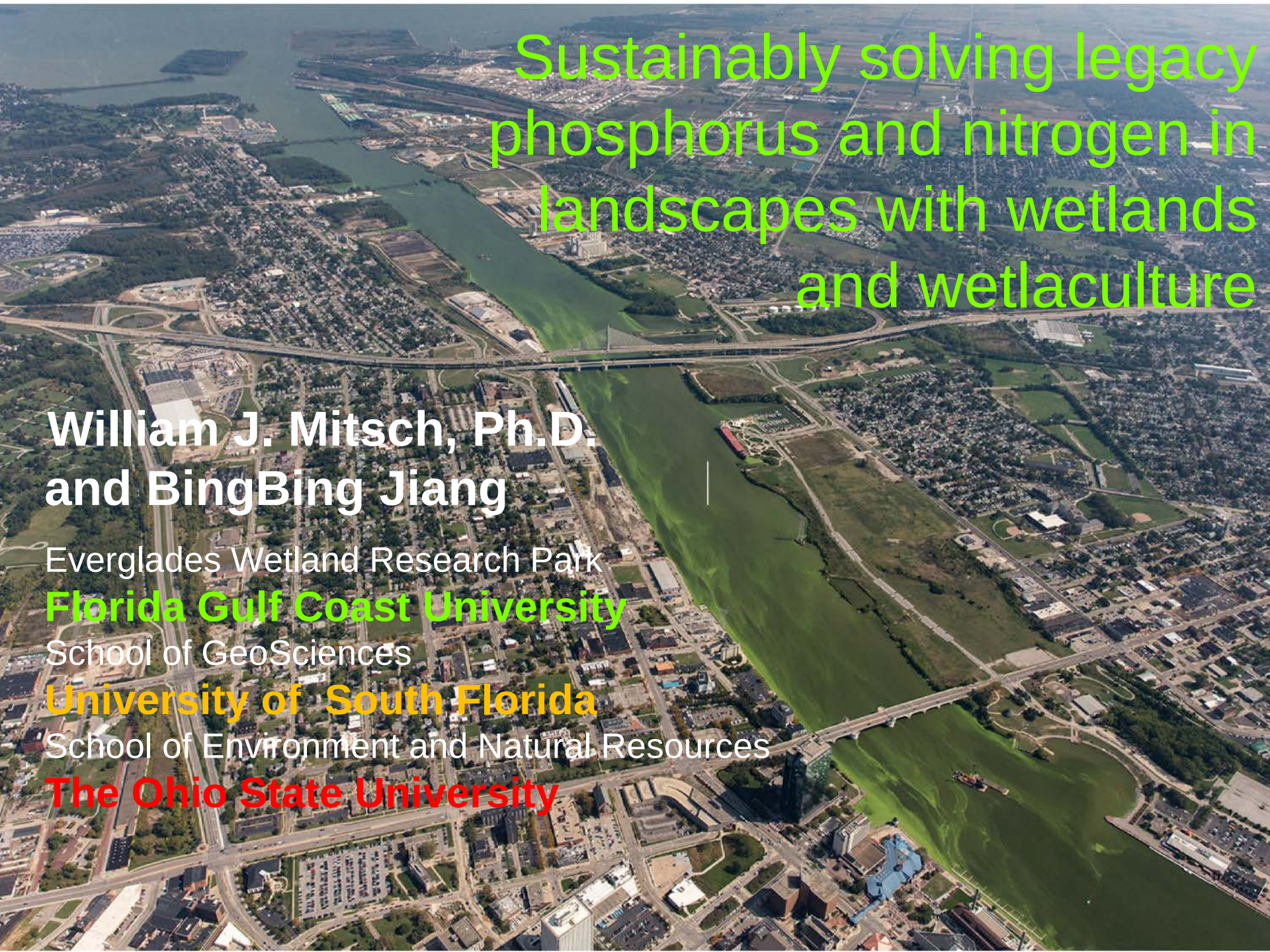


Sustainably solving legacy phosphorus and nitrogen in landscapes with wetlands and wetlaculture

William J. Mitsch, Ph.D.
and BingBing Jiang

Everglades Wetland Research Park
Florida Gulf Coast University
School of GeoSciences
University of South Florida
School of Environment and Natural Resources
The Ohio State University

Presentation Outline

- Harmful Algal Blooms in the World
- Wetland LossES in the World
- My Thesis on Reversing World's Wetland Losses
- Three Examples of Actual or Proposed Wetland Restoration/Creation to Solve Harmful Algal Blooms
- Wetlaculture
- Conclusions

More than 750 aquatic ecosystems worldwide currently suffer from degraded conditions due to urban and agricultural inflows that cause water quality degradation—often referred to as hypoxic or harmful algal blooms due to nitrogen and phosphorus

Source: World Resource Institute

Recent estimates of global wetland losses

1. The Economics of Ecosystems & Biodiversity (TEEB) study (Russi et al. 2013) suggested that the world lost half of its wetlands in the twentieth century alone.
2. Davidson (2014), in a meta-analysis determined that the world lost 53.5 percent of its wetlands “long-term” (i.e., multi-century). with higher loss rates in inland vs. coastal wetlands.
3. 87% of world’s wetlands have been lost globally in the last 300 years (Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, 2018)

Source: Mitsch and Gosselink, 2015

There are many opportunities to “ecologically engineer” a reversal the global loss of wetlands and at the same time mitigate, in a sustainable way, some of the most alarming pollution problems on our landscapes related to phosphorus and nitrogen (and carbon).

Coastal Water Pollution in Southwest Florida
Caloosahatchee River
2016

- An unseasonable amount of precipitation (>30 cm) fell on south Florida in the “dry season” in January 2016 due to extensive frontal storms caused by El Nino.

- Approximately 3.1 billion m^3 of polluted Lake Okeechobee (Lake O) water was sent down the Caloosahatchee River to the Gulf of Mexico and the St. Lucie Canal to the Atlantic Ocean in 2016, severely polluting both estuaries.

- The pumping of water to these outlets was deemed necessary because of high and unsafe Lake Okeechobee water levels, which were, in turn, due to the high rainfall events in January and back-pumping of even more water from flooded farmlands south of Lake O.

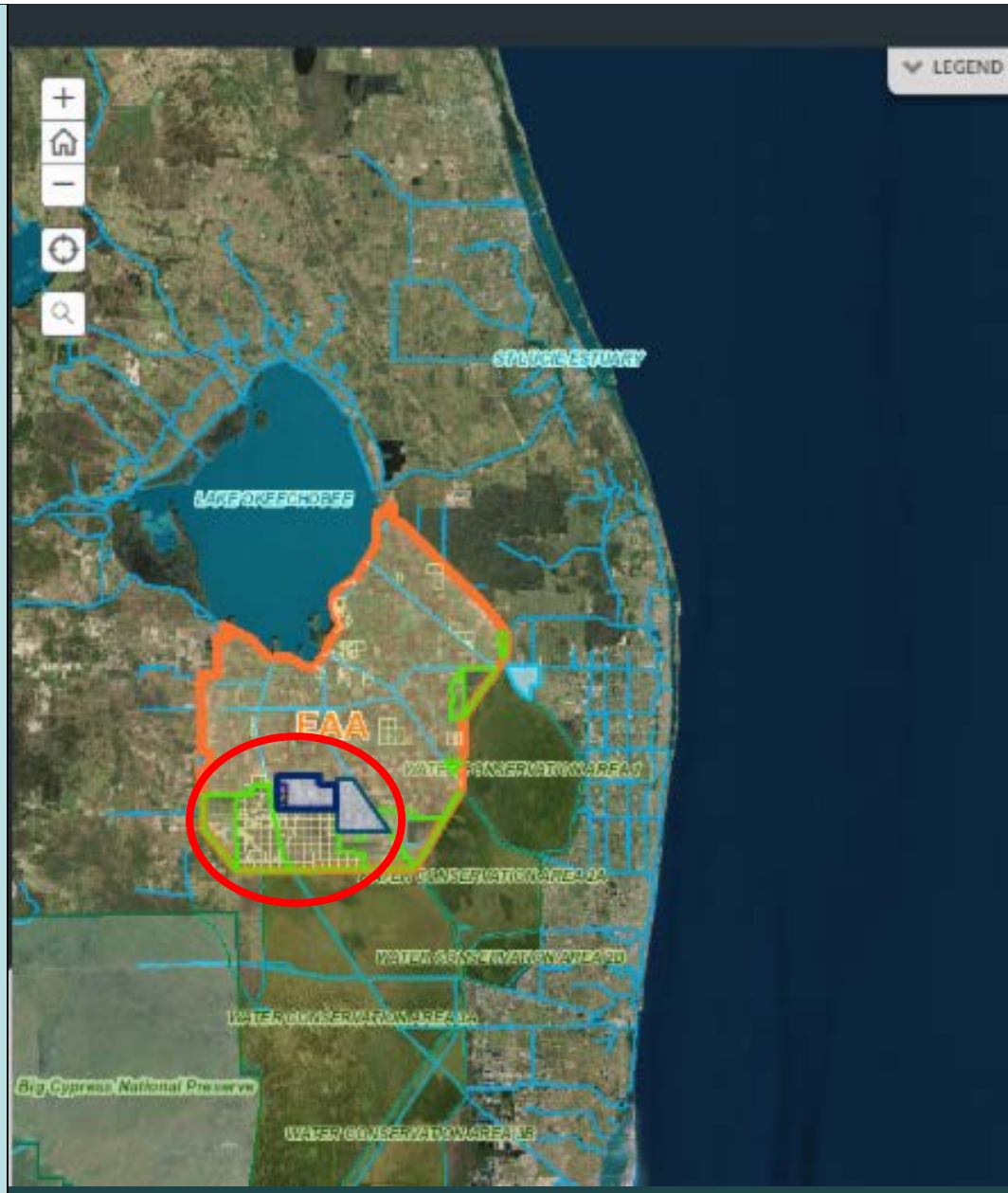
Florida governor declares state of emergency over 'guacamole-thick' algae

Published June 30, 2016 FoxNews.com

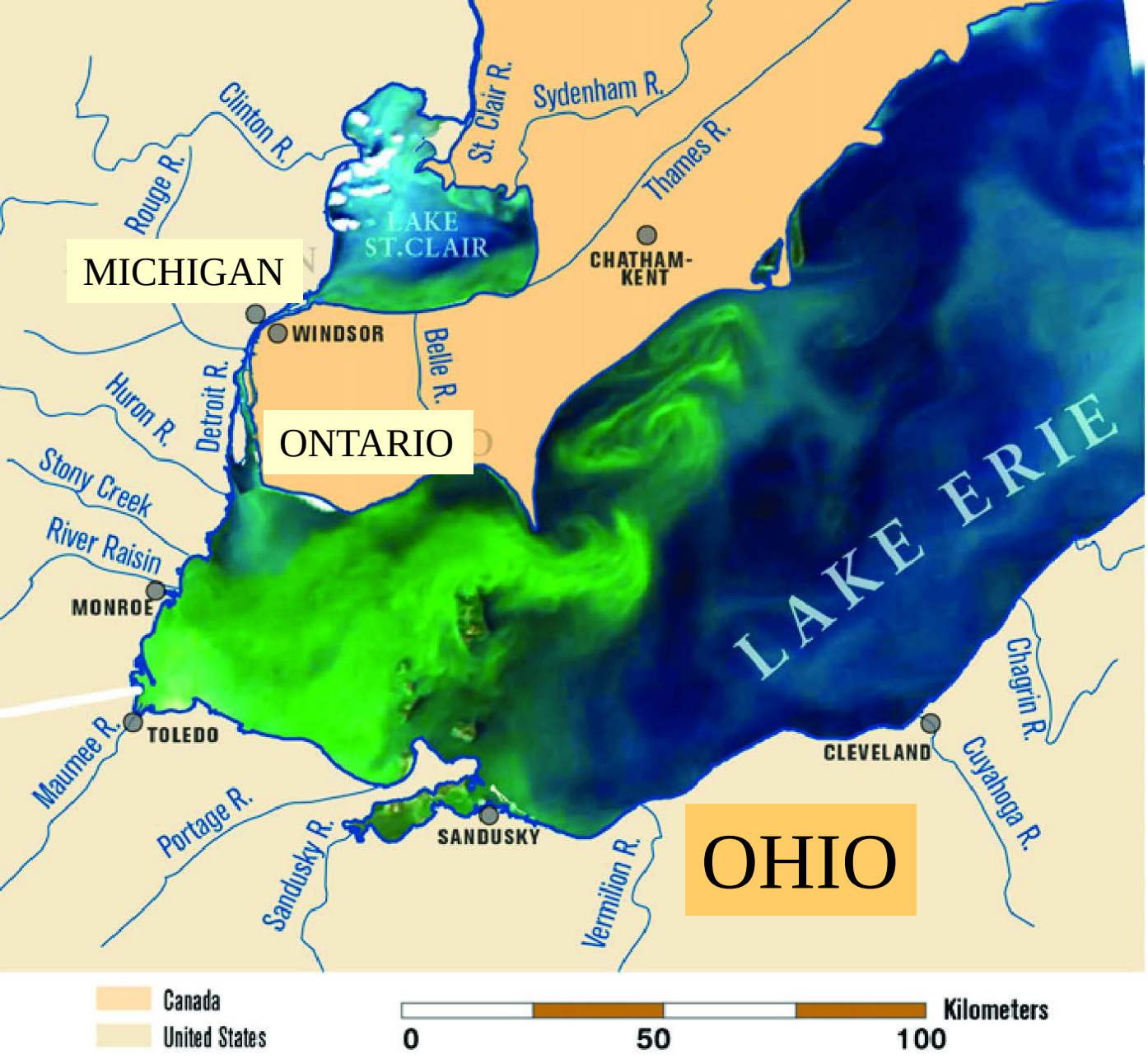

LOOK GEORGE, YOU CAN SEE THE CORRUPT & IMMORAL ENVIRONMENTAL POLICIES FROM HERE!
FLORIDA
Andy
arlette
Journal

Everglades Agricultural Area Reservoir Project

Flow south to the Everglades from Lake Okeechobee will increase by 76% from 210,000 to 370,000 acre-ft/yr. A 240,000 acre-foot reservoir (23 feet deep and 10,100 acres) and 6,550 additional acres of treatment wetlands (13% increase) are proposed.
(FL Dept of Environmental Protection letter of support to SFWMD, March 5, 2018).

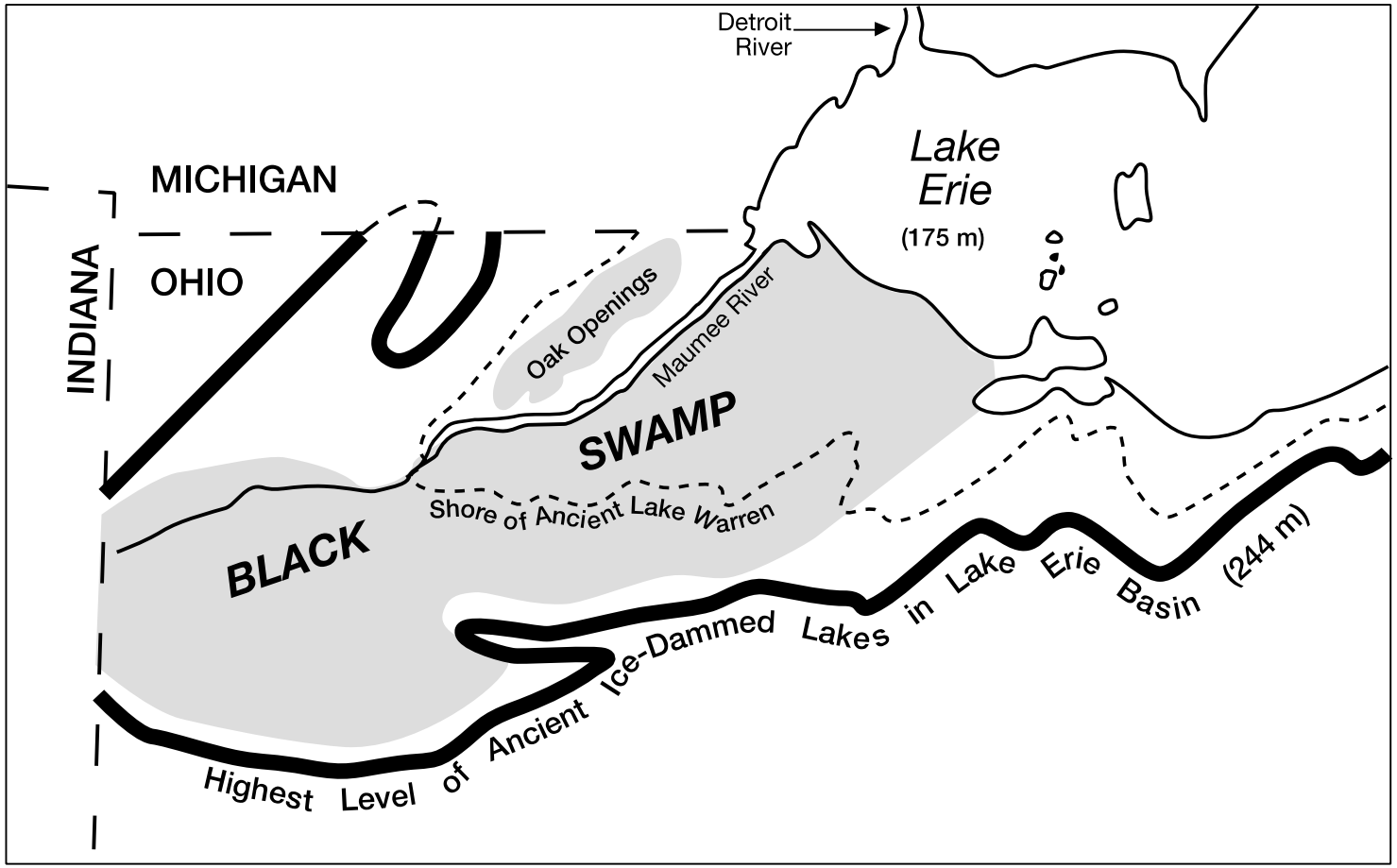


Lake Erie Algal Blooms



"Nutrient impairment continues to plague Lake Erie, impacting an $11.5 billion tourism industry"
Ohio Lake Erie Phosphorus Task Force (Nov 2013)

Satellite Image from Sept 3, 2011 of Western Lake Erie (Michalak et al. 2013) PNAS



The original **Black Swamp** was combination of marshland and forested swamps that extended about 160 km long and 40 km wide in a northeasterly direction from Indiana toward Lake Erie and covered an estimated 400,000 ha. It has been completely drained.

Learning to Love the Great Black Swamp

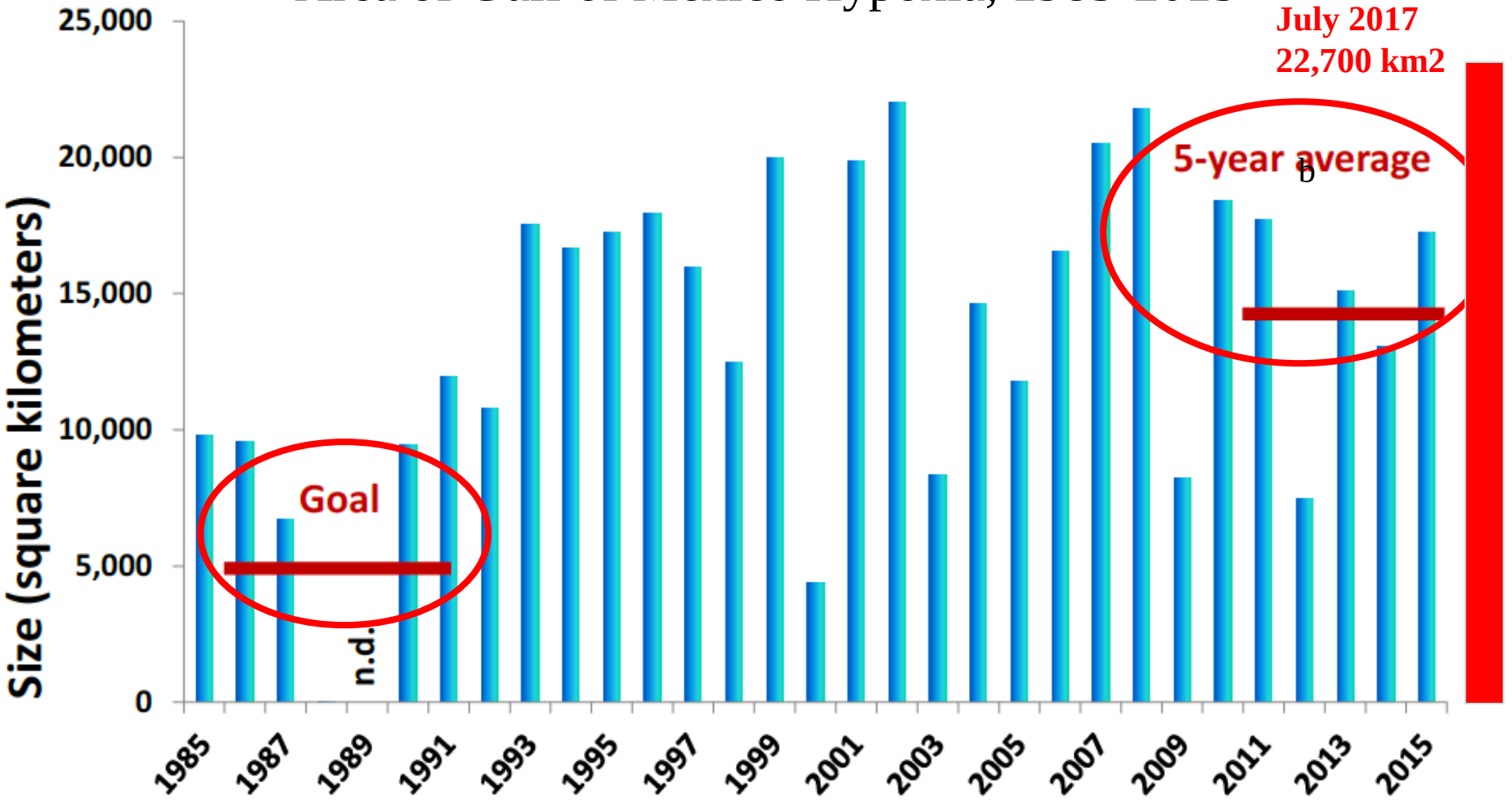
Midwestern settlers worked for generations to tame the wicked swamplands west of Lake Erie. Can they be convinced to give some back?

https://undark.org/


Let’s Make the Black Swamp Great Again!
Goll Woods—Remnant of Great Black Swamp

Mississippi-Ohio-Missouri (MOM) Basin Restoration

Area of Gulf of Mexico Hypoxia, 1985-2015



Data source: Nancy N. Rabalais, LUMCON, and R. Eugene Turner, LSU

Funding sources: NOAA Center for Sponsored Coastal Ocean Research and U.S. EPA Gulf of Mexico Program

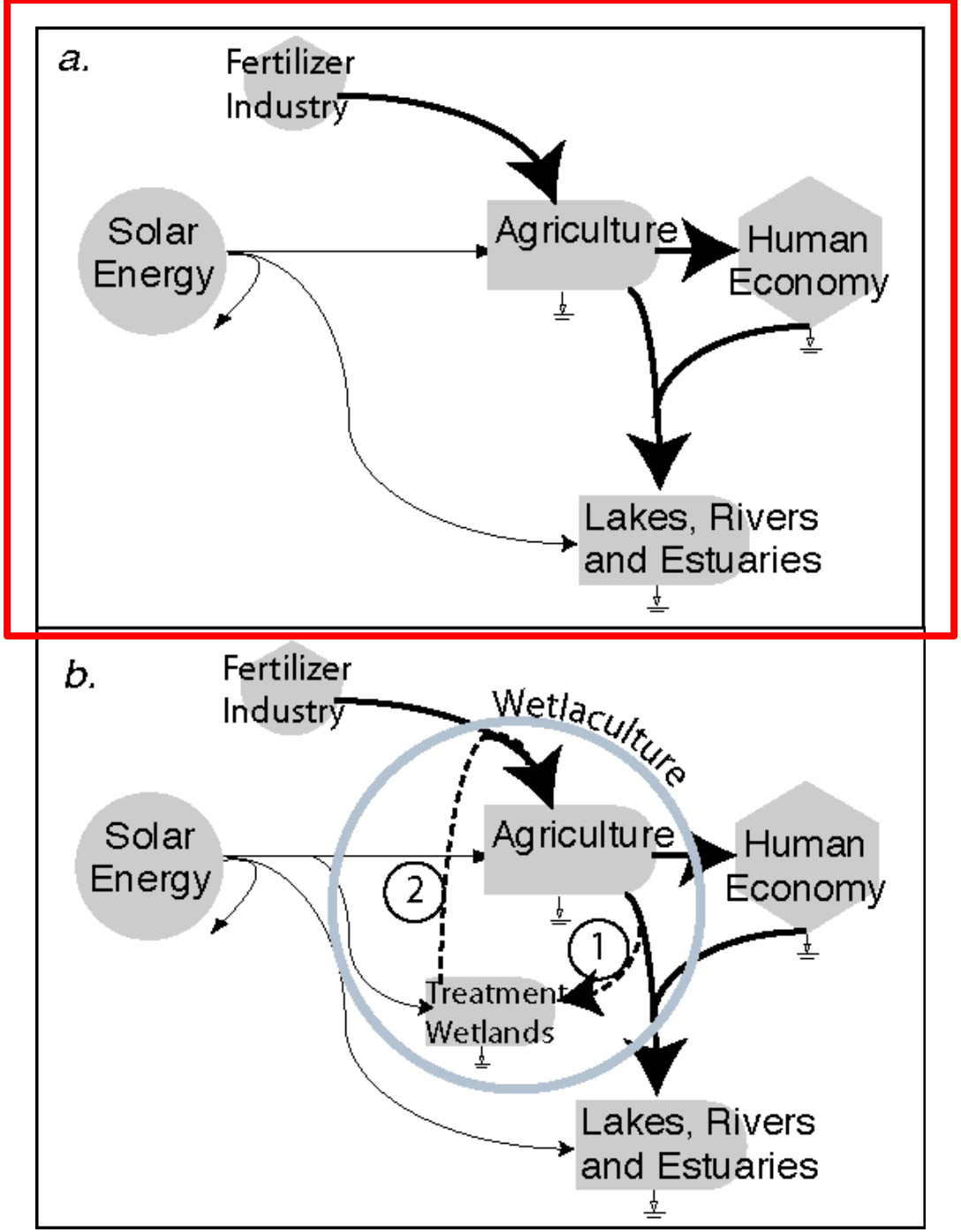
Mississippi-Ohio-Missouri (MOM) Basin Restoration

We estimated that 2 million ha of these ecosystems are needed

Our new landscape research initiative

“Wetlaculture”

= wetlands + agriculture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Fertilizer Industry
Solar Energy
Agriculture
Human Economy
Lakes, Rivers and Estuaries
b.
Fertilizer Industry
Wetlaculture
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Agriculture
Human Economy
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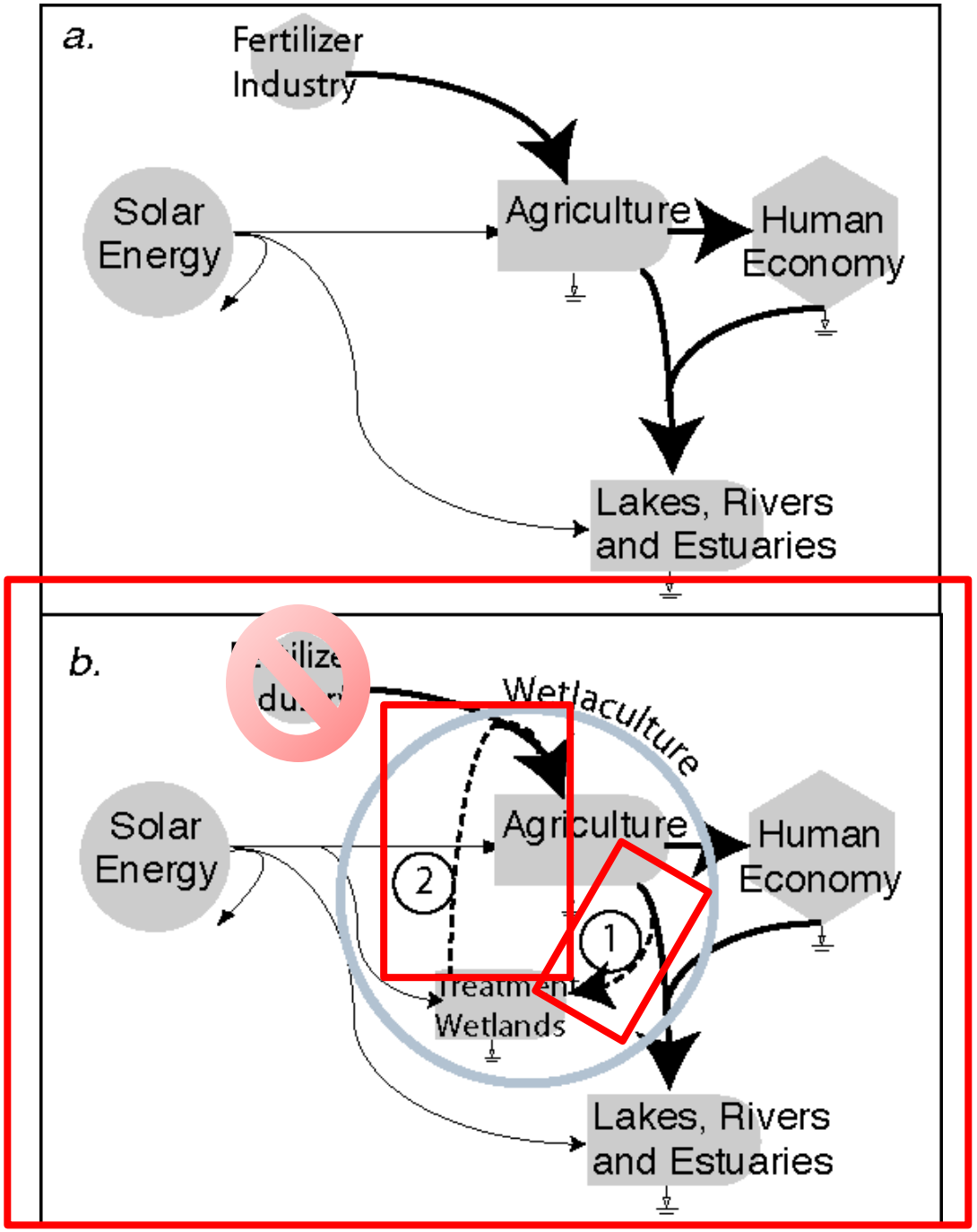
Treatment Wetlands
Lakes, Rivers and Estuaries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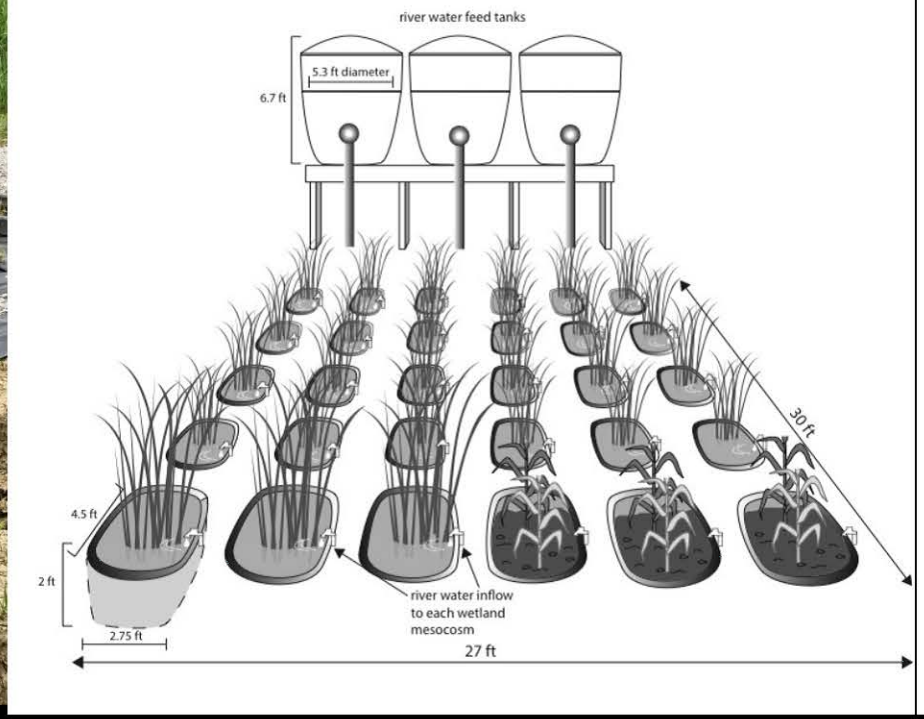
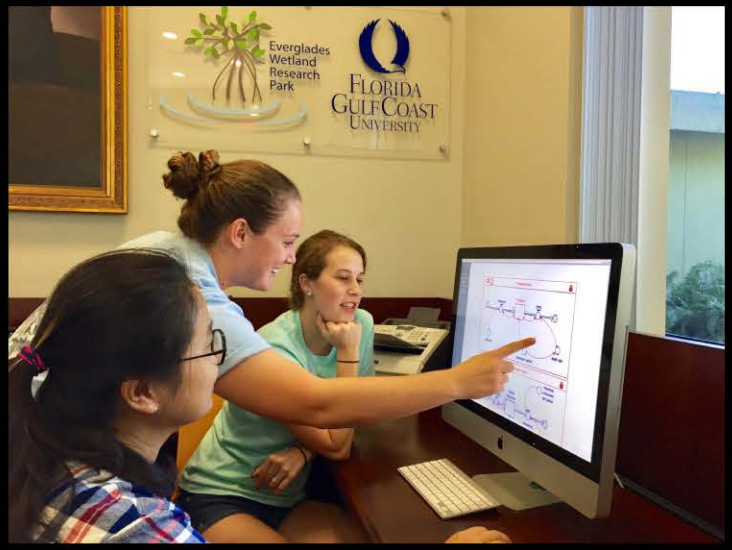
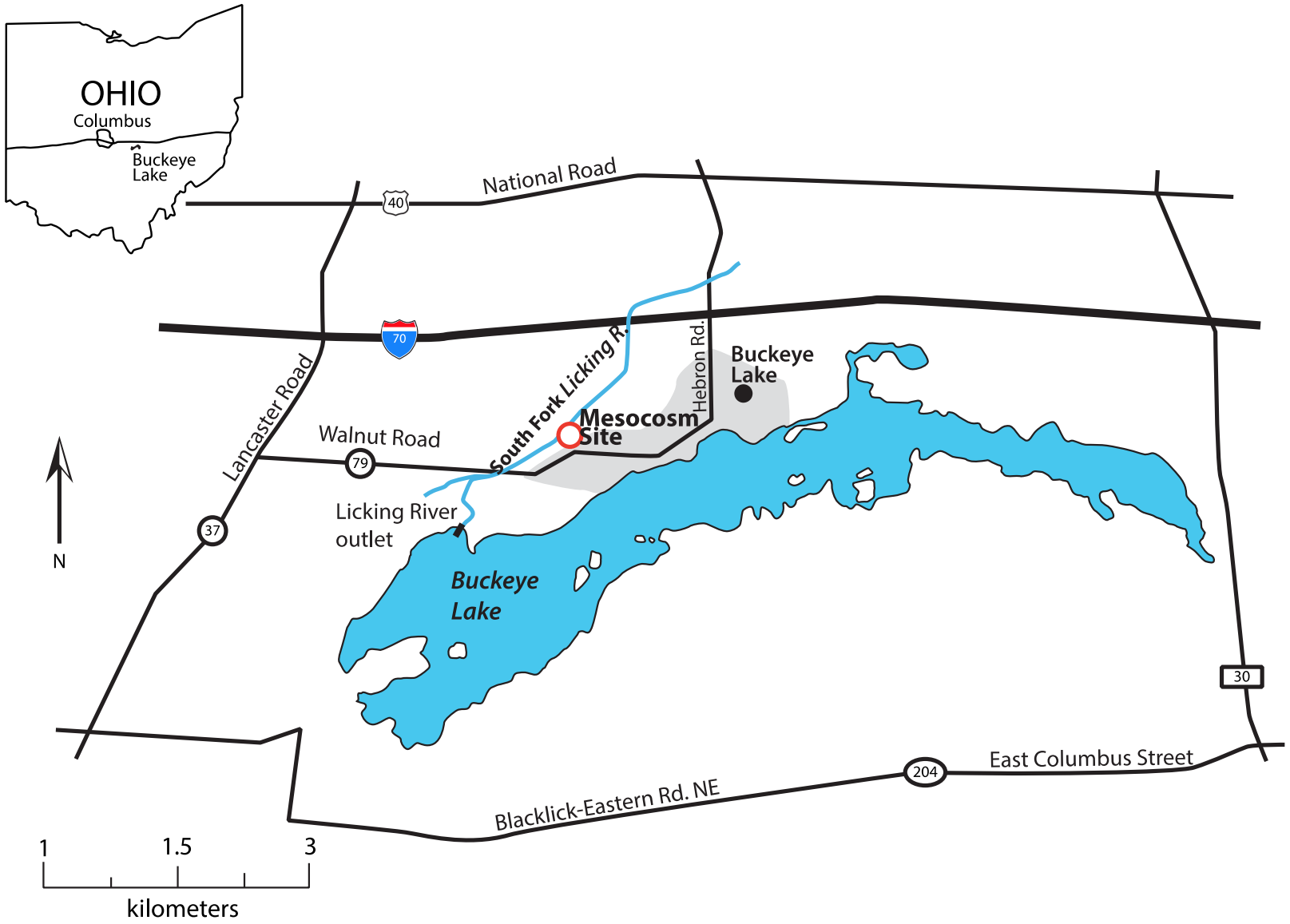

river water feed tanks
5.3 ft diameter
6.7 ft
30 ft
4.5 ft
2 ft
river water inflow
to each wetland
mesocosm
2.75 ft
27 ft


Everglades
Wetland
Research
Park
Florida
Gulf Coast
University

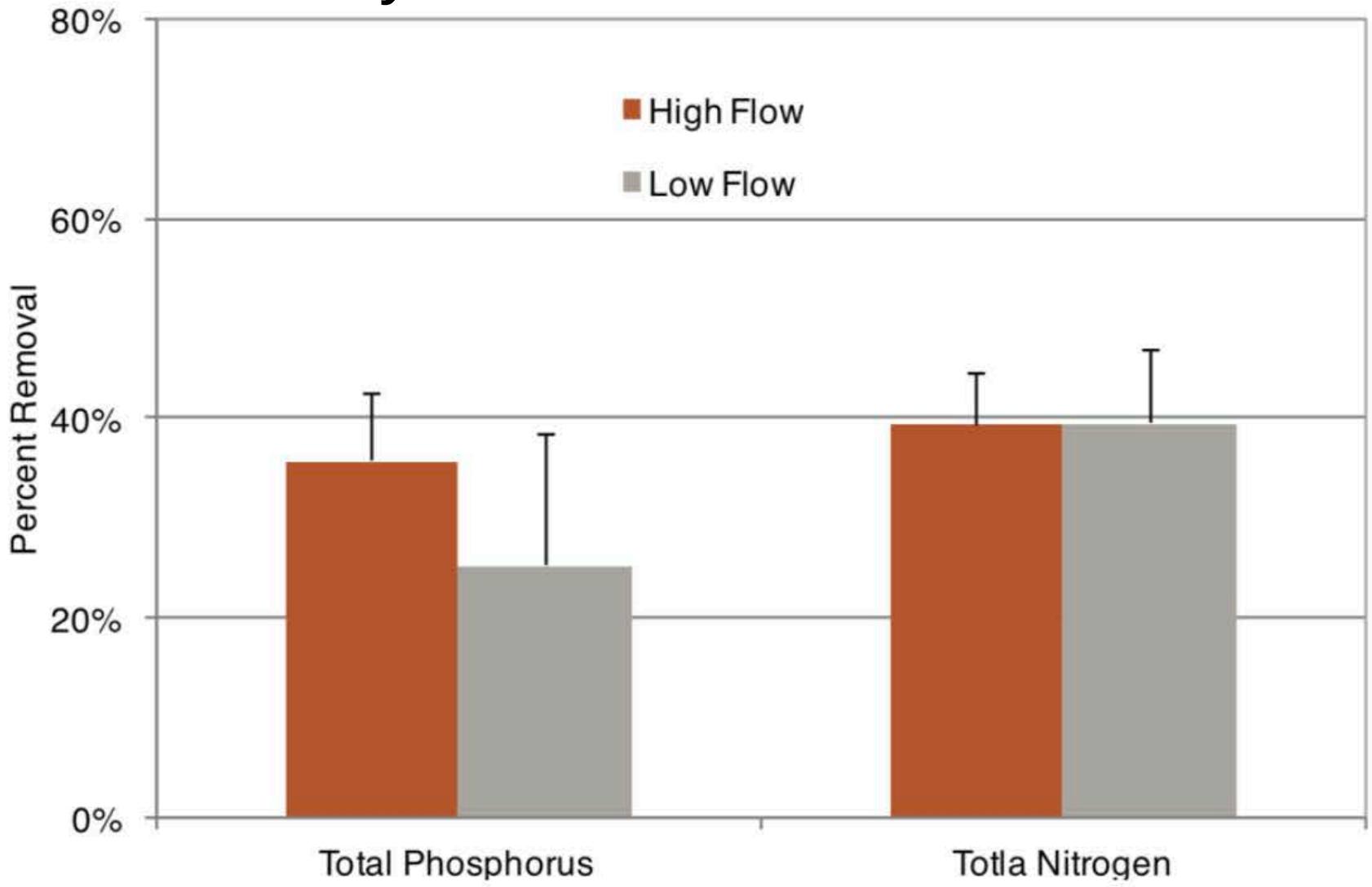

Black Swamp
Ohio
Buckeye Lake
Ohio
Atlantic Ocean
miles
0 100 200 300 400
0 320 640
kilometers
Gulf of Mexico
Freedom Park,
Florida



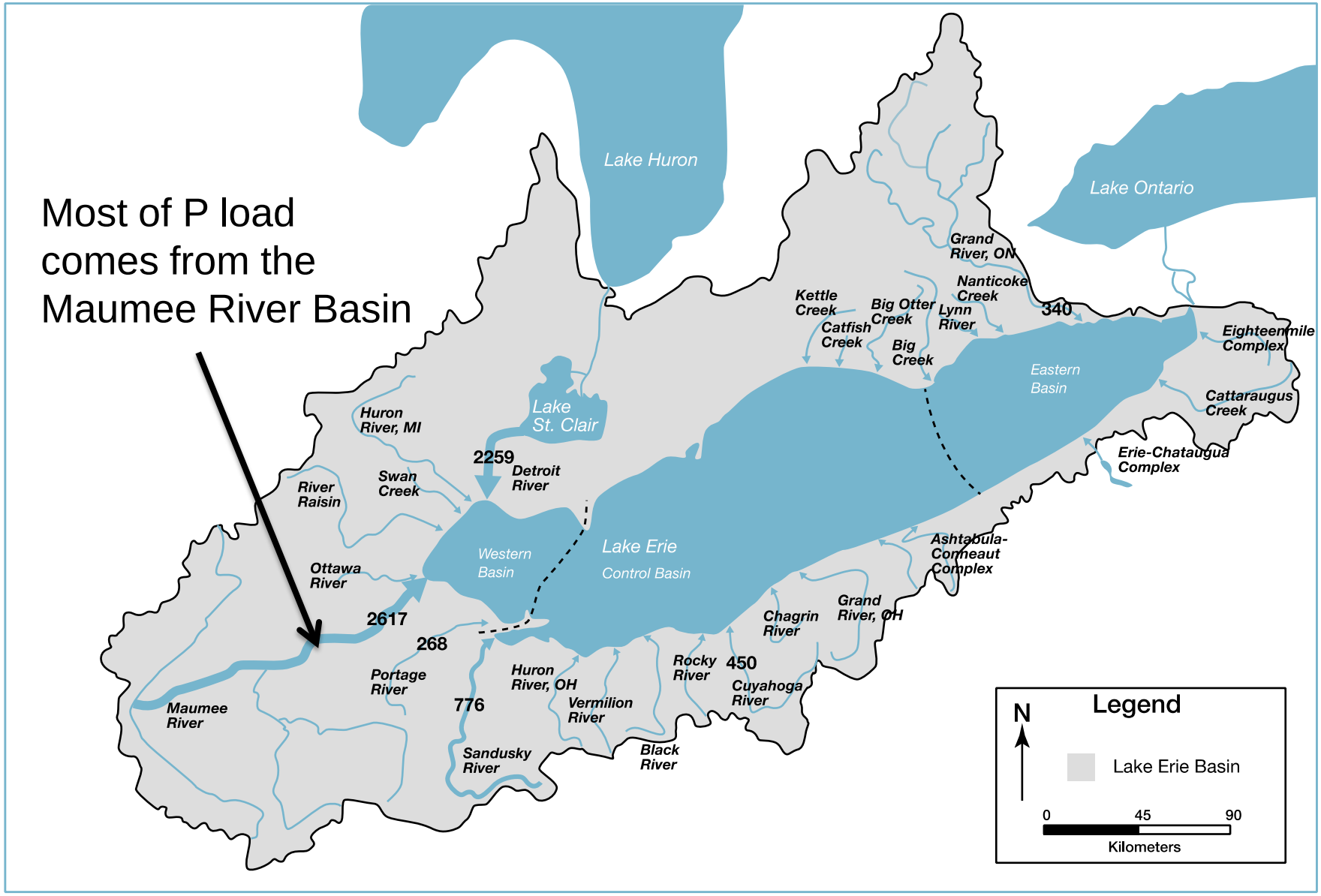
Buckeye Lake, central Ohio

Wetlaculture mesocosm compound
Buckeye Lake, central Ohio
Constructed 2016-17

Wetlaculture mesocosm compound
Buckeye Lake, central Ohio



Western Lake Erie--NW Ohio, SE Michigan, and southern Ontario



Source: Scavia et al (2017)


Drainage ditch in
Black Swamp region,
Defiance Ohio

Defiance OH Wetlaculture Mesocosm Birthday – March 21, 2018

Freedom Park Wetlaculture Mesocosm Design, Naples, Florida

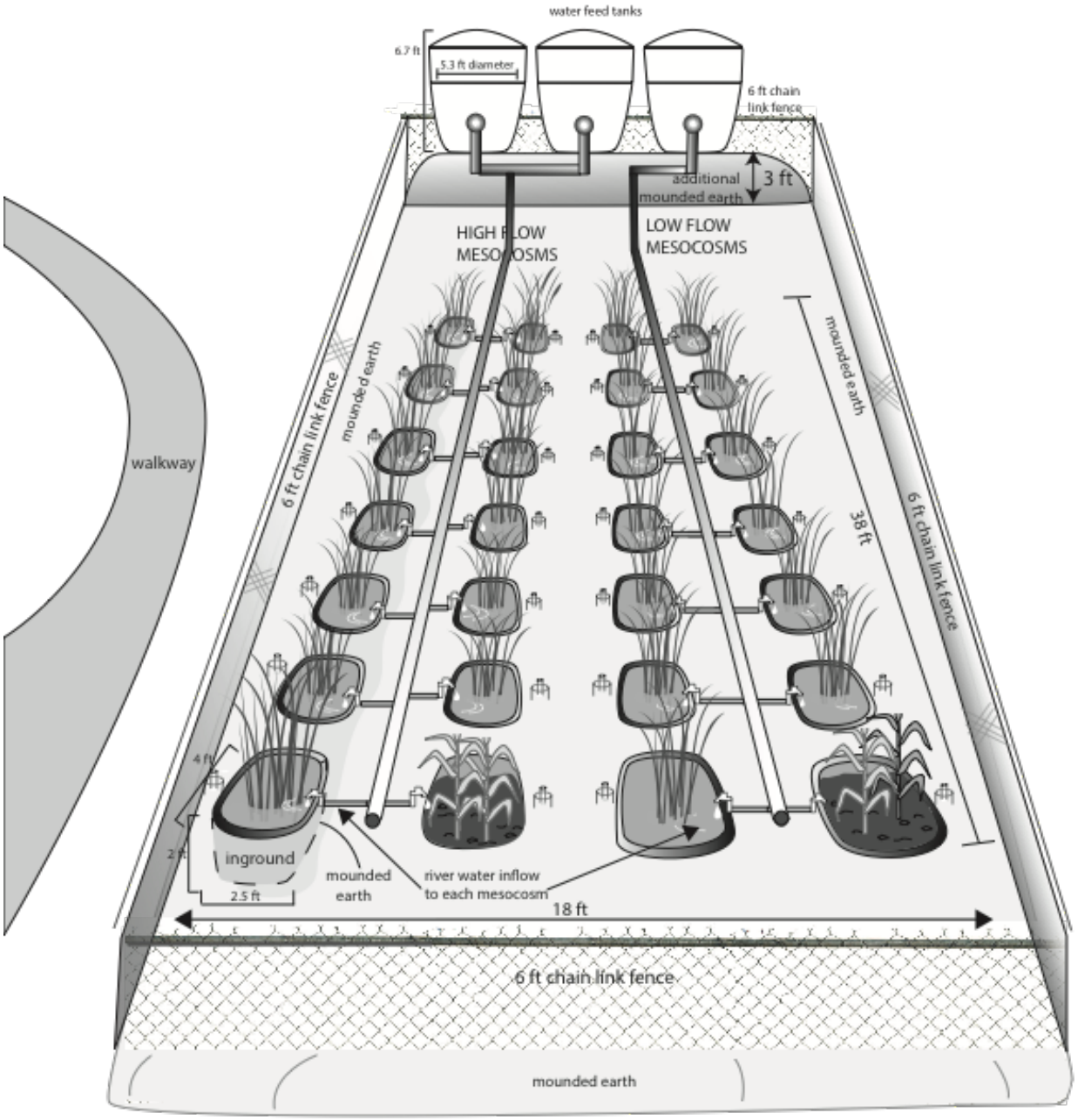
Legend

- Mesocosm Fence Area
- Water Supply Tank
- Mesocosm Tub (28)
- Mesocosm Inflow
- Mesocosm Location
- PipeAndCulvert
- FixedStageWeirs
- Channel_CL
- World Imagery
- Low Resolution 15m Imagery
- High Resolution 60cm Imagery
- High Resolution 30cm Imagery
- Citations

N W E S

40 20 0 40 Feet

Freedom Park Wetlaculture Mesocosm Design, Naples, Florida



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FIGHTING ALGAE BLOOMS

THE BLADE/AMY E. VOIGT

itsch, left, wetlands expert, and Angelica Vazquez carry a tub that will be used on the Lenhart farm in Defiance y to create miniature wetlands to study the removal of pollutants from farmland drainage and runoff.

cientist's idea to save Lake Erie: ring back Great Black Swamp

M HENRY
AFF WRITER

IANCE — The best r saving Lake Erie may a serious commitment ring 10 percent of the Great Black Swamp, ng to a scientific paper ed this month by one world's top wetlands

s 100,000 acres of the Great Black Swamp's 1 acres.

paper asserts that tak- much strategically lo- rmland out of produc- a time would itself 40 percent reduction o's phosphorus re- That's the same per- state and federal offi- e challenged Ohio to achieve by 2025.

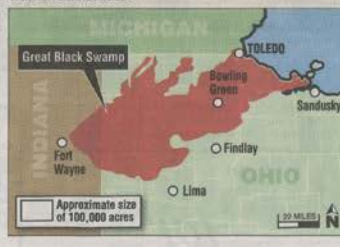
But as radical as it may seem to restore parts of the Great Black Swamp, Bill Mitsch — the highly renowned scientist pushing the idea — said he is in no way advocating a return to the horse-and-buggy era.

Mr. Mitsch told The Blade he believes portions of any farm can be taken out of production for a few years and used as a wetland without breaking apart drainage tiles, thereby allowing landowners to eventually return land they dedicate for marshes to farming again. He is suggesting drainage tiles be plugged temporarily.

See SWAMP, Page A3

GREAT BLACK SWAMP

The Great Black Swamp was 40 miles wide and 120 miles long. Its million-acre land mass was almost as large as the state of Connecticut.



Swamp

Continued from Page A1

Think of it as a real-estate "flip," Mr. Mitsch said. "We'd be flipping ecosystems," he added.

Mr. Mitsch says a more robust effort at reducing phosphorus is needed because he believes the western Lake Erie region has had only "limited" and "inconsequential" responses to the 2014 Toledo water crisis.

In his paper, he wrote how that landmark event — one in which an algal toxin deprived nearly 500,000 metro residents of safe water for almost three days — is "symptomatic that there is something very wrong with the way we are managing our landscapes around vulnerable aquatic ecosystems."

The scientist envisions a plan in which only one section of each participating farm is used as a wetland at a time. A new section ideally would be converted into a wetland each time a section is drained and put back into use for farming.

Enriched soil and rainwater flowing down area rivers, streams, and ditches could be trapped by marshes and recycled as fertilizer, he said, reducing a landowner's need to rely so heavily on manure and synthetic farm fertilizers.

Many scientists have said there is enough so-called "legacy phosphorus" deep down in soil, from decades of application, to last years.

"The whole point of this is to take phosphorus out," Mr. Mitsch said. "We need to recycle what we have."

COURTESY OF BILL MITSCH

Bill Mitsch modeled his wetlands experiment — called a mesocosm — after a similar experiment he designed in 2016 in the Buckeye Lake area in central Ohio, near Columbus.

Looking at strategies

Repeated back-and-forth flips of land-uses remains highly conceptual.

In his paper, published recently by the journal Ecological Engineering, where he also is listed as editor-in-chief, Mr. Mitsch said at least 10 years of small-scale research is needed to prove his theory before using it on a large scale.

The idea was immediately met with skepticism by Joe Cornely, Ohio Farm Bureau Federation spokesman, who called it "a pretty dramatic vision" and raised multiple questions about it. Meanwhile, he said, Ohio's agriculture industry is "concentrating on finding solutions that are both effective and practical."

Jay Martin, an OSU ecological engineering professor collaborating with Mr. Mitsch, said the the idea of se warned cautioned against putting too much faith in any one project as a "magic bullet." The fight against algae likely will require a suite of strategies, he said.

But Mr. Mitsch is no novice when it comes to wetlands.

Now the director of the Everglades Wetland Research Park at Florida Gulf Coast University, he is a professor emeritus at Ohio State University, where he worked for years and built a demonstration wetland on campus.

He also is an eminent scholar and Spreul chair for Southwest Florida Habitat Restoration at Florida Gulf Coast. He is chair of the U.S. National Ramsar Committee, which promotes America's continued commitment to a 1971 intergovernmental treaty called the Ramsar Convention on Wetlands. That treaty includes more than 160 countries. He is editor-in-chief of an Elsevier journal, Ecological Engineering, and holds courtesy and guest professor titles at the University of Florida, the University of Notre Dame, and the University of South Florida.

Mr. Mitsch has traveled from Ohio to New Orleans to the Everglades to China and to other parts of the world for wetland research. A textbook he co-wrote on wetland ecology is in its fifth edition.

On the ground

On Monday, Mr. Mitsch laid out his plans in the field for a long-term wetlands experiment — called a mesocosm — he designed for the Lenhart family farm in Defiance County. It was built to test his Great Black Swamp theory. It is modeled after a similar experiment he designed in 2016 in the Buckeye Lake area in central Ohio, near Columbus.

At both sites, about 30 large plastic tubs — each 100 gallons large — are arranged side-by-side underground into rows. Gaps are filled with soil and gravel to insulate them. The tubs are almost like individual garden beds, except they're designed to be miniwetlands that capture phosphorus-laden soil runoff and nutrient-enriched water from nearby rivers, streams, or ditches.

"These are our test tubes," Mr. Mitsch said of the tubs. "This is a test on a small scale to see if we can ramp them up."

The Great Black Swamp, formed 20,000 years ago when the last glacier retreated, spanned diagonally across much of northwest Ohio and into northeast Indiana near Fort Wayne. It was 40 miles wide and 120 miles long, encompassing a whopping 1,500 square miles — nearly enough to cover the state of Connecticut — before settlers starting draining it in the 1840s, a project that took years.

The Great Black Swamp was described in an Ohio Arts Council publication years ago as "the single most important natural feature of the presettlement landscape of northwest Ohio." The city of Perrysburg's website calls it "an oozing mass of water, mud, snakes, wolves, wildcats, biting flies, and clouds of gnats and mosquitoes."

Malarial fevers, cholera, and typhoid were not uncommon. Draining the swamp became such big business that northwest Ohio had more than 50 factories making clay tiles in 1880, according to Mr. Mitsch's paper.

The region became one of the world's most productive for farming after it was tiled and drained because the former swampland has such rich, fertile soil. Most of the work took until 1926, requiring a lot of sweat and aching muscles.

Chris Lenhart, a University of Minnesota hydrologist, is part of the family that owns the Defiance County farm where Mr. Mitsch is doing his initial Great Black Swamp research.

He said the Lenhart family has been involved in environmental projects for several years with its tree plantings and buffer strips, and that it has taken a keen interest in farming techniques that help improve water quality. The family put in a 36-acre wetland years ago to take advantage of incentives offered under the U.S. Department of Agriculture's Conservative Reserve Program, or CRP, as well as 10 acres of prairie grass and trees, he said.

The Great Black Swamp "just seems like it has to be part of the solution" to Lake Erie's chronic algae, Mr. Lenhart said.

Mr. Mitsch was in the area recently because Hurricane Irma pushed him out of Florida for a couple of weeks. He decided to spend the time setting up his newest test site.

Water samples will be collected once every two weeks by Bing Bing Jiang, a 32-year-old native of China in a PhD program at the University of South Florida. Ms. Jiang said she is making a three-year commitment to the sites as part of her studies and will have samples analyzed at a laboratory in Naples, Fla.

THE BLADE/AMY E. VOIGT

Bill Mitsch, right, discusses the Lenhart Farm experiment with Angelica Vazquez, center, and Liufeng Li. He theorizes that wetlands could catch nutrient-laden farm runoff.

LEARN ABOUT THE BLACK SWAMP

"The Great Black Swamp," an exhibit assembled by Black Swamp Conservancy, is open now through November at the National Center for Nature Photography at Secor Metropark, 10001 W. Central Ave., Berkey. The gallery is open Fridays through Sundays from 10 a.m. to 4 p.m. Admission is free.

A public reception is scheduled for 6 p.m. Oct. 13. RSVP by Oct. 9 to bsc@black-swamp.org or 419-833-1025.

Organizers said the exhibit features 35 images telling the story "of northwest Ohio's landscape and wildlife — from its pre-European settlement wild origins, to its current condition and looking onward to how the Swamp's revival might be the key to protecting our region's water supply."

She said she met Mr. Mitsch while he was in China doing wetlands research in 2012.

China's Lake Taihu is like Lake Erie in that it is chronically plagued by algae. A source of drinking water for 10 million people, it is China's third-largest lake. Some of its blooms last nine months a year. In May of 2007, in China's Jiangsu province near the city of Wuxi, a massive bloom of toxin-producing microcystis did almost the same thing that happened in western Lake Erie near Toledo seven years later: Algae there made water unsafe for 2 million people for more than a week.

Microcystis, also the dominant form of harmful algae in Lake Erie, is one of Earth's oldest living organisms at 3.5 billion years old. It has been on the rise globally the past 25 years, and some scientists say it is because of poor land use and climate change.

China is looking into the possibility of using rice paddies as artificial wetlands, Ms. Jiang said.

Pondnet Environmental, of Fairborn, Ohio, near Dayton, designed the in-flow control system for Mr. Mitsch's experiments. Tube in Defiance County and near Buckeye Lake have been equipped with devices that allow researchers to upload data and control valves remotely, Steve Fondriest, the firm's president and chief executive officer, said.

The same company designed buoys installed near the Toledo water intake, near OSU's Stone Laboratory, and other parts of western Lake Erie to help researchers monitor lake conditions as algae forms.

The cost of materials to set up each experiment is $15,000 to $20,000, Mr. Mitsch said.

"We're not going to clean the lake with that little experiment," he said. "We're going to show how it could happen."

Contact Tom Henry at thenry@theblade.com, 419-724-6079, or via Twitter @tomohenryohio.

The Columbus Dispatch

Editorial

Wednesday October 4, 2017
Posted at 12:01 AM Updated at 6:15 AM

Wetlands could fix pollution from farms

Persuading farmers to set aside productive land and restore it to swamp conditions will be an uphill slog, even for Bill Mitsch, an Ohio State University professor emeritus who is one of the world's foremost experts on wetlands and the pollution that results when they're absent. But all those who are sincere in their desire to fight the sickening, bright-green algae blooms that choke the life out of Lake Erie and other bodies of water most years should listen.

While industrial pollution and sewage contribute to the algae blooms, excess fertilizer running off of farm fields is by far the largest contributor. Mitsch believes temporarily re-establishing wetlands and returning them to cultivation after a few years can reduce the flow of phosphorus into streams by 40 percent.

Joe Cornely, spokesman for the Ohio Farm Bureau, said "I think there are a lot of other ways to go about fixing the problem that are not quite so dramatic." If so, farmers should come forward with those solutions. Ohioans haven't forgotten the super bloom of 2014 that invaded Toledo's water-intake plant and left the city without drinkable water for three days. If climate change makes the algae problem worse, as expected, people will demand radical change.

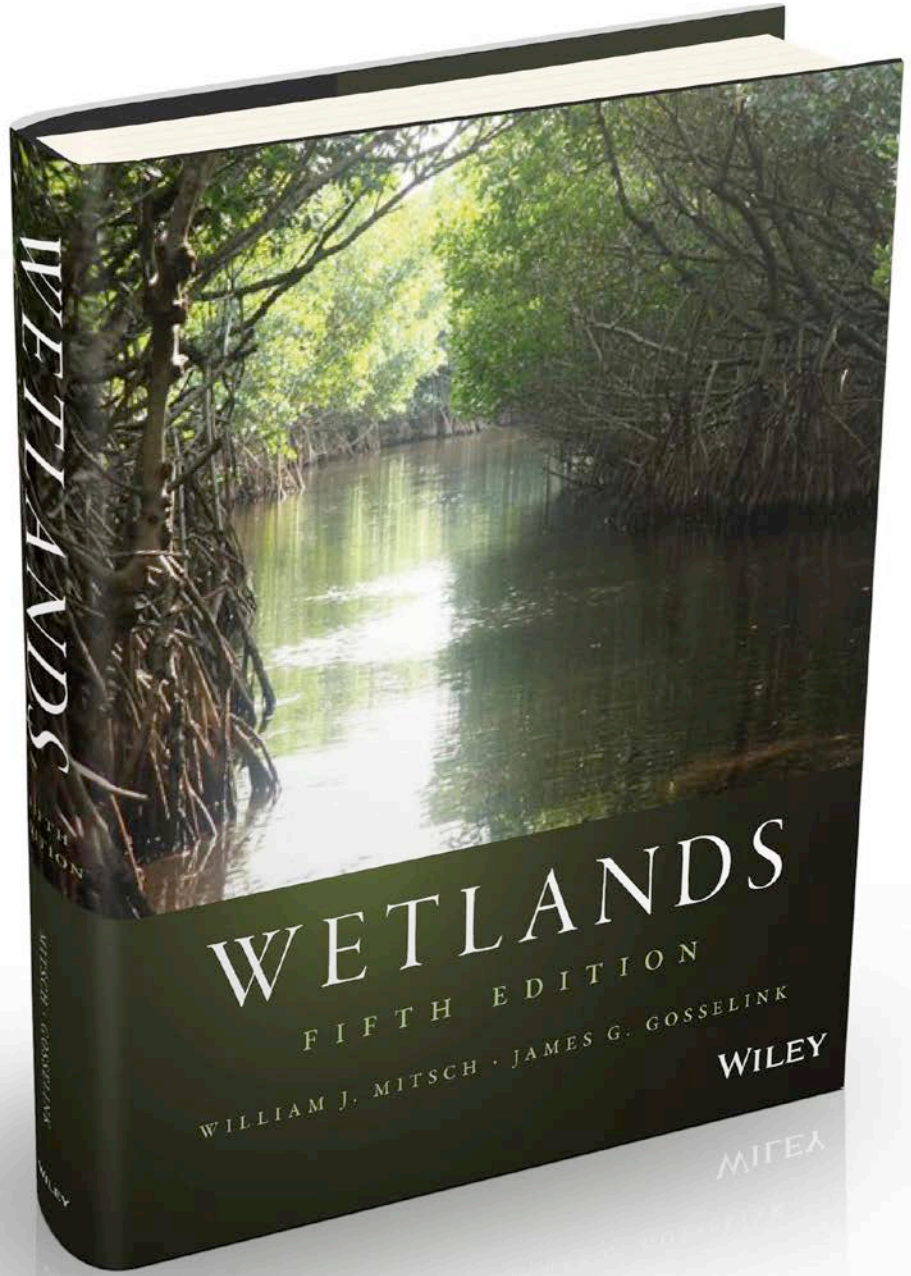
Mitsch's research project could provide a critical head start.

Conclusions

- The loss of up to half of the world's wetlands in the 20th century is a ecological disaster with major losses of important ecosystem services including flood mitigation, coastal protection, wildlife habitat, and water quality protection. We need these ecosystem services now more than ever.
- Wetlands can be designed to remove significant amounts of nitrogen and phosphorus from agricultural and stormwater runoff. Concentrations on the order of 30 ppb of total phosphorus and 1 ppm total N are reasonable expectations but lower concentrations can be achieved.
- In the Florida Everglades, the pollution of the estuaries by Lake Okeechobee water has to stop and the original north to south flow of the greater Everglades must be achieved.

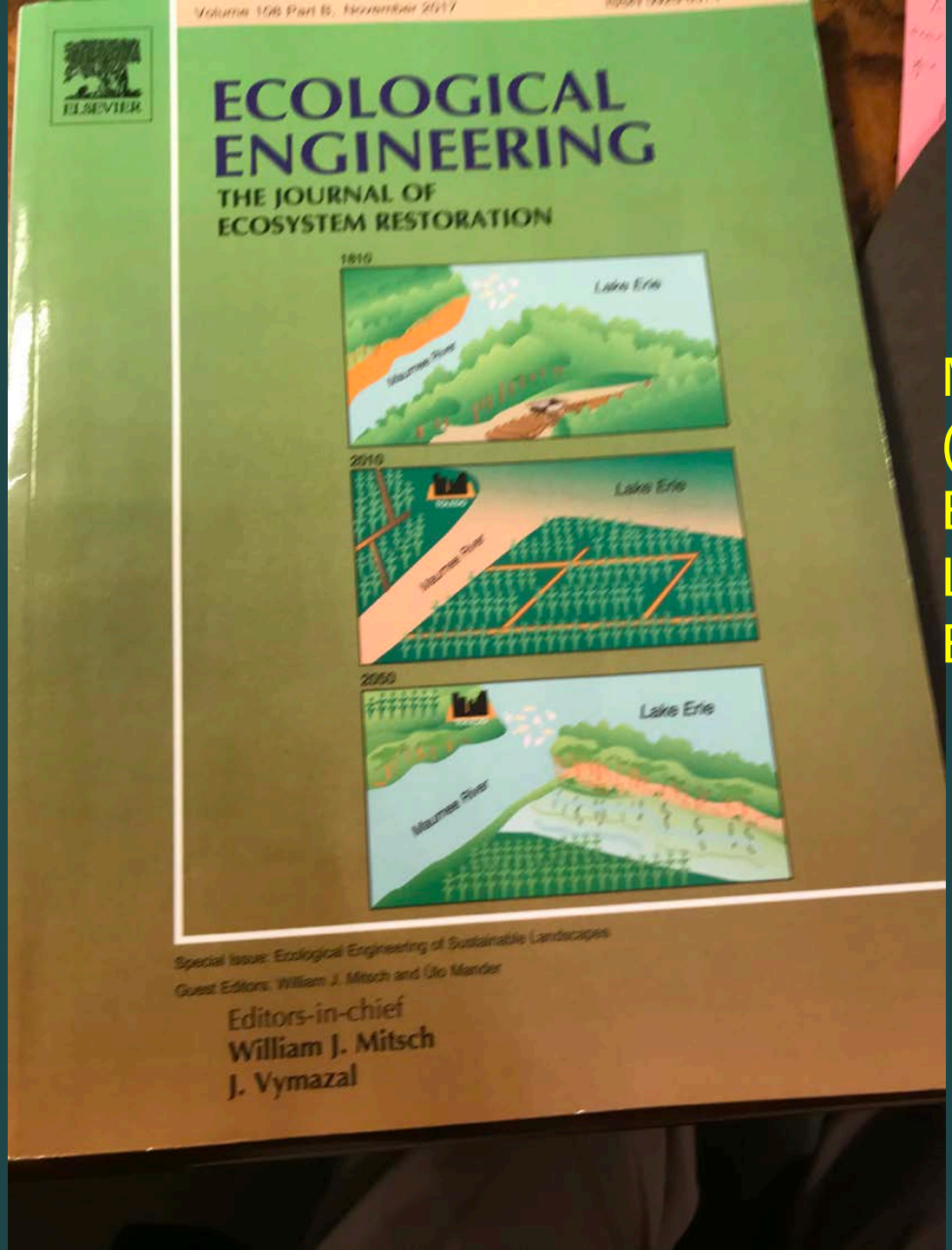
Conclusions

- To accomplish this, Florida needs to install 8 to 10 times more treatment wetlands than is currently planned with the EAA reservoir south of the Lake O to protect the downstream Florida Everglades essentially doubling the area of treatment wetlands in the EAA.
- Our *wetlaculture* approach should be tested experimentally wherever watershed management has resulted in extensive downstream harmful algal blooms.
- Wetland restoration and creation are not easy. They require attention to **Mother Nature** (self-design) and **Father Time** (these projects just take time to reach their potential).



Available on line at John Wiley and Amazon.com

Mitsch, W.J. and J.G. Gosselink. 2015. *Wetlands, 5th ed.* John Wiley & Sons, Inc., Hoboken, NJ. 744 pp.



Mitsch, W.J. and Ü Mander (eds.). 2017. Ecological Engineering of Sustainable Landscapes. Ecological Engineering 108: 351-596.


Thank you!
wmitsch@fgcu.edu
http://fgcu.edu/swamp