# Harmful Algal Blooms

# Funding for Better Monitoring, Prediction and Public Notification

CALUSA WATERKEEPER®

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# Presentation Outline

- What are HAB blooms and common species with an emphasis on cyanobacteria
- Characteristics that make the cyanobacteria successful
- Problems related to toxin production related to both public health and the economy
- The Florida HAB Task Force

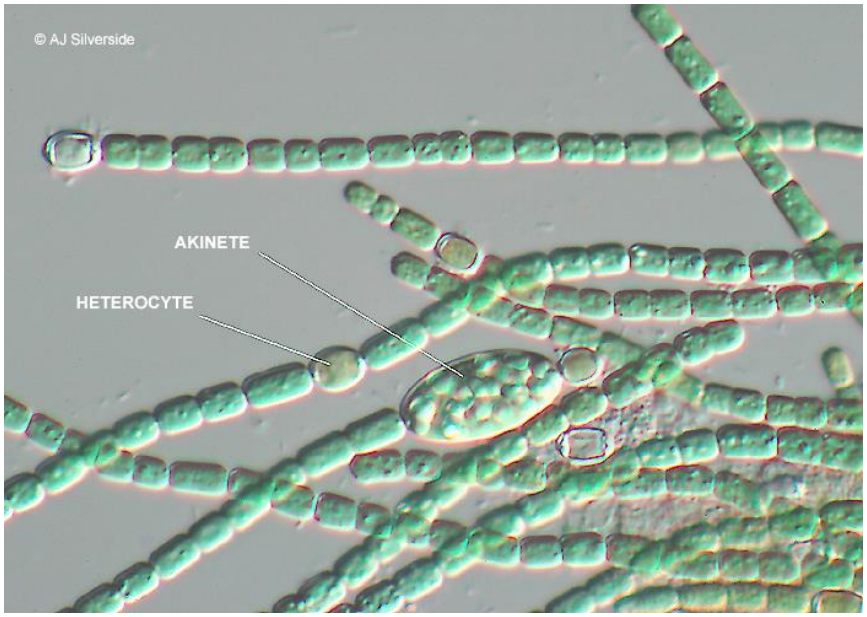
# Harmful Algal Blooms

**Defined generally as overgrowths of algae in water, some producing dangerous toxins**

- **Red Tides – marine dinoflagellates, can produce toxins**
- **Blue-green algae or cyanobacteria, freshwater and estuarine systems**

# Cyanobacteria

***Microcystis***




***Anabaena***

- One of the earliest life forms on the planet, oldest known photosynthetic microorganisms
- The ability to process atmospheric nitrogen and render it into an organic form
- Can regulate their position in the water column near the surface for optimal light
- Prefer warm, nutrient-rich fresh or brackish water with minimal flow or turbulence
- Produce toxins dangerous to humans and animals – at least 46 species cause toxic effects in vertebrates, at least 15 spp in FL
- Harmful algal blooms have severe impacts on human health, aquatic ecosystems and the economy.

In This Issue:

# ET&C FOCUS

Focus articles are part of a regular series intended to sharpen understanding of current and emerging topics of interest to the scientific community.

## Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems?

Bryan W. Brooks,*† James M. Lazorchak,‡ Meredith D.A. Howard,§ Mari-Vaughn V. Johnson,‖ Steve L. Morton,# Dawn A.K. Perkins,†† Euan D. Reavie,‡‡ Geoffrey I. Scott,§§ Stephanie A. Smith,‖‖ and Jeffery A. Steevens##

†Department of Environmental Sciences, Center for Reservoir and Aquatic Systems Research, Institute of Biomedical Studies

Harmful Algae
Volume 8, Issue 1, December 2008, Pages 3-13

# Eutrophication and harmful algal blooms: A scientific consensus

Author links open overlay
panelJ.Heisler[a3]P.M.Glibert[b]J.M.Burkholder[c]D.M.Anderson[d]W.Cochlan[e]W.C.Dennison[b]Q.Dortch[f]C.J.Gobler[g]C.A.Heil[h1]E.Humphries[i]A.Lewitus[jk2]R.Magnien[l2]H.G.Marshall[m]K.Sellner[n]D.A.Stockwell[o]D.K.Stoecker[b]M.Suddleson[f]
https://doi.org/10.1016/j.hal.2008.08.006

- **Degraded water quality from increased nutrient pollution promotes the development and persistence of many HABs and is one of the reasons for their expansion in the U.S. and other nations.**

DWR-733

Environmental Microbiology Reports (2009) **1**(1), 27–37 doi:10.1111/j.1758-2229.2008.00004.x

Minireview

# Climate change: a catalyst for global expansion of harmful cyanobacterial blooms

**“climatic change may benefit various species of harmful cyanobacteria by increasing their growth rates, dominance, persistence, geographic distributions and activity.”**

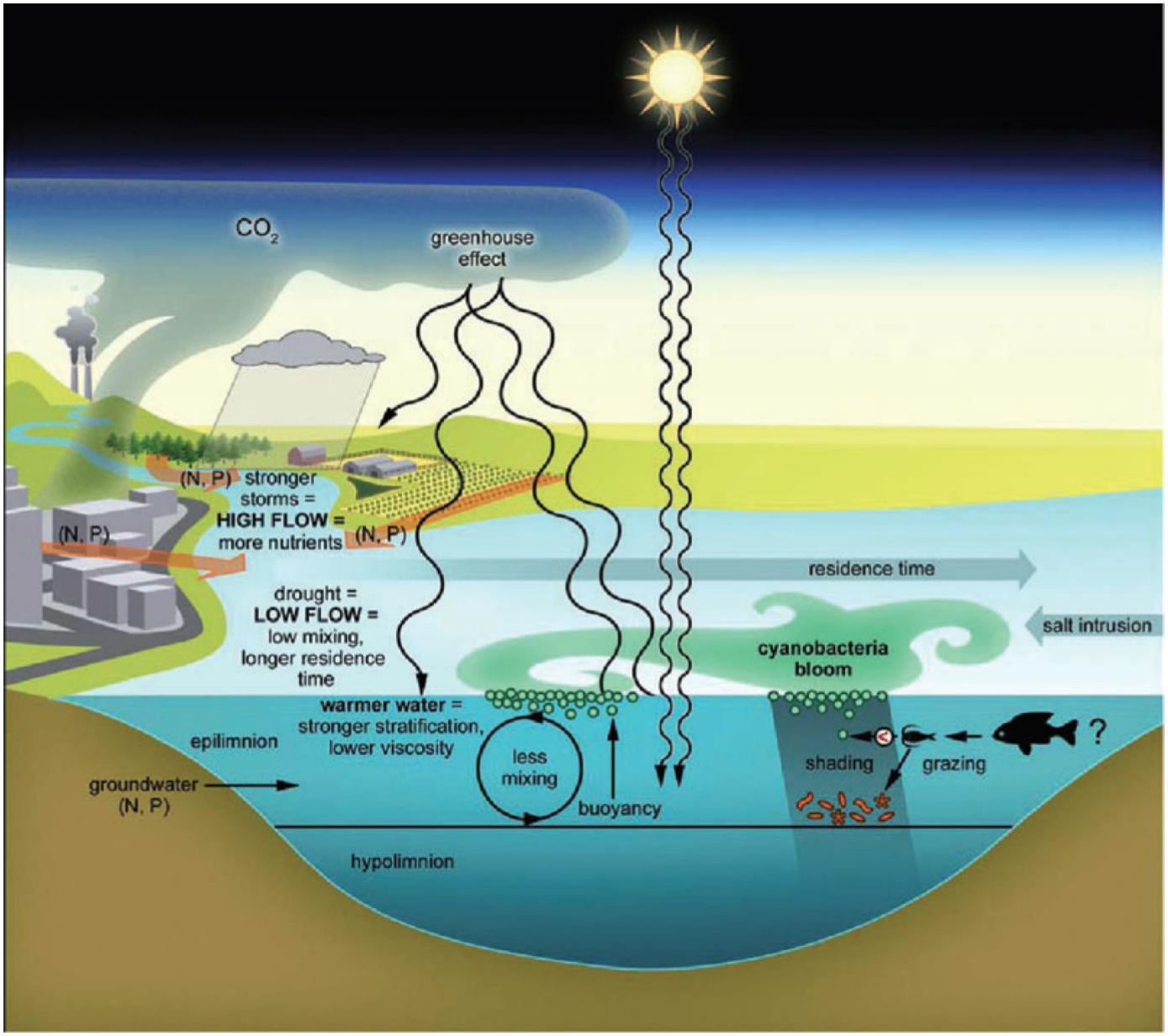



**Fig. 4.** Conceptual figure, illustrating the environmental controls of cyanobacterial bloom dynamics, and the direct and indirect effects of climate change on these dynamics.

# WATERKEEPER ALLIANCE PROTECTS THE NATION'S WATERS FROM HARMFUL ALGAL BLOOMS

Waterkeeper organizations protect waters across the US from harmful algal blooms by fighting their root causes: nutrient pollution from industrial agriculture, wastewater treatment plants and other sources.

Sustainable Table®
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Waterkeeper Alliance
@waterkeeper

# HABs and Public Health Issues

# Cyanotoxins

**Microcystins** (hepatotoxins)

> most widespread cyanobacterial toxins

> can bioaccumulate

> potentially carcinogenic

**Cylindrospermopsin** (hepatotoxin)

> toxic to liver and kidney

**Anatoxins** (neurotoxin)

**Saxitoxins** (Paralytic Shellfish Poisoning toxin)

> Also reported in freshwater

**BMAA** (neurotoxin)

# Modes of Exposure to Cyanotoxins

- **Dermal**
- **Inhalation or aspiration from aerosolized surface water**
- **Ingestion**

**EPA 10-day risk based drinking water guidelines.**

| Cyanotoxin | Drinking Water Health Advisory (10-day) | |
|---|---|---|
| | Bottle-fed infants and pre-school children | School-age children and adults |
| Microcystins | 0.3 µg/L | 1.6 µg/L |
| Cylindrospermopsin | 0.7 µg/L | 3 µg/L |

**Lee County Public Water Supply – Olga Water Treatment Plant**
**Supply Source is the Caloosahatchee River**
**Frequently shut down due to presence of cyanobacteria**

Harmful Algae
Volume 1, Issue 2, June 2002, Pages 157-168

# Blue green algal (cyanobacterial) toxins, surface drinking water, and liver cancer in Florida

Lora EFleming, CarlosRivero, JohnBurns, ChrisWilliams, Judy ABean, Kathleen AShea, John Stinn

**“A significantly increased risk for HCC with residence within the service area of a surface water treatment plant was found compared to persons living in areas contiguous to the surface water treatment plants. “**

BREAKING NEWS

# Ohio State University study links toxic algae blooms, fatal liver disease | Video

TYLER TREADWAY, TC PALM
MAY 22, 2017

*Francisco Hernandez skims dying blue-*

# Risk From Recreational Exposure – Primary Contact

**Table 6-1. Recreational Criteria or Swimming Advisory Recommendations for Microcystins and Cylindrospermopsin**

| Application of Recommended Values | Microcystins | | | Cylindrospermopsin | | |
|---|---|---|---|---|---|---|
| | Magnitude (µg/L) | Frequency | Duration | Magnitude (µg/L) | Frequency | Duration |
| Swimming Advisory | 4 | Not to be exceeded | One day | 8 | Not to be exceeded | One day |
| Recreational Water Quality Criteria | | No more than 10 percent of days | Recreational season (up to one calendar year) | | No more than 10 percent of days | Recreational season (up to one calendar year) |

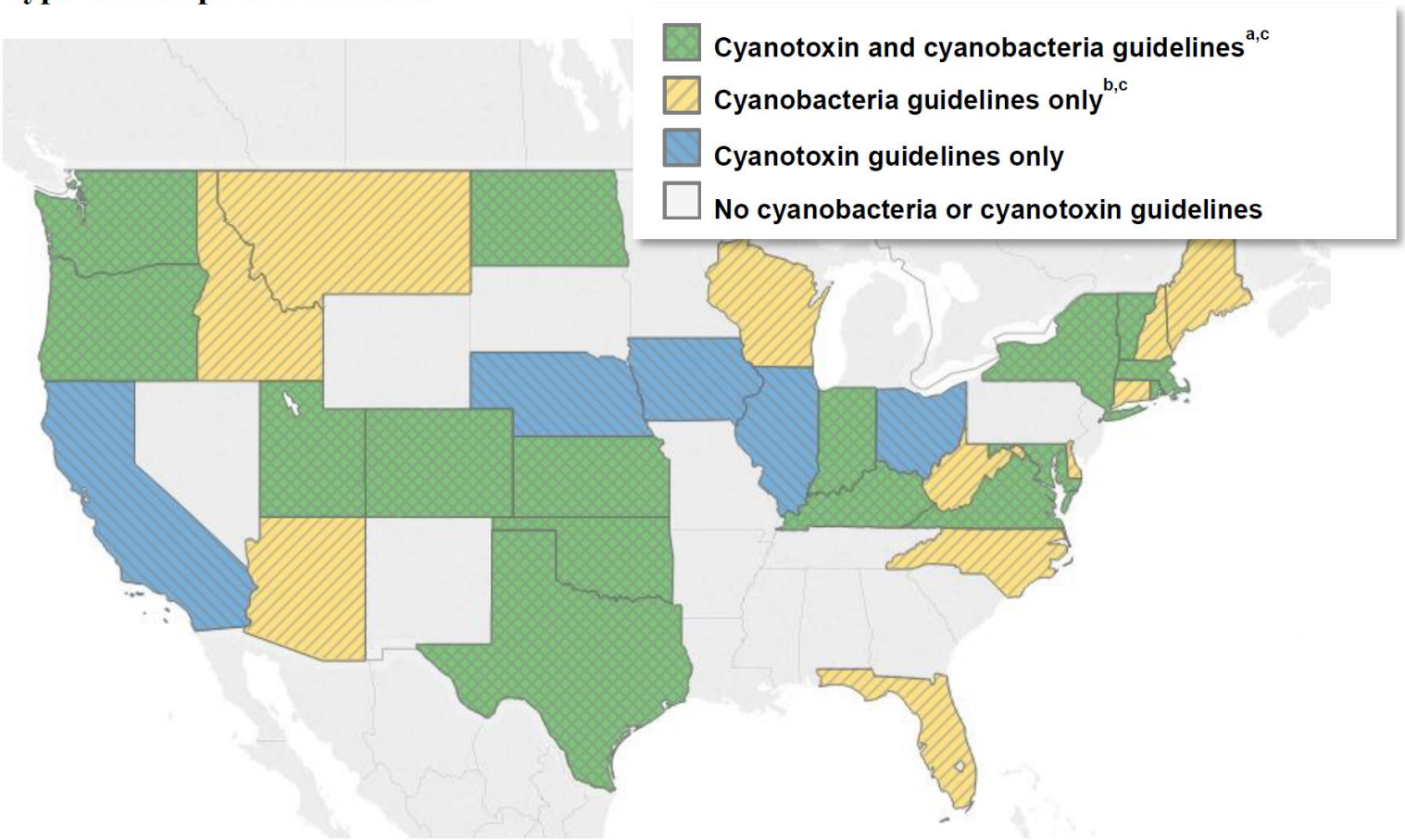
As an example:

- To protect swimmers, the concentration of total microcystins shall not exceed 4 micrograms per liter in a day.

- To protect the recreational use, the concentration of total microcystins shall not exceed 4 micrograms per liter more than 10 percent of days in a recreational season.

- Caloosahatchee River has had documented concentrations of Microcystin of > **5000 ug/l**
- Lake Okeechobee had a reported concentration of Microcystin of > **800 ug/l**

**Figure 2-3. State Guidelines for Cyanotoxins and Cyanobacteria in Recreational Water by Type and Scope of Guidelines**



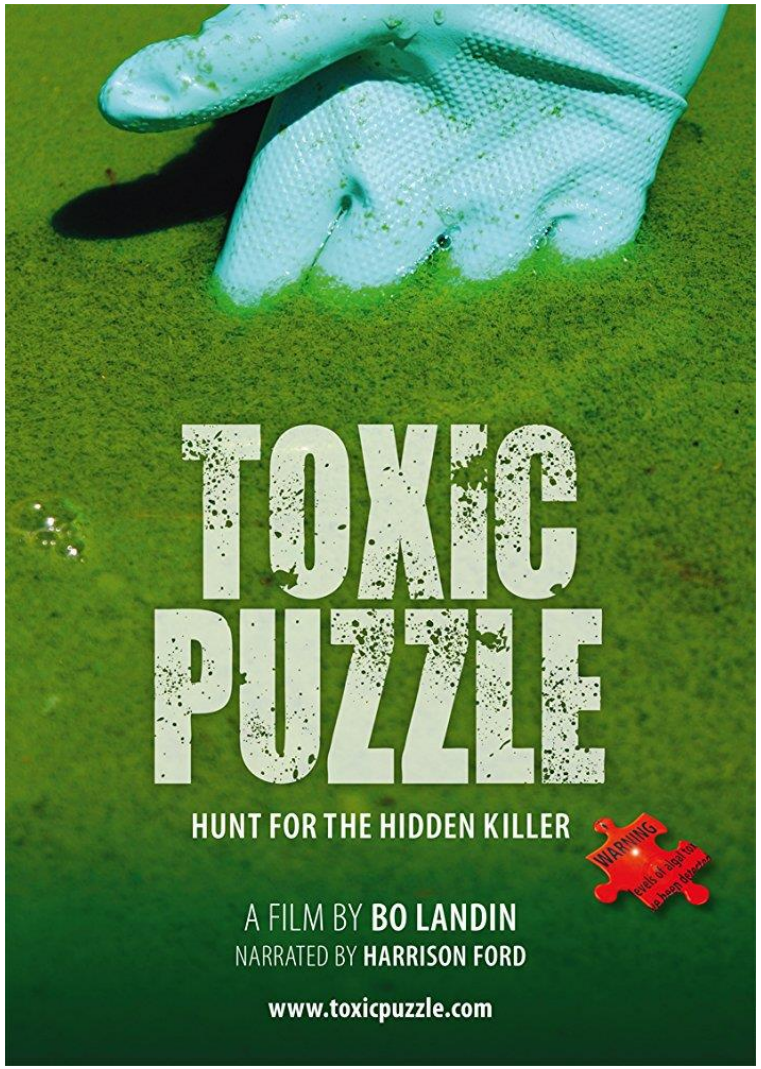
| State | Lowest Recreational Water Guideline or Action Level[a] | Reference |
|---|---|---|
| | water is generally clear; OR blue-green algae cells > 20,000 cells/mL and < 100,000 cells/mL | Environment (2013) |
| Delaware | thick green, white, or red scum on surface of pond | Delaware Department of Natural Resources and Environmental Control: Division of Water (2016) |
| Florida | cyanobacteria bloom | Florida Department of Environmental Protection (2016); Florida Department of Health (2016) |
| Idaho | *Microcystis* or *Planktothrix*: > 40,000 cells/mL | IDEQ (2015) |
| | sum of all potentially toxigenic taxa: ≥ 100,000 cells/mL | |
| Illinois | microcystin-LR: > 10 µg/L | Illinois Environmental Protection Agency (2015) |
| Indiana | blue-green algae: 100,000 cells/mL | Indiana Department of Environmental Management (2015) |
| | microcystin-LR: 6 µg/L | |

keysnews.com FLORIDA KEYS

# Toxins in algae linked to neurological diseases

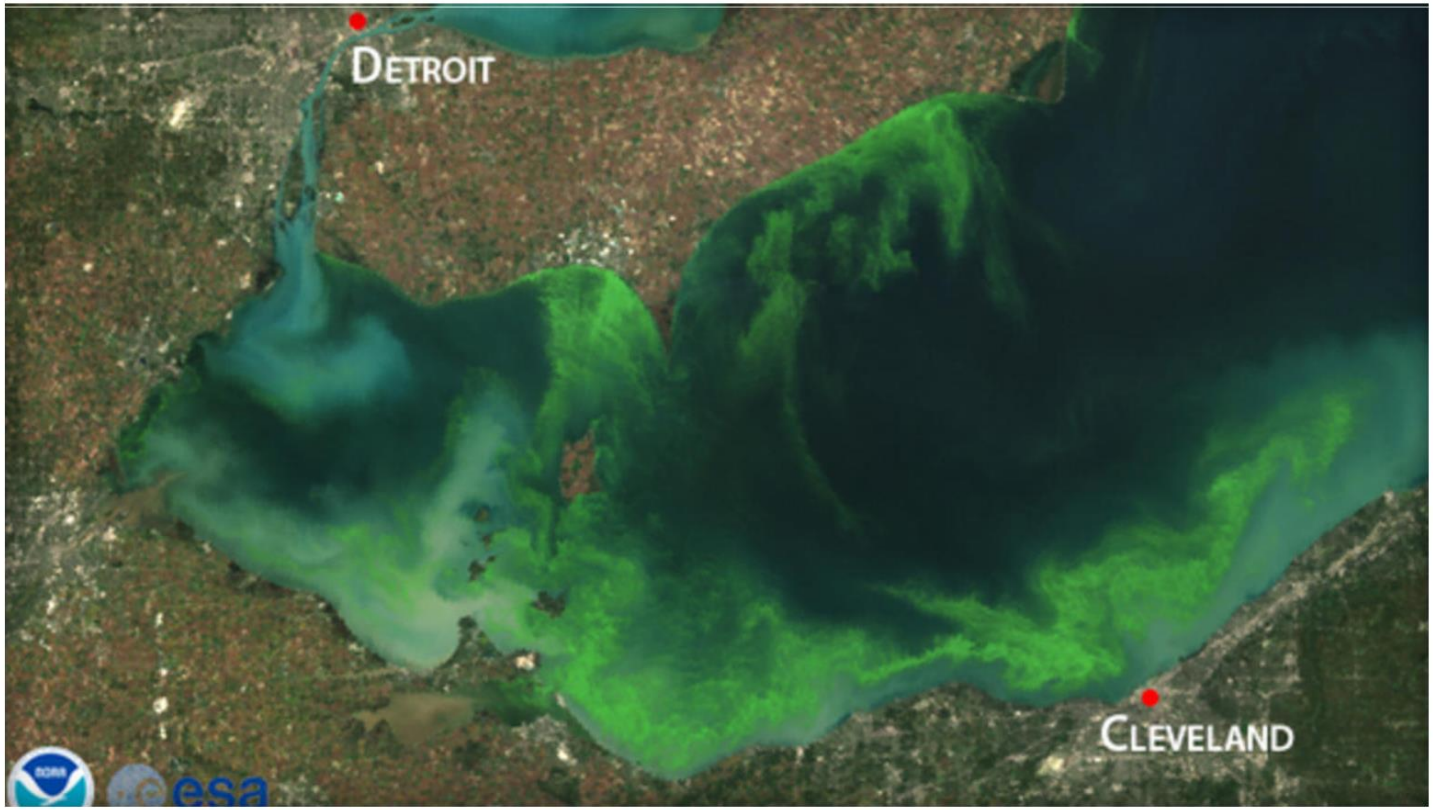
By Chuck Wickenhofer Free Press Staff

November 29, 2017



By AMY KRAFT / CBS NEWS / January 21, 2016, 3:32 PM

# Algae bloom toxin linked to Alzheimer's, other diseases




Satellite image of a toxic algae bloom in Lake Erie in 2011, one of the worst blooms in recent years. / **MERIS/ESA, PROCESSED BY NOAA/NOS/NCCOS**

# Institute for EthnoMedicine

**PUBLIC RELEASE: 22-JAN-2016**

Environmental toxin may increase risk of Alzheimer's disease and other neurodegenerative illnesses

*First time scientists have observed brain tangles in an animal model through exposure to environmental toxin*

# Cyanobacterial Blooms and the Occurrence of the neurotoxin beta-N-methylamino-L-alanine (BMAA) in South Florida Aquatic Food Webs

Larry E. Brand,[1,*] John Pablo,[2] Angela Compton,[1] Neil Hammerschlag,[1] and Deborah C. Mash[2]

Harmful Algae. Author manuscript; available in PMC 2011 Sep 1.
Published in final edited form as:
Harmful Algae. 2010 Sep 1; 9(6): 620–635.
doi: 10.1016/j.hal.2010.05.002

"It is predicted that human exposure to cyanobacteria and BMAA will increase, leading to a possible increased incidence of neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and Amyotrophic Lateral Sclerosis (ALS)."

# Health Risks to Animals

- Domestic animals and wildlife are also subject to poisoning by cyanotoxins
- Dogs are particularly vulnerable due to habit of swimming in or drinking contaminated water
- 58% of occurrences were fatal (Backer et al. 2013)
- Impacts of cyanotoxins on domestic and wild animals is significantly under-recognized.

# Status and Trends of HABs Nationally and in Florida

- Many HABs are **increasing in severity and frequency, and biogeographical range**.
- The number of **hypoxic** water bodies in the U.S. has increased 30 fold since the 1960s with over 300 coastal systems now impacted.
- Frequency of cyanoblooms in Caloosahatchee basin has gone from 2-3 blooms during the 1990s to every other year over the past decade.
- Monitoring and public health advisories have been inadequate often blamed on lack of adequate resources.

# Algal blooms in Lake Erie have been increasing

## 2011 harmful algal bloom

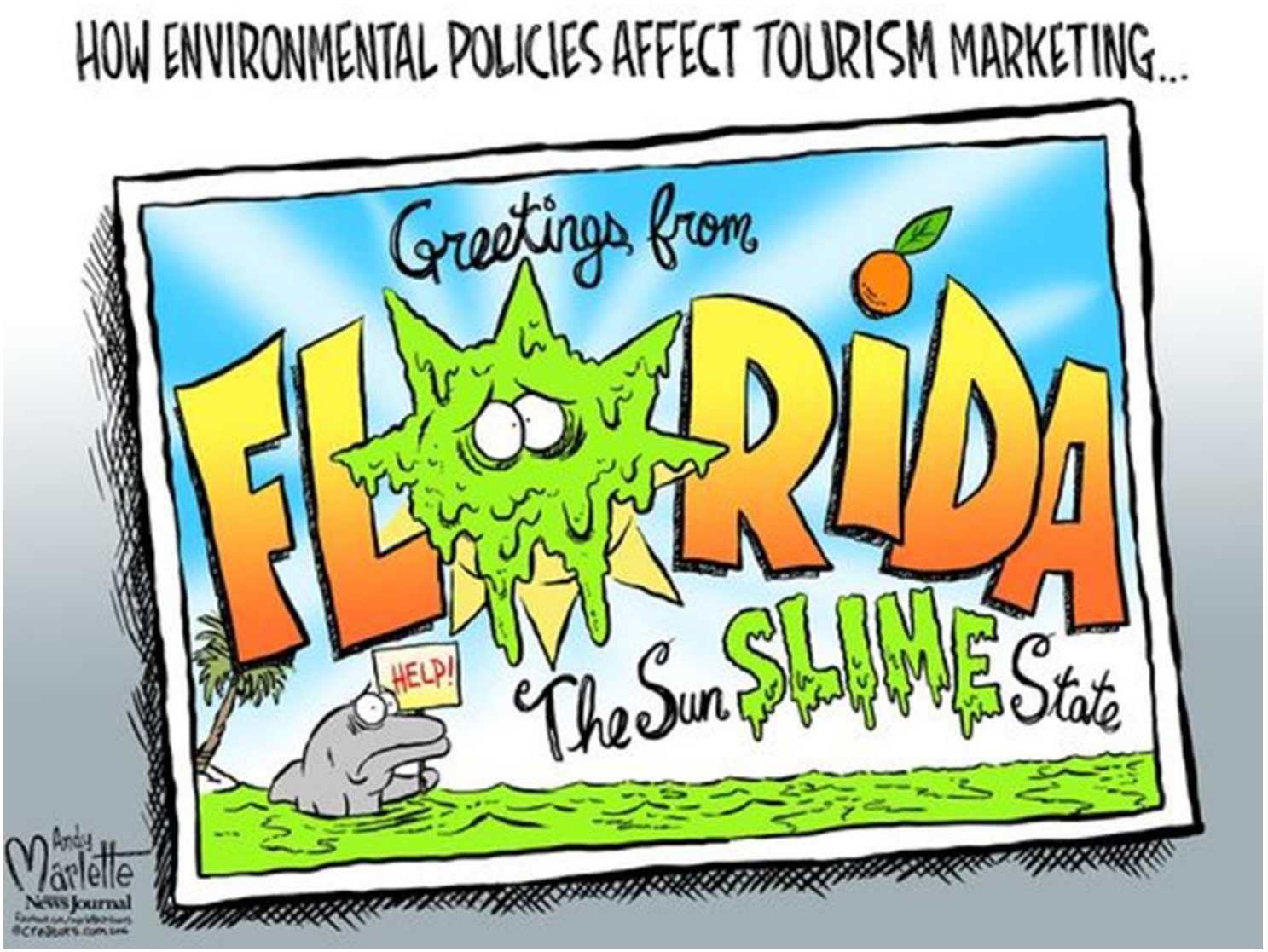
Primarily *Microcystis aeruginosa*

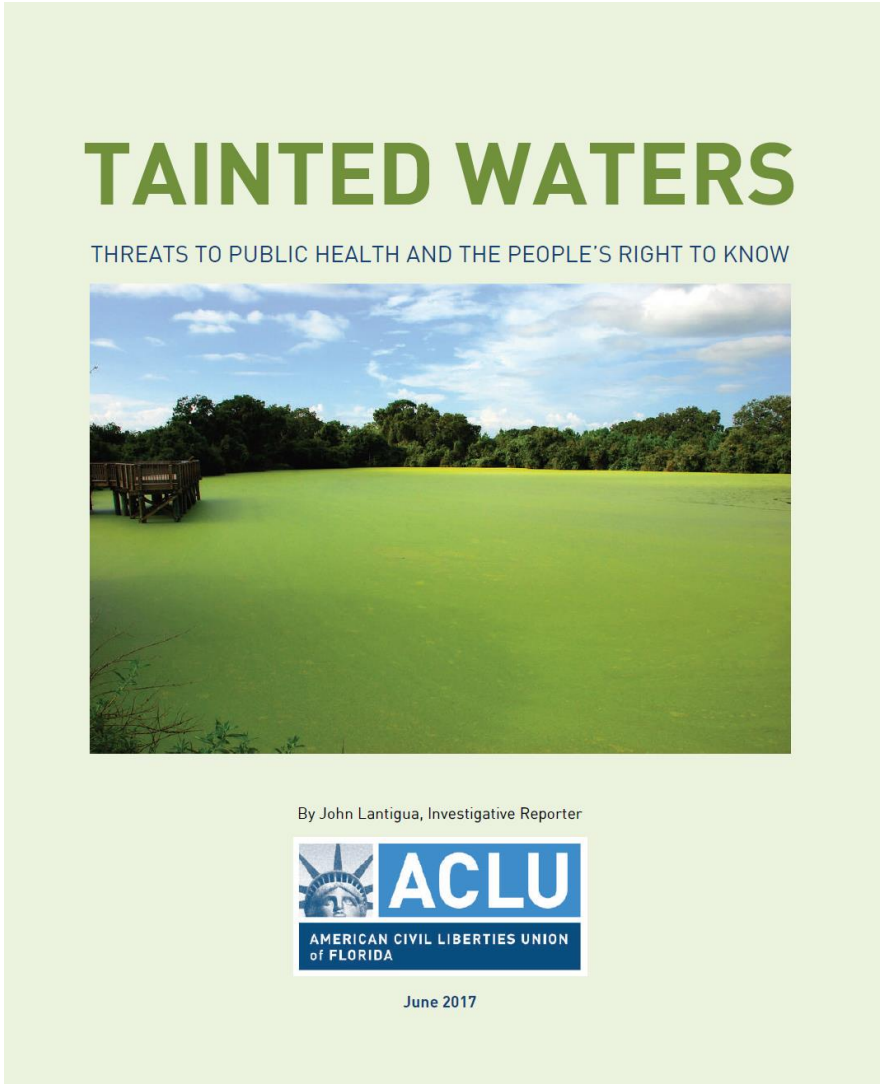

6 largest algal blooms since mid-1990s have occurred over the past 7 years

Toxins from the 2014 bloom shut down Toledo's (pop 400,000) drinking water

*May 2013 issue of National Geographic*

# 2016 Algae Bloom
# Governor Declares State of Emergency in Three Counties


HOW ENVIRONMENTAL POLICIES AFFECT TOURISM MARKETING...
Greetings from
FLORIDA
The Sun SLIME State
HELP!
Andy Marlette
News Journal




- **Delayed warnings from state agencies**
- **State toxicity measurements questioned. Readings much higher than state scientists report**
- **Lack of transparency in public information**
- **HAB Task Force Goes Unfunded**


Andy Marlette
News Journal
facebook.com/marlettecartoons
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LEMME GUESS: THIS IS OBAMA'S FAULT.
Scott

# Progress on Monitoring and Prediction of Cyanoblooms

# EPA Science Inventory

CONTACT US



# Satellite Remote Sensing and Crowd Sourcing to Monitor and Predict Cyanobacteria Blooms

**Citation:**

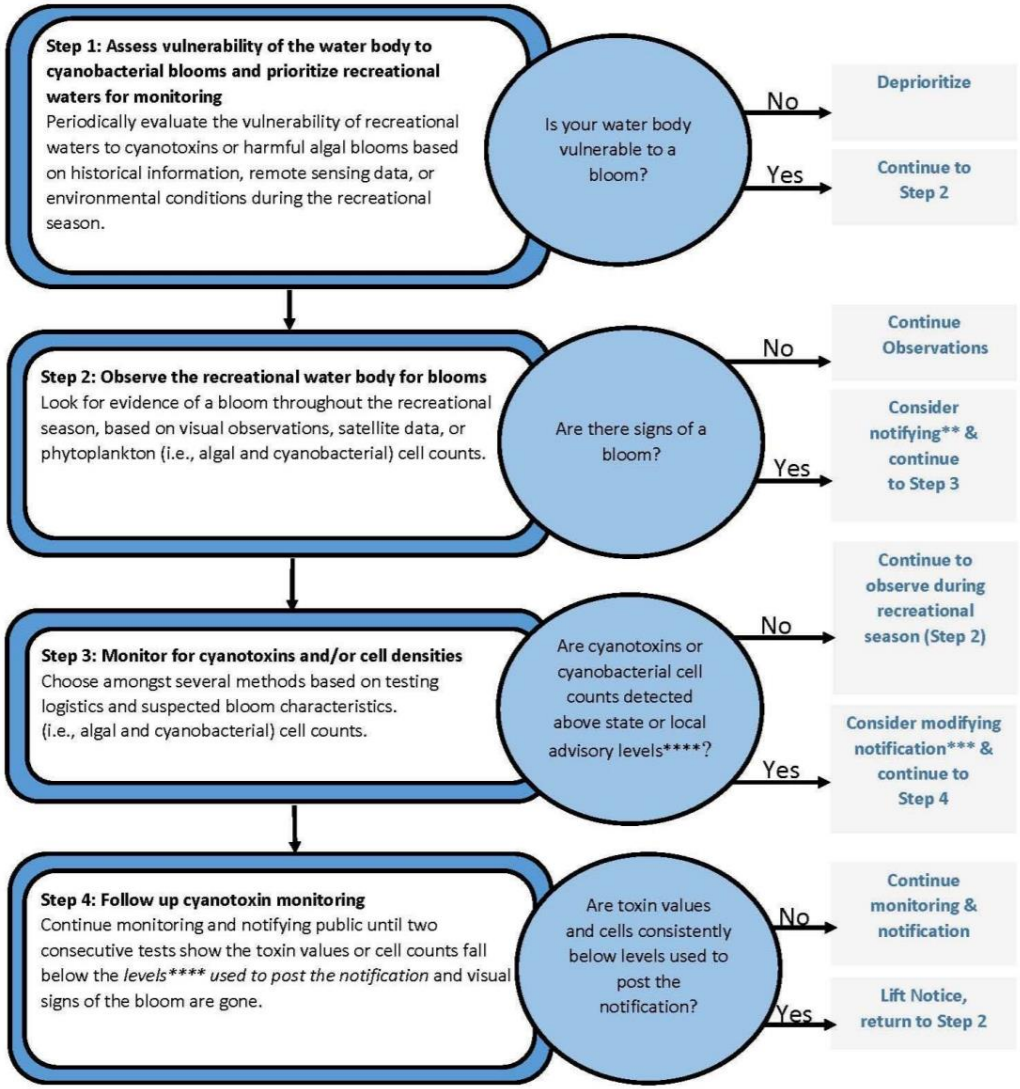
Schaeffer, B., R. Lunetta, AND R. Stumpf. Satellite Remote Sensing and Crowd Sourcing to Monitor and Predict Cyanobacteria Blooms. 9th National Monitoring Conference, Cincinnati, OH, April 28 - May 02, 2014.

**Contact**

NERLScience
email: nerlscience@epa.gov

The combined use of satellite technology with crowd sourcing provided a sophisticated stakeholder tool that may allow for more holistic management to reduce exposure risk to the public.

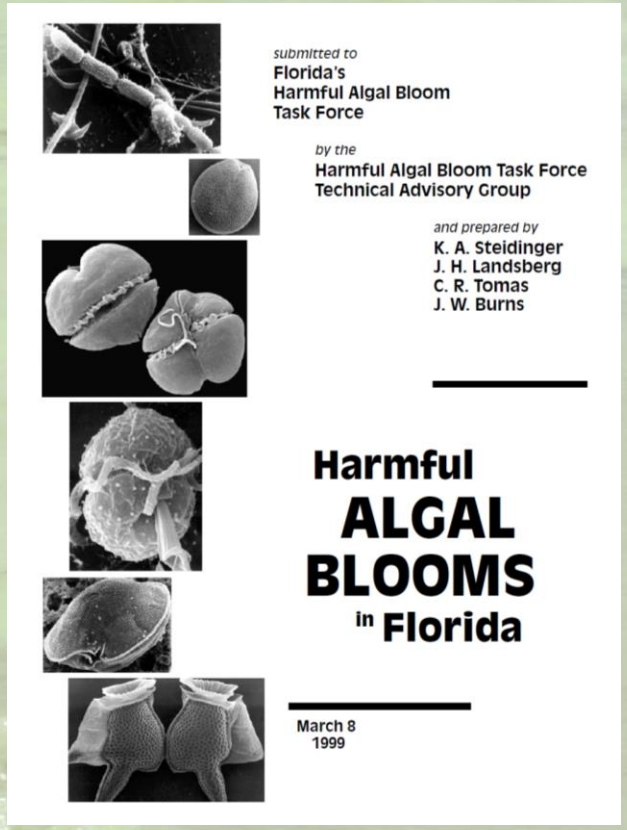
# How to Monitor Cyanobacteria/Toxins in Recreational Waters*



# Recreational Water Communication Toolbox for Cyanobacterial Blooms

# Florida HAB Task Force

- Established in 1999 through legislation
- Funded at about $1 million per year for 3 years
- Defunded in 2001
- Enabling statute still in effect FS 379.2271




SUNCOAST WATERKEEPER
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EMERALD COASTKEEPER
LAKE WORTH WATERKEEPER
COLLIER COUNTY WATERKEEPER
CC WK
CUSTOS QUIA AQUA MUNDO
TAMPA BAY WATERKEEPER
MATANZAS RIVERKEEPER
MIAMI WATERKEEPER
Suwannee RIVERKEEPER
ST. JOHNS RIVERKEEPER
Indian RIVERKEEPER
APALACHICOLA RIVERKEEPER
SAVING AN AMERICAN TREASURE

# Economic Impacts of Harmful Algal Blooms

A 2006 study shows that the economic impacts from a subset of HAB events in U.S. marine waters averaged to be $82 million/year (2005 dollars).

However, just one major HAB event can cost local coastal economies **tens of millions of dollars**, indicating that the nationwide economic impact of HABs is likely much larger.

Almost every state in the U.S. now experiences some kind of HAB event and the number of hypoxic water bodies in the U.S. has increased 30 fold since the 1960s with over 300 coastal systems now impacted.

# Economic Impacts From HABs in Florida

**Public Health**

**> $22 million lost annually**

**Tourism and Mitigation Costs**

**> $6.5 million in Okaloosa County 1995-2000**

**Commercial Fisheries Costs**

**> $18 million average annual impact (2000 dollars)**

**Florida Assoc. of Realtors 2015 report estimates > $500 million increase in property values when water clarity increase by one foot in Lee County alone.**

Miami New Times

Photo by L'eau Bleue / Flickr

# Florida Boat Companies Lose Millions as Polluted Waters, Fish Shortages Hammer Business

ISABELLA GOMES | AUGUST 4, 2017 | 8:30AM



Stationed beneath a navy-blue pennant, Capt. Chris Peterson strokes the plush lining of his company's prized 18-foot skiff. As a

# HAB Funding Inadequacy

TCPALM

## Algal blooms persist in Florida despite $35 million in federal funds

Lucas Daprile, lucas.daprile@tcpalm.com Published 10:02 a.m. ET Nov. 17, 2017 | Updated 10:08 a.m. ET Nov. 17, 2017

USDA

## *Algal blooms increase despite $1.8B USDA program*

***Lucas Daprile***

*Treasure Coast Newspaper s USA TODAY NETWORK - FLORIDA*

*The federal government's $1.8 billion*

*the state takes polluters at their word and does not factor in the use of treated human waste when calculating the effect of farm pollution on water quality.*

*Data the news organization released to*

- *Collier: $1.7 million*
- *Gilchrist: $1.4 million*
- *Okeechobee: $1.05 million*

# SUMMARY

- **Many HABs are increasing in severity, frequency, and biogeographical range.**
- **Federal deregulation combined with diminished funding will increase public health risks and economic impacts.**
- **Accelerated nutrient impairment of Florida waters has promoted HAB problems concurrent with rapid growth and static or decreased funding support.**

# Summary continued

- Advances in prediction and monitoring tools should be integrated into actionable policy.

- Reinstating and adequately funding the Florida HAB Task Force would be a significant step toward development of quantitative criteria for better monitoring and public notification.

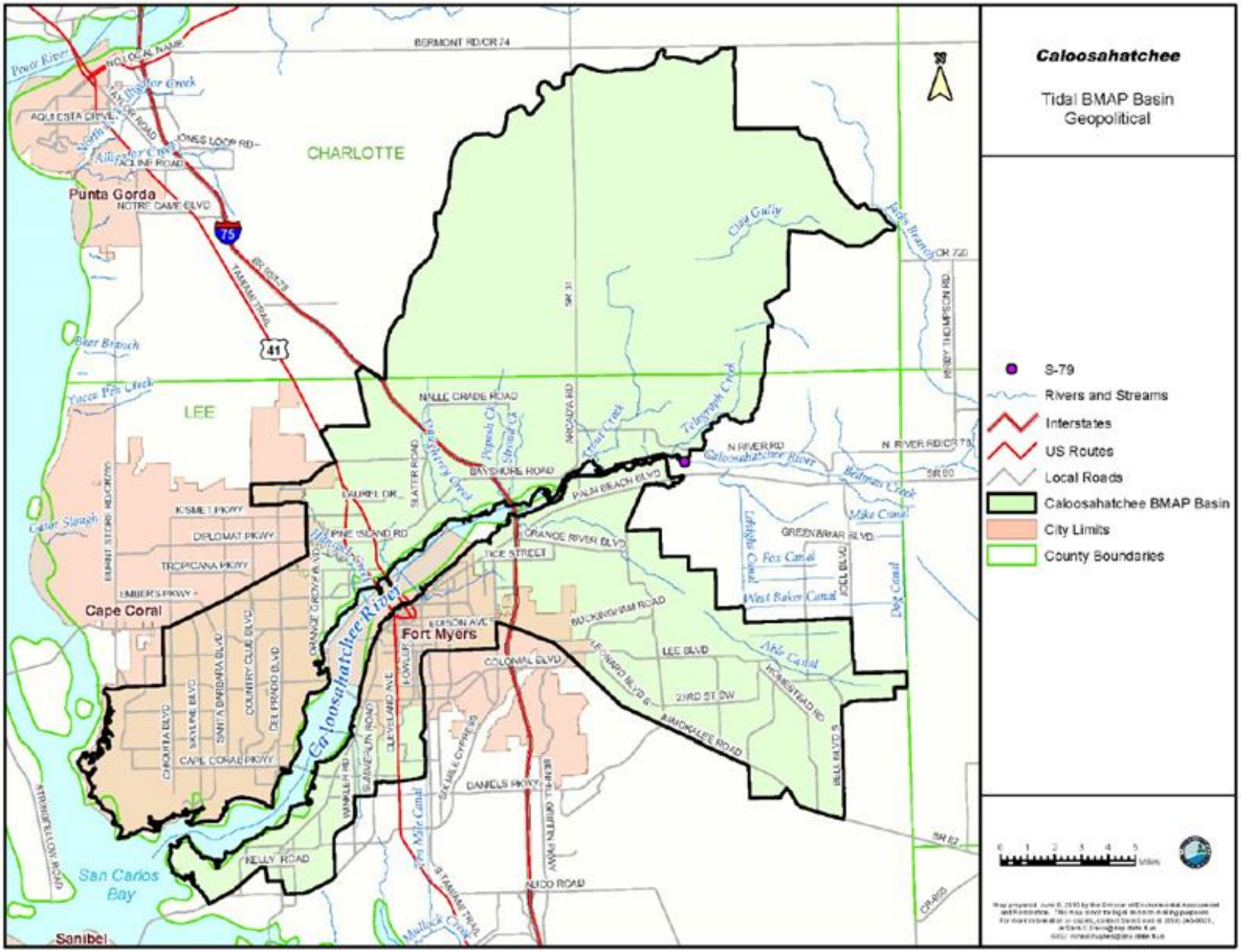


**Figure 1: Caloosahatchee Estuary Basin**

## Table 8. Reductions towards the TMDL

* Reductions to date only include TN reductions associated with projects completed as of the end of the reporting period (November 30, 2016).

| Lead Entity | TN Allocation (lbs/yr) | TN Reduction to Date* (lbs/yr) | % of Allocation Achieved |
|---|---|---|---|
| **Charlotte County** | 943 | 52 | 6 |
| **City of Cape Coral** | 103,414 | 48,567 | 47 |
| **City of Fort Myers** | 40,924 | 21,533 | 53 |
| **FDACS** | 55,597 | 31,169 | 56 |
| **FDOT** | 9,119 | 11,490 | 126 |
| **LA-MSID** | 37,736 | 23,168 | 61 |
| **Lee County** | 140,853 | 45,792 | 33 |
| **Lucaya CCD** | 132 | 0 | 0 |
| **Total** | **388,718** | **181,680** | **47** |