL
VII. Benthic cyanoHABs in marine and freshwater systems

Research & Management Priorities

- 2019 Research Needs
- New Data Gaps
- Facilitated Discussion
- Registration Question

Best Practices

- Methodologies
- Sharing & Minimizing Duplication
- Social Science Needs
- Definition of a bloom

MAJOR TAKEAWAYS

Image: Lisa Krimsky, UF

Progress since 2019

2019 CyanoHAB Research Priorities

1. Understand the factors that contribute to initiation, persistence, severity, and decline of blue-green HABs ✓✓✓✓
2. Evaluate past and current hydrology and the effects of freshwater releases on blue-green algae in Lake Okeechobee ✓✓✓

3a. Determine what is responsible for variability in toxicity and toxin production ✓✓✓
3b. Determine the function(s) of toxins

4. Understand the movement of toxins into the environment, including air ✓✓
5. Determine variability of strain toxin levels and the relationship with N and P ✓✓✓
6. Determine the role of herbicides on bloom development
7. Determine how to adequately measure bloom initiation ✓✓
8. Evaluate the role of viruses and viral interactions ✓
9. Assess food web ramifications and develop better ecological models ✓

2019 Research Priorities for HABs in General

1. Evaluate bloom termination (including environmental and ecological factors such as predation, hypoxia, etc.) and what is released when a bloom dies
2. Identify and understand the role of nutrient sources supporting blooms, specific gaps include:
   - Linkages to eutrophication
   - Benthic-pelagic coupling (internal cycling)
   - River influences (including iron)
3. Understand bloom triggers via experimental work (lab, mesocosm, and field experiments) and predict their movement, behavior, and termination
   - Identify direct link between HABs and climate change, such as increased water temperatures

4a. Clarify the relationship between blue-green algae and red tide

2019 CyanoHAB Research Priorities

1. Collect regular nutrient (external and internal) load data into Lake Okeechobee ✓✓

2a. Improve blue-green algae prediction ✓✓✓
2b. Develop good physical models of water column structure and circulation ✓✓✓

3a. Evaluate the accuracy of satellite imagery compared to discrete and *in situ* sampling ✓✓
3b. Create a better explanation of satellite imagery for the lay audience ✓

2019 Research Priorities for HABs in General

1. Develop models that can separate point source and non-point sources of pollution
2. Examine the relationships between water quality and bloom predictions

2019 CyanoHAB Research Priorities

1. Enhance blue-green algae monitoring, including time series (longitudinal) as another data point ✓✓✓
   - Improve blue-green algae field identification ✓
2. Determine if and what role environmental conditions have on cyanotoxin levels ✓✓✓
3. Develop a standard method for measuring *Microcystis* (cells through molecular). (Look at other state regulations for improvements or change)

4a. Evaluate if and what relationship exists between biomass and toxin levels ✓
4b. Implement vertical profiles to get an accurate assessment of biomass

5. Evaluate the correlations between hypoxia and nutrient fluxes
6. Develop sampling plans that meet existing recommendations and use (e.g., WHO, EPA) ✓✓
7. Understand sensor limitations ✓
8. Detect and treat taste and odor compounds

2019 Research Priorities for HABs in General

1. Conduct more comprehensive and consistent monitoring (biology, chemistry, and physics) including:
   - High resolution, *in situ* monitoring of bloom dynamics
2. Form partnerships (government, academia, and industry) to develop monitoring programs that will be comprehensive and non-overlapping. All types of HABs could be monitored during well-designed monitoring programs

3a. Develop affordable/effective field tests that are able to measure cells and toxins simultaneously
3b. Understand the fate and effects of HAB toxins

4. Plan for comprehensive statewide monitoring and mitigation response
5. Invest in updated and cost-effective monitoring technology

2019 CyanoHAB Research Priorities

1. Control all nutrient pollution (N & P) – including different forms of N (urea, ammonia, etc) ✓✓
   - Determine the relative importance (quantitative measures) of different nutrient inputs
   - Convert all septic tanks near water to municipal sewage

2a. Determine if your management practice will actually achieve the goal of reducing blooms in Lake Okeechobee and what the ramifications are (chemical, biological, ecological, socioeconomic) ✓✓✓
2b. Develop blue-green algae control methods ✓
2c. Evaluate and weigh engineering approaches versus ecological approaches ✓✓

3. Evaluate what hydrologic conditions can impact management and future management options ✓
4. Determine a strategy for effective messaging to public regarding expectations, timelines, and costs
5. Create a central database for alternative technologies ✓

2019 Research Priorities for HABs in General

1. Conduct pilot studies (lab, mesocosm, small areas) to mitigate blooms using new technologies ✓
2. Conduct coastal watershed investments/restoration activities that would reduce the occurrence, duration, and severity of future blooms
3. Plan for comprehensive statewide monitoring and mitigation response
4. Create a business or political model that funds or implements a mitigation or control solution ✓
   - Conduct a cost-benefit analysis to promote the business model

2019 CyanoHAB Research Priorities

1. Identify all toxins, risk, and levels of toxicity, including microcystin, BMAA, stress ✓✓✓
   - Determine longevity of diverse cyanotoxins in biota relevant for human health consumption
   - Understand the persistence of microcystins in sediments and the water column, their ability to be remobilized, and how that effects drinking water
   - Determine human exposure pathways through the food chain (e.g., beef, seafood, crops, and milk) ✓
   - Assess synergistic effects of toxins with other toxic chemicals
2. Develop more clear diagnostic criteria for health care providers ✓✓✓✓
3. Need clinically approved matrix-specific assays for cyanotoxins in biological samples ✓✓
4. Establish more effective guidelines for drinking water treatment for all contaminants (i.e., saxitoxin)
5. Determine the best way to measure toxins in the food web

2019 Research Priorities for HABs in General

1. Improve knowledge of and evaluate human and ecosystem health impacts, both short- and long-term
2. Conduct long-term, longitudinal health studies on the chronic, low-level exposure to HAB toxins in humans, including cumulative

3a. Evaluate physical, mental, and social health risks for the public and those implementing control strategies
3b. Determine psycho-social impact on individuals living near blooms

4. Identify human exposure to toxins through air and seafood vectors
5. Evaluate mixed exposures
6. Identify risk for all populations and occupations
7. Develop interdisciplinary teams ✓
8. Understand dose-response

Top 3

Research Priorities

Drivers	Prediction & Modeling	Detection & Monitoring	Management & Mitigation	Public Health
1. Understand the factors that contribute to initiation persistence, severity, and decline of blue-green HABs	1. Develop short and long-term operational forecasts of blooms	1. Need more comprehensive strategic routine monitoring (during non-bloom conditions), in addition to event HAB response sampling	1. Holistically improve nutrient source management to reduce nutrient pollution (N & P)	1. Understand short and long-term health effects from exposure to cyanotoxins
2. Understand nutrient sources and stoichiometry	2. Collect regular(internal & external) nutrient load data and develop nutrient budgets	2. Monitoring should include both taxonomic and nutrient assessment	2. Develop scalable HAB mitigation tools that are economically feasible	2. Develop more clear diagnostic criteria for health care & vet med professionals
3. Understand fundamental biochemistry & bloom dynamics	3. Improve the comparability of satellite imagery with discrete & *in situ sampling*	3. Conduct long-term quantitative monitoring of complete phytoplankton assemblages alongside routine water quality monitoring	3. Develop new technologies for mitigating sediments as related to HABs (nutrients mitigation)* 3. Need to field test potential control and/or mitigation strategies*	3. Characterize human exposure to cyanotoxins

* Tied vote

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Best Practices

Methodologies

- Universal streamlining of methodologies & parameters is not realistic
- Focus on:
  - Assurance of quality data
  - Metadata

Sharing & Minimizing Duplication

- Focused symposia – BGASOS
- Improved communication among funding agencies
- Central repository for cyanoHAB research & management community

Social Science

- Improve communication to various audiences
- Message framing to encourage informed decision-making
- Economic impact assessments

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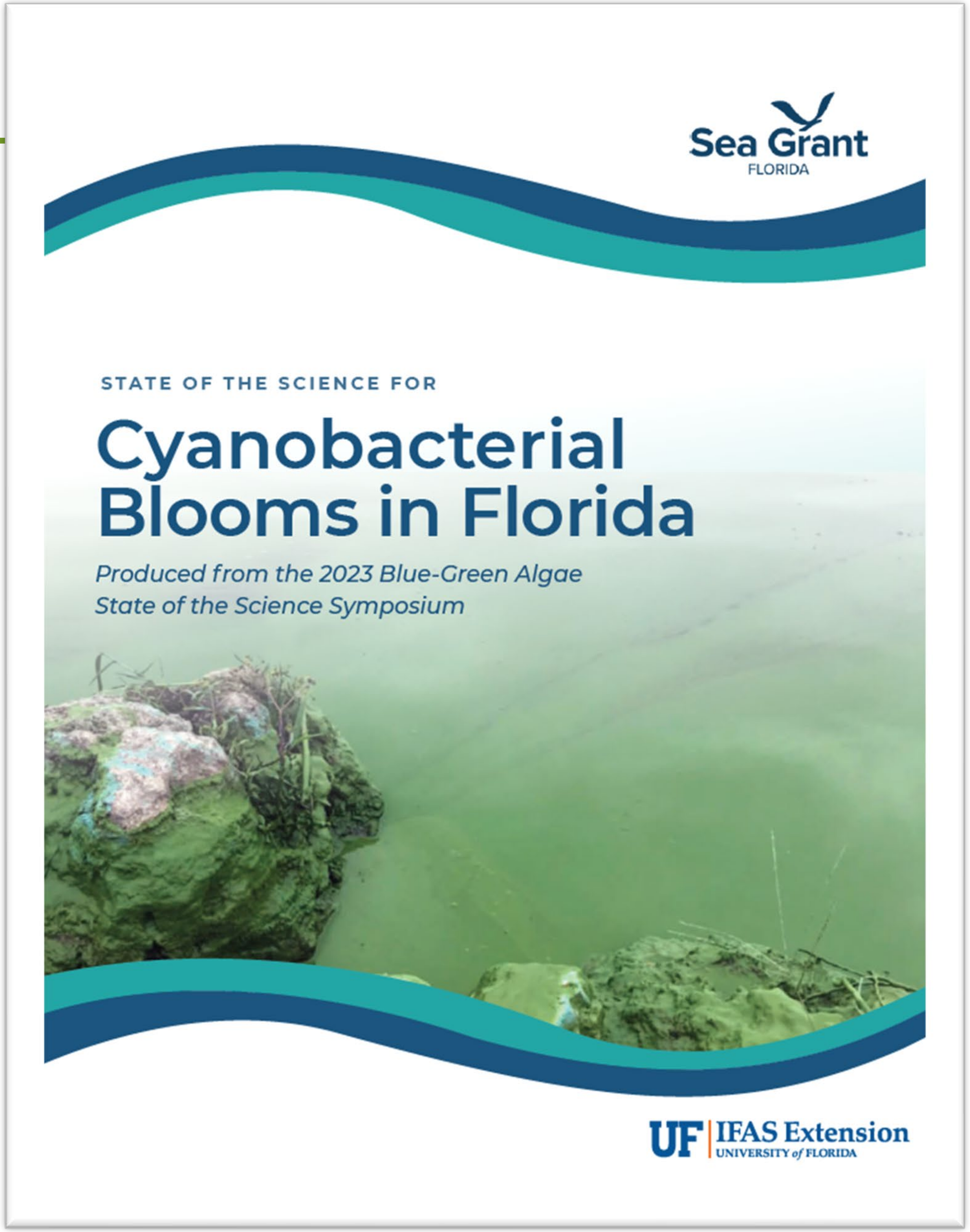
Final Report

Compiled Symposium Findings

- Consensus statements for what we've learned since 2019 (BGA phytoplankton)
- Prioritized Research Needs
- Best Practices
- Consensus statements
  - Pico- and nano-cyanoHABs in IRL
  - Benthic cyanoHABs in FL marine and freshwater systems



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Thank you

Lisa Krimsky
UF/IFAS Extension, Florida Sea Grant
lkrimsky@ufl.edu

Betty Staugler
Florida Sea Grant
Staugler@ufl.edu

Image: Lisa Krimsky, UF